Innovation Diffusion and E-Collaboration: The Effects of Social Proximity on Social Information Processing

Shaila M. Miranda, University of Oklahoma, USA
Pamela E. Carter, Florida State University, USA

ABSTRACT

Organizational arrangements such as telework are often believed to disrupt workers' social networks. This raises a concern regarding teleworkers’ abilities to adjust to technological changes in organizations. Based on innovation diffusion theory, this chapter considers telework and interdependence as parallel dimensions of social proximity that may be expected to affect the diffusion of innovation in terms of users’ social information processing (i.e., their technology beliefs, communication channels, and information sources). This proposition is investigated in a field-study conducted during the migration of a business unit to a new communications system. Technology users at the business unit were surveyed three times over a 12-week period—right before the conversion to the new system and at two six-week intervals following the conversion. These surveys assessed the impact of telework on respondents’ beliefs toward the communication technology. Findings partially supported our hypotheses regarding the negative effect of remoteness on beliefs about technology. Users were then surveyed to investigate the media and sources they utilized to stay informed about the new technology. As anticipated, telework was related to an increased use of electronic media and of individual and authority information sources. Contrary to our expectations, though, results indicated a positive effect of telework on the use of collective sources and face-to-face media. Therefore, we conclude that teleworkers make a special effort to preserve their social networks.

Keywords: diffusion; e-collaboration; social information processing; social proximity; telework

INTRODUCTION

The effects of social proximity have been of concern to researchers and practitioners in regard to evolving organizational practices such as virtual teams and telework. Such practices have been found to impede collaboration, to compromise workers’ identification with their organization, to engender feelings of isolation, and to constrict employees’ long-term career potential (Baker & Aldrich, 1996; Cooper & Kurland, 2002; Frank & Lowe, 2003; Gerber, 1995; Kugelmass, 1996; Maznevski & Chudoba, 2000; Nilles, 1994). If such organizational practices that reduce social proximity in the workforce thus disrupt
workers’ social systems, how will they affect the diffusion of new technologies? This is the question addressed by this chapter.

Social systems have been viewed as critical to innovation diffusion. Individuals process information about innovations within the context of these social systems (Rogers, 1995). Information flows through social systems, facilitating learning and assimilation of the innovation and influencing individuals’ beliefs about the innovation. Rogers reports on eight independent studies, all supporting the proposition that the interconnectedness within a social system has a positive impact on the diffusion of an innovation. He further proposes that relative advantage, an innovation characteristic, is “often based on information flows via the social system” (Rogers, 1995). The number of linkages in a social network is believed to determine the extent of innovation diffusion (Abrahamson & Rosenkopf, 1997). Speaking more directly to diffusion of computer technology, Burkhardt (1994) found that a lack of direct contact with other users hurt users’ perceptions of their self-efficacy with a new computer system, and self-efficacy has been shown to be an important predictor of technology diffusion (Compeau et al., 1999).

In a field study, we therefore explore this issue of social proximity and social information processing in a company undergoing a transition to a new communication system. Specifically, we studied the effects of telework and users’ beliefs about a technological innovation at three time periods: prior to the changeover from the old technology to the new and twice following the changeover. We also explored the media and sources utilized by workers in seeking information and attempting to learn about the novel technology.

ANTECEDENTS OF INNOVATION DIFFUSION

Central to the study of innovation diffusion is the understanding of diffusion as a process of social change entailing alteration to a social system in terms of its structures and functions (Rogers, 1995). Key aspects of the diffusion of innovation process are thus the innovation itself, the social system in which the innovation is introduced, the communication channels through which social system members learn about the innovation, and the timing of the process. Little attention has been paid, however, to how these four aspects of the innovation process come together. In Figure 1, we model the innovation in terms of users’ beliefs about them. Together with communication channels and information sources, beliefs are viewed as dimensions of users’ social information processing about the innovation. This social information processing is a critical precedent to innovation diffusion, as individuals within a social system are influenced by the opinions, information, and behaviors of salient others in the system (Fulk, 1993).

A key element of the social system that is relevant to the issue of innovation diffusion is social proximity. Such proximity facilitates the social information processing needed for diffusion to take place (Rice & Aydin, 1991). Other elements of the social system typically considered in the diffusion literature are organizational interventions such as championship (Kimberly & Evanisko, 1981), top management support (Sharma & Yetton, 2003), and training (Nelson & Cheney, 1987). However, given that our field study occurred within the context of a single organization within which organizational interventions did not vary across respondents, we limit the focus of our attention to the issue of
social proximity within the social system. While not explicitly represented in our model, timing is a critical element, as information is processed over time and the effects of proximity on social information processing vary with time (Yoshioka & Athanasiou, 1971). This overview of the diffusion process and its antecedents are represented in Figure 1.

**Social Proximity**

Proximity is the “extent to which one could be exposed to social information in a given social system” (Rice & Aydin, 1991, p. 221). Proximity has been demonstrated to have a significant impact on the diffusion of innovation in domains as diverse as agriculture (Hagerstrand, 1976) and biotechnology (Owen-Smith & Powell, 2004). There are three types of proximity: spatial, relational, and positional (Rice & Aydin, 1991). Spatial proximity reflects geographic distance, where individuals working close to each other increase the likelihood of exposure to social information processing and interaction. Relational proximity is reflected by communication proximity, the extent to which people interact directly and indirectly. Positional proximity reflects the structural proximity of individuals with regard to the extent to which individuals occupy the same roles. In this research, we focus on the first two forms of proximity. Spatial proximity is considered in relation to telework practices and relational proximity in terms of workers’ interdependence. We treat spatial and relational proximity as two independent dimensions of social proximity, since communication technologies provide the connectivity necessary for interdependence in the case of teleworkers (Ramsower, 1985; Wellman, Salaff, Dimitrova, & Garton, 1996).

Telework is defined as work away from one’s central office location in a variety of circumstances such as telecommuting, hoteling, mobile work, and supplemental at-home work (Raghuram, Wiesenfeld & Garud, 1996; Venkatesh & Vitalari, 1992). Irrespective of the availability of technological support, remoteness strains organizational communication, information sharing, and relationship development (Davenport & Pearlson, 1998; Maruca, 1998). Communication is easier when individuals are proximate and can communicate directly with others (Shane, 1979). It enables impromptu face-to-face communication, which is suitable not only for conveying information, but also for beliefs and work-related concerns (Davenport & Pearlson, 1998). In the face of conflicting data, managers tend to rely more on visual than non-visual data, which can be problematic for teleworkers who are limited, therefore, in the information they process (Kulik & Ambrose, 1993). In contrast, geographic collocation facilitates the transfer of complex information and collective sense making (McGlynn et al., 2004). It enables individuals to develop a shared interpretive context that is necessary for exploratory activities (Zack, 1993). The absence of spatial proximity reflected in telework compromises workers’ innovation-related modeling or vicarious learning.

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**Figure 1. Antecedents of innovation diffusion**

![Figure 1. Antecedents of innovation diffusion](image-url)
Social Information Processing

Social information processing refers to the social construction of meaning surrounding the focal innovation (Fulk, 1993). We consider social information processing in terms of the beliefs held by users about the focal innovation and the media and sources utilized in their search for information about the innovation. Beliefs and attitudes about a target are inherently social constructions as individuals engage in collective interpretation of the target itself, the behaviors in relation to the target, and the effects of those behaviors (Salancik & Pfeffer, 1978). Thus, beliefs and attitudes are the focus of social information processing. Positive user beliefs about focal innovations facilitate their diffusion (Compeau et al., 1999; Davis et al., 1992; Venkatesh, 1999).

Social information processing thus entails social influences that occur through various communication channels or media, and reference various information sources (Fulk, 1993). Typically, media that are rich in social cues are believed to be most conducive to social information processing (i.e., the most influential), while leaner media impede such processing. Similarly, collective information sources (e.g., one’s workgroup) have been noted to influence individuals’ information processing about focal innovations (Fulk, 1993; Rice & Aydin, 1991).

HYPOTHESES DEVELOPMENT

We now consider the manner in which the specific dimensions of social proximity modeled in Figure 1 (i.e., telework and interdependence) impact the three aspects of users’ social information processing: technology beliefs, communication channels or media used to solicit information about the technology, and information sources utilized.

Technology Beliefs

In the technology diffusion literature, diffusion (the adoption of an innovation, the intention to use or the actual usage of an innovation) has been considered in terms of users’ perceptions of the usefulness (or relative advantage) and ease-of-use (complexity) of the technology (Davis, Bagozzi & Warshaw, 1989; Rogers, 1983). Perceived usefulness refers to the extent to which users believe that the technology contributes to their self-efficacy, and the perceived ease-of-use of an innovation is the degree to which users believe interact-
ing with the technology is free of effort (Davis, 1989). Usefulness and ease-of-use have been found to have a strong positive impact on intentions to use the new technology, as well as reported current and projected future technology usage (Davis et al., 1989; Karahanna et al., 1999; Moore & Benbasat, 1991; Rogers, 1983; Venkatesh, 1999; Venkatesh, 2000).

Telework offers fewer opportunities for technology users to be exposed to the range of features and functionality of the novel technology. People adopt and subsequently use technologies when the perceived benefits from adoption and use exceed costs (Rogers, 1983; Tornatzky & Klein, 1992). Efforts to communicate features, functionality, and perceived benefits of new technologies through lean media are likely to be stymied as such media are ill-suited to communicating equivocal information (Dennis & Kinney, 1998). However, without this information it is unlikely that users will be able to adequately assess job relevance, output quality, and image considerations, which are all important factors in determining the perceived usefulness of a technology (Venkatesh & Davis, 1996).

In considering the effects of spatial proximity on user beliefs, it is also important to be attentive to the nature of the technology being implemented; viz., the communication system. A reliable technology infrastructure is critical to successful telework (Watad & DiSanzo, 2000), and a stable communication technology has been noted to have a positive impact on workers’ perceptions of their productivity and performance as well as worker satisfaction (Belanger et al., 2001). In contrast, technology newness poses a liability for cooperative work (McGrath et al., 1993). Norms for cooperative work that depend on electronic communication are likely to be disrupted with a change in communication technology (Duarte & Snyder, 1999). Thus, user beliefs about the usefulness of the new communication technology are likely to be negatively impacted by spatial proximity.

Coworkers can influence each others’ perceptions of the technology directly with overt statements concerning the technology, and indirectly via vicarious learning (Fulk, Schmitz & Steinfield, 1990). This influence provides external facilitating conditions, which make knowledge and resources available that can facilitate using the technology, and thereby also impact perceptions of ease-of-use (Taylor & Todd 1995; Venkatesh, 2000). However, to the extent that telework limits interactions through lean media, less social information processing of this sort can occur.

While both beliefs have been found to impact intentions to use a technology, the effect of perceived ease-of-use has been noted to be small and to decay more quickly over time than the effect of perceived usefulness (Davis et al., 1989; Karahanna et al., 1999). This is generally attributed to the fact that, over time, individuals gain experience with the technology, and with greater experience, the usefulness of the technology becomes more salient than the ease-of-use of the technology (Taylor & Todd 1995). In other words, perceived ease-of-use has been found to be less salient to the diffusion phenomenon. These arguments lead to the following hypotheses:

**Hypothesis 1:** Spatial and relational proximity will be related positively to perceived usefulness of a novel technology.

**Hypothesis 2:** Spatial and relational proximity will be related positively to perceived ease-of-use of a novel technology.
Hypothesis 3: Spatial and relational proximity will have a stronger and longer-term impact on perceived usefulness of a novel technology than on perceived ease-of-use.

Communication Channels

In regard to the medium through which innovations diffuse, interpersonal contact has been noted to be more effective than the use of mass communication channels in the diffusion of complex innovations (Rogers, 1983). We explored usage of three media in the solicitation of information about technology—email, phone, and face-to-face conversations. Reliance on electronic communication results in the weakening of social ties, thus diminishing the ability of coworkers to influence each other (Kiesler, 1986).

Communicating information about an unfamiliar technology is an ambiguous and uncertain task. Users initially lack sufficient information about the various features of the technology and how they may be used effectively. Problems occur frequently and without warning. When problems or suggestions regarding the use of technology are communicated, these problems or suggestions may be interpreted differently, based on the recipient’s level of expertise with the technology.

Rich media are more suitable than leaner media for ambiguous tasks, where necessary information is lacking, and the information available is subject to conflicting interpretations (Daft & Lengel, 1984). Rich media are required when the task involves a high occurrence of unexpected events, when there are no routinized procedures for dealing with such occurrences, and in communication across departments that are highly differentiated, for example, between corporate IT and other functional areas (Daft & Lengel, 1984).

Telework limits face-to-face interactions, making coworkers less physically available for face-to-face communication (Wiesenfeld, Garud & Raghuram, 1997). When the recipient of a message is potentially unavailable, utilizing leaner media, even in cases calling for richer media facilitates closure (Straub & Karahanna, 1998). Thus, teleworkers will need to resort to leaner media in order to reach closure. This leads to the following hypotheses:

Hypothesis 4: Spatial proximity will be related negatively to use of electronic media (email and phone) to share information about a new technology.

Hypothesis 5: Spatial proximity will be related positively to use of the face-to-face medium to share information about a new technology.

Information Sources

Innovation decisions may be optional (i.e., made by individuals), collective (i.e., made by the group), or authority (i.e., made at the organizational level) (Rogers, 1983). While the initiator of a major technological innovation is frequently a legitimate authority, individuals and coworkers, too, can instigate the diffusion of an innovation. In fact, such self- and clan-based controls may be more effective in ambiguous situations than bureaucratic controls (Ouchi, 1979). As already seen, the introduction of a new technology can generate ambiguity and uncertainty in the workplace.

Teleworkers tend to be more self-sufficient than their peers and also more isolated from their workgroup and other members of the organization (Belanger & Collins, 1998). Therefore, authority and collective sources internal to the organization are less accessible to the teleworker. Since individuals tend to utilize the most accessible sources (Saunders & Jones,
1990), at first glance, it would appear that teleworkers are less likely to invoke authority and collective sources.

However, as a function of their sense of isolation, teleworkers are strongly motivated to overcome the strains of remoteness by staying in touch with their supervisors, channeling much of their organizational communication through them (Maruca, 1998). Teleworkers who received technical and emotional support from their supervisors were found to be more satisfied (Hartman, Stoner & Arora, 1991). Teleworkers thus tend to be more dependent on their managers for a connection to the organization (Belanger & Collins, 1998) and tend to be concerned that their relationship with their managers may deteriorate over time (Reinsch, 1997). Teleworkers’ insecurities and sense of isolation is likely to be particularly heightened with the deployment of a new communication technology. Under such circumstances, we therefore can expect increased teleworker contact with their supervisors in an effort to dispel the uncertainties surrounding the new technology and solicitation of information from these authority sources.

The informal workgroup has a strong impact on socialization, dispensing information about the work environment (Sherman, Smith & Mansfield, 1986). However, telework reduces opportunities for such socialization (Ford & Butts, 1991), thereby limiting users’ access to these collective sources. Furthermore, teleworkers are motivated to be as self-sufficient as possible and tend to perceive that their productivity and performance are negatively affected by their need for communicating with their coworkers (Belanger, Collins & Cheney, 2001). Therefore, they are unlikely to rely on peers for information about the new technology.

Interdependence also is expected to impact the sources invoked by users in understanding the new technology. Under conditions of low workgroup attraction, authority sources have been found to be more salient; in contrast, when workers experience a high level of attraction to their workgroup, these collective sources become more salient to them (Fulk, 1993). Thus, when relational proximity is high, we can expect to see a heightened reliance on collective sources; when it is low, workers are more likely to invoke authority sources. We, therefore, propose the following:

Hypothesis 6: Spatial proximity will be related negatively to use of individual and authority information sources to learn about a new technology.

Hypothesis 7: Spatial proximity will be related positively to use of collective sources to learn about a new technology.

Hypothesis 8: Relational proximity will be related negatively to use of authority sources to learn about a new technology.

Hypothesis 9: Relational proximity will be related positively to use of collective sources to learn about a new technology.

METHODS

The site of this investigation was a company in the broadcast industry with operations around the U.S. The study traced the conversion from one communications system to another at a single division in the firm. The firm initially used MS Mail, a DOS-based electronic communications system that consisted primarily of email. The new electronic communications system was MS Exchange, which included not just enhanced email facilities, but also various tools to support group work and organizational memory, and enhanced se-
Table 1. Comparison of communication systems

<table>
<thead>
<tr>
<th>Tools</th>
<th>MS Mail</th>
<th>MS Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office support</td>
<td>• Basics (spell-check, attachments, etc.)</td>
<td>• Multiple profiles and mailboxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Automatic replying/forwarding without login</td>
</tr>
<tr>
<td>Organizational memory and</td>
<td>• Limited shared folders (no user-control)</td>
<td>• Improved public folders allowing user-specified</td>
</tr>
<tr>
<td>workgroup support</td>
<td>• Administrator-controlled distribution lists</td>
<td>permissions</td>
</tr>
<tr>
<td></td>
<td>• Individual schedules and contact lists</td>
<td>• User-controlled distribution lists</td>
</tr>
<tr>
<td>Security and performance</td>
<td>• Separate logins for network access and email</td>
<td>• Workgroup schedules and contact lists</td>
</tr>
<tr>
<td></td>
<td>• Slow</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Comparison of communication systems

security and performance. Table 1 provides a comparison of some of the features and support provided by the MS Mail vs MS Exchange implementations.

The impact of telework on the diffusion of the new communications system was explored via a series of surveys in two stages. Stage 1 explored the changing worker beliefs toward their communication technology at three time periods: before the conversion to the new system and twice after conversion to the new system. In Stage 2 of the study, we surveyed users to determine media and source usage in their search for information regarding the new communications system.

The first survey at Stage 1 was conducted during a training session that marked the conversion point from the old system to the new. The training was conducted by the CIO and the systems manager. Each session lasted about three hours. Users attended these training sessions in groups of about 30 at an on-site training facility. The training was not hands-on, but rather an overview and demonstration of the features of the new communication system. The users also were provided with a manual containing documentation on the features of the new system. The CIO and the systems manager, along with the site support staff, were available for on-site support for a couple of days during the transition and training period.

Users attending the training were required to respond to the pre-conversion survey, assessing their beliefs of the existing system, prior to arriving at the training session. Thus, the response rate at this time was 100%; a total of 159 responses were obtained at this time. The users were also surveyed at two time periods after the conversion to the new system: approximately six weeks after the conversion and another six weeks later. At these times, participants were given the option to respond to a paper version of the survey that was faxed to them, or an electronic version that was emailed to them. The second round of surveys yielded 57 responses, while the third round yielded 59 responses (51% and 54% percent of the sample, respectively). This design is similar to the one used by Davis et al. (1989) to test their technology acceptance model, in that users were surveyed twice after being trained to use the technology. However, this study also included a baseline measure before the training and administered the first survey later in the study than was done in the Davis et al. (1989) study. This latter choice was made to allow the effect of telework to emerge, rather than measure immediate perceptions following the training session.
On the first three surveys, subjects responded to questions that assessed their work habits and perceptions of the technology. Relevant questions from the survey instrument appear in Appendix A. The fourth survey assessed subjects’ information seeking behaviors. This survey was conducted approximately 14 weeks following the deployment of the new technology (and two weeks after the last technology beliefs survey). A total of 104 responses were obtained on this survey from people who had also completed the prior survey. The survey instrument used at this stage of the study is provided in Appendix B. All study variables, other than time, were assessed using self-report measures. Reliability of scales derived from all four surveys was determined using Cronbach’s α.

Since all independent and dependent variables (except for time) at Stage 1 of the study were obtained from a single source, the possibility of shared variance between the independent and dependent variables being attributable to a common method variance should be addressed (Podsakoff & Organ, 1986). To this end, we conducted a single factor analysis for all the self-report items at this stage of the study, including responses obtained at all three time periods. The results of this factor analysis, with an extraction criteria of minimum eigenvalues of 1 and loadings from an oblique rotation required for establishing discriminant validity (Ford, MacCallum & Tait, 1986), are presented in Table 2. Two criteria are used as indicators of the presence of common method variance: (1) a single factor or an extremely dominant first factor (Podsakoff & Organ, 1986) and (2) the smallest correlation between latent factors (Lindell & Whitney, 2001). The measurement model in Table 2 is a multi-factor model, and the variance captured by the first factor in the model in Table 2 is not close to the total variance captured by all factors. The smallest correlation between the latent factors was found to be 0.021. These criteria indicate a minimal common method variance problem, if any, and, therefore, call for no further remedial measures. The absence of cross-loadings indicates the discriminant validity of the measurement model.

Table 2. Oblique factor loadings for stage 1 variables

<table>
<thead>
<tr>
<th>Item</th>
<th>Usefulness</th>
<th>Ease-of-Use</th>
<th>Telework</th>
<th>Interdependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use1</td>
<td>0.836</td>
<td>-0.001</td>
<td>-0.004</td>
<td>-0.027</td>
</tr>
<tr>
<td>Use2</td>
<td>0.915</td>
<td>-0.026</td>
<td>0.034</td>
<td>-0.040</td>
</tr>
<tr>
<td>Use3</td>
<td>0.902</td>
<td>0.035</td>
<td>-0.059</td>
<td>-0.019</td>
</tr>
<tr>
<td>Use4</td>
<td>0.914</td>
<td>-0.045</td>
<td>-0.019</td>
<td>0.005</td>
</tr>
<tr>
<td>Use5</td>
<td>0.915</td>
<td>-0.018</td>
<td>-0.031</td>
<td>-0.013</td>
</tr>
<tr>
<td>Use6</td>
<td>0.699</td>
<td>0.258</td>
<td>0.011</td>
<td>0.091</td>
</tr>
<tr>
<td>Ease1</td>
<td>-0.088</td>
<td>0.867</td>
<td>0.018</td>
<td>-0.023</td>
</tr>
<tr>
<td>Ease2</td>
<td>0.131</td>
<td>0.712</td>
<td>0.100</td>
<td>-0.009</td>
</tr>
<tr>
<td>Ease3</td>
<td>0.056</td>
<td>0.801</td>
<td>0.039</td>
<td>-0.082</td>
</tr>
<tr>
<td>Ease4</td>
<td>0.223</td>
<td>0.617</td>
<td>-0.016</td>
<td>-0.042</td>
</tr>
<tr>
<td>Ease5</td>
<td>-0.080</td>
<td>0.851</td>
<td>-0.055</td>
<td>0.077</td>
</tr>
<tr>
<td>Ease6</td>
<td>-0.012</td>
<td>0.873</td>
<td>0.034</td>
<td>0.023</td>
</tr>
<tr>
<td>Interdependence1</td>
<td>0.044</td>
<td>-0.081</td>
<td>0.158</td>
<td>0.688</td>
</tr>
<tr>
<td>Interdependence2</td>
<td>0.014</td>
<td>-0.117</td>
<td>-0.122</td>
<td>0.623</td>
</tr>
<tr>
<td>Interdependence3</td>
<td>0.071</td>
<td>-0.146</td>
<td>0.142</td>
<td>0.698</td>
</tr>
<tr>
<td>Interdependence4</td>
<td>-0.181</td>
<td>0.031</td>
<td>-0.088</td>
<td>0.636</td>
</tr>
<tr>
<td>Telework1</td>
<td>-0.002</td>
<td>0.090</td>
<td>0.774</td>
<td>-0.124</td>
</tr>
<tr>
<td>Telework2</td>
<td>0.052</td>
<td>-0.078</td>
<td>0.766</td>
<td>0.109</td>
</tr>
<tr>
<td>Telework3</td>
<td>-0.007</td>
<td>0.003</td>
<td>0.804</td>
<td>-0.028</td>
</tr>
<tr>
<td>Telework4</td>
<td>0.040</td>
<td>0.035</td>
<td>0.819</td>
<td>0.092</td>
</tr>
</tbody>
</table>

| Variance Explained | 23.526% | 20.054% | 12.988% | 9.206% |

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Independent Variables

Telework was assessed using a four-item, five-point scale developed for this study based on research by Venkatesh and Vitalari (1992). Subjects indicated the number of regular workday hours and supplemental hours they worked away from their office. The reliability of this measure was determined to be 0.82. For the analysis of Stage 1 data (viz., hypotheses regarding users’ beliefs), the indicators of telework were scores reported on that survey. For the analysis of the Stage 2 data (viz., hypotheses regarding media and sources used), the telework scores used for the independent variable were a mean average of scores reported by users on the prior three surveys. This was done to accommodate constraints by management on the length of the survey administered. For hypothesis testing, telework was reverse-coded to yield the assessment of spatial proximity.

Interdependence or relational proximity was assessed using a four-item, five-point scale adopted from the Job Characteristics Index (Sims, Szilagyi & Keller, 1976). The reliability of this scale was determined to be 0.61. As with telework, assessments of interdependence for the analysis of beliefs were garnered from surveys 1-3. For the analysis of media and source usage, interdependence scores were computed as the mean average of scores from surveys 1-3.

Dependent Variables

Beliefs about the existing and the new email system were assessed using the Davis (1989) measures. The reliability of the six-item, five-point perceived usefulness scale was determined to be 0.94, and the six-item, five-point perceived ease-of-use scale was 0.89.

Communication channels or media usage (i.e., usage of phone, email, and face-to-face communication to learn about the new technology) were assessed using three-item, five-point scales. The reliabilities for the phone, email, and face-to-face scales were 0.85, 0.90, and 0.86, respectively. Factor analysis, presented in Table 3, was conducted with an extraction criteria of minimum eigenvalues of 1 and an oblique rotation, and supports the discriminant validity of this measurement model.

Information source usage (i.e., use of individual, authority, and collective information sources) was assessed using five-point scales, with five, six, and six items, respectively. Individual sources identified were books/magazines/manuals and videos. The reliability of this scale was 0.92. Authority sources identified were the help desk and other IS staff. The reliability of this scale

Table 3. Oblique factor loadings for communication channels used to seek information

<table>
<thead>
<tr>
<th>Items</th>
<th>Phone</th>
<th>Email</th>
<th>Face-to-Face</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone1</td>
<td>0.877</td>
<td>-0.129</td>
<td>-0.133</td>
</tr>
<tr>
<td>Phone2</td>
<td>0.942</td>
<td>0.134</td>
<td>-0.115</td>
</tr>
<tr>
<td>Phone3</td>
<td>0.830</td>
<td>-0.095</td>
<td>0.098</td>
</tr>
<tr>
<td>Email1</td>
<td>0.088</td>
<td>-0.862</td>
<td>-0.095</td>
</tr>
<tr>
<td>Email2</td>
<td>0.029</td>
<td>-0.866</td>
<td>0.061</td>
</tr>
<tr>
<td>Email3</td>
<td>-0.064</td>
<td>-0.034</td>
<td>0.103</td>
</tr>
<tr>
<td>FT1F</td>
<td>-0.077</td>
<td>0.029</td>
<td>0.879</td>
</tr>
<tr>
<td>FT1F</td>
<td>0.078</td>
<td>0.002</td>
<td>0.916</td>
</tr>
<tr>
<td>FT1F</td>
<td>0.049</td>
<td>0.002</td>
<td>0.916</td>
</tr>
<tr>
<td>Variance Explained</td>
<td>27.715%</td>
<td>26.408%</td>
<td>27.146%</td>
</tr>
</tbody>
</table>
was 0.87. Collective sources were immediate coworkers and other business acquaintances. The reliability of this scale was 0.84. High scores on these scales indicated more frequent usage. Factor analysis with an oblique rotation supporting the discriminant validity of this measurement model appears in Table 4. Note that an extraction criterion limiting the model to three factors was applied to preclude the fragmenting of each of the three factors into two separate factors.

A multivariate analysis of variance was conducted to test the effects of the time period, interdependence, telework, and the appropriate interaction terms on perceived ease-of-use and perceived usefulness. Table 6 summarizes the MANOVA results for all dependent variables at this stage. The test criterion employed was Roy’s Largest Root. This test has more power than the competing Wilks, Pillai, and Hotelling tests, and it is believed to be the most appropriate test when dependent variables are highly correlated (see Table 5) and when covariances are homogeneous (Box’s M=4.308, F=0.708, p=0.644) (Hair et al., 1998).

Further inspection of the interaction effects noted in the MANOVA via the individual ANOVAs indicated the effect held for perceived usefulness alone for both spatial proximity (F=3.232, p=0.023) and for relational proximity (F=2.836, p=0.039), not for perceived ease-of-use for either spatial proximity (F=0.880, p=0.452) or relational proximity (F=0.488, p=0.691). Further analysis, as depicted in Figure 2, indi-

Table 4. Oblique factor loadings for information sources used to seek information

<table>
<thead>
<tr>
<th>Items</th>
<th>Individual</th>
<th>Authority</th>
<th>Collective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual1</td>
<td>-0.800</td>
<td>0.153</td>
<td>-0.015</td>
</tr>
<tr>
<td>Individual2</td>
<td>-0.499</td>
<td>0.259</td>
<td>-0.062</td>
</tr>
<tr>
<td>Individual3</td>
<td>-0.880</td>
<td>-0.043</td>
<td>-0.058</td>
</tr>
<tr>
<td>Individual4</td>
<td>-0.418</td>
<td>0.323</td>
<td>-0.022</td>
</tr>
<tr>
<td>Individual5</td>
<td>-0.943</td>
<td>-0.117</td>
<td>-0.051</td>
</tr>
<tr>
<td>Authority1</td>
<td>0.185</td>
<td>0.849</td>
<td>-0.133</td>
</tr>
<tr>
<td>Authority2</td>
<td>-0.106</td>
<td>0.534</td>
<td>0.126</td>
</tr>
<tr>
<td>Authority3</td>
<td>0.154</td>
<td>0.825</td>
<td>-0.045</td>
</tr>
<tr>
<td>Authority4</td>
<td>-0.153</td>
<td>0.669</td>
<td>0.170</td>
</tr>
<tr>
<td>Authority5</td>
<td>0.086</td>
<td>0.868</td>
<td>-0.056</td>
</tr>
<tr>
<td>Authority6</td>
<td>-0.158</td>
<td>0.714</td>
<td>0.045</td>
</tr>
<tr>
<td>Collective1</td>
<td>0.221</td>
<td>0.044</td>
<td>0.898</td>
</tr>
<tr>
<td>Collective2</td>
<td>-0.308</td>
<td>0.220</td>
<td>0.408</td>
</tr>
<tr>
<td>Collective3</td>
<td>0.057</td>
<td>-0.110</td>
<td>0.878</td>
</tr>
<tr>
<td>Collective4</td>
<td>-0.310</td>
<td>0.216</td>
<td>0.491</td>
</tr>
<tr>
<td>Collective5</td>
<td>0.075</td>
<td>-0.072</td>
<td>0.877</td>
</tr>
<tr>
<td>Collective6</td>
<td>-0.340</td>
<td>0.163</td>
<td>0.523</td>
</tr>
<tr>
<td>Variance Explained</td>
<td>17.407%</td>
<td>21.908%</td>
<td>19.536%</td>
</tr>
</tbody>
</table>

Table 5. Descriptive statistics for stage 1—Technology beliefs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means (Standard Deviations)</th>
<th>Correlation (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Conversion</td>
<td>6-weeks</td>
</tr>
<tr>
<td>Telework</td>
<td>1.76 (0.64)</td>
<td>1.82 (0.54)</td>
</tr>
<tr>
<td>Interdependence</td>
<td>3.87 (0.61)</td>
<td>2.19 (0.56)</td>
</tr>
<tr>
<td>Ease-of-Use</td>
<td>4.10 (0.55)</td>
<td>4.18 (0.64)</td>
</tr>
<tr>
<td>Usefulness</td>
<td>4.13 (0.69)</td>
<td>4.16 (0.88)</td>
</tr>
</tbody>
</table>
Table 6. MANOVA for technology beliefs

<table>
<thead>
<tr>
<th>Effects</th>
<th>Roy’s Largest Root</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time*Spatial Proximity</td>
<td>0.047</td>
<td>3.283</td>
<td>0.023</td>
</tr>
<tr>
<td>Time*Relational Proximity</td>
<td>0.041</td>
<td>2.841</td>
<td>0.039</td>
</tr>
</tbody>
</table>

Figure 2. Correlation of spatial and relational proximity with usefulness over time

Means and correlations for the data from Stage 2 of the study—focusing on sources and media employed by users in learning the new system—are presented in Table 7.

Multivariate analyses of variance were conducted to test the effects of telework on media and sources used. Interdependence was retained as a control in this model. Table 8 summarizes the MANOVA results for all dependent variables at this stage. The test criterion employed was Roy’s Largest Root. This test was deemed appropriate, since the dependent variables are highly correlated (see Table 7) and covariances are homogeneous (Box’s $M_{\text{Source}}=24.668, F=0.962, p=0.503$; Box’s $M_{\text{Medium}}=27.244, F=1.062, p=0.388$).

Further analysis of the effect of telework on media used revealed a significant increase in the use of email with telework ($F=7.316, p=0.008$), and more marginal increases in the use of phone ($F=3.350, p=0.070$) and face-to-face communication ($F=3.085, p=0.082$). Thus, while hypothesis 4 was supported by the data, hypothesis 5 was not; in fact, the data indicate the opposite of the hypothesized effect to hold for the workers studied.

Further inspection of the significant effect of telework on sources used indicated no difference in the use of authority...
The results indicate no differences in use of individual (F=0.686, p=0.409) and collective (F=0.204, p=0.652) sources with increased interdependence, but increases in the use of authority sources (F=5.902, p=0.017). Thus, the data provided weak support for hypothesis 8 and no support for hypothesis 9.

**DISCUSSION**

The results of this study, reported in the preceding section, are summarized in Table 9. Below, we consider the effects of social proximity on each of the three aspects of social information processing.

**Impact of Social Proximity on Beliefs**

As anticipated, spatial proximity (i.e., low levels of telework) was found to have a significantly positive effect on perceived
usefulness with the implementation of the new communication system. However, this effect was short-lived and did not hold for relational proximity. Nor was it visible in the case of users’ beliefs about the perceived ease-of-use of the new technology.

One explanation for the absence of an effect for perceived ease-of-use may be the fact that teleworkers were simply less aware of the technical features offered by the new technology and, therefore, experienced no challenge in learning to use it. Given the very rudimentary capabilities of the old email system, there was probably very little time required for users to replicate the functionality of the old system within the new system. The transition from a command-line system to one with a GUI interface probably also contributed to enhanced ease-of-use of the new technology, wiping out any noticeable impairment in perceived ease-of-use from remoteness.

A second explanation for this finding may lie in the fact that perceived ease-of-use historically has had only a weak and fleeting salience to the diffusion phenomenon (Davis, 1989). Therefore, it is possible that any noticeable impairment in these perceptions stemming from remoteness may have been experienced before the first post-conversion survey was conducted, thereby masking the effects of remoteness on these beliefs.

While the effect of spatial proximity on perceived usefulness increased significantly between the pre-conversion and the six-week post-conversion periods ($r_0$,$r_1$=-0.392, $p=0.000$), by 12 weeks after the conversion, the effect was insignificant and close to pre-conversion levels ($r_0$,$r_2$=-0.001, $p=0.493$). This suggests that spatial proximity provided only a brief advantage in the technology diffusion. This, too, may have been a function of the heightened functionality of the new system relative to the old and the training provided to the users, enabling all users—proximate or remote—to discover quickly the usefulness of the new technology. On-site training, in particular, has been noted to be beneficial to teleworkers (Watad & DiSanzo, 2000).

While the post-conversion effects of relational proximity on perceived ease-of-use were insignificant, an examination of

---

**Table 9. Summary results of hypothesis testing**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Spatial and relational proximity will be positively related to perceived usefulness of a novel technology</td>
<td>Partially supported</td>
</tr>
<tr>
<td>2. Spatial and relational proximity will be positively related to perceived ease-of-use of a novel technology</td>
<td>Not supported</td>
</tr>
<tr>
<td>3. Spatial and relational proximity will have a stronger and longer-term impact on perceived usefulness of a novel technology than on perceived ease-of-use</td>
<td>Supported</td>
</tr>
<tr>
<td>4. Spatial proximity will be negatively related to use of electronic media (e-mail and phone) to share information about a new technology</td>
<td>Supported</td>
</tr>
<tr>
<td>5. Spatial proximity will be positively related to use of the face-to-face medium to share information about a new technology</td>
<td>Not supported – reversed</td>
</tr>
<tr>
<td>6. Spatial proximity will be negatively related to use of individual and authority information sources to learn about a new technology</td>
<td>Supported</td>
</tr>
<tr>
<td>7. Spatial proximity will be positively related to use of collective sources to learn about a new technology</td>
<td>Not supported – reversed for collective sources</td>
</tr>
<tr>
<td>8. Relational proximity will be negatively related to use of authority sources to learn about a new technology</td>
<td>Weakly supported</td>
</tr>
<tr>
<td>9. Relational proximity will be positively related to use of collective sources to learn about a new technology</td>
<td>Not supported</td>
</tr>
</tbody>
</table>
the profile for the effects suggests a disruptive effect of relational proximity on perceived ease-of-use in the post-conversion periods. The drop in the nearly significant positive correlation between relational proximity and perceived usefulness between the pre-conversion and the six-week post-conversion stage was highly significant ($r_0-r_1=0.341, p=0.000$). Unlike spatial proximity, the impact of relational proximity on perceived usefulness did not revert back to pre-conversion levels at 12-weeks past the conversion. Instead, the relationship was still significantly different from pre-conversions levels ($r_{0}\cdot r_2=0.339, p=0.000$) and no different from levels at the six-week period ($r_1-r_2=-0.002, p=0.486$). Thus, the data provides some evidence that relational proximity actually may inhibit perceived usefulness of a novel technology. However, the nature of the focal technology (i.e., one that supported employee communication) may explain this finding.

The initial email system available to users had limited collaborative functionality, largely enabling only the transmission of messages among users. The new email system introduced a range of collaborative tools such as shared contacts, calendars, and folders. These functions are particularly useful to highly interdependent workgroups. However, effective use of these functions requires users to develop shared norms regarding their use. The apparent disruption in the perceptions of usefulness of the technology among highly interdependent workers is, therefore, attributable to the absence of such shared norms, precluding effective use of the advanced collaboration functions of the new technology. In contrast, more independent workers relied more on features that did not require such consensus on norms of use (e.g., automatic forwarding and replying and integrated logins), and, therefore, perceived the new technology to be more useful than did their more interdependent counterparts.

**Impacts of Social Proximity on Communication Channels Used**

As anticipated, low spatial proximity (i.e., telework) was associated with an increased use of email in soliciting information about the novel technology. The increased usage of telephone queries with telework was more marginal. Contrary to our expectations, however, lower spatial proximity was not associated with a decreased use of face-to-face communication. Rather, the more individuals teleworked, the more they appeared to rely on face-to-face communication to learn about the new technology. This finding may be a function of the fact that few of the people in our sample appeared to telework for much more than half of their regular work week. They, therefore, took the opportunity to learn more about the technology when they could interact personally with their coworkers. Prior researchers have termed this effect “compensatory adaptation,” where individuals work to offset deficiencies in their available communication medium (Kock, 2001). Again, this finding is consistent with earlier research on telework, which suggests that teleworkers make every effort to preserve their ties with members of their organization (Belanger & Collins, 1998).

**Impacts of Social Proximity on Information Sources Used**

Our expectation was that spatial remoteness would encourage workers to seek information from individual and authority sources; in contrast, spatial proximity was expected to be positively related to use of collective sources. The data only supports our expectations with regard to individual
sources. No relationship between spatial proximity and use of authority sources was observed, and, contrary to our expectations, spatial remoteness was related also to the use of collective sources.

Again, the somewhat limited extent of telework within the organization studied may shed light on the unexpected findings with regard to sources invoked. Since workers were able to connect with their peers for at least half of the work week, they were unlikely to experience the disconnectedness from their work group that typically results in the over-reliance on those in authority (Belanger & Collins, 1998; Fulk, 1993; Maruca, 1998). Furthermore, the periodic accessibility of collective sources permitted workers to leverage them to learn about the novel technology (Saunders & Jones, 1990). Here, too, compensatory adaptation may have played a role.

Our data supported the anticipated negative effect of relational proximity on use of authority sources. Thus, disconnectedness from one’s workgroup does prompt a reliance on authority figures, as suggested by the communication literature (Fulk, 1993). However, the data provided no support for the anticipated increased reliance on collective sources with relational proximity. This suggests that perhaps workers with high spatial proximity avail themselves of the range of information sources that are accessible to them (Saunders & Jones, 1990).

RECONSIDERING THE SOCIAL NATURE OF INFORMATION PROCESSING

At first glance, the findings of this study appear to conflict with Granovetter’s (1973) theory of weak ties. Granovetter suggested that weak, rather than strong, ties were instrumental in diffusion. However, our findings point to reliance on strong ties, as reflected in the popularity of face-to-face interaction and collective sources. Perhaps considering the stages of diffusion will help us reconcile our apparently contradictory findings.

Rogers (1983) observed several stages in the diffusion of an innovation. Notably, he observed that awareness of an innovation precedes its evaluation, trial, and adoption. Granovetter’s work on weak ties addresses the awareness stage. This is true also of Burt’s (1995) more recent work on structural holes. Here, too, we see that weak ties that span groups are beneficial in making individuals competitively aware of information. However, once individuals are aware of an innovation, they may rely on stronger ties in assisting them in making further decisions on its adoption and use. Support for this perspective comes from Marsden’s work on discussion networks. Marsden (1987) found that Americans tend to rely on small, dense, and homogeneous networks for discussing matters important to them. Thus, while weak ties may be helpful in facilitating initial awareness, strong ties may be necessary in facilitating innovation evaluation and use.

IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The findings of this study are reassuring for managers and workers in telework environments. They demonstrate that telework need not retard the diffusion of an innovation. More importantly, they suggest that teleworkers can and do invest an effort in preserving their ties to their organization. As noted earlier, this has been
a frequent concern with teleworker environments, as well as with other alternate work arrangements.

The reliance of remote workers on face-to-face interaction and collective sources may suggest the need for richer electronic technologies such as videoconferencing. Management and worker strategies that facilitate face-to-face worker interactions, despite the nature of the work arrangement, also may be helpful in providing teleworkers with the interaction necessary for them to successfully complete their work and preserve their social networks.

Our research considered telework and interdependence in terms of spatial and relational proximity. While this represents a contribution to the telework literature, our design did not permit us to investigate the third type of proximity: positional proximity. Future research would do well to consider the effects of this form of proximity on social information processing. As with earlier research, our study highlights the fact that users’ beliefs about the ease-of-use of the innovation cease to be salient fairly early in the diffusion process. Future research, therefore, should assess beliefs earlier in the diffusion process.

Problems endemic to field studies prevented us from (1) studying the downstream effects of social information processing on diffusion and (2) contrasting the diffusion of an innovation that was also a critical communication channel with the diffusion of a different type of technology. These are important design issues that would greatly extend our understanding of the effects of proximity on innovation diffusion. Future research should also investigate the effects of more extensive telework. None of the workers in our sample indicated that they worked away from the office for more than 30 hours per week. We may notice different effects on diffusion and social networks with more extensive or with exclusive telework.

REFERENCES


ENDNOTES

1 A survey of 17 non-respondents on surveys 2 and 3 of Stage 1 indicated that 41% didn’t complete the surveys because they lacked time, 18% misplaced the surveys, 18% claimed they hadn’t received them, and 23% said they had completed them, but they probably hadn’t reached the researcher due to some administrative problems.

2 Since the training was not hands-on, immediate perceptions could not be expected to have any basis in the respondents’ experience and were, therefore, not solicited.

3 One item was dropped for cross-loading.

4 The participating company sold the division that was the focus of this study before we could investigate a second innovation, as was initially planned. Other research constraints included questionnaire length (i.e., limited to one page) and the kinds of questions that could be asked (i.e., precluded from asking specific questions regarding organizational position, etc.).

APPENDIX A: STAGE 1 QUESTIONNAIRE

We are interested in tracking your communication needs and comfort level using e-mail, now and throughout our conversion to the new system. Please use the scales provided to respond to the following questions.

Perceived Usefulness Questions

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

- Using e-mail in my job enables me to accomplish tasks more quickly.
- Using e-mail increases my productivity.
- Using e-mail enhances my effectiveness on the job.
- Using e-mail improves my job performance.
- Using e-mail makes it easier to do my job.
- I find e-mail useful in my job.

Perceived Ease-of-Use Questions

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

- Learning to use our e-mail system was easy for me.
- I find it easy to get e-mail to do what I want it to do.
- My interaction with our e-mail system is clear and understandable.
- I find our e-mail system to be flexible to interact with.
- It was easy for me to become skillful at using our e-mail system.
- I find our e-mail system easy to use.
Interdependence Questions

Not at all   A little   Moderate amt.   Great extent   Very great extent
1           2           3           4           5

- How much of your job depends upon your ability to work with others?
- To what extent do you complete work that has been started by another employee?
- To what extent is dealing with other people a part of your job?
- How much feedback do you receive from individuals other than your manager?

Telework Questions

None   1-15 hours   16-30 hours   31-45 hours   >45 hours
1           2           3           4           5

- How many hours per week do you work away from your office location during your regular work hours?
- How many hours per week do you work away from your office location outside your regular work hours?
- How much time do you spend during the regular work day away from your office location on work that you would normally do at your office?
- How much time do you spend after-hours each week away from your office location on work that you would normally do at your office?

APPENDIX B: STAGE 2 QUESTIONNAIRE

Email Survey

We would like to understand how you have continued to learn about the new e-mail system since the initial training session. Please take a few moments and use the scale below to respond to the following three questions.

Never   Rarely   Sometimes   Often   Always
1           2           3           4           5

- When I have a problem with e-mail, I look for a solution:
  - in books, magazines, or manuals (SOURCE USAGE: INDIVIDUAL)
  - from the help desk (SOURCE USAGE: AUTHORITY)
  - from other IS staff (SOURCE USAGE: AUTHORITY)
  - from coworkers (SOURCE USAGE: COLLECTIVE)
  - from other business acquaintances (SOURCE USAGE: COLLECTIVE)
  - in training videos (SOURCE USAGE: INDIVIDUAL)
  - by talking with people over the phone (MEDIA USAGE: PHONE)
  - by interacting with people via e-mail (MEDIA USAGE: E-MAIL)
  - by talking with people face-to-face (MEDIA USAGE: FACE-TO-FACE)
I learn about new e-mail features:
- from books, magazines, or manuals (SOURCE USAGE: INDIVIDUAL)
- from the help desk (SOURCE USAGE: AUTHORITY)
- from other IS staff (SOURCE USAGE: AUTHORITY)
- from coworkers (SOURCE USAGE: COLLECTIVE)
- from other business acquaintances (SOURCE USAGE: COLLECTIVE)
- in training videos (SOURCE USAGE: INDIVIDUAL)
- by talking with people over the phone (MEDIA USAGE: PHONE)
- by interacting with people via e-mail (MEDIA USAGE: E-MAIL)
- by talking with people face-to-face (MEDIA USAGE: FACE-TO-FACE)

I learn about new ways to use e-mail on my job:
- from books, magazines, or manuals (SOURCE USAGE: INDIVIDUAL)
- from the help desk (SOURCE USAGE: AUTHORITY)
- from other IS staff (SOURCE USAGE: AUTHORITY)
- from coworkers (SOURCE USAGE: COLLECTIVE)
- from other business acquaintances (SOURCE USAGE: COLLECTIVE)
- in training videos (SOURCE USAGE: INDIVIDUAL)
- by talking with people over the phone (MEDIA USAGE: PHONE)
- by interacting with people via e-mail (MEDIA USAGE: E-MAIL)
- by talking with people face-to-face (MEDIA USAGE: FACE-TO-FACE)

Shaila M. Miranda is an associate professor of MIS at the Price College of Business, University of Oklahoma. She obtained her doctorate in MIS from the University of Georgia in 1991. She also has an MA in sociology from Columbia University, and a Master of Management Studies and BA in psychology from the University of Bombay. Her current research interests in information systems include electronic collaboration, outsourcing, and alternate work arrangements. She also has a strong interest in sociological theory. She has published in journals such as the Information Systems Research, Journal of Management Information Systems, Small Group Research, Information and Management, and Data Base.

Pamela E. Carter is an assistant professor of MIS in the College of Business, Florida State University. Her research interests include the diffusion of complex technologies, meanings and interpretations of/within information systems, project management, and IS infrastructure management. Her work is forthcoming in MIS Quarterly and has been presented at numerous national and international conferences. She received her PhD from Florida State University and her MBA from the University of Maryland.