THE ORGANIZATIONAL DYNAMICS OF COMPUTERIZED TECHNOLOGY IMPLEMENTATION:

A REVIEW OF THE EMPIRICAL LITERATURE

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INTRODUCTION

In the past decade, numerous researchers (e.g., Argote, Goodman, & Schkade, 1983; Leonard-Barton, 1988; Rivard, 1987; Zuboff, 1988) have examined the organizational dynamics of computerized technology implementation. In this chapter, we review the results of this research, highlighting the consistent findings from this research as well as the inconsistencies and unknowns that remain to be addressed and resolved.

We begin by defining implementation and outlining, in brief, the computerized technologies most often studied in implementation research. We then describe the research strategies most commonly

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employed in studies of the organizational dynamics of computerized technology implementation: the key question, theories, methods, and levels of analysis used in this work. This information provides the context for our subsequent review of the results of this research. We conclude with a discussion of the questions that remain to be answered. These provide a challenging agenda for future research and theory-building on the organizational dynamics of computerized technology implementation.

IMPLEMENTATION: A DEFINITION

Innovation is commonly conceptualized as a process that proceeds through a predictable series of interrelated stages. Two types of stage models are most common (Tornatzky & Fleischer, 1990). *Source-based stage models* of innovation take the perspective of the innovation developer or source. They trace the creation of new products from the gestation of the idea to the marketing of the final product (e.g., basic research, applied research, development, testing, manufacturing or packaging, marketing or dissemination) (Amabile, 1988; Kanter, 1988; Tornatzky & Fleischer, 1990). *User-based stage models* of innovation, in contrast, trace the innovation process from the user's initial awareness of the need or opportunity for change to the final incorporation of the innovation in the user's behavioral repertoire (e.g., awareness, selection, adoption, implementation, routinization) (Beyer & Trice, 1978; Nord & Tucker, 1987; Tornatzky & Fleischer, 1990).

Implementation is a critical step in user-based models of innovation. *It is the period of change between the user's adoption of the innovation (the user's decision to purchase the innovation) and routinization (the permanent incorporation of the system into the user's repertoire of practices)* (Tornatzky, Eveland, Boylan, Hetzner, Johnson, Roitman, & Schneider, 1983). Implementation is the transition period between use of the old and use of the new.

Historically, innovation scholars have devoted much greater attention to the *adoption* of innovations than to the *implementation* of innovations (Beyer & Trice, 1978; Hage, 1980; Nord & Tucker, 1987; Roberts-Gray & Gray, 1983). Adoption does not insure implementation, however (Beyer & Trice, 1978; Hall & Loucks, 1977; Tornatzky & Fleischer, 1990); adopted policies may never be put into action and adopted technologies may sit in unopened crates on the factory floor. Further, the determinants of innovation adoption and implementation are not identical (Hage, 1980; Tornatzky & Klein, 1982). The cost of an innovation, for example, is likely to be negatively related to innovation adoption (other things being equal), but once the innovation is adopted, positively related to implementation (Tornatzky & Klein, 1982). Finally, the organizational actors central to the adoption decision process (e.g., top management and the innovation champion) are likely to differ substantially from the organizational actors central to the implementation process (e.g., end-users of the innovation) (Dean, 1987). For all of these reasons, then, the implementation stage of the innovation process warrants special attention.

COMPUTERIZED TECHNOLOGIES

Computerized technologies come in a variety of shapes, sizes, power, and functions. Computerized office automation systems include stand-alone or dedicated word processors, spreadsheet software packages, facsimile (FAX) technology, electronic mail systems, optical character recognition (OCR) devices, video-teleconferencing, and expert systems (U.S. Congress, Office of Technology Assessment, 1984; Majchrzak & Klein, 1987). These technologies aid in a variety of basic office functions: data gathering, data organization and storage, data access and retrieval, data processing, and communication (U.S. Congress, Office of Technology Assessment, 1985).

Computerized manufacturing systems include robots, computer-assisted design (CAD), computer-assisted manufacturing (CAM), manufacturing resource planning (MRP), computer-assisted process planning (CAPP), and the integration of all or most of these systems as computer-integrated manufacturing (CIM) (U.S. Congress, Office of Technology Assessment, 1985; Kozlowski, 1987; Majchrzak & Klein, 1987). Like the computerized office automation technologies, many of the manufacturing technologies are designed to increase an organization's information processing capabilities, improving planning, coordination, design, and communication (U.S. Congress, Office of Technology Assessment, 1985). In addition, computerized manufacturing technologies are designed to increase the efficiency, precision, reliability, and flexibility of production. Their use is thus expected to reduce waste, inventory, and labor costs while increasing the flexibility and quality of production (Hayes & Jaikumar, 1988; Kozlowski, 1987; U.S. Congress Office of Technology Assessment, 1985).

RESEARCH STRATEGIES IN THE STUDY OF COMPUTERIZED TECHNOLOGY IMPLEMENTATION

Before reviewing the results of research on the organizational dynamics of computerized technology implementation, we provide a general overview of the nature of research on this topic: its focus, common designs, theoretical orientation, and levels of analysis.

Research Focus

The guiding premise—the starting point—for research on the organizational dynamics of computerized technology implementation is that implementation is a daunting, but very important task for organizations. Implementation is time-consuming, disruptive, expensive, and fraught with uncertainty (Tornatzky, 1986). Successful implementation may bring improvements in organizational productivity, sales, quality, and efficiency, while implementation failure may engender significant financial losses, performance decreases, and tremendous frustration and demoralization. Research on the organizational dynamics of computerized technology implementation is thus designed to identify the factors that lead to implementation success rather than implementation failure.

Research Design

To identify the factors that differentiate between implementation success and failure, the vast majority of researchers have employed qualitative research methods. Thus, the prototypical study of computerized technology implementation is a single-site case study of an organization in the process of implementing office automation, electronic mail, robots, computer-aided design, or computer-integrated manufacturing (e.g., Argote et al., 1983; Klein, Hall, & Laliberte, 1990; Roitman, Liker, & Roskies, 1988). Reviews of the findings from consultation or case study research across multiple organizations are also common (e.g., Leonard-Barton & Krauss, 1985; Rivard, 1987; Rousseau, 1989; Schaffitzel & Kersten, 1985). Articles of both types typically describe the strengths and weaknesses of the organization(s)' implementation practices, and recommend alternative implementation strategies to improve the outcomes of technology implementation.

Far less common are quantitative studies of computerized technology implementation. Typically, quantitative studies examine the impact of selected implementation practices on individual (Chao & Kozlowski, 1986; Fleischer, Liker, & Arnsdorf, 1988; Leonard-Barton & Deschamps (1988); Parsons, Liden, O'Connor, & Nagao, 1989; Baronas & Louis, 1988), group (Bikson, Gutek, & Mankin, 1987; Fleischer et al., 1988), or organization responses to implementation (Ettlie & Rubenstein, 1980).

Theory in Research on Computerized Technology Implementation

The bulk of both qualitative and quantitative research on computerized technology implementation is exploratory and atheoretical. Although implementation studies report many common findings, these studies lack a common theoretical model or paradigm. A few researchers have drawn upon organizational change theories (e.g., Goodman, Griffith, & Fenner, 1990; Walton, 1989) or theories of organizational politics (e.g., Markus, 1987) to frame their research. Finally, some analysts (e.g., Lucas, Ginzberg, & Schultz, 1990) have attempted to develop their own theoretical models of the computerized technology implementation process. Nevertheless, as we discuss in the concluding section of this paper, additional theory development is much needed to guide future research on computer technology implementation.

Levels of Analysis

In many of the existing studies of computerized technology implementation, the level of analysis is unstated. Many studies implicitly use the organization level of analysis, seeking to find the roots of organizational success or failure in implementation in organizational practices. Other studies, however, focus on the individual or group levels of analysis in an effort to explain between-individual or between-group differences in implementation effectiveness. We return to a discussion of levels of analysis issues in the final section of the paper.

In sum, the empirical literature on computerized technology implementation is still young. The literature, as we show below, provides rich, practical descriptions of the organizational dynamics of computerized technology implementation. Lacking from the literature, however, are established conceptual models to make sense of these organizational dynamics—to categorize, integrate, and explain the numerous factors that appear to influence the outcomes of technology implementation. Nor have there been sufficiently complex and integrative quantitative studies to clarify the organizational dynamics of computerized technology implementation—to separate, definitively, the significant predictors of implementation success from the nonsignificant.

COMMON FINDINGS IN RESEARCH ON THE IMPLEMENTATION OF COMPUTERIZED TECHNOLOGIES

Below, we review empirical studies of the organizational dynamics of computerized technology implementation. All of the studies we review share a common characteristic: they identify the organizational practices, processes, and factors that lead to successful or unsuccessful computerized technology implementation in organizations. Thus, we have excluded from our review research studies that examine, for example, the relationship between technical features of computer menus and user satisfaction in the laboratory (e.g., Borgman, 1986; Malone, 1982; Roberts & Moran, 1983) or the effect of individual user characteristics on human-computer interaction (e.g., Chrysler, 1978; Irons, 1982; Vincente, Hayes, & Williges, 1987), or on computer skill acquisition (e.g., Carroll & Carrithers, 1984; Gist, Schwoerer, & Rosen, 1989; Gomez-Mejia, Egan, & Bowers, 1988; Koubek, LeBold, & Salvendy, 1985).

Befitting the youth of research on the organizational dynamics of computerized technology implementation, we have defined the term "empirical study" quite liberally. Thus, if the authors of the article, chapter, or book, report that their conclusions are based upon their empirical research, we have included the piece in our review. Some of the 29 studies we review were published in highly regarded, refereed academic journals. But, much of the research we review was published in relatively popular, and not very rigorous, outlets. Because it is often difficult to locate implementation studies, our review is surely not exhaustive. It is, we believe, quite thorough and representative of this body of work. Because 62 percent of the studies we review are qualitative, we quote fairly extensively from the studies. In the absence of numerical results, the quotations are designed to exemplify the various studies' evidence and conclusions.

We begin by describing the dependent variable in this research—implementation success and failure—and then review the independent variables—the organizational practices—found to predict implementation success and failure.

Implementation Success

The criteria for determining the extent of implementation success and failure are often unstated in research on computerized technology implementation. Three criteria are, however, typically implicit (e.g., Leonard-Barton & Krauss, 1985; Rousseau, 1989) and occasionally explicit (e.g., Bikson, Gutek, & Mankin, 1987) in research on this topic. They are: (1) use of the technology, (2) changes in organizational or work unit performance, and (3) employee reactions to the technology and to the implementation process itself.

Use of the technology describes the extent to which members of the adopting unit regularly use all or the most appropriate functions or core features of the new computerized system (Tornatzky & Fleischer, 1990; Hall & Loucks, 1977). Use of the technology may also be operationalized as the ratio of actual to potential users and/or the proportion of potential users who expect to be interacting with the computer system in the future (Bikson et al., 1987). Full use of the most appropriate functions of the implemented system is by no means a certain outcome. Thus, for example, Fleischer and others (1988) surveyed CAD users and found that many organizations used only the relatively simple two-dimensional drafting function of their CAD systems rather than the more complex and advantageous three-dimensional modeling function.

The second criterion describes changes in organizational or unit performance following the implementation of new computerized technology. Ideally, a new computerized system increases the speed and flexibility of production, improves quality, planning and scheduling, and/or reduces material and labor costs (Beatty & Gordon, 1988; Office of Technology Assessment, 1984, 1985; Kozlowski, 1987). The academic literature reports few such unqualified successes, however. More common are reports of management disappointment in the failure of these performance benefits to occur (e.g., Dean, 1987; Beatty & Gordon, 1988). Indeed, in some cases, the implementation of new technologies may impair organizational performance, at least temporarily (Leonard-Barton, 1988). Ettlie (1986) lists changes in parts per shift, the meeting of account justifications, the reduction of work in process inventory, payback period, and direct labor savings, as frequently mentioned valid indicators of organizational performance success from manufacturing technology implementations.

The third criterion describes the level of employee enthusiasm or disdain for the new technology and its implementation. Employee reactions may predict turnover (cf. Mobley, 1977) and anticipate later implementation problems (e.g., low use, few performance gains) (Lucas, 1978). Further, employee reactions to the change may serve as a useful measure of the smoothness of the implementation effort overall (Nord & Tucker, 1987). Some authors (e.g., Bikson et al., 1987) consider general job satisfaction as part of the third criterion of implementation success, as well.

In sum, an implementation effort is considered successful if: (1) employees use the new technology extensively, (2) organizational performance improves following the implementation of the technology, and (3) employees are supportive of the new technology and the implementation effort. The greater these outcomes, the greater the implementation success. The poorer these outcomes, the greater the implementation failure. While this definition is relatively clear, questions remain regarding the conceptualization of implementation success and failure, as we discuss in the concluding section of the paper.

THE PREDICTORS OF COMPUTERIZED TECHNOLOGY IMPLEMENTATION SUCCESS

Although reviewers have occasionally lamented a lack of consistency in the conclusions of research on the implementation of computerized technologies, our reading of the literature is just the opposite. There

is substantial consistency in the conclusions of research on the organizational dynamics of computerized technology implementation. Indeed, in reading this research, we noted repeated references to nine predictors of implementation success: (1) training, (2) user support, (3) time to experiment with the new technology, (4) top management support, (5) user involvement, (6) rewards, (7) job security, (8) cooperation, and (9) technology quality and availability. Accordingly, we coded each of the 18 qualitative studies we reviewed, noting whether each study mentioned each of the nine predictors as a significant determinant of implementation success. The results of our coding appear in Appendix 1. Appendix 2 summarizes the results of the 11 quantitative studies of implementation that we reviewed.

We begin by reviewing research results pertaining to three factors commonly mentioned as determinants of user skill acquisition during the implementation process: training, user support, and time to experiment with the new technology. Below, and throughout our review, we discuss exemplary studies, but not necessarily all of the studies, pertaining to each factor.

Training

Training is mentioned as a key determinant of implementation success in 67 percent of the qualitative studies we reviewed. The more thorough and accessible training is, and the greater the percentage of affected employees who receive training, the more likely implementation is to be successful, these studies suggest.

Klein, Hall, and Laliberte (1990, p.15), for example, highlight training in their "qualitative, grounded theory (Glaser & Strauss, 1967) approach" to the study of the implementation of three-dimensional computer-aided design and drafting. In this study, the authors interviewed 26 designers, drafters, supervisors, support staff members, managers, and engineers about the implementation, transcribed the interviews, and then content analyzed the transcripts for key themes. Their results, the authors argue, reveal the importance of training during the technology implementation process:

> First and foremost, technological change, like all organizational change, involves the learning of new skills, behaviors, and attitudes... Second, the training program provides many employees with their first introduction to the new technology... Third, the design and implementation of the technology

> training program may influence organizational processes, structure, and outcomes.... Culture norms may change as the organization places new value on opportunities to learn and grow, or instead emphasizes conformity to new, more narrowly confined roles and tasks. (Klein et al., 1990, p. 7)

Further, Klein and others (1990) suggest that four aspects of training may strongly influence the course and outcomes of implementation. The four training aspects are: (1) the selection of trainees, (2) training conditions, (3) training content, and (4) incentives and obstacles for transfer of training. For example, because only designers and drafters (not supervisors and managers) were selected for CAD training, "designers and drafters had lowered confidence in, and respect for, managers and supervisors" (Klein et al., 1990, p. 25). Further, "supervisors had lowered ability to guide and assist subordinates [and] difficulty evaluating subordinate performance" (Klein et al., 1990, p. 25).

Schaffitzel and Kersten (1985) come to a similar conclusion in their research on computer-aided design. They conducted qualitative case studies of the implementation of computer-aided design in 20 medium-sized companies "in five of which [user-developer communication] problems were investigated in depth" (Schaffitzel & Kersten, 1985, p. 49). (The authors provide no further description of their research methods.) Discussing training, Schaffitzel and Kersten (1985, p. 50) suggest that CAD systems require that:

> ...users adopt a fundamentally new way of working (e.g., planning of work, drawing structures, data handling). This in turn means that much time must be spent on introduction and training activities. Something which is often overlooked here is that management staff also need thorough training in the new techniques and the associated working methods.... Senior staff who have not received appropriate training retain the standard conventional working attitudes and thereby greatly impede the introductory process.

Other authors speak more globally about the importance of training for implementation success. Drawing upon the results of six case studies of the implementation of various information technologies "as well as a wide range of other materials, including an electronic conference between one of the authors and a dozen middle managers with extensive experience in IT," McKersie and Walton (1991, p. 245) highlight training as one of the "human resource policies [that] played an important—in some instances, critically important—supportive role" (McKersie & Walton, 1991, p. 255). Further, they suggest that:

> The most important characteristic of the formal training approach associated with successful implementation is a willingness to adjust and adapt training packages. For example, when it became clear at several of the telephone installations that the vendor-supplied training program was inadequate, implementation was stopped and new materials were developed, and the changeover subsequently progressed much better (McKersie & Walton, 1991, p. 258).

Very few quantitative studies have addressed the relationship between training and implementation success. Fleischer, Liker, and Arnsdorf (1988), however, collected survey data about computer-aided design use from 272 designers and engineers in six manufacturing firms. They found that the number of hours of training that users reported they had received for each CAD feature was significantly positively correlated with the users' self-rated proficiency in using that CAD feature for twelve out of thirteen features. (The significant correlations ranged from a low of .19 to a high of .66.) Users' proficiency was in turn significantly positively related to the impact of CAD on core functions of the design task.

Bikson, Gutek, and Mankin (1987) also conducted quantitative research on the topic, surveying 530 employees in 55 work groups in 26 organizations. They analyzed users' "satisfaction with support for learning to use the computer" and found that:

> ...relying heavily on self instruction as a training procedure results in general dissatisfaction with learning support. On the positive side, we found that almost any combination of techniques works better when employees are not at their own desks—in part because it frees them from the stream of interruptions and demands in the regular work environment. Vendor-provided training also contributed strongly to learner satisfaction, perhaps because vendors are more experienced than training units within user organizations (Bikson et al., 1987, p. 55).

In sum, training appears to play a key role in determining employee use and acceptance of the new technology. The importance of formal training procedures to success of technology implementation is one of the most consistent conclusions of the implementation literature.

User Support

Closely related to training is user support, the provision of technical assistance regarding the technology to technology users on an as-needed basis. User support was mentioned as a key predictor of implementation success in 33 percent of the qualitative studies we reviewed.

Rivard (1987), for example, is a strong proponent of user support. Rivard (1987, p. 26) studied computer use in "ten large business firms." In the first part of her study, she interviewed 65 users and approximately 30 information system professionals. In the second phase of the study, she distributed a questionnaire to users in the ten companies ($n = 272$). (She provides no further description of her measures or analyses.) On the basis of her results, Rivard (1987, pp. 27-28) suggests that:

> Even if a user is well trained in the use of a system (or software tool), learning most often takes place while actually using the system. For this learning to occur, users must be supported by good documentation and human advisors.

Further, Rivard (1987, p. 28) suggests that:

> The quality of support largely depends on those responsible for providing support. They should be "people-oriented," available, have a good knowledge of the software tools, understand the users' applications, and be good instructors.

Klein and others (1990) underscore the importance of user support in their case study of the implementation of three-dimensional computer-aided design and drafting, discussed above. They found that, for many employees, there was a substantial delay between the conclusion of 3D CADD training and actual use of 3D CADD on the job. "As a result," they suggest, "employees often forgot their 3D CADD skills because with a skill as complex as 3D CADD, the interviewees explained, 'it's either use it or lose it'" (Klein et al., 1990, p. 20). Because users had often forgotten the computer skills learned in training by the time they began to use the system on the job, they "wanted ready access to friendly and expert assistance and advice. Unfortunately, they found user support personnel competent, but slow to address users' concerns and requests" (Klein et al., 1990, p. 21).

McKersie and Walton (1991, p. 258), discussed above, elaborate this point:

> Clearly, the biggest component of training is what happens on the job, what some people call on-the-job learning. The heavy 'unlearning' or decay factor associated with the acquisition of formal knowledge, especially knowledge of a technical nature, accounts for the limited role formal classroom training plays in [information technology] implementation. Learning does not become integrated until a user becomes engaged with a technology and begins to incorporate its routines and assimilate the deep learning necessary for its effective operation.

Finally, Graham and Rosenthal (1986) summarize the results of "intensive fieldwork in eight companies, and corroborating data from numerous other sites" (no further detail presented). Discussing user support, Graham and Rosenthal (1986, p. 219) comment simply that, "effective [flexible machining systems] are heavily dependent on good software support and instantaneous responses from support services."

Only one of the quantitative studies examined user support. Fleischer and others (1988) found that the more CAD users relied on formal user support sources (officially designated individuals or groups) versus informal user support services (help is not formally a part of the helping employee's job), the more appropriate was their use of advanced 3D CAD features. Fleischer and others, (1988, p. 45) argue that "formal sources apparently help CAD users make better choices about which CAD features to use."

In sum, existing research suggests that user support is an important determinant of effective and continued use of new technologies. Much of the users' knowledge of the technology will be developed when they are using the technology on the job, and therefore sufficient technical user support appears to be an important element in successful technology implementation.

Time to Experiment With the New Technology

A third factor that appears to be associated with the computer skill acquisition necessary for implementation success is user time to experiment with the new technology, mentioned in 22 percent of the qualitative studies we reviewed. McKersie and Walton (1991, p. 258), for example, suggest that:

> A...technique for fostering informal learning is to allow (and even to encourage) users to 'play' with the new technology....[Positive] results were seen at several locations where IRS examiners provided with lap-top computers were encouraged to take them home to gain familiarity with the keyboard, play games, and become conversant with the new system at a more leisurely pace.

Results from Zuboff's (1988) case studies, based on both interviews and participant observation in eight different organizations facing significant technological change, further documents the importance of time for experimentation during implementation. Zuboff (1988) reports that in the case of the implementation of a computerized expense tracking system, management efforts to formalize procedures limited operators' opportunities to play and experiment with the system. As one operator suggested:

> It was no longer possible to play around with the thing, to experiment. But that is how you have to use the system if you are going to get at its potential (Zuboff, 1988, p. 262).

Zuboff describes operators' attempts to circumvent this limitation by designing experiments to be conducted on the less supervised graveyard shift. Zuboff (1988, p. 252) suggests that, "this way they were free to 'play' and learn, without managerial pressure."

Rousseau (1989) reviewed the results of five case studies, funded by the Office of Technology Assessment, of the introduction of office automation. In her analysis of these cases, she highlights the importance of organizational culture and norms regarding experimentation with the new technology:

> At the installation phase, norms that pertain to the learning process become salient. Are risk-taking and experimentation encouraged or sanctioned? Are individuals who try out new skills and techniques held to strict performance standards or are they allowed some slippage in performance quality or quantity while they learn?...CPMHQ is a firm where 25 percent of new programs introduced failed, but management regarded these failures as part of the learning process and did not treat them as wasted expenditures....Not surprisingly, CPMHQ implemented [office automation] successfully and easily (Rousseau, 1989).

Finally, in the single quantitative study we found that bore on this point, Fleischer and others (1988, p. 45) found that self-reported "time

to learn to use the system without too much pressure to keep up with production" was significantly positively related to self-reported use of more advanced 3-D CAD functions when there was high potential for such use, but not when there was low potential.

In sum, opportunities for experimentation with the new system appear to increase the likelihood of successful implementation.

We turn now to a review of findings regarding four factors that appear to influence user acceptance of the new system: top management support, user involvement, rewards, and job security.

Top Management Support

Fifty percent of the qualitative studies listed top management support for the new technology as a key determinant of implementation success. Top management support, the existing research suggests, is beneficial because it: (1) establishes priorities, (2) motivates users, and (3) clarifies the fact that the technology represents a significant and permanent, rather than temporary, change in the way work will be accomplished.

Based on their "combined research and consulting experience with more than 20 large multinational corporations and with some 70 organizations within General Electric" (Leonard-Barton & Krauss, 1985, p. 102) (no further detail describing the research provided), Leonard-Barton and Krauss (1985, p. 109) suggest that top management support is critical for successful implementation:

> Whether the action takes the form of a memo, a speech, or a minor policy change, it must send a signal that top management will stand behind this technology even in a budget crisis.

Similarly, McKersie and Walton (1991, p. 262), suggest that, based on their own case study results:

> The appropriate role for top management is a blend of providing central guidance and encouraging local initiative. Top management should provide a clear vision of the organization it wants and delineate the steps to the realization of that vision.

Rousseau's (1989) review of the Office of Technology Assessment case studies underlines this point. Rousseau (1989, p. 42) comments:

> Clear vision of change is easy to recommend, but hard to do. It is very difficult to have a clear image of the change unless there is visible top management support and involvement.

Two of the quantitative research pieces that we reviewed assessed the consequences of top management support for new technology. Lucas, Ginzburg, and Schultz (1990) conducted two separate survey studies of the implementation of a decision support system in one organization. The first study surveyed 45 managers and 267 users who used the technology exclusively, and the other study consisted of 145 users who used other data sources as well as the decision support system. In both studies, Lucas and others found that management support was a significant positive predictor of the user's personal stake, or "the degree to which the user's future (e.g., rewards) is tied to the system and its use" (Lucas et al., 1990, p. 41). User's stake in turn was a significant predictor of user involvement in system development, user assessment of the system, and use in both studies.

Studying the implementation of an expert system technology for salespeople, Leonard-Barton and Deschamps (1988) found that context-specific employee characteristics mediated the effects of managerial influence. Specifically, they found that users who were low in personal innovativeness, who rated the subjective importance of the task being computerized as low, whose task-specific skills were low, and who were low in overall job performance, all perceived that their management had encouraged them to adopt the technology. Users who were high in any of these measures, however, did not perceive any management influence in their adoption decisions. Leonard-Barton and Deschamps (1988, p.1252) thus concluded:

> Employees whose characteristics incline them to adopt an innovation will do so without management support or urging if it is simply made available. Employees low on these characteristics will await a managerial directive before adopting.

In sum, the qualitative studies we reviewed suggest that top management support for the new computerized technology should ideally be clear, constant, and unwavering. Leonard-Barton and Deschamps' (1988) research suggests, however, that the consequences of top management support vary as a function of the individual characteristics of the users.

User Involvement

Sixty-one percent of the qualitative studies highlight the benefits of user involvement, or participation, in decision making regarding the adoption and implementation of new technologies. The greater user involvement in these decisions, these studies suggest, the more likely the users are to embrace and use the new technology and the more likely the organization is to realize the performance benefits of the new technology. Below, we review the results of several qualitative and quantitative implementation studies documenting the effects of user involvement.

Based on their visits to "many U.S. companies that use robots" (no further description of the research provided), Foulkes and Hirsch (1984, p. 98) praise Westinghouse for its tenet that "the probability of success of a robot installation is directly proportionate to the number of affected people who are involved in the discussions and planning of the project." Further, they suggest that "in companies where the integration of robots has been successful, management continually solicits employees for ideas on how to improve their operation" (Foulkes & Hirsch, 1984, p. 101).

Discussing the results of their own research and consulting experience in implementing new technologies, Leonard-Barton and Krauss (1985, p. 104) suggest that:

> Selling top management on the case for new technology—without simultaneous involvement of user organizations in the decision-making process—is not enough. It is equally important for users of an innovation to develop "ownership" of the technology.... Although it is patently impossible to involve all users in the choice and/or development of an innovation, that is no excuse not to involve their representatives.

McKersie and Walton (1991, p. 265) attempt to offer more precise guidelines for user involvement:

> The question is not whether to have user involvement, but when and under what circumstances to have it and for what purposes.... User involvement may... be limited when a new system's design must be highly specified to make it interdependent with other systems.... Another negative aspect of user involvement brought to light by several of our case studies is the potential for incorporating too many bells and whistles. Allowing users to specify equipment features without realistic guidelines can set them up for raised

> expectations that are subsequently dashed when decision makers find it necessary to eliminate some of the desired options.

Based on his interviews in 41 computerized manufacturing technology vendor and user firms, Ettlie (1986, p. 85), too, offers cautions about user involvement:

> It would seem an unwise implementation strategy to involve people in the decision to adopt a radical process technology if they know nothing about the technology and do not have an important stake in the success or failure of the new system. People who do not have a stake in participation will be angry when asked to participate...and people who do not know anything about the technology are being asked to expose their ignorance—at least at first.

Several of the quantitative implementation studies also address the benefits of user involvement. For example, in their study of the implementation of CAD, Fleischer and others (1988) found that designer-reported input into decisions about the CAD system when it was introduced was significantly positively related to designers' self-reported use of the more advanced features of their CAD systems when there was high potential for such use. In their quantitative, longitudinal study of the implementation of office automation in a single firm, Parsons, Liden, O'Connor, and Nagao (1989) found that self-reported user involvement at Time 1 (just prior to implementation) was significantly positively related to satisfaction with the decision to purchase the new system and satisfaction with training at Time 2 (six months later). Further, user involvement was significantly positively related to system use at Time 3 (12 months following Time 2).

Baronas and Louis' (1988) field experiment, in which the treatment group of users experienced greater involvement in and influence over the implementation process than the control group of users, also demonstrates the benefits of user involvement. Treatment group members participated in discussion groups regarding the new computer system and the implementation plan (rather than simply attending lectures on the technical features of the new system). Further, treatment group members received advance warning when implementation would begin (rather than having implementors arrive on-site unannounced). In addition, the supervisors of treatment group members received greater information about the social aspects

of implementation (e.g., stress, fatigue) than did the supervisors of the control group members and also had greater influence in selecting deadlines and times for key events than did the control group supervisors. Baronas and Louis (1988) found that treatment group members were significantly more satisfied with the new system, the implementation schedule, their interactions with system implementors, and the amount of information they received about the system than were control group members. On the basis of these results, Baronas and Louis (1988, p. 120) argue that "user involvement is effective because it restores or enhances perceived control" during the implementation of computerized systems.

In sum, the qualitative and quantitative studies of computerized technology implementation that we have reviewed strongly suggest that user involvement in decision making regarding the purchase and implementation of new systems is beneficial for user acceptance of the system. However, the research suggests that user involvement efforts may backfire if employee expectations for influence are not met or if employees lack sufficient knowledge to provide useful input into adoption, design, and implementation decisions.

Rewards

Thirty-nine percent of the qualitative studies suggest that the rewards people receive for the use of new technologies influence successful implementation. For example, in her review of the five Office of Technology Assessment case studies of the implementation of office automation (OA), Rousseau (1989, pp. 44-45) suggests that:

> Readying people to learn to use OA means overcoming resistance in the adoption phase, creating incentives to participate in training, and rewarding use of the system in the performance of job duties. Rewards can derive from formal review systems (tied into compensation and promotion), from improvements in the intrinsic characteristics of the work (variety, responsibility, judgement) or in the ease with which existing job functions are performed.

Klein and others (1990) discuss many of the same rewards for technology use in their report of their case study of the implementation of three-dimensional computer-aided design and drafting. For example, they report that:

> Top management—in combination with the shrinking engineering and construction labor market—provided strong, if somewhat coercive, incentives for 3D CADD use. Design supervisors failed to translate these incentives into praise and support for their subordinates' use of 3D CADD. Finally, the technology itself provided both incentive and obstacles for CADD use (Klein et al., 1990, p. 24).

Leonard-Barton (1988) provides a yet more sophisticated analysis of rewards, or incentives, for technology use. She conducted "12 in-depth case studies of new technology...introduced into the operations of large corporations within the past five years" (Leonard-Barton, 1988, p. 251) using a "replicated case study approach" (explained by Yin, 1984). On the basis of these studies, Leonard-Barton (1988, pp. 258-259) suggests that:

> Each set of users evaluates the technology first in terms of the *significance* the activities being altered have to job performance criteria....The second dimension affecting a technology's value is its expected net *impact* on the activity being altered, positive or negative. Impacts include effects on the profitability of the activity, but of course financial measures are not the only ones to be considered. Technologies can 'cost' in terms of lost time, decreased status, or unpleasant routine, and they can 'benefit' in terms of increased skills, better quality output, and so forth....Each evaluation of the expected net consequences of using a technology (the expected net impact) is weighted by the subjective significance that the expected consequence will have for the reward system under which the users operate.

None of the quantitative implementation studies we reviewed addressed the role of rewards in technology implementation. Thus, this is an area of needed quantitative research.

Job Security

Job security is mentioned as an important determinant of implementation success in 17 percent of the qualitative studies we reviewed. For example, based on their visits to companies implementing robotics technology, Foulkes and Hirsch (1984, p. 94) conclude that, "fear of loss of jobs is at the root of workers' objections to robots". Further, Foulkes, and Hirsch (1984, p. 97) suggest that, "a no-layoff policy obviously contributes enormously to workers' acceptance of the machines, and in most companies we visited, attrition and retraining have sufficed to prevent layoffs."

Argote, Goodman, and Schkade (1983) interviewed approximately 60 production workers, supervisors, and managers before and after the implementation of the plant's first robot. Based on their interviews, they suggest that:

> Questions concerning job security and pay are likely to be uppermost in the minds of the work force. Failure to resolve these questions prior to the introduction of the robot is likely to reduce the effectiveness of the introduction (Argote et al., 1983, p. 12).

Similarly, McKersie, and Walton (1991: 259) suggest that:

> More and more firms are recognizing both the desirability and feasibility of providing a good measure of employment security and the associated career planning and training of employees that is necessary to make such a policy work....Workers who believe that the employment consequences of change are being handled in a fair and constructive fashion will be more likely to embrace a new technology and pursue its potential than workers left to assume that they will be out the door or displaced to less meaningful positions by that technology.

Roitman, Liker, and Roskies (1988) reach a comparable conclusion. They interviewed 60 workers and managers before and after the implementation of computer-integrated manufacturing. On the basis of the interviews, the authors reliably sorted individuals into three groups: (1) winners ($n = 21$), who saw the implementation as positive for them personally, (2) losers ($n = 17$) who saw implementation as negative for them personally, and (3) sideliners ($n = 18$) who felt uncertain about how the implementation would affect them or who thought the implementation would have little effect upon them. The key factor that appeared to differentiate these groups was "job fate" (Roitman et al., 1988, p. 231), the extent to which the employee's job would be protected or expanded, threatened or diminished, or unaffected by the CIM implementation. Further, status as a winner, loser, or sideliner was closely related to employee evaluations of the impact of CIM on quality of life at the plant.

Finally, in the only quantitative study we found that explored issues of job security during computerized technology implementation, Chao and Kozlowski (1986) surveyed 461 employees of a plant that was planning to implement robotics. Chao and Kozlowski (1986, p. 74) predicted that low-skill workers "would be concerned about displacement and the security of their jobs, whereas high-skill employees were expected to find new opportunities salient and to feel less threatened by job loss." Indeed, a multivariate analysis of variance and subsequent discriminant analysis revealed significant differences between the views of line workers (low skill), job setters (medium skill), and skilled trades (high skill):

> [Line workers] saw the implementation as threatening their security, were generally negative toward robots, felt management was unconcerned, and did not see new opportunities for themselves. Skilled trades, on the other hand, regarded robots as not threatening their security, were generally positive about robots, felt that management evidenced some concern, and saw new opportunities as a potential outcome (Chao & Kozlowski, 1986, p. 75).

In sum, the research on job security and technology implementation suggests that job security is a relevant concern to employees affected by the implementation of computerized technologies. The research further suggests that the role of job security on user acceptance of new technology may be mediated by one's skill and position in the organization.

Below, we conclude our review by discussing two final factors that may influence implementation success: (1) intergroup cooperation, and (2) technology quality and availability.

Intergroup Cooperation

Sixty-seven percent of the qualitative studies suggest that the success of computerized technology implementation depends, in part, on the level of cooperation and communication between the diverse employee departments and groups likely to be affected by the new technology. Thus, for example, Schaffitzel and Kersten (1985, p. 49) comment that:

> When CAD methods are available, the structural organization and all work processes from development and design to manufacturing and technical sales are changed step by step. The traditional autonomy of the individual technical departments is greatly curtailed by the integrative effect of CAD systems.

Further, Schaffitzel and Kersten (1985, p. 50) note that:

> Experience with the introduction of CAD systems has shown that the affected areas such as design, production, work preparation, and computing center accept the high degrees of integration imposed by the new technique only with great reluctance.

In a similar vein, Beatty and Gordon (1988) comment on the need for integration of diverse work groups for the successful implementation of computer-aided design and manufacturing (CAD/CAM). Based on their interviews and surveys of over 200 managers and operating-level employees, they suggest that:

> The orientations, tasks, environments, goals, and reward systems of [design/engineering and manufacturing] are radically different.... The wall between them must be torn down—or at least a door must be inserted—if CAD/CAM is to reach its potential (Beatty & Gordon, 1988, p. 28).

Finally, Graham and Rosenthal (1986, pp. 216-217) report that:

> Even when companies are acquiring 'turnkey' systems, FMS [Flexible Machining Systems] project teams need to include (or at least have easy access to) a wide range of disciplines and staff expertise previously seldom used for what would ordinarily be considered simple facilities planning.... These may include, among other things, NC [numerical control] programming, software and systems expertise, fixtures and tooling, machine control, labor relations, and/or personnel.

Two of the quantitative studies also suggest the importance of inter-departmental cooperation and communication. First, Bikson and others, (1987) assessed the relationship between four structural group characteristics (centralization, formalization, fragmentation, and openness of communications) and implementation success (use, satisfaction, and performance). Only openness of communication, they report, was "positively (albeit not significantly) related to all three types of success indicators" (Bikson et al., 1987, p. 20).

Tjosvold's (1990) critical incidents study highlights the benefits of cooperation. Tjosvold (1990) used a critical incidents technique to gather interview data from 50 sales employees. Employees were asked to generate detailed examples of when they had solved a problem with their new computerized scanning system effectively and of when they had been unable to solve problems with the new technology effectively. Interviewees were then asked to rate each incident as involving cooperative, competitive, or independent goal interdependencies between themselves and others involved in the incident. Tjosvold (1990, p. 1123) found that:

> To the extent employees believed their goals were cooperative, they had positive expectations prior to the interaction, interacted constructively, worked efficiently, made progress solving the problem, and developed confidence they could work with the other in the future.

In summary, the research suggests that a common characteristic of most new computerized technologies is that they integrate departments and work areas that may have previously had little task-related contact. Therefore, interdepartmental cooperation may influence the success or failure of technology implementation.

Technology Quality and Availability

The existing research suggests that the quality of the technology software and hardware and the accessibility of computer workstations can affect the success of the technology implementation. Technology quality and availability were mentioned as important variables for implementation success in 61 percent of the qualitative studies we reviewed.

For example, based on their visits to companies implementing robotics, Foulkes and Hirsch (1984, p. 96) report that:

> In locations where robots didn't work and had to be dismantled, constant breakdowns undermined morale and destroyed the employee enthusiasm that characterizes successful projects.

Based on their survey and interview research on the implementation of CAD/CAM with "more than two hundred managers and operating-level employees" (Beatty & Gordon, 1988, p. 25) (no further description provided), Beatty and Gordon (1988, p. 32) concluded that:

> Lack of system compatibility was the major technical barrier to implementation. Incompatibility created a kind of Tower of Babel effect: different computer systems used incompatible software mounted on different hardware. Communication was possible in only the most fortunate of circumstances.

Summarizing from her interviews and questionnaires from "10 large business firms" (Rivard, 1987, p. 26) implementing information systems, Rivard (1987) listed the "user-friendliness of the software tools" as one of the key contributors to user satisfaction with computing. Rivard (1987, pp. 26-27) defines a user-friendly information system as:

> One that requires the user to learn only a few new concepts and easy-to-remember and meaningful keywords in order to get started. The tool should be powerful, allowing the user to develop large and complex applications that are easy to modify. A user-friendly tool should also be integrated, perhaps incorporating a data-base management system with a query language, a report generator, modeling facilities, and the ability to ensure data integrity and validity. Meaningful and helpful error messages contribute to user-friendliness, as does a high quality user manual.

Other qualitative studies highlight the importance of the accessibility of the computer technology for implementation success. For example, based on her summary of the Office of Technology Assessment case studies, Rousseau (1989, p. 47) states:

> Access to equipment is part of efficient utilization of training resources. There is little learning without practice; for this equipment must be readily available.

Likewise, based on their descriptive case study of the implementation of office automation at Westinghouse, which included survey results of a company administered questionnaire regarding the technological change process, Lederer, Stubler, Sethi, and Ryan (1987, p. 83) suggest:

> A terminal should be placed on each user's desk. All 40 subjects in the experimental group had terminals at their desks. Such personal access might well be the major reason the system was used despite the users' job pressures.

Four of the quantitative studies we reviewed examined the effects of technology characteristics (including user friendliness and accessibility) on implementation success. Bikson, and othes, (1987) found that several perceived software characteristics (e.g., software modifiability and functionality) were significantly positively related to use of the computer system and user satisfaction. Conversely, having to share a computer terminal was significantly negatively related to employee use and satisfaction.

Similarly, in a survey study of 142 employees involved in the implementation of a decision support system, Lucas and others (1990) found that user assessment of the technology was significantly positively related to user acceptance and ease of access or proximity to the technology was significantly positively related to use.

Fleischer and others (1988) found that when the potential use of advanced three dimensional computer-aided design features was high, the number of designers per terminal was significantly negatively related to use.

Finally, research by Leonard-Barton and Deschamps (1988) provides an important qualifier to the technology accessibility—technology use relationship. In their quantitative study of 93 salespeople using an expert system software package, they found that computer accessibility was a significant and important determinant of use for those employees high in innovativeness, job-determined importance of the technology innovation, subjective importance, and software use skills, but not for salespeople low in these characteristics.

In sum, the research suggests that technology quality and accessibility play a significant role in user acceptance and actual use of the technology.

Summary

There is widespread agreement among computerized technology implementation researchers that the following nine factors may have a significant impact on the success of technology implementation: (1) training, (2) user support, (3) time to experiment with the new technology, (4) top management support for the new technology, (5) user involvement, (6) rewards, (7) job security, (8) cooperation, and (9) the quality and availability of the technology. This list, and the research reviewed above, amply demonstrates the complexity of computerized technology implementation. Each of the nine factors reviewed above may, the research suggests, cause the implementation process to go awry. Thus, existing research provides a useful set of guidelines for managers in charge of computerized technology implementation—a checklist of factors to which implementation managers should attend. And yet, as the basis for a fully developed theory of implementation or for more sophisticated research on the topic, the research reviewed above is less helpful. Next, we pose eight questions that we believe must be addressed and answered if the field is to move from lists to theory and from exploratory research to hypothesis-testing research.

QUESTIONS FOR FUTURE THEORY AND RESEARCH ON COMPUTERIZED TECHNOLOGY IMPLEMENTATION

1. When does implementation begin and when does it end?

Standard definitions of implementation, such as the one we provided at the beginning of the chapter, place implementation *after* adoption. Other observers (e.g., Walton, 1989), however, consider adoption processes part of the implementation process. Thus, for example, they consider user involvement in the decision to purchase the new technology a critical implementation process. Still others (e.g., Leonard-Barton, 1988) devote considerable attention to user involvement in the development of the new technology and yet consider such user involvement in the development part of the implementation process.

We will not attempt to provide a definitive answer to the question of when implementation begins here. Indeed, as we discuss in brief below, the onset of implementation may differ from computerized technology to computerized technology. Nevertheless, the question of when implementation begins is important for two reasons. First, without some common understanding of when implementation begins, scholars working in this area may unknowingly use the term implementation to refer to differing innovation stages and processes, thus making the integration of implementation studies and reviews very difficult. Second, without a common understanding of when implementation begins, researchers have little to guide them in designing implementation research: When must they begin their research if they are truly to study implementation processes?

The question of when implementation ends is no more resolved. Standard descriptions of the stages of innovation (e.g., Nord & Tucker, 1987; Tornatzky & Fleischer, 1990; Yin, 1979) assert that implementation ends with routinization, but operationalizing routinization may be difficult. Further, this definition appears to assume that implementation is successful; if users fail to use the new technology, then by definition the new technology is not routinized. The question of when implementation ends is further complicated by questions regarding how one should conceptualize, and when one should assess, the effects of computerization. Are studies of computerization effects implementation studies? Finally, as above, the absence of a common understanding of when implementation ends leaves implementation researchers uncertain of what they must study, and for how long, to assess implementation adequately.

2. Can the list of nine implementation factors reviewed above be rendered more parsimonious? Should it be?

The list of nine implementation factors, reviewed above, lacks a certain conceptual elegance. Although useful, perhaps especially for practitioners, lists like the one above are not theories (Bacharach, 1989). Thus, many would argue that to begin the move from list to theory, the length of the list above should be shortened and its explanatory power increased.

We perceive two possible strategies to both shorten the list and increase its explanatory power. Both require an exploration of the processes that mediate between the nine factors and implementation failure and success: How do the nine factors influence the dynamics and outcomes of computerized technology implementation?

One potential answer to this question, we believe, is that the implementation factors reviewed above determine the level of employee *ability and motivation* to use the new technology, two presumably critical variables for implementation success. That is, employee ability and motivation to use the new technology mediate the link between the nine implementation factors and implementation success and failure; if users are not able *and* motivated to use the new technology, they surely will not use the technology and implementation will fail. As suggested in our review above, three of the nine factors appear likely to determine the level of user ability to operate the new technology: training, user support, and time to experiment with the new technology. Four of the nine factors appear most likely to determine the level of user motivation to operate the new technology: top management support for the new technology, user involvement, rewards, and job security. The remaining two characteristics are not so easily categorized. Intergroup coordination

may, however, affect motivation to use the new technology insofar as users may or may not want to cooperate with other organizational groups. Further, if cooperation between groups is poor, reducing the potential benefits of technology use, this too may lessen employee motivation to use the new technology. Technology quality and availability seems likely to affect both motivation and ability. That is, the more user-friendly and accessible the new technology, other things being equal, the more motivated employees are likely to be to use the new technology. Further, the more user-friendly and accessible the new technology, the more skilled employees are likely to be in using the technology (relative to the level of skill needed to operate the technology effectively). Researchers may wish to test this conceptualization by assessing the relationship among the nine implementation factors, employee motivation and ability to use the new technology, and various measures of implementation failure and success.

A second possibility is to conceptualize organizational climate—and more specifically, the organizational climate for implementation—as the mediating link between the nine implementation factors and implementation success. Schneider (1990, p. 384) defines climate as "incumbents' perceptions of the events, practices, and procedures and the kinds of behaviors that get rewarded, supported, and expected in a setting." Further, he links climate to strategy, arguing that employees' climate perceptions constitute employees' conclusions about the imperatives of the setting:

> Management...makes choices, implicitly or explicitly, to adopt certain practices and procedures and to reward and support certain behaviors such that even implicit goals become clear to the organization's employees. These practices and procedures and the activities and behaviors that get rewarded and supported play a critical function in organizations-they are the criteria on which employees base their work decisions (Schneider, 1990, p. 403).

According to this perspective, then, the nine factors identified above define the organization's or work unit's climate for implementation. This climate may be relatively weak if, for example, training is sporadic, user involvement is minimal, top management support is negligible, and so on. Or, the climate for implementation may be very strong if training, user involvement, top management support and the remaining implementation factors are optimized. To explore this conceptualization, researchers may wish to assess the relationship among the nine factors, the perceived climate for implementation, and various measures of implementation success and failure.

Clearly, it will take more to build a theory of computerized technology implementation than evoking ability and motivation, or climate for implementation. Nevertheless, we have tried to indicate two possible routes the field might take to begin to build implementation theory and to design more sophisticated research. We should note, of course, that the two explanatory mechanisms we have described are quite compatible. Indeed, a climate for implementation may create employee motivation and ability to use the new technology. Further, other analysts (e.g., Goodman et al., 1990) have proposed somewhat similar sets of processes that mediate the implementation process.

Our discussion in this section thus far implies that the complexity and length of the list of implementation factors, as a whole, should be reduced. An alternative strategy is to disassemble the list—to treat each factor in isolation. This allows the implementation observer to produce a more finely-grained and detailed analysis of the factor of interest. Thus, for example, Goodman, and others (1990) distinguish among four types of training (although they use the term "socialization"): structured, formal training; structured, informal training; less structured, formal training; and less structured, informal training. Their analysis highlights the differing consequences of each of these types of training for user skills and attitudes. In a somewhat similar vein, Leonard-Barton and Sinha (1990) distinguish among four types of user-involvement in internal or in-house software development projects: (1) delivery mode (in which user involvement is low during the early and late stages of the project), (2) consultancy (in which user involvement is moderately high throughout the project), (3) lagged co-development (in which user involvement is initially low, but increases greatly during the later stages of the project), and (4) co-development (in which user involvement is very high throughout the project). Their analysis highlights the differing consequences of each of these forms of user involvement for user satisfaction with various aspects of the technology.

We have described several ways to begin the movement from variable list to implementation theory. Our key point, however, is that it is time to begin this movement. The empirical literature

reviewed in the main body of the chapter provides a valuable basis for further theory development.

3. What is the relationship among the dimensions or criteria of implementation success?

Early in the paper, we identified three dimensions or criteria of implementation success: employee use of the new technology, improvements in employee, group, or organizational performance, and employee acceptance of the new technology. A true theory of computerized technology implementation would specify the causal inter-relationships among the three constructs. Unfortunately, their likely inter-relationship is far from certain.

Perhaps, for example, use of the new technology leads to improvements in performance, which in turn leads to employee acceptance. Alternatively, employee acceptance may lead to use which in turns leads to performance improvements. Further complicating this issue, employees may use the new technology (under pressure or duress), but not in fact accept or endorse the new technology. Further, use of the new technology may or may not lead to performance improvements. Indeed, recent research on office automation suggests that use of office automation often fails to increase organizational productivity (Attewell, 1985, 1990; U.S. Congress, Office of Technology Assessment, 1985; Schneider & Klein, 1994). Finally, the predictors of technology use, performance improvements following technology implementation, and employee acceptance of the new technology may or may not be the same. We cannot hope to resolve these issues here, but only suggest that the outcomes of implementation warrant greater attention.

4. How should the longitudinal nature of the implementation process be conceptualized and assessed?

Surprisingly little of the existing research on computerized technology implementation is longitudinal. Nor are the vast majority of the existing conceptual analyses of computerized technology implementation expressly longitudinal in nature. Thus, the field knows very little about the over-time processes and dynamics of computerized technology implementation. How do employee perceptions of and reactions to new computerized technology change over time? If employees are initially critical of the new technology and the implementation process, under what circumstances do they develop more favorable assessments? What are the triggers that lead managers to change their implementation strategies, to increase user involvement, training, time to experiment, or rewards for technology use? Further, as asked previously, which comes first: use, acceptance, or performance improvements? We have no answers to these questions, but can only suggest that these questions, too, warrant greater attention.

5. Is the process of implementation the same for all computerized technologies?

In our review, we have combined studies of the implementation of computer-aided design, office automation, robotics, and more without regard to the specific technology in question. Indeed, the nine factors identified above appear influential for the successful implementation of any computerized technology. Nevertheless, like Goodman (1986), we question the appropriateness of blithely disregarding the nature of the specific technology in question.

To our knowledge, the field lacks a widely accepted schema to categorize computerized technologies. Indeed, the dimensions by which one might sort computerized technologies, to say nothing of the relationship of these dimensions to implementation processes, are far from clear. Thus, we do not know to what extent word-processing systems, robots, electronic mail systems, computer-aided design systems, and manufacturing resource planning systems share common characteristics and dimensions, nor to what extent the processes of implementing these systems are alike or different.

The innovation and organizational change literatures (e.g., Beyer & Trice, 1978; Hage, 1980; Ledford, Mohrman, Mohrman, & Lawler, 1989; Nord & Tucker, 1987), however, may shed some light on the commonalities and disparities of implementing different computerized technologies. These literatures suggest that the more complex and radical an innovation, the more difficult it is to implement the innovation. Surely, the more complex and radical the computerized technology, the more difficult it will be to implement and thus, the greater the consequences of the nine factors reviewed above. For example, the more complex the computerized technology, it seems to us, the more important training, user support, and time to

experiment with the new technology for successful technology implementation. The more radical the computerized technology, it seems to us, the more important top management support, user involvement, and rewards for using the new technology are likely to be for successful implementation.

An alternative approach to addressing this question is to proceed deductively from the existing research. Thus, one might examine to what extent each of the nine factors reviewed above is emphasized within studies of differing technologies. Job security, for example, is probably discussed more often in the context of manufacturing technology implementation studies than office automation implementation studies. Further, the existing literature suggests that the implementation process may differ from computerized technology to computerized technology. For example, studies of technologies that are developed in-house emphasize the importance of a substantial period of user involvement in the design or, perhaps, re-design of the system (Leonard-Barton, 1988). This aspect of implementation is likely to be less extensive, less salient, and less important for turn-key technologies purchased from vendors outside the adopting and implementing organization.

6. What is the relationship between the effects of computerized technology and computerized technology implementation?

Just as the literature on computerized technology implementation is growing steadily, so too is the literature examining the effects of computerization—on productivity (e.g., Brooks, 1982; O'Neill, 1983), job characteristics (e.g., Adler, 1987; Boddy & Buchanan, 1982), organizational structure (e.g., Child, 1987; Rockhart & Short, 1989), and employee stress (e.g., Danziger, 1985; Riche, 1982; Shaiken, 1984). Many studies of the effects of computerization (e.g., Kiesler, 1986) pay little or no attention to the implementation process.

Many researchers who study computerized technology *implementation* argue, however, that the *effects* of computerization can not be meaningfully examined *except in the context of implementation.* These analysts argue that computerized systems have few inviolate, predetermined consequences. Rather, they suggest, the effects of a given computerized technology depend on how the technology is implemented in the specific setting. Goodman and others, (1990, pp.

52-53) comment, for example:

> Social constructions of the technology are the result of three variables: the technology itself, the organizational context and history, and the implementation process. We think the process of implementation is an important variable, which is omitted in many analyses of the impact of technology on the individual.... The process of introducing technological change is independent of the technology, and yet the process is the major way people learn and, hence, construct an image of the technology.

In a similar vein, Zuboff (1988) suggests that the very same technology may have the effect of de-skilling (automating) workers' jobs or enriching ("informating") them, depending in large part upon how the organization chooses to implement the technology. Finally, a close reading of Barley's (1986) study of the social construction and consequences of the adoption of computed tomography (CT) scanners in two hospitals suggests that the differing consequences of the adoption of the same technology in the two hospitals may reflect varying implementation processes, including differences in the way each hospital selected and trained personnel to use the new technology.

Thus, we support the view that it is difficult to assess and interpret the impact of a given computerized technology in a given setting without a thorough understand of how that technology was implemented in that setting. We must note, however, that this is a very limited proposition. Which aspects of the implementation process affect which consequences of computerization? Further, do some aspects of the technology have invariant consequences for users and organizations? These questions warrant future theoretical and empirical attention.

7. What is the appropriate level of analysis for research and theory on computerized technology implementation?

As noted above, few works on computerized technology implementation expressly define the target level of analysis or theory. Many writers (e.g., Dansereau, Alutto, & Yammarino, 1984; Glick & Roberts, 1984; Klein, Dansereau, and Hall, 1994; Rousseau, 1985) have observed, however, that a failure to identify a target level of analysis or theory reduces the specificity and theoretical rigor of a work. When theorists fail to specify the level of theory, testing the

theory empirically may prove difficult. Thus, for example, it is not entirely clear about what level—individual, group, or organization—Goodman and others (1990, p. 48) conceptual model of the "individual-technology relationship" should be operationalized. Similarly, when researchers adopt a level of statistical analysis with little reference to the level of theory, the research may lack conceptual rigor. For these reasons, then, we encourage writers in this area to more precisely specify the level of theory and analysis for their work. Our goal here is not to specify *the* level of theory and analysis for work on computerized technology implementation, but only to review several possibilities and to thereby foster greater attention to levels of analysis issues in this area of work.

Research and theory on computerized technology implementation might, for example, assume an individual level of analysis focusing on individual attitudes towards computerization, cognitive skills, and/or related individual differences. In keeping with our emphasis on the organizational dynamics of computerized technology implementation, a researcher or theorist might choose an individual level of analysis but examine individual-organizational interactions, for example, the interaction of cognitive ability and training, or of computer-related self-efficacy and management support for computerization.

A second possible level of analysis and theory is the group, the level chosen by Bikson and her colleagues (e.g., Bikson et al., 1987). In such a case, the researcher or theorist focuses on differences in computer use and related variables among the groups. The researcher thus aggregates individual-level data to the group level or collects data that are inherently at the level of the group (e.g., changes in group performance as a function of computerization).

A third option is to choose the organizational level of analysis in an effort to explain, theoretically or empirically, between-organization (not between-group or between-individual) differences in implementation. Thus, for example, one might seek to explain why a given technology is implemented successfully in some organizations but not others. How and why, for example, do some organizations build a stronger climate for computerized technology implementation than others?

As we suggested above, any one of these three choices—and there may be others as well—is viable. The key is to choose explicitly the level of one's theory and analysis.

8. What is unique about the implementation of computerized technologies? Is the process any different from the implementation of other innovations?

There is, we think, no simple answer to these questions. On the one hand, the implementation of computerized technologies probably shares much in common with the implementation of other non-computerized and/or non-technological innovations. On the other hand, many aspects of computerized technologies make them, if not unique, at least unusual among typical organizational innovations. We explore briefly these points of view, later.

As we noted in the opening section of this paper, *implementation* has received far less attention in innovation literature than *adoption.* Thus, the innovation literature provides relatively little guidance for the literature on computerized technology implementation. Nevertheless, several organizational factors commonly identified as predictors of the implementation of innovations in general—particularly, top management support for the innovation (e.g., Angle & Van de Ven, 1989; Nadler & Tushman, 1989; Nutt, 1986) and employee involvement and input in the implementation process (e.g., Nord & Tucker, 1987; Nutt, 1986)—are also prominently identified as predictors of the implementation of computerized technologies in the literature reviewed above. This alone suggests that the implementation of computerized technologies is to a considerable extent a generic organizational change process.

And yet, as suggested above, computerized technologies are distinctive technologies in many respects. First, computerized technologies commonly have a major impact on how the members of an organizational work unit carry out their daily tasks. In this sense, computerized technologies have a central and substantial impact on an organizational unit; they are relatively rarely peripheral interventions in the workplace. Other, non-computerized, non-technological, innovations may be quite peripheral to how an organizational unit's work is done. Employee ownership (Klein, 1987), for example, has very little if any impact on how organizational members carry out their work tasks. Accordingly, the implementation of computerized technologies is perhaps more likely to be met with employee and organizational resistance than the implementation of other workplace innovations. Computerized technologies alter organizational members' daily routines; these technologies hit close to home.

Second, many computerized technologies have substantial spillover effects upon numerous aspects of organizations. Thus, the implementation of computerized technologies may ultimately alter not only the way work is done, but job characteristics, pay levels, selection, training, and performance appraisal systems, organizational power bases, and even organizational culture (Koppel, Appelbaum, & Albin, 1988; Lund & Hansen, 1986; Majchrzak, 1988; Osterman, 1991). Again, many non-computerized, non-technological innovations may have far more limited effects upon organizations. Employee ownership is again a prime example. Thus, the implementation of computerized technologies may be more complex than the implementation of other innovations with less pervasive effects upon organizations.

Third, the very nature of a given computerized technology varies from setting to setting. Thus, as suggested above, the very same computerized system may have quite different characteristics and consequences depending upon the implementation practices and characteristics of the adopting unit. In contrast, many other non-computerized, non-technological innovations may be relatively invariant across settings. This too may make the implementation of computerized technologies particularly complex. A larger number of organizational actors may seek to influence the shape of the innovation and its implementation if the innovation is a computerized technology rather than some other innovation. Further, implementation researchers' and theorists' tasks are complicated by the variability of the computerized technological innovation.

Fourth, the implementation of computerized technologies is often led, not by senior managers, but by technical experts (Dean, 1987). While these technical experts may have the requisite knowledge to manage the technical aspects of the innovation, they may lack the power to motivate organizational members. The implementation of other, non-computerized, non-technological innovations is perhaps more likely to be led by senior managers, more central to the organizational power structure. As a result, the implementation of computerized technologies may be slower and more riddled with political in-fighting than the implementation of non-technical innovations.

Fifth, computerized technologies, unlike many other organizational innovations (e.g., quality circles) are literally tangible; they have a physical presence. As a result, computerized technologies may be less likely to "die off" or "fade away" (see Lawler & Mohrman,

1985) than other, less tangible innovations. This may render the implementation of computerized technologies easier, or at least more urgent, than the implementation of other, non-tangible innovations.

Finally, organizations incur huge financial costs in adopting and implementing computerized technologies. In contrast, it may be far cheaper to adopt and implement non-computerized, non-technological innovations (e.g., quality circles). This, too, may render the implementation of computerized technologies easier, or at least more urgent, than the implementation of other, less expensive innovations. The expense of computerized systems may escalate organizational managers' commitment to the innovation.

It is not clear what effect the six characteristics of computerized technology implementation described above have, in combination, on the implementation process. Do they render computerized technology implementation easier or harder, simpler or more complex than the implementation of other, non-computerized, non-technological innovations? The field awaits further theoretical and empirical work to answer this question. But, clearly this is an important question to answer; the answer is likely to further clarify, delimit, and legitimate the study of computerized technology implementation.

CONCLUSION

The research literature on computerized technology implementation is still young. It lacks an established theoretical paradigm. It even lacks an established outlet; its results are published in disparate books and journals. And yet, as our review shows, there is significant coherency to the field—significant agreement among the research results. The time is ripe to advance work in this area still further, to build theoretical models and tests of hypothesized relationships. We hope that by highlighting the common findings in the field as well as several key questions that remain to be addressed in theory and research, we have provided at least a small stepping stone to more rigorous theory and research on this important topic. When computerized technology implementation succeeds, its consequences may touch virtually every aspect of the implementing organization. When computerized technology implementation fails, the implementing organization suffers substantial financial and psychological costs. Thus, gaining a better understanding of the determinants of implementation success and failure is of both theoretical and practical value.

Appendix: Qualitative Research on the Implementation of Computerized Technology

	General Description				Implementation Outcomes			Implementation Practices & Processes									
Study	Technology	N of Organizations	N of Individuals	Technology Use	Org. Performance	Employee Reactions	Training	User Support	Time to Experiment	Top Mgt. Support	User Involvement	Rewards	Job Security	Cooperation	Tech. Qual/Avail.
Argote, Goodman, & Schkade, 1983	Robots	1	92			X	X			X	X	X	X		
Beatty & Gordon, 1988	Computer-Aided Design & Manufacturing	?	200	X	X	X	X	X				X		X	X
Blumberg & Gerwin, 1984	Computer-Aided Mfg.	5	7	X	X	X						X			X
Ettlie, 1986	Programmable Manufacturing	41	55	X	X	X	X			X	X				X
Foulkes & Hirsch, 1984	Robots	"Many"	?		X	X	X				X		X		X
Gerwin, 1982	Computer-Aided Manufacturing	6	35	X	X						X				
Graham & Rosenthal, 1986	Flexible Manufacturing Systems	8	?	X	X		X	X	X					X	X
Klein, Hall & Laliberte, 1990	Computer-Aided Design	1	26	X		X	X	X	X	X		X			X
Lederer, Stubler, Sethi, & Ryan, 1987	Office Automation	1	?	X	X	X	X	X		X	X				X
Leonard-Barton, 1988	Expert System	1	?	X	X	X					X				X
Leonard-Barton & Krauss, 1985	Internally Developed Tech.	20	?	X	X	X				X	X	X			

Appendix 1. (Continued)

	General Description			Implementation Outcomes			Implementation Practices & Processes								
Study	Technology	N of Organizations	N of Individuals	Technology Use	Org. Performance	Employee Reactions	Training	User Support	Time to Experiment	Top Mgt. Support	User Involvement	Rewards	Job Security	Cooperation	Tech. Qual/Avail.
Markus, 1987	Financial Info. System	1	?			X				X					X
McKersie & Walton, 1991	Information technology	6	7		X		X			X	X		X	X	
Rivard, 1987	End-user Computing	10	95		X	X	X	X		X					X
Roitman, Liker & Roskies, 1988	Computer-Integrated Mfg.	1	60	X	X	X									
Rousseau, 1989	Office Automation	5	?	X	X	X	X	X	X	X	X	X			X
Schaffitzerl & Kersten, 1985	Computer-Aided Design	20	?	X	X	X	X				X				
Zuboff, 1988	Information Technology	8	7	X	X	X	X		X		X	X		X	

Note: A question mark (?) indicates that the author(s) provided no information either about the number of organizations studies or about the number of individuals interviewed.

Appendix 2: Quantitative Research on the Implementation of Computerized Technology

	General Description							Implementation Outcomes			
Study	Technology	N of Organizations	N of Groups	N of Individuals	LOA = Individual	LOA = Group	LOA = Organization	Technology Use	Org. Performance	Employee Reactions	Principal Findings
Baronas & Louis, 1988	Management Information	35		92	X					X	Treatment group members received a user involvement intervention designed to increase perceived user control through educational information, discussion of potential user concerns and sensitization of the implementation team to control issues. Treatment group members were more satisfied with the new technology and with the implementation team than control group members.
Bikson, Gutek & Mankin, 1987	Office Automation	26	55	530		X		X	X	X	Implementation outcomes were significantly positively related to implementation process characteristics (e.g., user involvement, support for learning) and several technology characteristics (e.g., ease of access to the computer). Organizational characteristics (e.g., formalization, job characteristics) were more weakly related to implementation outcomes.

(continued)

Appendix 2. (Continued)

Study	Technology	General Description: N of Organizations	N of Groups	N of Individuals	LOA = Individual	LOA = Group	LOA = Organization	Implementation Outcomes: Technology Use	Org. Performance	Employee Reactions	Principal Findings
Chao & Kozlowski, 1986	Robots	1		461	X					X	Perceiving robots to be a threat to their job security, low skilled employees expressed more negative attitudes towards the impending implementation of robots than did more highly skilled employees.
Ettlie & Rubenstein, 1980	Numerically controlled production routers	4		19			X	X	X		Implementing organizations with prior experience with the new technology used the technology earlier than organizations without prior experience. Employees in organizations with prior experience with the technology felt less stress than employees in organizations without prior experience.
Fleischer, Liker, & Arnsdorf, 1988	Computer-aided Design & Computer-Aided Engineering	6	153	473	X	X		X	X	X	Less pressure to learn, more time to learn the system, more user input about changes, and fewer designers per terminal were associated with greater and more appropriate use of the computer-aided design system.
Ginzberg, 1981	Management Information	1		35	X			X		X	Employees who held realistic pre-implementation expectations about a new MIS technology used the system more heavily and were more satisfied with it than those who held less realistic expectations.

Study	Technology	N of Organizations	N of Groups	N of Individuals	LOA = Individual	LOA = Group	LOA = Organization	Technology Use	Org. Performance	Employee Reactions	Principal Findings
Leonard-Barton & Deschamps, 1988	Expert System	1	X				93	X			Perceived management support for using the technology was positively related to employee use of the technology only for employees low in personal innovativeness, job-determined importance of the technology, subjective importance of the task, task related skills, and performance.
Lucas, Ginzburg, & Schultz, 1990 (Study 1)	Decision Support System	1		412	X			X		X	User perceptions of management support for the system, organizational change caused by the system, and urgency of the problems addressed by the system were all related to user personal stake in the system.
Lucas, Ginzberg & Schultz, 1990 (Study 2)	Decision Support System	1		142	X			X		X	User perceptions of management support for the system, organizational change caused by the system, and urgency of the problems addressed by the system were all positively related to user personal stake in the system. In addition, use of the system was related to user personal stake in the system and ease of access to the system.
Parsons, Liden, O'Connor, & Nagao, 1989	Office Automation	1		105	X				X	X	Implementation outcomes were significantly positively related to user involvement (e.g., contract with vendor and other organizational personnel regarding the new technology).
Tjosvold, 1990	Scanning Information	1		50	X				X		Employees who said they had cooperative goals during a recent attempt to solve a problem with the scanning system reported they had positive expectations prior to the inter-action, worked efficiently, made progress, and were confident they could work with the other person again.

Note: LOA [illegible]

REFERENCES

Adler, P. (1987). New technologies, new skills. *California Management Review, 29,* 9-28.

Amabile, T. M. (1988). A model of creativity and innovation inorganizations. In B.M. Staw & L.L. Cummings (Eds.), *Research in organizational behavior* (Vol. 10, pp. 123-168). Greenwich, CT: JAI Press.

Angle, H., & Van de Ven, A. (1989). Suggestions for managing the innovation journey. In A. Van de Ven, H. Angle, & M. S. Poole (Eds.), *Research on the management of innovations: The Minnesota studies* (pp. 663-697). New York: Harper & Row.

Argote, L., Goodman, P. S., & Schkade, D. (1983). *The human side of robotics: Results from a prototype study on how workers react to a robot.* Report No. 83-11, Pittsburgh, PA: Carnegie-Mellon University, The Robotics Institute.

Attewell, P. (1985). *The automated office: A case study.* Unpublished paper. Stony Brook, NY: SUNY, Department of Sociology.

Attewell, P. (1990). *Information technology and the productivity paradox.* Unpublished paper. New York: CUNY, Graduate Center Department of Sociology.

Bacharach, S. (1989). Organizational theories: Some criteria for evaluation. *Academy of Management Review, 14,* 496-515.

Barley, S. R. (1986). Technology as an occasion for structuring: Evidence from observations of CT scanners and the social ordering of radiology departments. *Administrative Science Quarterly, 31,* 78-108.

Baronas, A. M. K., & Louis, M. R. (1988). Restoring a sense of control during implementation: How user involvement leads to system acceptance. *MIS Quarterly, 12,* 111-123.

Beatty, C. A., & Gordon, J. R. M. (1988). Barriers to the implementation of CAD/CAM systems. *Sloan Management Review, 29*(4), 25-33.

Beyer, J. M., & Trice, H. M. (1978). *Implementing change.* New York: The Free Press.

Bikson, T. K., Gutek, B. A., & Mankin, D. A. (1987). *Implementing computerized procedures in office settings.* Santa Monica, CA: The Rand Corporation.

Boddy, D., & Buchanan, D. (1982). Information technology and the experience of work. In L. Bannon, U. Barry, & O. Holst (Eds.), *Information technology: Impact on the way of life* (pp. 144-157). Dublin: Tycooly International Publishing.

Borgman, C. L. (1986). Why are online catalogs hard to use? Lessons learned from information-retrieval studies. *Journal of the American Society for Information Science, 37,* 387-400.

Brooks, H. (1982). Social and technological innovation. In S.B. Lundstedt & E. W. Colglazier, Jr. (Eds.), *Managing innovation: The social dimensions of creativity, invention and technology* (pp. 1-30). New York: Pergamon Press.

Carroll, J. M., & Carrithers, C. (1984). Blocking learner error states in a training-wheels system. *Human Factors, 26,* 377-389.

Chao, G. T., & Kozlowski, S.W.J. (1986). Employee perceptions on the implementation of robotic manufacturing technology. *Journal of Applied Psychology, 71,* 70-76.

Child, J. (1987). Information technology, organization, and response to strategic challenges. *California Management Review, 30,* 33-50.

Chrysler, E. (1978). Some basic determinants of computer programming productivity. *Communications of the ACM, 21,* 472-483.

Dansereau, F., Alutto, J. A., & Yammarino, F. J. (1984). *Theory testing in organizational behavior: The varient approach.* Englewood Cliffs, NJ: Prentice-Hall.

Danziger, J. N. (1985). Social science and the social impacts of computer technology. *Social Science Quarterly, 66,* 3-21.

Dean, J. W., Jr. (1987). *Deciding to innovate.* Cambridge, MA: Ballinger.

Dean, J. W., Jr. (1987). Building the future: The justification process for new technology. In J.M. Pennings & A. Buitendam (Eds.), *New technology as organizational innovation* (pp. 35-58). Cambridge, MA: Ballinger.

Ettlie, J. E. (1986). Implementing manufacturing technologies: Lessons from experience. In D. Davis (Ed.), *Managing technological innovation* (pp. 72-104). San Francisco: Jossey-Bass.

Ettlie, J. E., & Rubenstein, A. H. (1980). Social learning theory and the implementation of production innovation. *Decision Sciences, 11,* 648-668.

Fleischer, M., Liker, J., & Arnsdorf, D. (1988). *Effective use of computer-aided design and computer aided engineering in manufacturing.* Ann Arbor, MI: Industrial Technology Institute.

Foulkes, F. K., & Hirsch, J. L. (1984). People make robots work. *Harvard Business Review, 62* (1), 94-102.

[illegible]ist, M., Schwoerer, C., & Rosen, B. (1989). Effects of alternative training methods on self-efficacy and performance in computer software training. *Journal of Applied Psychology, 74,* 884-891.

[illegible]aser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory.* Chicago: Aldine Publishing Company.

[illegible]ck, W. H., & Roberts, K. (1984). Hypothesized interdependence, assumed independence. *Academy of Management Review, 9,* 722-735.

[illegible]mez-Mejia, L., Egan, O. E., & Bowers, C. (1988). Learning to use a text editor: Some learner characteristics that predict success. *Human-Computer Interaction, 2,* 1-23.

[illegible]odman, P. S. (1986). Impact of task and technology on group performance. In P.S. Goodman & Associates (Eds.), *Change in organizations* (pp. 1-46). San Francisco: Jossey-Bass.

[illegible]odman, P. S., Griffith, T. L., & Fenner, D. B. (1990). Understanding technology and the individual in an organizational context. In P.S. Goodman & L.S. Sproull (Eds.), *Technology and organizations* (pp. 45-86). San Francisco: Jossey-Bass.

[illegible]ham, M.B.W., & Rosenthal, S. R. (1986). Flexible manufacturing systems require flexible people. *Human Systems Management, 6,* 211-222.

[illegible]e, J. (1980). *Theories of organizations.* New York: John Wiley & Sons.

Hall, G. E., & Loucks, S. F. (1977). A developmental model for determining whether the treatment is actually implemented. *American Educational Research Journal, 14,* 263-276.

Hayes, R. H., & Jaikumar, R. (1988). Manufacturing's crisis: New technologies, obsolete organizations. *Harvard Business Review, 66*(5), 77-85.

Irons, D. M. (1982). Cognitive correlates of programming tasks in novice programmers. *Proceedings of the Human Factors in Computer Systems* (pp. 219-222). New York: ACM.

Kanter, R. M. (1988). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organization. In B.M. Staw & L.L. Cummings (Eds.), *Research in Organizational Behavior* (Vol. 10, pp. 169-211). Greenwich, CT: JAI Press Inc.

Kiesler, S. (1986). The hidden messages in computer networks. *Harvard Business Review, 64*(1), 2-8.

Klein, K. J. (1987). Employee stock ownership and employee attitudes: A test of three models. *Journal of Applied Psychology* [*Monograph*], *72,* 319-332.

Klein, K.J., Dansereau, F., & Hall, R.J. (1994). Levels issues in theory development, data collection and analysis. *Academy of Management Review, 19,* 195-229.

Klein, K. J., Hall, R. J., & Laliberte, M. (1990). Training and the organizational consequences of technological change: A case study of computer-aided design and drafting. In U.E. Gattiker & L. Larwood (Eds.), *Technology and end-user training* (pp. 7-35). New York: Walter de Gruyter.

Koppel, R., Appelbaum, E., & Albin, P. (1988). Implications of workplace information technology: Control, organization of work and the occupational structure. *Research in the sociology of work, 4,* 125-152.

Koubek, R. J., LeBold, W. K., & Salvendy, G. (1985). Predicting performance in computer programming courses. *Behavior and Information Technology, 4,* 113-129.

Kozlowski, S.W.J. (1987). Technological innovation and strategic HRM: Facing the challenge of the future. *Human Resource Planning, 10*(2), 69-79.

Lawler, E. E., III, & Mohrman, S. A. (1985). Quality circles after the fad. *Harvard Business Review, 63*(1), 64-71.

Lederer, A. L., Stubler, W. F., Sethi, V., & Ryan, J. C. (1987). The implementation of office automation. *Interfaces, 17,* 78-84.

Ledford, G. E., Jr., Mohrman, S. A., Mohrman, A. M., Jr., & Lawler, E. E., III. (1989). The phenomenon of large-scale organizational change. In A.M. Mohrman, Jr., S.A. Mohrman, G.E. Ledford, Jr., T.G. Cummings, & E.E. Lawler (Eds.), *Large-scale organizational change* (pp. 1-31). San Francisco: Jossey-Bass.

Leonard-Barton, D. (1988). Implementation as mutual adaptation of technology and organization. *Research Policy, 17,* 251-267.

Leonard-Barton, D., & Deschamps, I. (1988). Managerial influence in the implementation of new technology. *Management Science, 34,* 1252-1265.

Leonard-Barton, D., & Krauss, W. A. (1985). Implementing new technology. *Harvard Business Review, 63*(6), 102-110.

Leonard-Barton, D., & Sinha, D. K. (1990). *Dependency, involvement, and user satisfaction: The case of internal software development.* Unpublished manuscript, Harvard Business School, Cambridge, MA.

Lucas, H. C. 1978. Unsuccessful implementation: The case of a computer-based order entry system. *Decision Sciences, 9* 68-79.

Lucas, H. C., Ginzberg, M. J., & Schultz, R. L. (1990). *Information systems implementation: Testing a structural model.* Norwood, NJ: Ablex Publishing Corporation.

Lund, R. T., & Hansen, J. A. (1986). *Keeping America at work: Strategies for employing the new technologies.* New York: John Wiley & Sons.

Majchrzak, A. 1988. *The human side of factory automation.* San Francisco: Jossey-Bass.

Majchrzak, A., & Klein, K. J. (1987). Things are always more complicated than you think: An open systems approach to the organizational effects of computer-automated technology. *Journal of Business and Psychology, 2,* 27-49.

Markus, M. L. (1987). Power, politics, and MIS implementation. In R.M. Becker & W.A.S. Buxton (Eds.), *Readings in Human-Computer Interaction: A Multidisciplinary Approach* (pp. 68-82). Los Altos, CA: Morgan Kaufmann.

McKersie, R. B., & Walton, R. E. (1991). Organizational change. In M.S. Scott Morton (Ed.), *The corporation of the 1990's* (pp.244-277). New York: Oxford University Press.

Malone, T. W. (1982). Heuristics for designing enjoyable user interfaces: Lessons from computer games. *Proceedings of Human Factors in Computing Systems,* 63-68.

Mobley, W. H. (1977). Intermediate linkages in the relationship between job satisfaction and employee turnover. *Journal of Applied Psychology, 62,* 237-240.

Nadler, D. A., & Tushman, M. L. (1989). Leadership for organizational change. In A.M. Mohrman, Jr., S.A. Mohrman, G.E. Ledford, Jr., T.G. Cummings, & E.E. Lawler (Eds.), *Large-scale organizational change* (pp. 100-119). San Francisco: Jossey-Bass.

Nord, W. R., & Tucker, S. (1987). *Implementing routine and radical innovations.* Lexington, MA: Lexington Books.

Nutt, P. C. (1986). Tactics of implementation. *Academy of Management Journal, 29,* 230-261.

Office of Technology Assessment. (1984). *Computerized manufacturing automation: Employment, education and the workplace.* Washington, DC: U.S. Congress (OTA-CIT-235).

Office of Technology Assessment. (1985). *Automation of America's offices.* Washington, DC: U.S. Congress (OTA-CIT-287).

Neill, G. K. (1983). *The technology edge: Opportunities for america in world competition.* New York: Simon & Schuster.

terman, P. (1991). Impact of IT on jobs and skills. In M.S. Scott Morton (Ed.), *The corporation of the 1990's: Informational technology and organizational transformation* (pp. 220-243). New York: Oxford University Press.

rsons, C. K., Liden, R. C., O'Connor, E. J., & Nagao, D. H. (1989). *Employee responses to technologically driven change: The implementation of office automation in a service organization.* Unpublished manuscript.

Riche, R. W. (1982). Impact of new electronic technology. *Monthly Labor Review, 105,* 37-39.

Rivard, S. (1987). Successful implementation of end-user computing. *Interfaces, 17*(3), 25-33.

Roberts, T. L., & Moran, T. P. (1983). The evaluation of text editors: methodology and empirical results. *Communications of the ACM, 26,* 265-283.

Roberts-Gray, C., & Gray, T. (1983). Implementing innovations: A model to bridge the gap between diffusion and utilization. *Creation Diffusion, Utilization, 5,* 213-233.

Rockhart, J. F., & Short, J. E. (1989). IT in the 1990's: Managing organizational interdependence. *Sloan Management Review, 30* (2), 7-17.

Roitman, D. B., Liker, J. K., & Roskies, E. (1988). Birthing a factory of the future: When is "all at once" too much? In R.H. Kilmann & T.J. Covin (Eds.), *Corporate transformation* (pp. 205-246). San Francisco: Jossey-Bass.

Rousseau, D. M. (1985). Issues of level in organizational research: Multilevel and cross level perspectives. In L. Cummings & B. Staw (Eds.), *Research in organizational behavior, 7,* 1-37. Greenwich, CT: JAI Press.

Rousseau, D. M. (1989). Managing the change to an automated office: Lessons from five case studies. *Office: Technology & People, 4,* 31-52. Elsevier Science Publishers Ltd.

Schaffitzel, W., & Kersten, U. (1985). Introducing CAD systems: Problems and the role of user-developer communication in their solution. *Behaviour and Information Technology, 4*(1), 47-61.

Schneider, B. (1990). The climate for service: An application of the climate construct. In B. Schneider (Ed.), *Organizational climate and culture* (pp. 383-412). San Francisco, CA: Jossey-Bass.

Schneider, B., & Klein, K. J. (1994). *What is enough? A systems perspective on individual-organizational performance linkages. In D.H. Harris (Ed.), Organizational linkages: Understanding the productivity paradox* (pp. 81-104). Washington, D.C.: National Academy Press.

Shaiken, H. (1984). *Work transformed: Automation and labor in the computer age.* New York: Holt, Rinehart, and Winston.

Tjosvold, D. (1990). Making a technological innovation work: Collaboration to solve problems. *Human Relations, 43,* 1117-1131.

Tornatzky, L. G. (1986). Technological change and the structure of work. In M.S. Pallak & R.O. Perloff (Eds.), *Psychology and work: Productivity, change, and employment* (pp. 57-83). Washington, DC: American Psychological Association.

Tornatzky, L. G., Eveland, J. D., Boylan, M. G., Hetzner, E. C., Roitman, D., & Schneider, J. (1983). *The process of technological innovation: Reviewing the literature.* Washington, DC: National Science Foundation.

Tornatzky, L. G., & Fleischer, M. (1990). *The process of technological innovation: Reviewing the literature.* Washington, DC: National Science Foundation.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management, 29*(1): 28-45.

Vincente, K. J., Hayes, B. C., & Williges, R. C. (1987). Assaying and isolating individual differences in searching a hierarchical file system. *Human Factors, 29,* 349-359.

Walton, R. E. (1989). *Up and running: Integrating information technology and the organization.* Boston, MA: Harvard Business School Press.

Yin, R. K. (1979). *Changing urban bureaucracies.* Lexington, MA: Lexington Books.

Yin, R. K. (1984). Case Study Research: Design and Methods. *Applied Social Research Methods Series, 5,* Beverly Hills, CA: Sage Publications.

Zuboff, S. (1988). *In the age of the smart machine.* New York: Basic Books.