CHANGING FRAMES: UNDERSTANDING TECHNOLOGICAL CHANGE IN ORGANIZATIONS

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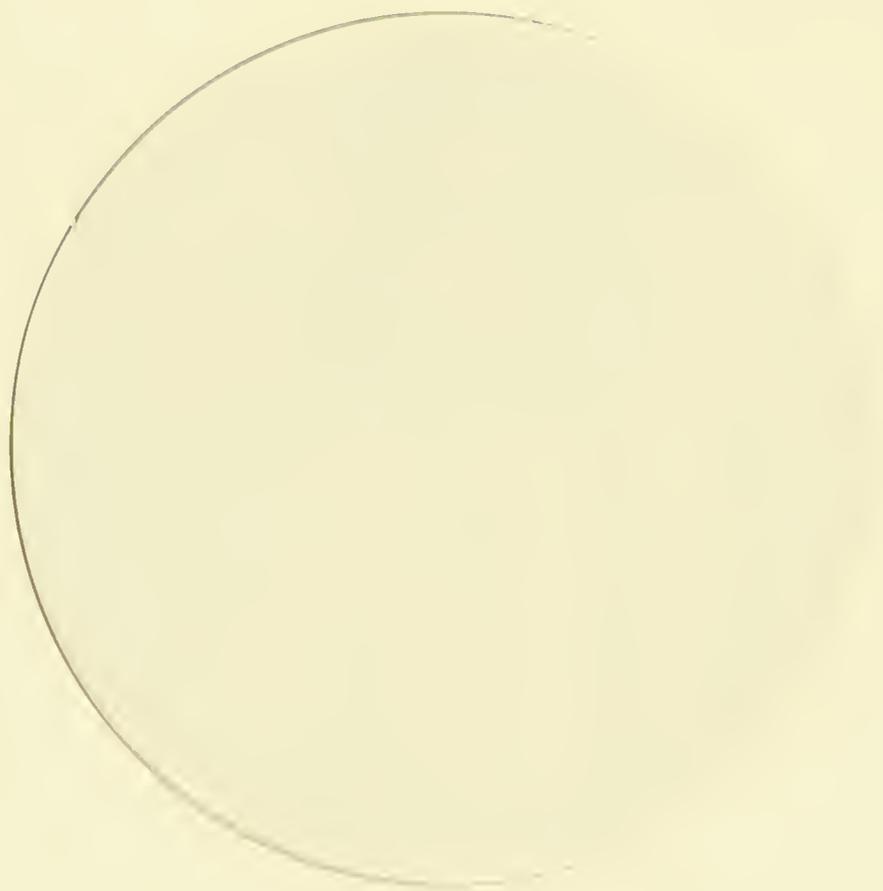Wanda J. Orlikowski

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ABSTRACT

In this paper we propose a theoretical approach to the study of technological change that is based on the premise that people act on the basis of their interpretations of the world, and in doing so they enact particular social realities and endow them with meaning. Our interest in this approach is motivated by a belief that existing studies of technological change have often overlooked the underlying assumptions, meanings, and expectations that people have about information technology. We believe that these interpretations of information technology are critical to an understanding of technological use and change as they significantly influence the way actors in the social world of computing respond to it. Further, we posit that patterns of organizational change occasioned by different types of technological interventions can be investigated through changes in interpretations over time. This framework allows for the diagnosis and understanding of intended and unintended changes around the development and use of information technology in organizations.

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With the increased deployment of information technology[1] in all aspects of organizational life, organizational change around information technology is becoming increasingly commonplace. A model of such organizational change that can provide insight and guidance to researchers and practitioners is becoming increasingly necessary. In this paper we suggest that a useful way of understanding and assessing organizational change around information technology is through examining the shared cognitive models that people have about the information technology and its role in their organization. This view is grounded in the interpretive notion that people act on the basis of the meanings that things and events have for them (Blumer 1969; Strauss 1978), and that understanding what and how such meanings are created, used, reinforced, and changed provides a vehicle for explaining people's actions. People's cognitive models are particularly salient sense-making devices during processes of organizational change (Bartunek and Moch, 1987; Isabella 1990; Starbuck 1989; Van Maanen and Schein 1979). Hence, by tracking changes in the meanings people ascribe to information technology over time, we can investigate the processes and outcomes of organizational change around information technology. Further, because this approach examines change as experienced and interpreted by different organizational players, unintended as well as intended changes around new technology can be studied.

Information technology has often been thought of as an organizational intervention, designed to bring about desired changes (Bostrom and Heinen 1977; Kling and Scacchi, 1982; Markus, 1983). Past research into organizational change around technology has focused on changes in structure (Barley 1986, 1990; Carter, 1984; Kling and Iacono, 1984), information processing and communication patterns (Daft and Lengel, 1986; Huber, 1990; Sproull and Kiesler, 1986; Zmud, Lind and Young, 1990), power relations (Markus, 1983; Newman and Rosenberg, 1985; Pettigrew, 1973; Robey, Farrow, and Franz, 1989), the nature of work and skills (Buchanan and Boddy, 1983; Kraut, Koch and Dumais, 1988; Zuboff, 1988), and culture (Hirschheim and Newman, 1991). While diverse in nature and rich in findings, we believe that existing approaches of technological change have largely downplayed the underlying assumptions, expectations, and meanings that people have about information technology.

In this paper we develop a framework of technological change that is grounded in the shared meanings people have about information technology. By looking at patterns of these shared meanings over time around a specific organizational issue--the development and use of information technology--we are seeking a balance between context sensitivity and theoretical replicability. Further, our framework allows for the examination of intended as well as unintended changes around the development and use of information technology in organizations.

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[1] By information technology we mean any form of computer-based information system (including mainframe as well as microcomputer applications).

In the following section we develop our concepts by drawing on research in social cognition and organizational change. Next we discuss the framework of technological change that integrates cognitive models and types of change, positing certain relationships and outcomes around the processes of technological change. Finally we discuss the implications of this framework for research and practice.

THEORETICAL GROUNDING

Based on research in social cognition and organizational change, our framework employs two theoretical constructs, technological frames and types of technological change, respectively.

Technological Frames

A major premise of the research on social cognitions is that people act on the basis of their interpretations of the world (Bartlett, 1932; Bartunek and Moch, 1987; Bougon, Weick, and Binkhorst 1977; Goffman, 1974; Neisser, 1976; Porac and Thomas 1990; Schutz, 1970). For individuals in organizations, these interpretations are organized and shaped by implicit guidelines that constitute people's cognitive models or frames (Moch and Bartunek, 1990; Weick 1979b).

To the extent that information technology constitutes a core aspect of organizations, aspects of members' cognitive models will concern information technology. In a recent paper (Orlikowski and Gash, 1991) we defined this cognitive aspect as members' *technological frames,* and described how these shape the way information technology is designed and used in organizations. Technological frames are the set of assumptions, meanings, knowledge, and expectations that people use to understand the nature and role of technology in organizations (Pinch and Bijker, 1987). For example, they may include understandings of what the organization's core business is, and how information technology should be deployed therein. Because technologists are often the most intimately involved in the building of technological artifacts it is frequently their assumptions, meanings, knowledge, and expectations that most influence the design and construction of the technology (Noble, 1986; Orlikowski, forthcoming).

The assumptions and meanings that constitute people's technological frames are often shared by similar experiences, occupational training, socialization, group membership, functional specialization, and organizational roles (Rousseau, 1978; Shibutani, 1962; Schein, 1985; Spybey, 1984; Strauss, 1978; Van Maanen and Schein, 1979). In particular, because individuals work in what Brown and Duguid (1991) refer to as "communities of practice," technological frames reflect the shared understanding of a technology by members of a social group. In the social world of computing we can single out three distinct social groups which are implicated in technological use or change within organizations--managers, technologists, and users (Kling and Gerson, 1978). *Managers* or organizational decision makers control resources, set organizational objectives and

strategy, and hence influence the direction of change. *Technologists*--either internal or external systems developers--design, construct, install, and maintain the information technology to be used in the organization. *Users* employ the information technology in their daily tasks to perform production work for the organization. We posit that each of these three groups will have distinctive technological frames representing that group's particular experience, interaction, and understanding of the information technology. With respect to the development of information technologies there is clear empirical support for the notion of multiple interpretations of underlying system features, purposes, and design options (Bostrom and Heinen 1977; Lucas, 1974; Markus, 1983; Pettigrew, 1973). Diverse understandings of the nature and limits of technology, actors' intentions, expectations, knowledge, and experiences, and the availability of organizational resources (expertise, time, money, etc.) may easily create (at least temporarily) alternative conceptualizations of the artifact to be designed.

In this paper we focus on commonalities of frames within each group and differences in frames across groups. Past research has shown that different groups in organizations will perceive interventions differently. For example, changes in human resource policies were perceived differently by managers who created the policies and employees who were users of the policies (Kossek, 1990). We recognize that the subset of assumptions, meanings, and knowledge that we have labeled technological frames cannot easily be distinguished from the matrix of assumptions and knowledge that individuals have about their work, social relations, career orientation, etc. Nevertheless, we believe it is useful--analytically at least--to examine technological change by investigating those assumptions, meanings, and knowledge that concern information technology.

Through an examination of the literature on organizational change and information technology, we have identified seven sets of dimensions that may constitute the core dimensions of technological frames across managers, technologists, and users (see figure 1 for a definition of these dimensions and an initial set of components). These dimensions are an initial attempt to elicit and articulate people's interpretations of information technology, and are not intended to be exhaustive or complete. In particular, they are expected to vary by context and over time:

> *Philosophy towards technology* is concerned with both individuals' own philosophy as well as their perception of their organization's stance towards information technology. For example, we expect people to hold fairly general, implicit assumptions about technology that it is helpful, enabling, and empowering, or deskilling, disruptive, and controlling (Giuliano 1985; Noble, 1986; Winner 1986).

> *Issues around initiation* concern the knowledge, expectations, and experiences that individuals have about the initiation of a specific information technology, including background to and motivation for the proposal, experiences with past information technology, nature and scope of the proposed information technology (Ginzberg 1981; Perrow, 1983). For example, people's experiences of mainframe computers in the seventies may have led to their expectations that such computers are expensive, cumbersome, inflexible, and not "user friendly."

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Figure 1: DIMENSIONS OF TECHNOLOGICAL FRAMES

DIMENSION	DEFINITION	COMPONENTS
1. Philosophy towards technology	Beliefs and assumptions about technology and information technology in general, as held by self and perceptions of organizations' philosophy	Personal philosophy Organizational philosophy
2. Issues around Initiation	Knowledge and experiences of the initiation stage of a specific technology, including background, participants, feasibility assessment, and perceptions of the technology's objectives, utility, and importance.	Rationale/History Costs/Benefits Decision process Managerial Support
3. Issues around Implementation	Knowledge and experiences of the implementation process of a specific technology, including background, participants, stages, design issues, support from users, managers, technologists, and others.	Involvement Barriers/Facilitators Cost/Scope/Timeframe Training Managerial Support
4. Issues around Use	Knowledge and experiences of the use of a specific technology, including frequency and discretion of use, level of customization, satisfaction, technical support, maintenance requirements, and expectations and experiences about the technology's criticality, ease of use, usefulness, quality, reliability, integrity, and availability.	Customization Maintenance Technology attributes
5. Criteria of success	Beliefs about how the success of a specific technology is being or should be assessed, and which particular criteria and measures are or should be be used. Assessment of how a specific technology is meeting these criteria.	Criteria Measures Experiences
6. Impact	Expectations or experiences about the impact of a specific technology on the strategy, structure, culture, and way of doing business, as well as how a specific technology should or has/will change jobs, tasks, autonomy, control mechanisms, skills/knowledge, responsibility, social relations, status, workload and stress.	Organization-wide effects Task-level effects Individual effects
7. Relations with other players in the computing social world	Expectations and experiences about the frequency and extent of interaction with other players about IT, the nature of the interaction including the role played in this relationship, and perceptions of attitude towards and understanding of technology	Managers (senior, middle) Technologists Users Third parties (consultants, vendors, etc.)

Issues around implementation include knowledge, expectations, and experiences that individuals have about the design, development, and installation of a specific information technology, including background to and history of the implementation process, the timeframe and stages of the implementation process, the amount, level, and quality of training, and perceptions of implementation issues, barriers, and facilitators (Ginzberg 1981; Markus 1983; Markus and Pfeffer, 1983; Robey, Farrow and Franz 1989).

Issues around use deal with knowledge, expectations, and experiences that individuals have about the use of a specific information technology, including frequency and discretion of use, level of customization, satisfaction, technical and maintenance support, and perceptions of the information technology's cost, size, complexity, quality, and usefulness (Weick, 1990).

Criteria of success include the ways in which individuals evaluate a specific information technology, that is, their assumptions about how the success of a specific information technology is or should be assessed, and which criteria and measures are or should be utilized. For example, we might expect managers to focus on return on investment or productivity as measures of technological success, ignoring specific and local issues of task mediation. Technologists, on the other hand, may concentrate on the technical capabilities of the information technology, measuring success in terms of run-time, defect rate, or the complexity and elegance of the program code. Contrary to both these views, users may care about how the information technology helps them accomplish their work, emphasizing such dimensions as usefulness, ease of use, and quality of information.

Impact deals with the expectations and experiences individuals have about the effect a specific information technology has or will have on an organization's structure, culture, way of doing business, workflow, nature of work, skills, control mechanisms, social relations, social status, workload and stress (Markus 1983; Zuboff, 1988).

Relations with other players in the computing social world focuses on the relationships and interactions that individuals have with actors in other social groups around information technology. This dimension encompasses the three key groups already identified--managers, users and technologists--and may also include third party players such as vendors, consultants, customers, and government regulators.

We have suggested that groups will have different interpretations and hence frames about information technology. We define the notion of *congruence* in technological frames as referring to frames that are aligned on assumptions, meanings, expectations, and knowledge. By aligned, we do not mean identical, but rather falling within a certain range on a continuum. That is, while there will always likely be a difference in amount and detail of knowledge about information technology across frames, we are interested in differences in kind not degree. Whether or not different groups within a particular organization have incongruent technological frames at a point in time is an empirical question. However, when technological change is initiated in organizations it is reasonable to expect that technological frames will likely be modified. During this cognitive change, frames may shift differently across groups, potentially resulting in frame incongruence.

We adopt a process-oriented perspective to examine how frames are created, used, and how they may shift over time by drawing on structuration theory (Giddens, 1984). In processes of organizational structuring, organizational members draw on shared frames to accomplish their action, and thereby reinforce (or change) the social and technological structures of an organization (Barley, 1986; Giddens, 1984; Ranson, Hinings, and Greenwood, 1980; Macintosh and Scapens, 1990; Weick 1990). Likewise, organizational members draw on shared technological frames to design or use information technology, thereby reinforcing (or changing) not only the structural properties of the organization but also their own technological frames.

Our notion of technological frames attempts to capture both the historical and the contextual nature of change. Under relatively stable organizational conditions, technological frames will largely be taken for granted. By drawing on these technological frames to guide their action around technology, individuals will reaffirm the validity of those frames and hence reinforce a particular interpretation and use of information technology (Orlikowski, forthcoming). In less stable organizational conditions where new and different technologies are introduced, established technological frames will likely be challenged and potentially changed (Pettigrew, 1987).

When a change in technological frames is attempted, assumptions, meanings and knowledge of information technology may change inconsistently, or not at all, due to institutional inertia (Kling and Iacono, 1989), conflict (Robey, Farrow, and Franz, 1989) resistance (Markus, 1983), or misinterpretation by certain actors of the nature of change. Whether established frames will persist, whether they will change incongruently, or whether new frames will in fact emerge depends on the nature of the change intended, the criticality of the technology to the organization, and the relative power of the various groups negotiating the change in meanings around the technology. To more specifically articulate the process of change in frames and their likely outcomes, we need a better understanding of different types of change.

Types of Technological Change

Organizational researchers have for some time been concerned with identifying and discriminating among different types of organizational change (Armenakis, 1988; Golembiewski, Billingsley, and Yeager, 1976; Meyerson and Martin, 1987; Miller and Friesen, 1984; Nadler, 1988; Watzlawick, Weakland, and Fisch, 1974). Pioneered by Lewin (1951), the study of broad-based, paradigmatic change has emerged over time into the field of study sometimes referred to as organizational transformation (Kilmann and Covin, 1988; Porras and Silvers, 1991). The different perspectives in this area focus attention on different aspects of the change process, such as the environment, structure, strategy, or culture. Because their perspective is based on shared frames, we find the typology offered by Jean Bartunek and Michael Moch (Bartunek and Moch, 1987;

Moch and Bartunek, 1990) to be particularly useful for our purposes.[2] Bartunek and Moch (1987) suggest that organizational interventions can be understood in terms of one of three types of organizational change processes:

First order change reinforces existing frames and processes by incrementally modifying current assumptions, meanings, knowledge, and processes. It is an organizational change that occurs within an established mode of operating By presuming the utility of established frames, first order change tacitly serves to reinforce present interpretations and the existing configuration of interests and interest groups (Bartunek and Moch, 1987).

Second order change involves a shift to radically different frames and processes, with the shift reflecting a replacement of the status quo. Much of the organizational transformation literature has focused on this kind of discontinuous change (Kimberly and Quinn, 1984; Tushman and Romanelli 1985; Levy, 1986; Hinings and Greenwood, 1988; Moch and Bartunek, 1990; Porras and Silvers, 1991). Such radical shifts require extensive reorientation of people's frames to facilitate the organization's shift "from one way of understanding significant aspects of itself to another" (Moch and Bartunek, 1990:12). To accomplish this not only changes in frames, but also evaluation criteria, formal roles, structures, and norms may be needed to reinforce the change. A particular risk of radical change noted by Ackerman (1986:5) is that "Once a new state is announced there is a risk that people will assume that when finally implemented, it will cure all ills and the organization will not have to go through the change again. Unless the need to stay adaptable is communicated clearly, people tend to fixate on achieving the "end" state and then lock into it."

Third order change is less an actual organizational change as the creation of a capability to change. The attempt is to avoid locking in to a paradigmatic state that may lose validity over time. Such change builds a capacity for individuals to regularly reflect on their existing frames, processes, and interactions, and to change them if needed. Morgan (1986:78) notes "Under changing circumstances it is important that elements of organization be able to question the appropriateness of what they are doing and to modify their action to take account of new situations." Third order change does not imply that organizations must change continuously, but it requires that individuals believe change to be an ongoing reality and hence that they need to be regularly revisit their conceptual and material structures, and be open to alternative ones. Systems--human, organizational, and technological--need mechanisms that allow awareness of and reflection on the limits of assumptions, mechanisms that monitor and question taken-for-granted assumptions, and capabilities that recognize when particular assumptions, meanings, knowledge, expectations, and actions are appropriate and when they are not. Organizational change theorists

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[2] Interested readers are referred to Gersick (1991), Levy (1986), Meyerson and Martin (1987), Porras and Silvers (1991), and Sheldon (1980) for reviews of other typologies of organizational change.

have noted that future organizations must develop a self-diagnostic capacity to be aware of the perspectives from which they are operating. That is, they should become "self-designing" or "continuously improving" via frequent, critical examination of key assumptions, processes, and structural decisions (Argyris and Schon, 1978; Hedberg, Nystrom and Starbuck 1976; Schein, 1989). For example, the so-called "learning organization" continually seeks to more appropriately fit the present environment and to anticipate and create desired futures (Porras and Silvers, 1991; Senge 1990). The total quality movement may also be seen as an attempt to increase the self-diagnostic capacity of organizations.

We must emphasize that the three orders of change do not imply a sequence or a logical progression of development, they merely outline the range of different changes that organizations may undertake. Which type of technological change is more appropriate for a particular organization is a function of environmental conditions, organizational and technological characteristics, and the intentions of key players. While examining intentions around technological change, we recognize that outcomes of technological development and use also reflect factors beyond strategic choice (Noble, 1986; Orlikowski, forthcoming; Winner, 1986). In general, the literature on the organizational impact of information technologies has considered unintended changes as random error or interesting side notes to the main event. Recently, however, some researchers have begun to focus specifically on the unanticipated, often subtle changes in organizational structures and social relationships that follow technological implementations (Barley 1986; Gash, 1987; Kraut et al., 1988; Orlikowski 1989, 1991; Pettigrew, 1987; Zuboff, 1988).

Using the notion of frames and types of change, we suggest that one way of indexing or understanding technological change is in terms of shifts in the technological frames of managers, technologists, and users over time. Comparison of frames across groups over time reveals the nature of change that particular groups have experienced as well as the areas and extent of incongruence around new information technology. These analyses can identify sources of conflict among groups involved in the change, barriers facilitators to technological change, as well as the intended and unintended outcomes of the change process.

FRAMES, CHANGE, AND INFORMATION TECHNOLOGY

This typology uses technological frames to identify three archetypal outcomes of technological change: aligned intended, partial intended, and unintended changes. While numerous other outcomes of technological change are possible, we believe that most such outcomes can be expressed in terms of the three archetypal types (Greenwood and Hinings, 1988).

By *aligned intended change* we mean changes for which a dominant group, often management, has an intended purpose and there is common understanding, agreement, and commitment to that particular change direction and outcome across the groups of managers,

technologists, and users. These include discrete, smaller, task-based changes that together constitute a general direction of movement from one state to another. Put another way, aligned intended change is agreement among groups about the direction and nature of a particular planned change (encompassing possibly smaller changes), its implementation and outcomes. Typically in the aligned intended change process, managers convey their intentions to technologists who develop or modify the technological artifact according to these intentions which are clearly communicated to and accepted by the users. All three groups modify their technological frames in accordance with the change in the artifact and concomitant change in work practices.

In contrast, partial intended and unintended changes do not demonstrate the above-mentioned quality of shared agreement and common vision. That is, the groups' frames are not aligned, or only minimally. Partial intended and unintended changes differ on the dimension of intentionality, or the degree to which an actor or group has consciously planned the change.

Partial intended change indicates that only some of the groups' technological frames have shifted as a result of the technological change. A variety of scenarios is possible. The common theme among them is that at least one group does not accept the intended change. Its members' frames do not shift as expected during the intervention period, and they retain their pre-intervention assumptions and understandings of information technology. We believe that a large part of the difficulties around technological change are associated with difficulties in shifting technological frames. Frames are "habits of the mind" and are often well entrenched and taken-for-granted. Changing them requires overcoming inertia that tends to accrue in established and embedded habits. Whether through the weight of old thinking habits, political or personal concerns, lack of incentives, inadequate training, or simply insufficient exposure to the idea, members of a group do not see or accept the idea of different ways of using information technology in the workplace. In the sections below on each order of technological change, we describe scenarios that illustrate some possible outcomes when various groups are "out of synch" with the others because they remain fixed in their "pre-intervention" frames, while others have shifted their frames.

Unintended change occurs when one or more group does not resist change but experiences the change differently from the other groups. That is, one or more group buys into a different vision of the change than that intended. Where first or second order change is being attempted, participants may perceive and experience unintended change that differs from intended change on a range of organizational dimensions, such as workflow, decision-making authority, social relations, nature of tasks, and so on. While we would expect managers to be less likely to experience unintended changes, there may be significant differences between upper and lower level managers.

It is clear that a large number of permutations of the three archetypal outcomes are possible. For example, consider the case where managers intend second order change, users only perceive these as minor modifications to their current work, and technologists develop a radical information

technology that is different from that intended by the managers (e.g., they embed more decision-making authority in the interface thus passing power down to the users). This is partial intended change (the users) along with some unintended change (the technologists). Clearly we could make even finer distinctions within groups but we are limiting our discussion to more clear-cut cases for exposition purposes. Once the concepts developed here (group frames, orders of change, notion of congruence or alignment) have been found to have utility, then finer distinctions can be made in later applications of the framework.

With technological frames of three key groups of actors as the starting point and a structuring process over time, we can sketch the outlines of a process of technological change. We make the assumption (a simplistic one--but necessary at this early stage of model development) that at the starting point the technological frames of the three key groups are aligned--that is, congruent at least in terms of the core dimensions. We represent this starting position in the column labeled "Pre-Intervention Frames" of figure 2. We now trace the process of technological change in terms of changes in technological frames for each of the three types of change discussed above.

First Order Technological Change

Implementors of intended first order technological change do not wish to radically alter the way of understanding or doing business, but rather to improve established operations through, for example, increasing productivity, efficiency, throughput, the handling of transactions, or decreasing costs (Scott Morton and Rockart, 1984). Automation of existing tasks and processes creates information systems that reflect and hence retain and reaffirm the organizational status quo. This results in incremental changes in current practices and relationships that do not require radically different assumptions, processes, or structures. Classic examples of first order information technology changes are the early transaction processing systems built in the sixties, such as payroll systems and large accounts receivable systems, whose primary goal was to streamline high volume, highly routine paper processing work. First order change is not limited to transaction processing systems, however. Initial versions of electronic spreadsheets were developed simply to automate analysts' tedious manual calculations, not to transform their work.

Aligned Intended Change

In this change, the technological frames of all three groups have shifted to reflect a common understanding of the incremental technological change usually through targeted communication and training. The second column of figure 2a shows this parallel shift of all the groups' frames around the new information technology. The groups use these altered technological frames to drive their subsequent actions around the information technology, institutionalizing and reinforcing the incremental changes in procedures, routines, and work practices.

Figure 2: ARCHETYPAL OUTCOMES:
INTENDED TECHNOLOGICAL CHANGE

Pre-Intervention Frames

Post Intervention Frames

a: Aligned Intended Technological Change

b: Partial Intended Technological Change

c: Unintended Technological Change

Managers

Technologists

Users
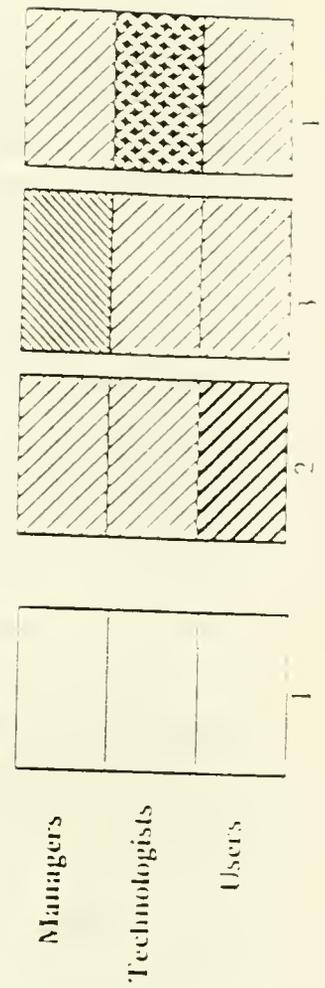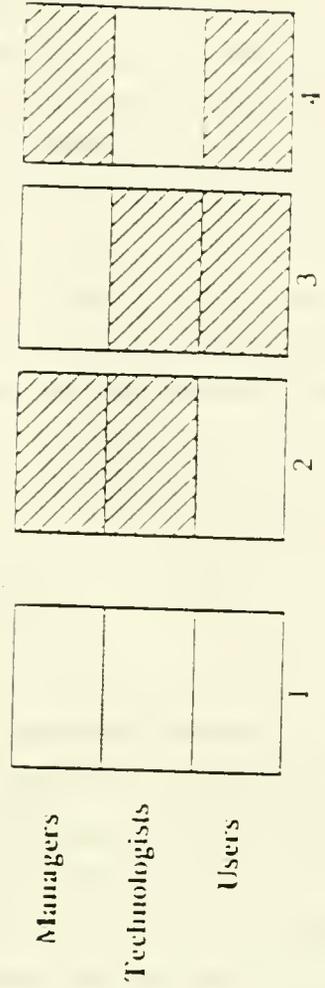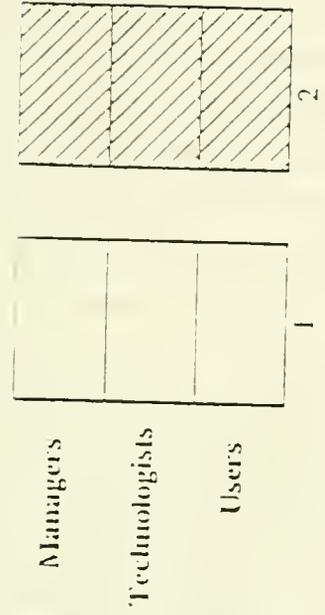
When the technological frame of one or two of the three groups has not changed to accommodate the incremental change in assumption, procedures, and information technology, partial intended change results. The consequences of such a change are not expected to be highly disruptive; an incremental change is by definition not a major departure from the status quo so that a failure to accomplish it should not significantly jeopardize the organization. However, such a change may result in inadequate development of technological capabilities by technologists or an under-utilization of the information technology by managers and users.

Where users are the group that does not change, managers convey their intentions to technologists who appropriately build or modify information technology (both groups altering their technological frames in the process). The implementation of the new or changed information technology is not accepted by the users who continue to operate under their old technological frames and draw on existing practices to accomplish their work. The column 2 of figure 2b shows that the users remain uncommitted to the change and are frozen in their pre-intervention frame. To illustrate, Venkatraman's (1991) recent analysis of the Venkatraman and Zaheer (1990) study reveals that insurance agents were using laptop computers inappropriately by trying to apply old assumptions and norms to the new information technology. For example, agents would complete spreadsheets manually and simply enter them into the electronic spreadsheets rather than using the computational features for which spreadsheet programs are typically used. While managers may attempt to force users to use new procedures, users may find ways to bypass these and stick with what is familiar. This is particularly likely where the means of accomplishing work the old way have not been dismantled, and users can easily draw on familiar routines rather than move to new ones. Gasser (1986:217) for example, found that users "worked around" new computing arrangements by reversing organizational procedures and employing backup, duplicate, or manual systems. Markus (1983) also reports that the division accountants she studied surreptitiously maintained a manual reporting system in parallel with the official computer-based one, fearing loss of control if they should give up all their data to the computer (and hence to the centralized corporate accountants).

Sometimes, however, a first order technological change is initiated by senior executives or technologists (e.g., by upgrading existing software), and middle managers are the group reticent to change. For example, headquarters may force a technological change on a division without buy-in from local managers. Markus' (1983) study of corporate accountants imposing a centralized system on divisional accountants is a case in point. Another scenario is when managers initially intend first order change, even commissioning technologists to implement such modifications, but they back away from these changes when they realize their implications, retreating to their pre-intervention technological frames (see column 3 of figure 2b).

A third way in which partial intended change may occur is when technologists do not understand the intentions of managers to modify organizational processes through information technology, or if they refuse to implement those changes because of backlogs or lack of computing resources. While managers and users may change their technological frames, the technologists remain rooted in their existing frames and the information technology does not deliver the intended changes (see column 4 of figure 2b). Gasser (1986) in a study of MRP systems found that users faced long delays in system enhancements because of lack of expertise in the information systems department, restrictions on computing resource use, and unresponsiveness to requests for improvements. For example, sales personnel reported "that they no longer requested new or revised reports because they could not get a response from the DP department" (1986:214).

As we noted above, incongruent frames resulting from first order partial intended change are unlikely to be so disruptive as to force resolution of the situation. The anticipated benefits of the information technology improvements will not be fully realized and actors' expectations will likely be disappointed. However, unless the first-order change in information technology is critical to maintaining competitiveness, the incongruent state may continue.

Unintended Change

First order technological change sometimes creates outcomes that differ from implementors' expectations. For example, as automation efforts spread throughout organizations, and as hardware and software developments create opportunities for more complex and integrated systems, some of the effects of the technological change experienced by users may be sufficiently substantial as to go beyond the intended first order change. Even though managers may have planned to merely create efficiency improvements, it is possible for unintended first order or second order changes to occur.

In one scenario of unintended change, users may experience work changes due to the information technology that is different from the changes intended by managers and technologists. For example, Kraut et al. (1988) found that customer service operators, using a new system that only allowed them to view one screen at a time, became less efficient as they were unable to handle multiple transactions at the same time, for example, with the previous system they had closed out one customer's transaction while dealing with a new customer's query. In this case, as shown in column 2 of figure 2c, the technological frame of the users is different from that of the managers and technologists.

Another example is where technologists implement changes to the information technology that go beyond that intended by the managers or understood by the users. Technologists often wish to create more sophisticated applications than managers had envisioned or are willing to pay for. This is a classic case of a system with too many "bells and whistles" (see column 4 of figure 2c).

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Second Order Technological Change

In contrast to first order technological change where the information technology augments and reinforces existing frames and processes, second order technological change deploys information technology to replace existing frames and processes. The implementors of the information technology do not intend to merely improve productivity or decrease costs, but to change the way of doing business. The focus is on innovation, on for example, creating new production processes, new structures, different products and services, defining new markets, forging new relations with customers, suppliers, and entering into partnerships with related players and even competitors. Huber (1984) and Scott Morton and Rockart (1984) note that multiple discontinuous changes in information technology are triggered by various environmental conditions, including increased complexity, turbulence and globalization. While implementors may also intend to improve productivity or decrease costs, their primary aim is to change the established assumptions and mode of operating. Second order changes--because of their scope and expense-- are frequently initiated when a crisis is perceived. That is, managers believe that the survival of the organization is threatened unless the radical shift in information technology, operations, products, markets, etc., is accomplished.

Examples of second order technological change are particularly evident in the information system implementations of the eighties, when managers attempted to use information technology strategically or for competitive advantage by radically redesigning old business processes (McFarlan, 1984; Porter and Millar, 1985). These changes have often been associated with large-scale organizational change, such as the initiatives labeled "business process redesign" (Davenport and Short, 1990; Hammer, 1990) or "organizational transformation" (Kimberley and Quinn, 1984). For example, Walmart's just-in-time inventory system directly links check-out scanners with warehouse computers and, through electronic data interchange, with suppliers' computers, thus replacing previous systems that relied on personal selling and manual order-entry.

Aligned Intended Change

Where all three groups achieve a common understanding of the second order change in information technology and work practices, we have aligned intended second order change (see column 2 of figure 2a). To accomplish such second order change, managers must successfully convey their vision of what the information technology is to do (their changed technological frame) to technologists who need to understand these intentions well enough to be able to translate them into appropriate systems. Managers must also ensure that users adequately understand and accept the radical change and that there is a comparable change in users' technological frames. This typically requires organizational interventions such as change management training and process

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workshops. In addition, because second order change implies substantial change in business processes and modes of operating, managers need to institute changes in procedures, tasks, incentive schemes, and reporting relationships to reflect the changed organizational vision. Working within these changed organizational conditions, users will draw on their changed technological frames to use the new information technology, and thereby enact a changed organization.

Partial Intended Change

Second order technological changes are typically more difficult to accomplish than first order changes because of the significant modifications in assumptions, meanings, and action required. Problems of misinterpretation and inertia are even more likely here, and resistance to change--either deliberate or inadvertent--may cause one or two groups to remain attached to their pre-intervention technological frames. In contrast to partial intended first order change, the consequences of partial intended second order changes are expected to be highly disruptive and unstable because incongruence in frames will lead to serious ambiguity and conflict over goals and outcomes.

One scenario for partial intended second order change is users' lack of commitment to the second order change, either through lack of understanding, resistance to change, or initial discomfort with the radically different information technology. Thus, users do not change their technological frames to reflect the second order change, and attempt to use the new information technology with an inadequate or incorrect understanding of it (see column 2 of figure 2b). Because the organization reality they enact with their inadequate understanding will jar with that expected by other groups, such partial changes are unstable, creating significant organizational tension that will eventually have to be resolved. How, depends on the magnitude of incongruence and the relative power of the groups. Two general resolution strategies are possible. First, the managers may attempt to force the second order change on the users by either replacing the recalcitrant users and bringing in individuals who accept the changes, or by massive retraining of users and changes in incentive schemes. Second, the managers may have less authority or desire to force their view on others. Here the autonomy of the users prevails and managers have to abandon the attempted organizational change, thus aborting the second order change and returning to old ways of doing things or slightly modified old ways of doing things.

Lack of real commitment by managers may also trigger partial intended second order change (column 3 of figure 2b). While managers may commission technologists to implement innovative information technology to create new ways of doing business, they may not fully understand or buy into the implications of their intentions. Radical change is threatening for many managers because it challenges and potentially undermines their established bases of power, status,

authority, and influence. Thus, while they may publicly support the change effort, their compliance may be only symbolic (Markus, 1983). Hence, managers' surface commitment does not reflect a fundamental change in their assumptions, meanings, and knowledge of technology, and they will not create the requisite changes in resource allocation, reward systems, and production processes to do business differently with the new information technology.

For example, Zuboff's (1988) case studies found that managers were unable to accept information technology that would increase workers' autonomy and decision-making authority. The managers' technological frames were so rooted in traditional ideas of managerial authority that they could not "wrest themselves from deep-seated images of managerial control" (1988:278). This led to a serious incongruence between managers' and users' interpretation of the same technology. Managers would not acknowledge that operators' jobs had changed significantly as a result of the information technology, while the operators--experiencing the technological change--perceived a fundamental shift in their meanings, tasks, and responsibilities. These frame clashes soon led to social clashes around worker grievances and union action. Zuboff (1988:281) also recounts how system developers contributed to the difficulties by creating what users perceived to be unfriendly and complex interfaces which were difficult to manipulate.

At least three resolution strategies may be followed when managers are unable to accept the intended second order change. The first assumes that the managers are dominant, and hence that their view will prevail. The second order change is aborted, leaving the organization with a new, sleek information technology that is used to support old ways of doing business--at best an unintended first order change. The second resolution strategy would force the managers to buy into the second order change, either through threat, extensive re-training, or by replacing them with others more willing to accept the changes. Finally, the organization may continue to operate in an unresolved state of tension for a while, but it will likely lose business and credibility, thus threatening its own survival.

Sometimes technologists may inhibit intended second order change by not understanding the intentions of managers to radically change the organization through information technology, or by refusing to implement those changes because of inadequate skills and resources, or a fear of losing influence. Here the managers and users share a common understanding of the change, while the technologists retain their existing frame (column 4 of figure 2b), and create a technology that does not support the expected changes. This scenario is less likely to occur than that described below where technologists implement more substantial changes than expected. Where it does occur, we expect managers to resolve the conflict either by forcing the change (perhaps using external technologists) or by backing down and accepting what they perceive to be inadequate technology. Depending on the criticality of the information technology to the survival of the organization, this latter resolution may--in the long term--be self-defeating.

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Unintended Change

Even though second order technological change involves deliberate radical breaking with past frames and processes, unintended changes may still occur. Greater unintended changes should be expected under second order than under first order change, because of the difficulties and discontinuities involved in shifting to new frames of reference and ways of organizing. While it would appear that strategic systems enable organizations to plan and execute second order changes, it is often the case that the second order changes that occur are quite unintended. Despite reports that imply rational planning and decision-making, the reality is that many times systems such as American Airlines' Sabre system create a dynamic that creates new opportunities through serendipity rather than a priori strategic planning.

One scenario is where users experience a different kind of change to that intended, largely because they encounter organizational or contextual situations not anticipated by technologists (Perrow, 1983; Weick, 1986, 1990). For example, Perrow (1983) showed how the increasing complexity of technological systems being built today may cause failure and breakdown because of the technologists' inabilities to think through and test all the potential interactions that may occur in operation. So too, with second order technological change, it is possible that the changed technological frames and processes are poorly understood by users who have been inadequately trained or who feel threatened by the transformation of their familiar structures, relations, culture, and knowledge. Or the interdependencies in business processes may not have been understood, so that the new way of doing things--thought to be self-contained--in fact disrupts other parts of the organization, creating tensions, disjunctures, and inconsistencies. Users interacting with such systems will develop frames that reflect the information technology as they experience it and not as the implementors intended it (Weick, 1990). We depict such a possibility in column 2 of figure 2c, where the users' experiences of the new information technology are seen to depart significantly from those of the managers and technologists.

Another scenario of unintended second order change is the case of technologists interpreting the desired changes very differently, and hence creating an artifact that represents a different second order change than that intended by the managers (see column 4 of figure 2c). This often happens when an organization buys an application package from an outside vendor to perform a particular function, yet once the package is deployed various unintended and often significant changes in business are required to accommodate the package specifications. Unable or unwilling to modify the software package, managers and users are forced to change their understanding and the organization around the information technology.

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Third Order Technological Change

Despite increasing attention to more organic organizational forms capable of dealing with unexpected future environments (Huber, 1984; Malone, Yates and Benjamin, 1987; Drucker, 1988; Nolan, Pollack and Ware, 1989; Schein, 1989), we have yet to see information systems embody the notion of third order change. We thus consider intended third order technological change something of a special case at this time and we can only speculate on what the archetypal outcomes might look like. At this point, however, we have no reason to expect that the three outcome archetypes described above and depicted in figure 2 will not apply.

Third order technological change requires a qualitative shift in technological frames and the use of information technology. The change requires the recognition of technological frames, and an understanding of their influence--for example, on technologists in their creation and maintenance of information technology and on users in their assimilation and use of the information technology in their work lives (Dahlbom and Mathiassen, 1991). This recognition of the existence and role of technological frames in shaping technological artifacts (in design and use) establishes the need for mechanisms that monitor and question the assumptions. meanings, and knowledge underlying technological frames. Thus, in the "learning" organization, groups need to be sensitive to the appropriateness of their current frame and current technology to the organizational context and environment. Mechanisms--human, organizational, and technological--to support this sensitivity are critical. As the situation changes, and frames and technologies prove inappropriate to mediating organizational work, built-in mechanisms would trigger changes in the frames and technologies. This capability requires flexible technological and organizational designs rather than closed and frozen systems.

Information technologies could provide some of these mechanisms. For example, mechanisms may be built into the work procedures supporting the use of the information technology or into the software of the system itself. Information systems, for example, may allow the representation of technologists' and users' cognitive maps, it may record the assumptions under which they were developed, and it may include procedures that notify users when the underlying assumptions no longer hold or are being violated routinely. Most information systems have helped significantly in fostering single-loop learning (Argyris and Schon, 1978), through the controls, performance monitoring, exception reporting, and information memory that these systems offer. Most do not have the capacity to support double-loop learning by questioning their own premises. Information technology representing a third order change would provide a platform for change, that would mediate current work as well as monitor usage and reliance on built-in assumptions simultaneously.

Third order technological change requires that managers and users are capable of distinguishing when their current technological frame and artifact no longer meet their needs, and

are able to act to change the situation. Such a capability requires local autonomy and knowledge. Users will need to know what portfolio of information technology-based options is available, how to utilize those options and tools, and which options to pick for the different situations they encounter. Where they are unable to do so because of inappropriate frames, inadequate resources, or poor training, or where managers or technologists thwart them in their efforts to exercise this authority, partial intended third order change will result. Factors that inhibit the move to third order change include the inherent inertia of frames and the installed technological base, (i.e., the existing application systems, methods, and technical architectures that need ongoing maintenance and operation and are expensive and time-consuming to change).

DISCUSSION

In this paper we have outlined an approach to studying technological change that is grounded in the underlying assumptions, meanings, and knowledge that people have about information technology. We believe that these interpretations of information technology are critical to an understanding of technological use and change as they significantly influence the way managers, technologists and users in the social world of computing respond to it. We discussed three archetypal outcomes of technological change that are occasioned by these groups' differential understanding and acceptance of the technological intervention. We suggested that these patterns of change and their likely outcomes can be investigated through examining changes in the three groups' interpretations of information technology over time (see summary in figure 3).

In the sections above we have articulated the conceptual apparatus that can be used to drive empirical work. Below we will explore some of the methodological and practical implications of using this conceptual framework.

Implications for Research on Technological Change in Organizations

Our framework has a number of implications for research into technological change. Recognizing the type of change intended, for example, has important implications for the measurement of technological change. By not paying attention to the order of change intended, researchers investigating technological change have assumed that measures of productivity or use are valid throughout the change process; that is, the same measures have been used before and after the technological intervention. Such measures, however, can only capture first order or alpha change, that is, "changes in level of phenomena, while the type, dimensions, and criteria for evaluating the phenomena remain constant" (Mohrman and Lawler, 1985:137). Such measures are unable to capture intended second or third order changes, or any type of unintended change.

Figure 3: SUMMARY OF ORDERS OF INTENDED TECHNOLOGICAL CHANGE

	First order change	Second order change	Third order change
Characteristics	- Incremental change intended to refine and extend status quo - Technological frames are modified to reflect extensions to technology - Motivated by desire to cut costs, increase efficiency, or improve productivity	- Radical change intended to transform or replace the status quo - Technological frames are changed to reflect the new technology - Motivated by crisis or significant innovation opportunity	- Human, organizational, and technological systems are intended to be open to the possibility of future change - Acknowledges that frames need frequent monitoring and modification when assumptions become invalid - Motivated by desire to be more flexible and reflective in fast changing world
Examples	- Typically systems built in the 1960s and 1970s - Accounts receivable system that automates existing manual procedures	- Typically systems built in the 1980s - Just-in-time inventory system that replaces manual order entry and purchasing procedures by creating direct electronic link between retailers and suppliers	- Future systems - Tax software that monitors and updates its routines when it detects changes in the tax law or changes in interpretation and application of the tax law
Incongruence	- More subtle than in second or third order change - If it occurs, is not likely to be disruptive - May be addressed with increased training or communication	- More obvious than in first or third order change - If it occurs, is likely to be very disruptive - Increased training or communication may be less effective if incongruence is due to political battles; requires process workshops and change management education - Either one group forces the other/s to change their frames or revert to old ones, or the organization becomes increasingly dysfunctional and unstable over time	- More likely due to divergent interpretations of change rather than resistance - Requires training in learning systems and process workshops, as well as a belief in the high probability of future change
Measurement Issues	- Traditional research designs can detect measurable improvements in process and outcome with pre and post measures - Traditional research designs cannot detect any unintended changes	- Traditional research designs can detect measurable improvements in outcomes, but cannot detect paradigmatic change with pre and post measures - Traditional research designs cannot detect any unintended changes - Alternative research designs and measures may be more useful to capture unintended changes, and paradigmatic change	- Traditional research designs cannot detect change in paradigm to continual learning - Alternative research designs and measures may be more useful to capture change in paradigm, such as the development of learning and reflecting mechanisms

Thus, assessing first order technological change with performance measures is relatively straightforward *only if* the basic tasks and procedures have remained intact and there is no radical change in frames. In this case, the performance criteria relevant before the change will still be appropriate after the new or changed information technology is in use. For example, measures of the number of insurance claims adjudicated per day, before and after the introduction of an information technology to insurance agents, can be compared to determine the change in performance afforded by the information technology.

However, where the information technology has also inadvertently triggered unintended changes, assumptions and processes have been radically altered, and pre-defined measures that are associated with performance criteria of the *before* condition cannot detect or assess this shift (Golembiewski, Billingsley and Yeager, 1976). Unintended changes are typically more easily recognized and understood through in-depth fieldwork which does not presume taken-for-granted technological frames, and allows for the emergence of new assumptions, meanings, and knowledge. For example, some researchers using process-oriented, qualitative methodologies have reported unanticipated second order changes in organizations intending only first order change (Gash, 1987; Markus, 1983; Orlikowski 1988; Zuboff, 1988; Barley 1990).

Intended second order changes, unlike intended first order changes, pose measurement problems because frames and organizational processes are altered (Golembiewski, Billingsley, and Yeager, 1976; Armenakis, 1988). Measurement of intended second order change is not straightforward because the performance criteria may be qualitatively different--so that measures of the *before* and *after* conditions cannot be compared because there has been paradigmatic change. For example, where insurance claims processing has been automated, measuring workers' productivity by number of claims adjudicated per day may no longer be appropriate, as other features not measurable or pertinent in the before condition (such as quality of service and customer satisfaction) may now be important components of the job. Further, unintended changes--such as managerial sabotage--are also more difficult to detect because they are by definition unexpected. Qualitative fieldwork may be especially useful in detecting and assessing intended and unintended second order changes.

We propose (building on Greenwood and Hinings (1988)) that it is possible to assess technological frames across groups over time by tracking both perceptions of intended change and experienced change throughout the technological change process. Given that frames are unlikely to shift rapidly, periodic assessments of technological frames across groups will indicate movement in the core dimensions. Focus groups, individual interviews, and specially designed workshops provide useful data, such as shared images and specific language used. Clinical interviewing (Schein, 1987) provides some guidelines for eliciting assumptions and meanings. Data gathered at interactions between members of multiple groups (managers, users, technologists) may provide the

best opportunity for observing congruence and diagnosing incongruences. The important consideration is not which interaction is best suited for data gathering, but rather how to best analyze the data. We posit that content analysis of qualitative data is a viable method for "reading between the lines" of data to assess underlying assumptions, values and expectations, much as culture researchers interpret manifest artifacts, symbols and stories. Such analysis would determine what order of change is indicated within the currently held frames, and the extent of incongruence. Interpretations of data by researchers may be validated directly with sources, and in fact such validation may constitute a powerful intervention. By providing the parties with a relatively analytic perspective, these interpretations may serve to foster discussion, reflection, and reorientation.

Empirical work is needed to track technological frames over time, as well as to assess the value of the core dimensions posited for technological frames (see figure 1), and their use in different situations and change efforts. We believe our approach is replicable across contexts because technological frames and archetypal outcomes encompass more than situation-specific, contextually unique elements. At the same time, the framework is more circumscribed than similar cognitive approaches (Ciborra and Lanzara, 1990) that are inherently difficult to measure.

We believe that the shared or social aspect of cognitions is extremely powerful in understanding the influence of information systems in organizations. To date, it would appear that contributions of cognitive researchers have been essentially limited to understanding individual cognitive processes such as learning, problem-solving, and knowledge representation in artificial intelligence research, and issues around human factors such as visual and linguistic interfaces. Our framework which focuses on the influence of shared frames suggests a potentially broader role for social cognitive research in studying information systems. In particular, the manner in which technologists' frames are embedded in the artifact they design and construct, and the influence of other group's cognitions and organizational context on this process are important areas of study (Dahlbom and Mathiassen, 1991; Perrow, 1983). Other areas might include identifying the means through which frames around information technology become shared or divergent, and determining areas of incongruence among managers, technologists, and users frames.

Implications for Managing Technological Change in Organizations

The framework presented has powerful implications for enhancing the process of managing technological change in organizations. As Lucas (1974) and many others have noted, human issues are typically the major source of failures in information systems implementation. Our framework lends itself to both diagnostic and predictive uses in more timely identification of areas of conflict, misinterpretation, collaboration, and synergy. Toward that end, it may be used as grounding for diagnosis and feedback in an action research approach to information systems development and implementation (Cummings and Huse, 1989).

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Our conceptualization of technological frames, with the dimensions posited earlier, provides a means for monitoring groups' frames as the technology development and implementation process proceeds. Initial assessment or benchmarking of frames will indicate the degree to which participants share an understanding of the order of organizational change desired. Readiness for technological change will be highlighted in particular by examining the frames of technologists, managers, and users for acceptance, understanding, and expectation of a common type of change. For example, the more all participants perceive that a particular type of change is desirable and expected, the greater their readiness to change is likely to be, and the better the likelihood of success. Obviously, the greater the congruence of perception across frame dimensions, the greater the likelihood of success. Change agents may find that incongruence or non-aligned understandings of the desired change outcome require a variety of interventions, including reframing the change effort. Bartunek (1984), for example, observed that a school principal was able to effectively bring about change via introduction of microcomputers by assessing the situation and reframing the desired change as a more comfortable first order change rather than a more uncertain second order change.[3]

Thus, preliminary assessment or diagnosis of frames should indicate areas of congruence and incongruence, allowing change agents to identify the order of change people are expecting and prepared for, and their implicit and explicit measures of success. This should lead to more effective management of the communication, direction and timing of technological change efforts.

Implications for Developing Information Technology in Organizations

The framework developed here also has implications for the practice of information systems development. Technologists have tended to rely on structured methodologies to elicit information requirements from managers and users and design and construct information systems. Traditionally these methodologies have paid inadequate attention to technologists' assumptions, meanings, knowledge, and expectations, and how these aspects of frames might differ significantly from the frames of managers and users for whom the technology is being built. Some of the techniques of frame assessment mentioned above might usefully be applied to technologists to track the degree to which they are aligned with their clients. These techniques would be particularly important in the case of external systems consultants as they have no common organizational context with their clients, hence communication is more difficult. In addition, technologists would benefit greatly from understanding systems development as a change process, as well as appreciating the order of change intended by their clients. A general understanding of

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[3] See Orlikowski and Gash (1991) for further discussion of interventions such as the consulting mode used by technologists, the need for role clarification, consensus building, and information sharing.

change processes increases sensitivity to client reactions (such as resistance), while appreciation of the type of change intended allows technologists to better match their expectations with those of their clients. This would more likely result in a closer alignment between the technology that is actually built and the technology that was intended.

Calls for "learning" or "self-designing" organizations heighten the need for third order information systems. There clearly are situations for which third-order technological change may be appropriate, yet the technologies being developed today appear to reflect first or second order changes. For those organizations attempting a third order change, the definition of what a third order technology may look like is critical. Adopting first or second order technologies in such a situation would be problematic, because by their nature, such technologies make the recognition of and move towards third order change difficult. That is, first order change assumes that the existing frame is fundamentally valid, while second order change assumes that the old frame is no longer valid but that the new one is. Neither recognize that frames may need to be assessed regularly for validity. Further, first and second order changes make it difficult for organizational members to remain open to future change. That is, first and second order change encourage the transparent mediation of work, where users take for granted the assumptions underlying their interaction with the information technology. Perhaps it will turn out that newer technologies, including object-oriented development (Chorafas, 1989), may allow for greater paradigmatic permeability and frame flexibility. Instead of creating multiple specialized and stand-alone information technology, technologists building for third order change may need to construct flexible, technological platforms that embody multiple alternative modules and options from which technological capabilities for particular conditions can be quickly constructed, assembled, and used.

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We have argued that one can examine patterns of organizational change occasioned by different types of technological interventions in terms of changes in technological frames over time. One of the major contributions of this paper is the integration of technological frames and orders of organizational change. There is increasing recognition of the importance of social cognitions with respect to the development and use of information technology in organizations. To date, however, there has been a lack of concepts or models for thinking more specifically about the process of technological change, with an eye for both theoretical rigor and practical use. We believe that our framework allows researchers to explore the nexus between technical and organizational change processes through the vehicle of technological frames and archetypal change outcomes. We have proposed a framework and methodology for assessing the process and outcomes of technological change in organizations, which allows us to distinguish between intended, unaligned, and unintended technological changes, and to investigate how and under what conditions they occur.

REFERENCES

Ackerman, L. 1986. Development, Transition, or Transformation: The Question of Change in Organizations. OD Practitioner, 18(4).

Allison, G.T. 1971. Essence of Decision. Boston, MA: Little, Brown.

Argyris, C. and Schon, D. 1978. Organizational Learning. Englewood Cliffs, NJ: Prentice-Hall.

Armenakis, A. 1988. A Review of Research on the Change Typology. Research in Organizational Change and Development, 2: 163-194.

Barley, S. 1986. Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments. Administrative Science Quarterly, 31: 78-108.

Barley, S. 1990. The Alignment of Technology and Structure through Roles and Networks. Administrative Science Quarterly, 35: 61-103.

Bartlett, F. 1932. Remembering: A Study in Experimental and Social Psychology. London: Cambridge University Press.

Bartunek, J. 1984. Changing Interpretive Schemes and Organizational Restructuring: The Example of a Religious Order. Administrative Science Quarterly, 29: 355-372.

Bartunek, J. and Moch, M. 1987. First Order, Second Order, and Third Order Change and Organization Development Interventions: A Cognitive Approach. Journal of Applied Behavioral Science, 23: 483-500.

Berger, P.L. and Luckmann, T. 1967. The Social Construction of Reality. New York: Anchor.

Bijker, W. 1987. The Social Construction of Bakelite: Toward a Theory of Invention. In W. Bijker, T. Hughes, and T. Pinch (Eds.), The Social Construction of Technological Systems: 159-187. Cambridge, MA: MIT Press.

Blumer, H. 1969. Symbolic Interactionism: Perspective and Method. Los Angeles CA: University of California Press.

Boland, R.J. 1979. Control, Causality and Information Systems Requirements. Accounting, Organizations and Society, 4(4): 259-272.

Bostrom, R.P. and Heinen, J.S. 1977. MIS Problems and Failures: A Socio-Technical Perspective, Part I--The Causes. MIS Quarterly, 17-32.

Bougon, M., Weick, K., and Binkhorst, D. 1977. Cognition in Organizations: An Analysis of the Utrecht Jazz Orchestra. Administrative Science Quarterly, 22: 606-639.

Buchanan, D.A. and Boddy, D. 1983. Organizations in the Computer Age: Technological Imperatives and Strategic Choice Hants, England: Gower, 1983.

Calder, B. and Schurr, P. 1981. Attitudinal Processes in Organizations. Research in Organizational Behavior, 3: 283-302.

Carter, N.M. 1984. Computerization as a Predominate Technology: Its Influence on the Structure of Newspaper Organizations, Academy of Management Journal, 27, 247-270.

Chorafas, D.M. 1989. System Architecture and System Design, New York: McGraw-Hill.

Ciborra, C.U. and Lanzara, G.F. 1990. Designing Dynamic Artifacts: Computer Systems as Formative Contexts. In P. Gagliardi (Ed.) Symbols and Artifacts: Views of the Corporate Landscape. New York: Walter de Gruyter: 147-165.

Cummings, T.G. and Huse, E.F. 1989. Organization Development and Change. St. Paul, MN: West Publishing Company.

Daft, R.L., and Lengel, R.H. 1986. Organizational Information Requirements, Media Richness and Structural Design. Management Science, 32: 554-571.

Dahlbom, B. and Mathiassen, L. 1991. Struggling with Quality: The Philosophy of Developing Computer Systems, Report 4, Gothenburg Studies In Information Systems, University of Göteborg, Sweden.

Davenport, T.H. and Short, J.E. 1990. The New Industrial Engineering: Information Technology and Business Process Redesign. Sloan Management Review, 31(4): 11-27.

Drucker, P. 1988. The Coming of the New Organization. Harvard Business Review, January-February, 45-53.

Gash, D. 1984. A Cognitive Examination of Job Involvement. Unpublished Masters thesis, Cornell University: Ithaca, NY.

Gash, D. 1987. The Effects of Microcomputers on Organizational Roles and the Distribution of Power. Unpublished Doctoral dissertation, New York State School of Industrial and Labor Relations, Cornell University: Ithaca, NY.

Gasser, L. 1986. The Integration of Computing and Routine Work. ACM Transactions on Office Information Systems, 4(3): 205-225.

Gersick, C.J.G. 1991. Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm. Academy of Management Review. 16(1): 10-36.

Giddens, A. 1984. The Constitution of Society: Outline of the Theory of Structure. Berkeley CA: University of California Press.

Ginzberg, M.J. 1981. Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Questions. Management Science, 27(4): 459-478.

Giuliano, V.E. 1985. The Mechanization of Office Work. In Forester, T. (Ed.) The Information Technology Revolution, Cambridge, MA: MIT Press.

Goffman, I. 1974. Frame Analysis. New York: Harper.

Golembiewski, R., Billingsley, K., and Yeager, S. 1976. Measuring Change and Persistence in Human Affairs: Types of Change Generated by OD Designs. Journal of Applied Behavioral Science, 12: 13-157.

Goodman, P. 1968. The Measurement of an Individual's Organization Map. Administrative Science Quarterly. 13, 246-265.

Goodman, P. and Burke, L. 1982. Studies of Change in Organizations: A Status Report. In P.S. Goodman and Associates (Eds.), Change in Organizations: New Perspectives in Theory, Research, and Practice. San Francisco, CA: Jossey-Bass.

Goodman, P., Griffith, T.L, and Fenner, B. 1990. Understanding Technology and the Individual in an Organizational Context. In P.S. Goodman, L.S. Sproull and Associates (Eds.), Technology and Organizations. San Francisco, CA: Jossey-Bass, 45-86.

Gray, B., Bougon, M., and Donnellon, A. 1985. Organizations as Constructions and Destructions of Meaning. Journal of Management, 11: 83-95.

Greenwood, R. and Hinings, C.R. 1988. Organizational Design Types, Tracks and the Dynamics of Strategic Change. Organization Studies, 9(3): 293-316.

Hammer, M. 1990. Reengineering Work: Don't Automate, Obliterate. Harvard Business Review, July-August: 104-112.

Hedberg, B., Nystrom, P., and Starbuck, W. 1976. Camping on Seesaws: Prescriptions for a Self-designing Organization. Administrative Science Quarterly, March: 41-65.

Hedberg, B., Nystrom, P., and Starbuck, W. 1977. Designing Organizations To Match Tomorrow. TIMS Studies in the Management Sciences, 5: 171-181.

Heidegger, M. 1962. Being and Time. New York: Harper and Row.

Hinings, C.R. and Greenwood, R. 1988. The Dynamics of Strategic Change. Oxford: Basil Blackwell.

Hirschheim, R.A. and Klein, H.K. 1989. Four Paradigms of Information Systems Development. Communications of the ACM, 32(10): 1199-1216.

Huber, G.P. 1984. The Nature and Design of Post-Industrial Organizations. Management Science, 30(8): 928-951.

Huber, G.P. 1990. A Theory of the Effects of Advanced Information Technologies on Organizational Design, Intelligence, and Decision Making, Academy of Management Review 15,1, 47-71.

Isabella, L.A. 1990. Evolving Interpretations as a Change Unfolds: How Managers Construe Key Organizational Events. Academy of Management Journal, 33(1): 7-41.

Kilman, R.H. and Covin, T.J. 1988. Introduction: Key Themes in Corporate Transformation. In Kilmann, R.H., Covin, T.J. and Associates Corporate Transformations: Revitalizing Organizations for a Competitive World. San Francisco, CA: Jossey-Bass, 1-13.

Kimberly, J. and Quinn, R. 1984. Managing Organizational Transitions. Homewood, IL: Irwin.

Kling, R. and Gerson, E. 1978. Patterns of Segmentations and Intersections in the Computing World. Symbolic Interaction, 1: 24-43.

Kling, R. and Iacono, S. 1984. Computing as an Occasion for Social Control. Journal of Social Issues, 40(3): 77-96.

Kling, R. and Iacono, S. 1989. The Institutional Character of Computerized Information Systems. Office: Technology and People, 5(1): 7-28.

Kling, R. and Scacchi, W. 1982. The Web of Computing: Computer Technology as Social Organization, in M. C. Yovits (ed.), Advances in Computers, 21: 1-90.

Kossek, E.E. 1989. The Acceptance of Human Resource Innovation: Lessons for Management. New York: Quorum Books.

Kraut, R., Koch, S. and Dumais, S. 1988. Computerization, Productivity, and Quality of Employment," Communications of the ACM, 32, 2: 220-238.

Kuhn, T. 1970. The Structure of Scientific Revolutions. Chicago: University of Chicago Press.

Lawrence, P.R. and Lorsch, J.W. 1967. Organizations and Environment: Managing Differentiation and Integration. Boston, MA: Harvard Business School Press.

Levy, A. 1986. Second-Order Planned Change: Definition and Conceptualization. Organization Dynamics. Summer, 5-20.

Lewin, K. 1951. Field Theory in Social Science. New York: Harper and Row.

Loveman, G. 1988. An Assessment of the Productivity Impact of Information Technologies. MIT Management in the 90's Working Paper: 88-054, Massachusetts Institute of Technology, Cambridge, MA.

Lucas, H.C. Jr. 1974. Toward Creative Systems Design. New York: Columbia University Press.

Macintosh, N.B. and Scapens, R.W. 1990. Structuration Theory in Management Accouting. Accouting, Organizations and Society, 15(5): 455-477.

Malone, T., Yates, J., and Benjamin, R. 1987. Electronic Markets and Electronic Hierarchies. Communications of the ACM, 30(6): 484-497.

Markus, M.L. 1983. Power, Politics and MIS Implementation. Communications of the ACM, 26: 430-444.

Markus, M.L. and Robey, D. 1988. Information Technology and Organizational Change: Causal Structure in Theory and Research. Management Science, 34(5): 583-598.

McFarlan, W.F. 1984. Information Technology changes the way you compete. Harvard Business Review, May-June: 98-103.

Meyerson, D. and Martin, J. 1987. Cultural Change: An Integration of Three Different Views. Journal of Management Studies, 24(6): 623-647.

Miller, D. and Freisen, P. 1984. Organizations: A Quantum View. Englewood Cliffs, NJ: Prentice-Hall.

Moch, M. and Bartunek, J. 1990. Creating Alternative Realities at Work: The Quality of Work Life Experiment at FoodCom. New York: Harper Business.

Mohrman, A.M. and Lawler, E.E. 1984. A Review of Theory and Research. In F.Warren McFarlan (Ed.), The Information Systems Research Challenge: Boston MA: Harvard Business School Press: 135-164.

Morgan, G. 1986. Images of Organization. Beverly Hills, CA: Sage Publications.

Nadler, D.A. 1988. Organizational Frame Bending: Types of Change in the Complex Organization. In Kilmann, R.H., Covin, T.J. and Associates Corporate Transformations: Revitalizing Organizations for a Competitive World. San Francisco, CA: Jossey-Bass, 66-83.

Neisser, U. 1976. Cognition and Reality: Principles and Implications of Cognitive Psychology. San Francisco, CA: W.H. Freeman and Co.

Newman, M. and Rosenberg, D. 1985. Sysetms Analysts and the Politics of Organizational Control. Omega, 13: 393-406.

Noble, D. 1986. Forces of Production: A Social History of Industrial Automation, New York: Oxford University Press.

Nolan, R., Pollock, A. and Ware, J. 1988. Creating the 21st Century Organization. Stage by Stage, 8(4): Nolan, Norton Institite.

Orlikowski, W. 1988. Information Technology and Post-Industrial Organizations: An Examination of the Computer-Mediation of Production Work. Unpublished Doctoral dissertation, New York University: New York, NY.

Orlikowski, W.J. 1989. Division among the Ranks: The Social Implications of CASE tools for Systems Developers, Procs. of the Tenth International Conference on Information Systems Boston MA: 199-210.

Orlikowski, W. J. Forthcoming. The Duality of Technology: Rethinking the Concept of Technology in Organizations. To appear in Organization Science.

Orlikowski, W.J. and Gash, D.C. 1991. Technological Frames: Understanding Information Technology through Interpretive Schemes. Unpublished Manuscript, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA.

Perrow, C. 1983. The Organizational Context of Human Factors Engineering, Administrative Science Quarterly, 28: 521-541.

Pettigrew, A. 1973. The Politics of Organizational Decision Making. London: Tavistock Ltd.

Pettigrew, A. 1987. Context and Action in the Transformation of the Firm. Journal of Management Studies, 24(6): 649-670.

Pfeffer, J. 1980. Power in Organizations. Boston, MA: Pitman.

Pfeffer, J. 1981. Management as Symbolic Action: The Creation and Maintenance of Organizational Paradigms. In L.L. Cummings, and B.M. Staw (Eds.), Research in Organizational Behavior. 3: Greenwich, CT: JAI Press.

Pfeffer, J. 1982. Organizations and Organization Theory Marshfield MA: Pitman Publishing.

Pinch, T. and Bijker, W. 1987. The Social Construction of Facts and Artifacts. In W. Bijker, T. Hughes, and T. Pinch (Eds.), The Social Construction of Technological Systems: 17-50. Cambridge, MA: MIT Press.

Porac, J.F., Thomas, H. and Baden-Fuller, C. 1989. Competitive Groups as Cognitive Communities: The Case of Scottish Knitwear Manufacturers. Journal of Management Studies, 26(4): 397-416.

Porac, J.F. and Thomas, H. 1990. Taxonomic Mental Models in Competitor Definition. Academy of Management Review, 15(2): 224-240.

Porat, M. 1977. The Information Economy: Definition and Measurement. Washington D.C.: US Government Printing Office.

Porras, J.I. and Silvers, R.C. 1991 Organizational Development and Transformation. Annual Review of Psychology, 42: 51-78.

Porter, M.E. and Millar, V.E. 1985. How Information gives you Competitive Advantage. Harvard Business Review, 63(4): 149-160.

Ranson S., Hinings, B. and Greenwood, R. 1980. The Structuring of Organizational Structures. Administrative Science Quarterly, 25, 1-17.

Riley, P. 1983. A Structurationist Account of Political Culture, Administrative Science Quarterly, 28: 347-414.

Robey, D., Farrow, D.L., and Franz, C.R. 1989. Group Process and Conflict in System Development. Management Science, 35(10): 1172-1191.

Rousseau, D.M. 1978. Characteristics of Departments, Position, and Individual Contexts for Attitudes and Behavior. Administrative Science Quarterly, 23: 521-540.

Schein, E. 1985. Organizational Culture and Leadership. San Francisco CA: Jossey-Bass.

Schein, E. 1987. The Clinical Perspective in Fieldwork. Newbury Park, CA: Sage Publications.

Schein, E. 1989. Reassessing the "Divine Rights" of Managers. Sloan Management Review, 30(2): 63-68.

Schutz, A. 1970. On Phenomenology and Social Relations. Chicago, IL: University of Chicago Press.

Scott Morton, M.S. (Ed.) 1991. The Corporation of the 1990s: Information Technology and Organizational Transformation. New York: Oxford University Press.

Scott Morton, M.S., and Rockart, J.F. 1984. Implications of Changes in Information Technology for Corporate Strategy. Interfaces, 14, January-February: 84-95.

Senge, P.M. 1990. The Fifth Discipline: The Art and Practice of the Learning Organization. New York: Doubleday.

Sheldon, A. 1980. Organizational Paradigms: A Theory of Organizational Change. Organizational Dynamics, Winter: 61-80.

Smircich, L. 1983. Organizations as Shared Meaning. In L.R. Pondy, P. Frost, G. Morgan, and T. Dandridge (Eds.), Organizational Symbolism: 55-65. Greenwich, CT: JAI Press.

Shibutani, T. 1962. Reference Groups and Social Control. In Rose, A. (Ed.) Human Behavior and Social Processes. Boston MA: Houghton Mifflin Company, 128-147.

Smircich, L. and Stubbart, C. 1985. Strategic Management in an Enacted World. Academy of Management Review, 10(4): 724-736.

Sproull, L. and Kiesler, S. 1986. Reducing Social Context Cues: Electronic Mail in Organizational Communication. Management Science, 32(11): 1492-1512.

Spybey, T. 1984. Traditional and Professional Frames of Meaning in Management. Sociology, 18(4): 550-562.

Starbuck, W.H. 1989. Why Organizations Run into Crises ... and Sometimes Survive Them. In Laudon, K. and Turner, J. eds. Information Technology and Management Strategy Englewood Cliffs NJ: Prentice Hall, 1989: 11-33.

Strauss, A. 1978. A Social World Perspective. Studies in Symbolic Interaction, 4: 171-190.

Tushman, M. and Romanelli, E. 1985. Organizational Evolution: A Metamorphosis Model of Convergence and Reorientation. Research in Organizational Behavior, 7: 171-222.

Van Maanen J. and Schein, E. 1979. Toward a Theory of Organizational Socialization. Research in Organizational Behavior, 1: 209-264.

Venkatraman, N. and Zaheer, A. 1990. Electronic Integration and Strategic Advantage: A Quasi-Experimental Study in the Insurance Industry, Information Systems Research 1: 377-393.

Venkatraman, N. (1991). Personal discussion.

Watzlawick, P., Weakland, J.H. and Fisch, R. 1974. Change: Principles of Problem Formation and Problem Resolution. New York: Norton.

Weick, K.E. 1979a. The Social Psychology of Organizing Reading, MA: Addison-Wesley.

Weick, K.E. 1979b. Cognitive Processes in Organizations. Research in Organizational Behavior. 1: 41-74.

Weick, K.E. 1986. Cosmos vs Chaos: Sense and Nonsense in Electronic Contexts. Organizational Dynamics, 51-64.

Weick, K.E. 1990. Technology as Equivoque: Sensemaking in New Technologies. In P.S. Goodman, L.S. Sproull and Associates (Eds.), Technology and Organizations. San Francisco, CA: Jossey-Bass, 1-44.

Winner, L. 1986. The Whale and the Reactor: A Search for Limits in an Age of High Technology Chicago: University of Chicago Press.

Zmud, R.W., Lind, M.R. and Young, F.W. 1990. An Attribute Space for Organizational Communication Channels. Information Systems Research, 1(4): 440-457.

Zuboff, S. 1988. In the Age of the Smart Machine. New York: Basic Books.