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Managing Team Interpersonal Processes Through Technology: A Task–Technology Fit Perspective

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This article addresses the broad question, How can virtual teams that manage a majority of their interactions through information and communication technologies (ICTs) be made more effective? Focusing specifically on interpersonal interactions, the task–technology fit paradigm is used as the foundation for a theoretical model that seeks to identify how such teams can match available communication technologies to the different types of interpersonal interactions in which they engage. The authors draw on media synchronicity theory to identify the functionalities of the wide range of ICTs available today, and map these functionalities onto the salient communication needs of 3 key interpersonal processes: (a) conflict management, (b) motivation and confidence building, and (c) affect management. The model also incorporates a temporal dimension examining how the communication needs, and hence, the need for ICT functionality, varies depending on the virtual team's developmental stage. Opportunities for future research arising from the theoretical model are discussed.

Pressure from the complex and turbulent competitive environment of the information economy has led to the emergence of new work designs within and across organizations. Increasingly, organizations are finding that competition necessitates the design of work that spans temporal, spatial, and geographic boundaries (D'Aveni, 1995; Davidow & Malone, 1992; Jarvenpaa & Ives, 1994). In this context, virtual teams, defined as "a group of people who interact through interdependent tasks, guided by common purpose. . .with links strengthened by webs of communication technologies" (Lipnack & Stamps, 1997, p. 7), represent one emerging type of alternative work design that has generated considerable attention. Embedded in the multiple definitions of virtual teams that are extant in the literature (e.g., Jarvenpaa & Ives, 1994; Townsend, DeMarie, & Hendrickson, 1998) are the common themes that (a) these teams are geographically or organizationally dispersed and (b) they use information and communication technologies (ICTs) as a significant medium for facilitating coordination and communication to perform team tasks.

The appeal of virtual teams is that they span functional, organizational, geographic, and temporal boundaries, giving firms access to a wide array of intellectual resources (Adler, 1997; Bartlett & Ghoshal, 1989; Maznevski & Chudoba, 2000). However, the mediation of a team's interactions by ICTs creates both opportunities and challenges. Prior empirical research suggests that although teams that rely on computer-mediated communication are superior to co-located/face-to-face groups in brainstorming (Dennis & Valacich, 1993; Gallupe, Bastianutti, & Cooper, 1991) and decision-making tasks (Sambamurthy, Poole, & Kelly, 1993), they are less adept at performing other tasks such as conflict management and problem-solving (Straus & McGrath, 1994). For instance, Straus and McGrath (1994) found lower levels of productivity in electronically mediated groups than in face-to-face groups on performance of judgment tasks. Adrianson and Hjelmquist (1991) found evidence of lower degrees of conformity in teams relying on computer-mediated communication than in face-to-face groups.

Additionally, because virtual teams typically span functional, organizational, and geographic boundaries, they are often composed of members with little or no shared work history and a diversity of expertise and knowledge domains, cultural background, and work norms. Although some empirical evidence points to the value of diversity for team performance (e.g., Harrison, Price, Gavin, & Florey, 2002; Watson, Kumar, & Michaelson, 1993), research also suggests that it is more likely to lead to intragroup conflict (Jehn & Mannix, 2001; Jehn, Northcraft, & Neale, 1999; Lau & Murnighan, 1998). Hence, virtual teams are inherently faced with the challenge of managing conflict that arises as a result of crossing multiple boundaries (e.g., Cramton, 2001; Jarvenpaa & Leidner, 1999; Maznevski & Chudoba, 2000).

Dysfunctional team member behaviors, including low organizational commitment, low team commitment, role ambiguity, social loafing, and absenteeism, can be detrimental to team performance. Scholars have suggested that such dysfunctional behaviors are exacerbated in the context of virtual teams (O'Hara-Devereaux & Johansen, 1994). Additionally, feelings of isolation (Cascio, 2000) and loss of social identity (Wiesenfeld, Raghuram, & Garud, 1999) become particularly salient in virtual teams and can lead to deficiencies in team performance through turnover and lack of participation. Managing team social or interpersonal interactions is thus a critical team process, which if mishandled, can spill over and

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affect the efficiency with which other team processes are conducted (Jehn, 1995; Jehn & Mannix, 2001). As Marks, Mathieu, and Zaccaro (2001) observed, "interpersonal processes lay the foundation for the effectiveness of other processes" (p. 368).

In this article we pose the broad question, How can distributed teams that manage interactions through information and communication technologies be made more effective? Focusing specifically on interpersonal interactions, we develop a theoretical model that seeks to identify how such teams can match available communication technologies to the different types of interpersonal interactions in which they engage over time. In doing so, we contribute to the research literature on virtual teams in two ways. First, although prior research has studied the use of technology for managing specific interpersonal processes (e.g., socialization: Ahuja & Galvin, 2003; task-related conflict management: Montoya-Weiss, Massey, & Song, 2001), little has been done to encompass a wider range of social interactions. Second, studies have typically focused on the use of a single communication technology, rather than a broader spectrum. For example, Montoya-Weiss et al. (2001) studied the use of Lotus Notes for managing conflict in virtual teams. Similarly, Ahuja and Galvin (2003) studied new member socialization processes in virtual groups using e-mail. Thus, prior research has not fully addressed the question of how virtual teams can best utilize the wide array of communication technologies available at their disposal today.

The core of our model is constructed around the task–technology fit paradigm (Goodhue, 1988), which asserts that certain functionalities of ICTs are better suited for managing specific types of interpersonal processes. We define *functionalities* as the specific set of capabilities enabled by a technology. The major argument underlying task–technology fit is simple: The model emphasizes the importance of matching appropriate technological functionalities to the demands imposed by a given task (Goodhue, 1988) and suggests that a better match yields improved outcomes. Using this theory as the underlying foundation, we draw on media synchronicity theory to elaborate on the wide range of technological functionalities available to virtual teams. Media synchronicity theory focuses on the ability of communication media to transmit social cues that are important in face-to-face human interactions (Daft & Lengel, 1986; Dennis & Valacich, 1999) and is particularly appropriate to help us understand the capabilities ICTs can offer to support team interpersonal processes. Then, drawing on prior research on team processes, we examine how specific technology functionalities better enable the effective management of three key interpersonal processes: (a) conflict management, (b) motivation and confidence building, and (c) affect management. We develop propositions related to the effects of a match between ICT functionalities and group interpersonal processes on team effectiveness.

The remainder of this article is organized as follows. We begin with a discussion of the theories supporting the proposed model, that is, task–technology fit and media synchronicity theory. Next, we present our theoretical model and, after examining each of the three interpersonal processes in detail, map the communication needs of each process to specific technology functionalities in the form of research propositions. This is followed by a discussion of the model, where we present examples illustrating how technological functionalities are bundled into specific ICTs and how best to match these ICTs to both the specific process as well as the temporal stage of team development. The article concludes with directions for future research, including measurement issues and additional constructs that could be added to enrich the theory.

Theoretical Background

The two major theories that form the foundation for our theoretical model are task–technology fit and media synchronicity. We begin with a brief overview of the major tenets of these theories.

Task–Technology Fit

The level of correspondence between the functionalities of a specific technology and the requirements of a given task, along with its subsequent influence on performance, is a central tenet of task–technology fit research (Goodhue, 1988). *Task–technology fit* is defined as "the degree to which a technology assists an individual in performing his or her portfolio of tasks" (Goodhue & Thompson, 1995, p. 216). Task–technology fit can be broadly applied to any situation in which individuals use technology to accomplish specific tasks; however, given our emphasis on virtual teams, it is instructive to see what task–technology fit means in the context of teamwork.

Scholars have observed that teams perform a variety of tasks, ranging from member support to actual production (i.e., substantive team output; McGrath, 1991). Different types of team tasks are argued to have different levels of interdependence and uncertainty associated with them (Daft & Lengel, 1986; McGrath, 1991; McGrath & Hollingshead, 1993). As a consequence, tasks differ on the degree of information processing, coordination, and communication required for successful completion. Just as team tasks vary in their nature, information and communication technologies also differ in the extent to which they are able to support task requirements. For instance, whereas e-mail is able to support asynchronous group communication, it cannot effectively support tasks requiring real time coordination. This suggests that the ability of groups or individuals to successfully complete their tasks is dependent on the specific functionalities of the technology being used. In other words, task–technology fit, which is an emergent property of the interaction between task and technology, provides a useful framework for examining how teams can better select technologies to meet their needs as they progress through the team's activities. Indeed, task–technology fit is the only specific theory of which we are aware that attempts to formally articulate the outcomes of congruence between task requirements and technological functionalities (Goodhue, 1995) and is supported by empirical evidence (Dennis, Wixom, & Vandenberg, 2001; Goodhue & Thompson, 1995).

To the extent that virtual teams use ICTs to accomplish a majority of the team-related activities, task–technology fit would predict that the team's outcomes would be positively affected by the degree to which the technology used for the task fits the specific information-processing and coordination requirements imposed by the task. Indeed, task–technology fit has been applied in the context of group support systems (e.g., Shirani, Tafti, & Affisco, 1999; Zigurs & Buckland, 1998), where research has examined the application of ICTs to group activities that may be co-located or dispersed. For instance, in an experimental lab setting, Shirani et al. (1999) compared the performance (number of

unique ideas generated) of two groups, one using e-mail for communication and the other using group support system. The authors found that groups communicating through the group support systems generated a greater number of ideas than did groups using e-mail. Zigurs and Buckland (1998) developed a set of propositions that linked the fit between various dimensions of group support systems technologies and group task attributes with group effectiveness. In Zigurs and Buckland's work, information-processing, communication support, and process structuring functionalities of group support systems were identified as salient dimensions.

Our application of task–technology fit is consistent with this research but is broader in scope in two ways: (a) We identify functionalities of the best fitting technologies (as opposed to facets of a single technological artifact) for specific virtual team tasks, and (b) we theorize about the effects of these functionalities across a wider range of virtual team tasks. An understanding of technology functionalities is accomplished by drawing on media synchronicity theory, as described below.

Media Synchronicity Theory

Media synchronicity theory is a recent extension of media richness theory (Daft & Lengel, 1986), which has been an influential framework for explaining managerial choices related to communication media. Media richness theory is rooted in the information-processing view of organizations; a fundamental tenet of this theory is that organizational entities use a vast amount of information to operate within their respective environments (Galbraith, 1977), and communication represents the means by which required information gets disseminated throughout the organization. Media richness theory asserts that the effectiveness with which information is delivered depends largely on the specific communication medium used. Hence, the theory outlines a framework for assessing the functionalities of various communication media and the ability of these media to alleviate problems of ambiguity associated with information communication (Daft & Lengel, 1986; Daft, Lengel, & Trevino, 1987).

Media richness theory features richness as the key characteristic of the communication medium (or ICT) that is important for communication effectiveness. *Richness* is defined in terms of the ability of information to change understanding within a time interval (Daft & Lengel, 1984, 1986). Specifically, rich communications are those that are able to clarify ambiguity and amplify understanding in a timely manner. By contrast, lower levels of richness in communication require a longer time to enable the comprehension of information (Daft & Lengel, 1986) and, hence, less rich communication is typically viewed as less effective. In essence then, media richness refers to the clarity with which information can be communicated through a specific channel in a way that reduces information ambiguity in a timely manner (Daft & Lengel, 1986).

Although media richness theory is useful in its parsimony with regard to media characteristics and has been empirically validated in a few studies (e.g., Lengel & Daft, 1988; Trevino, Lengel, & Daft, 1987), scholars have argued that today's advances in ICTs require a reconceptualization of media functionalities that provides finer-grained insight into the relative efficacy of various media (Dennis & Valacich, 1999). Thus, media synchronicity theory was developed, whereby Dennis and Valacich proposed five functionalities of media that yield communication capabilities: immediacy of feedback, symbol variety, parallelism, rehearsability, and reprocessability. Immediacy of feedback essentially captures the synchronicity of the medium, whereas symbol variety speaks to the availability of multiple cues and language variety that are supported by the medium. Parallelism captures the possibility that some media permit multiple simultaneous conversations, and rehearsability represents the ease with which communications can be rehearsed and edited prior to their transmittal. Finally, reprocessability embeds the ability of the medium to maintain a history or memory of the communication that has occurred.

In the same spirit as media richness theory, media synchronicity theory attempts to match the requirements of the communications task to the capabilities of the medium. Media synchronicity theory proposes that all team tasks are composed of two key communication processes: conveyance and convergence. Whereas conveyance speaks to the exchange of information and subsequent deliberation on its meaning, convergence represents the development of shared meaning for information (Weick & Meader, 1993). Participants of convergence communication processes strive for agreement on the meaning of information. Thus, in general, convergence processes are best supported by communication environments enabling high immediacy of feedback and low parallelism. In contrast, communication environments enabling low immediacy of feedback and high parallelism are posited to support the conveyance process. The impact of symbol variety on convergence and conveyance processes is contingent on the type of information involved. Finally, rehearsability and reprocessability are important for conveyance and convergence processes, especially in cases where deliberation is required (Dennis & Valacich, 1999). Although conceptually appealing, it is important to note that as a relatively new theory, empirical tests of media synchronicity theory are limited. Dennis, Valacich, Connolly, and Wynne (1996) tested media synchronicity theory in a laboratory study for conveyance and convergence tasks, while Carswell (2001) used media synchronicity theory as the theoretical basis for proposing and testing hypotheses related to learning outcomes in a technology-mediated learning environment. Both studies found empirical support for the basic tenets of media synchronicity theory.

The essence of both media synchronicity theory and media richness theory is that communications media (e.g., face-to-face, telephone, letters, e-mail) can be situated along a continuum of richness ranging from low to high. However, media synchronicity theory further emphasizes that the richness of any given medium varies as a function of the capabilities demanded by the specific situation (Dennis & Valacich, 1999). Thus, media synchronicity theory conceptualizes a high richness communication medium as one that best provides the set of capabilities required by the situation (in terms of the task and social context). This conceptual definition of media richness is adopted throughout the remainder of the article.

Figure 1 provides an illustrative example of how a variety of technologies may be characterized in terms of the functionalities they enable. All technologies are naturally imbued with certain features in their design; thus, the location of any given communication medium along the media richness continuum is a function of its capacity to enable immediate feedback, the number and variety

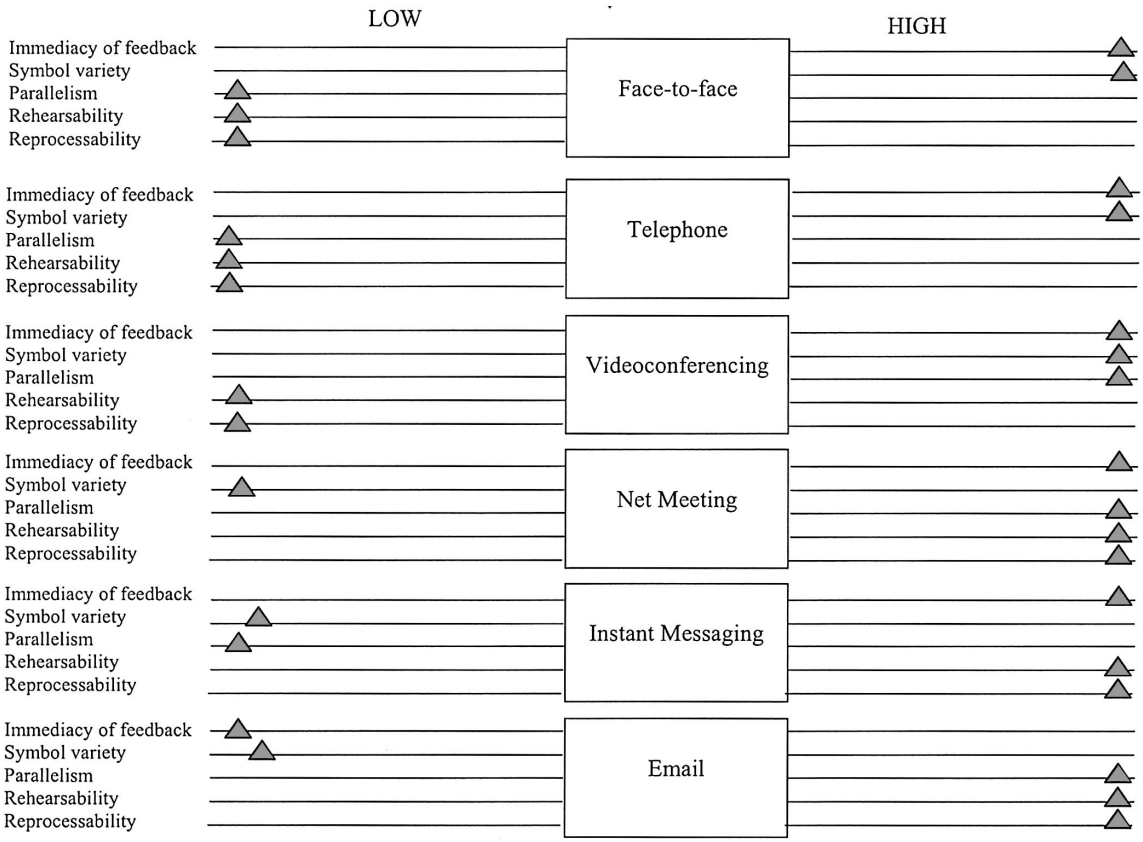

Figure 1. An illustration of media synchronicity theory.

of cues that can be transmitted, the number of communication channels (i.e., simultaneous participants) enabled (Daft & Wiginton, 1979), its reprocessability, and its rehearsability. For instance, video-conferencing enables high immediacy of feedback as all communications are conducted in real time. Furthermore, video capabilities offer high symbol variety in communications. Videoconferencing also allows communication with multiple participants simultaneously, enabling high parallelism. However, because communication is conducted in real time, the ability to rehearse communications is low. It is also difficult to maintain a record of all communications occurring through videoconferencing, making it low on reprocessability. Along the media richness continuum, face-to-face communication is considered high in richness for tasks requiring social presence because it provides immediate feedback so that interpretation can be checked, and it provides multiple cues such as body language and tone of voice. E-mail, on the other hand, is lower in richness for such tasks because communicators are limited in their ability to give immediate feedback, and fewer nonverbal cues can be transmitted.

By virtue of their dispersed nature, and indeed, by definition, virtual teams use a variety of communication media for accomplishing team tasks (McGrath & Hollingshead, 1993). On what basis should teams make their communication media choices? To the extent that communication needs change as the task changes (Dennis & Valacich, 1999), it follows that the nature of the task is an important criterion in determining which communication media are best suited to the task's requirements. Furthermore, beyond the nature of the task, the developmental stage of the team's processes is likely to have implications for media choice (Bell & Kozlowski, 2002; Dennis & Valacich, 1999; McGrath, 1991; Tuckman, 1965). For instance, virtual teams at early stages of team development may require richer media for socialization and trust-building processes, whereas established teams may communicate using less rich media. Indeed, the results of Jehn and Mannix (2001) and Montoya-Weiss et al. (2001) point to the importance of the temporal dimension for managing conflict in virtual teams. Finally, perceptions of richness can change over time as team members develop familiarity and shared language for communication with each other (Carlson & Zmud, 1999). Thus, a theory of media choice for virtual teams' use of ICTs to manage interpersonal processes must address the needs of the task as well as temporal issues arising from the developmental stage of the team. This notion is developed further through our theory of media choice, as presented next.

A Theory of ICTs and Team Interpersonal Processes

Overview

Figure 2 shows our theoretical model, which posits that the nature of the interpersonal process as well as the developmental stage of the team's processes interact with the functionalities of the

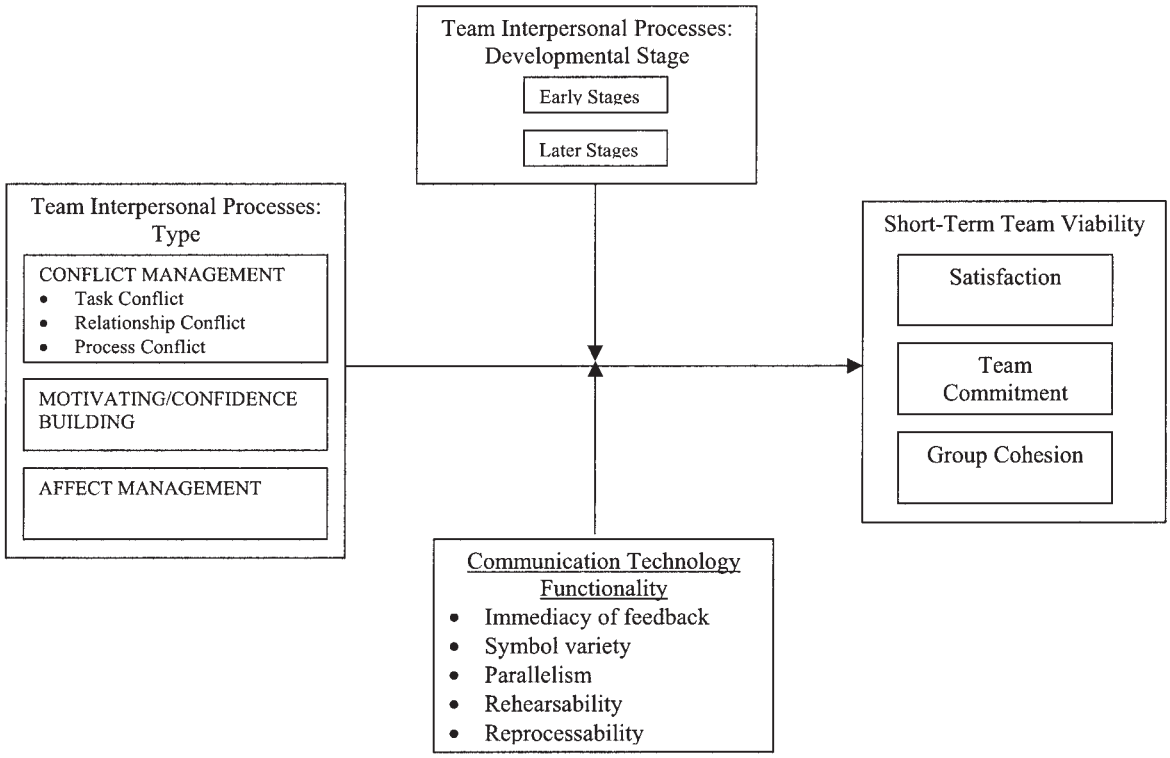

Figure 2. A theoretical model of technology-mediated interpersonal process management in virtual teams.

communication medium in their effects on team process outcomes. Rather than consider the wide variety of different tasks and processes in which teams engage (e.g., McGrath, 1991), we limit our theory to team interpersonal processes. As noted earlier, these processes are important because they are instrumental in shaping the downstream effectiveness with which other team tasks are performed (Marks et al., 2001). Although a variety of conceptualizations of interpersonal process exist in the literature (e.g., Hackman, 1969; McGrath, 1991; Tuckman, 1965), we focus on a recent conceptualization put forward by Marks et al. (2001) that incorporates many of the key interpersonal processes outlined in prior literature. Marks et al. defined interpersonal processes in terms of the conflict management, motivation/confidence building, and affect management activities in which teams engage to manage relationships among team members and observed that these interpersonal processes occur throughout all phases of team development.

The underlying causal mechanism in our model is one of task–technology fit: The greater the congruence between the communication requirements of the task (its nature and timing) and the specific functionalities of the selected medium, the more effectively the task can be managed. Thus, media choice and the specific interpersonal task constitute the two explanatory variables for virtual team effectiveness, mediated by the indicators of short-term team viability, viz., satisfaction, team commitment, and group cohesion. Following Cohen and Bailey (1997), we conceptualized effectiveness as team performance measured in terms of quality and quantity of outputs. What are the specific characteristics of the interpersonal processes of conflict management, motivation, and affect management that yield particular communication needs? We examined these salient communication needs and mapped them onto the dimensions of communication media identified in media synchronicity theory (Dennis & Valacich, 1999). The constructs and relationships in the model are developed in greater depth below.

Conflict Management Processes

Conflict refers to any perception of incompatibilities between individuals (Boulding, 1963). Working within teams provides a context in which conflict is likely to arise between individuals (Jehn, 1995). Conflict is especially likely to arise in virtual teams, where team member diversity is inherent given the boundary spanning nature of such teams (Hinds & Bailey, 2003; Jehn, Northcraft, & Neale, 1999). Two primary types of conflict in groups that have been identified include task-based and interpersonal relationship-based conflict (Guetzkow & Gyr, 1954). Task-related conflict arises from the substantive content of group tasks. It occurs any time there is disagreement among group members about the substance of the task being performed (Wall & Nolan, 1986). By contrast, relationship or socioemotional conflict is the culmination of discrepancies between group members that are not related to the task being performed (Priem & Price, 1991). A third type of conflict that has not received as much attention in the literature is process conflict, which relates to disagreements on managing tasks or allocating resources (Jehn, 1997).

Not surprisingly, both relationship- and task-based conflict have been linked to poor group performance in the literature. Relation-

ship conflict between coworkers decreases employees' satisfaction with the group experience because of high levels of interpersonal tension (Surra & Longstreth, 1990). Jehn (1995) demonstrated that perceptions of relationship conflict led to significant decreases in member satisfaction, the liking of other group members, and intentions to remain in the group. Similarly, task conflict between team members leads to dissatisfaction with the group experience: Schweiger, Sandberg, and Ragan (1986) showed that employees on teams exhibiting high levels of consensus on task-related issues were more satisfied with the group experience and had higher intention to remain in the group than members of teams exhibiting high levels of task conflict. Jehn (1995) found that the greater the perceived level of task conflict, the lower the satisfaction of group members. High perceived task conflict was also negatively related to liking of other group members and intentions to remain in the group. Collectively, these studies suggest that the frustration of dealing with task- and relationship-related dissension could have negative implications for team viability.

Unlike relationship conflict, which always yields negative outcomes, moderate levels of task conflict can enhance group productivity through the incorporation of diverse ideas and perspectives and by providing constructive criticism (Jehn, 1995; Guetzkow & Gyr, 1954; Priem & Price, 1991). Jehn and Chatman (2000) found that task conflict contributed positively to team performance (in terms of commitment, cohesiveness, and satisfaction) when relationship and process conflict were proportionally lower. However, although it can be beneficial at moderate levels, task conflict needs to be resolved in order to maintain the well-being of group members, because it can lead to relationship conflict. As Jehn (1997) pointed out: "If group members cannot agree on task issues, they may begin to dislike other members and attribute this task-related conflict to personality issues" (p. 532). Jehn and Chatman (2000) argued that task conflict could degenerate into relationship conflict to the extent that relationship conflict already exists. Additionally, high levels of task conflict can interfere with the completion of tasks (Jehn, 1995).

Even in the presence of task conflict, ultimately team consensus (convergence) regarding the decision has to be reached. Amason and Schweiger (1994) identified a decision quality paradox in which teams need to engage in task-related conflict to produce decisions of high quality while also reaching consensus without interfering with the quality of the decision. The resolution of task conflict through collaboration behaviors has been shown to have positive team outcomes (Montoya-Weiss et al., 2001). Collaboration behaviors reflect a joint concern for tasks and the engagement in purposeful problem-solving activities by team members. Furthermore, collaborative behaviors involve higher levels of task focus, participation, and goal congruity among team members (Townsend, DeMarie, & Hendrickson, 1998).

ICTs and Conflict Management Processes

On the basis of these descriptions of conflict management, what are the specific ICTs that are best suited for conflict management processes, that is, how can ICTs facilitate collaborative behaviors? Virtual teams that are in the early stages of their development are less likely to have developed the norms of openness and debate required for task conflict to be effective, particularly when interpersonal trust is low (Lovelace, Shapiro, & Weingart, 2001; Mortensen & Hinds, 2001). Instead, disagreements about task-related issues can easily be interpreted as personal attacks (Kelley, 1979). The technology-mediated nature of communication increases the likelihood of such misinterpretations. Thus, individuals who are members of virtual teams that are in the early stages of development may be subject to misinterpreting constructive criticism as disparaging (Griffith, Mannix, & Neale, 2003).

ICTs that offer greater symbol variety enable individuals to reduce the potential for misinterpretation of their comments (Dennis & Valacich, 1999). The ability to communicate tone of voice and other nonverbal cues is essential to regulating exchanges between individuals (Kiesler, Siegel, & McGuire, 1984). High symbol variety is instrumental in the regulation of task- and process-related discussion (Dennis & Valacich, 1999; Jehn, 1997). Further, immediacy of feedback enables team members to verify, in a timely manner, that the intended meaning of their comments was understood. As Dennis and Valacich (1999) suggested, feedback becomes important when the goal of communication is to understand others' interpretations of information and ultimately to achieve convergence. We therefore argue that for virtual teams that are in the early stages of development, ICTs with high symbol variety and high immediacy of feedback will be important in effectively managing task conflict.

> *Proposition 1a:* Virtual teams that use ICTs high in feedback, symbol variety, and parallelism (e.g., video- or audio-conferencing) for managing task conflict during early team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

In contrast to newly formed virtual teams, ongoing (established) teams often have in place the norms and trust necessary to manage task conflict. Hence, the need for high symbol variety and feedback becomes less salient in communications regarding task conflict. For instance, Mortensen and Hinds (2001) found that virtual teams that had developed a sense of shared identity demonstrated lower levels of task conflict. Communication media that are low in richness mask the emotional cues in communication. In addition, although communication media do not remove affect from decision making, low richness reduces the appeal of expressing affective content through such communication media (Hinds & Bailey, 2003). To the extent that communications can be rehearsed, they are likely to be better crafted and reasoned. Multiple concurrent inputs into the team process provide an opportunity for all team members to "have their say" (Dennis et al., 1997; Gallupe, Cooper, Grise, & Bastianutti, 1994). Likewise, the existence of a communication memory in the form of a written document or e-mail message offers opportunities for off-line deliberation and reflection after the interaction has occurred. All of these functionalities collectively reduce the emotional content of communication and focus the teams' attention on the substantive aspects of collaboration.

Technologies such as group decision support systems limit and structure certain aspects of the decision process (Dennis, Valacich, Connolly, & Wynne, 1996; Hollingshead & McGrath, 1994; Mullen, Johnson, & Salas, 1991). For instance, group decision support systems have tools for structuring idea generation, agenda setting, and processes for attaining consensus (Greenberg & Folger, 1983; Hollingshead & McGrath, 1994). Such technologies

are typically low in information richness because the focus of their use is on the substance of group tasks. Features of such technologies facilitate high team member participation and interaction in resolving task conflict. The outcome is improved decision quality (Dennis & Valacich, 1993; Gallupe et al., 1991). Furthermore, group members feel a sense of ownership of the decision through the enhanced participation and the ability to reach consensus through the group decision support system (McGrath & Hollingshead, 1993). Finally, to the extent that the management of task conflict is more easily facilitated by the ICT, individuals in teams are more likely to demonstrate higher levels of satisfaction and commitment to the team. We therefore expect that virtual teams that manage task conflict through such technologies will have more positive assessments of the group experience, yielding the following.

> *Proposition 1b:* Virtual teams that use ICTs that are low in feedback and symbol variety and high in parallelism, rehearsability, and reprocessability (e.g., e-mail) for managing task conflict at later team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

As observed earlier, relationship or affective conflict involves interpersonal issues such as dislike, annoyance, frustration, and irritation. Unlike other forms of conflict, relationship conflict is not beneficial at any point in the life of a group (Jehn & Mannix, 2001). It is therefore important that teams reduce the potential for relationship conflict as early as possible in the team's life. Jehn (1995) and Shah and Jehn (1993) suggested that establishing politeness norms in the early stages of group interaction enables team members to become more familiar with each other. Such familiarity can result in greater information sharing and improved conflict resolution (Gruenfeld, Mannix, Williams, & Neale, 1996; Jehn & Shah, 1997).

Face-to-face communication and interaction during the early stages of team development helps establish trust among group members (Jarvenpaa, Knoll, & Leidner, 1998). Because of the socioemotional dimensions of trust and familiarity building, visual (e.g., body language, smiling, nodding, and eye contact) and voice (e.g., voice inflections, tone) cues play a central role in communications among group members (Daft & Lengel, 1986; Daft et al., 1987). Therefore, the ICT used for communication must allow for the exchange of social cues between interacting team members.

Teams using technologies that are high in media richness during the early stages of team development are more likely to be successful in managing trust-building processes than teams relying on leaner technologies (Griffith et al., 2003; Jarvenpaa & Leidner, 1999). Technologies that can transmit visual and voice cues (e.g., video-conferencing) are best suited to performing such relationship management tasks. Furthermore, such communication media need to enable synchronous rather than asynchronous communication. As Griffith et al. (2003) pointed out, lean media such as e-mail, which are fairly deficient in their processing of social cues, often lead to misinterpretation of communications and consequently greater relationship conflict. Cramton (2001) provides further evidence of misinterpretations that can occur in lean computer-mediated communication.

Theories of impression development in the communication literature suggest that individuals seek any cues they can get to form impressions of their communication partners. Social information processing theory, for instance, notes that in the absence of nonverbal cues, communicators naturally adapt their relational behaviors to those cues that remain in computer-mediated communication (Walther, 1992). Similarly, Lea and Spears's (1992) social identity and deindividuation theory argues that the absence of nonverbal cues in computer-mediated communication forces users to form impressions on the basis of social categories of communicators as opposed to interpersonal cues. In adapting to the richness constraints of computer-mediated communication media, communicators develop uncertainty reduction strategies to better acquaint themselves with their communication partners. Finally, to the extent that relationship conflict manifests itself at a dyadic level, it must also be resolved at this level. In this context, the participation of multiple team members via technologies that support parallelism such as video-conferencing may introduce greater noise into the conflict resolution process. Hence, technologies that enable greater feedback and symbol variety while reducing parallelism are more likely to facilitate the management of relationship conflict, giving way to positive outcomes (Montoya-Weiss et al., 2001). Collectively these findings suggest the following:

> *Proposition 2:* Virtual teams that use ICTs that are high in feedback and symbol variety and low in parallelism (e.g., telephone) for managing relationship conflict during early team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

Over time, virtual team members develop shared knowledge and a shared context for engaging in interpersonal discourse through lean communication technologies (e.g., e-mail) provided that norms of communication have become well established (Cramton, 2001). Carlson and Zmud's (1999) channel expansion theory posited that perceptions of richness of a communication medium can change over time and are shaped by channel experience, communication partner experience, topic experience, and context experience. The fundamental premise of channel expansion theory is that low richness communication media can be perceived as being rich (i.e., having high symbol variety) if, over time, communicators become accustomed to using the medium and have developed a system of understanding each other (Carlson & Zmud, 1999). If relationship conflict arises during later stages of team development, and team members have already established trust and norms of communication during earlier developmental stages, then virtual team members can successfully manage conflict in the absence of nonverbal cues, that is, feedback and symbol variety are not as critical (Fulk, Steinfield, Schmitz, & Power, 1987; Schmitz & Fulk, 1991). These arguments yield our third proposition:

> *Proposition 3:* Virtual teams that use ICTs that are low in feedback, symbol variety, and parallelism (e.g., e-mail) for managing relationship conflict at later virtual team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

The final form of team conflict—process conflict— is critical to resolve in the early stages of group interaction. Managing process

conflict early enables team members to agree on work norms over the life of the team (Tuckman, 1965). Responsibilities are assigned to various group members, and deadlines and pacing of tasks are set. Such activities enable groups to later focus on the substantive content of group tasks (Gersick, 1988).

Team member participation in the assignment of responsibilities and identification of important group tasks and deadlines ensures that everyone understands and is committed to group decisions (Greenberg & Folger, 1983). Hence, communication media must enable full member participation in decision-making activities that resolve process conflict. Similar to the management of task conflict, process conflict makes itself amenable to solutions generated through participative synchronous or asynchronous communication through low symbol variety communication technologies provided that the norms of openness and debate have been established.

The timing of the use of such technologies is also important. Although Gersick (1988) argued that moderate levels of process conflict were beneficial in the early stages of group interaction, findings by Jehn and Mannix (2001) suggest that successful teams also have moderate levels of process conflict in the final stages of the group task. During this completion phase, group members need to decide who the most capable team members are for completing new tasks in this phase (Jehn & Mannix, 2001). The use of high symbol variety technologies is unnecessary since the emotive content and nonverbal cues of communication are neither needed nor useful (McGrath & Hollingshead, 1993). Indeed, such technologies can lead to inefficiencies in handling process conflict if emotional cues are embedded in communications. This is not to say that affect can be removed from the decision-making process but rather that the technology should reduce communicators' ability to effectively convey emotion in communications (Hinds & Bailey, 2003). The focus needs to be on how to approach team tasks. Therefore technologies of low symbol variety richness are better suited to managing process conflict. The level of participation that such communication technologies enable is likely to increase team members' assessments of the virtual team experience and commitment to the team to the extent that they feel ownership over final decisions (Greenberg & Folger, 1983). Additionally, deliberation and forethought is important in reducing process conflict as is the ability to document agreements reached between team members.

Finally, it is important to note that in newly formed virtual teams that are early in their development, debates and disagreements related to process conflict can potentially degenerate into relationship conflict as discussions of resource allocation become arguments about members' contribution to the team (Jehn, 1997; Jehn & Chatman, 2000). Such teams have not developed the norms of openness, debate, and constructive criticism necessary to successfully manage process conflict. Hence, it is important for such teams to use ICTs that offer high symbol variety and immediacy of feedback so as to reduce the potential for misunderstanding constructive process-related comments (Griffith et al., 2003). Further, Dennis and Valacich (1999) argued that such newly formed teams are likely to be focused on socially related communication activities and thus may be better off communicating through high symbol variety ICTs. Hence, we suggest that newly formed virtual teams that use ICTs that are high in symbol variety and immediacy of feedback will manage process conflict more effectively. The effective management of process conflict is expected to manifest itself in higher levels of team member satisfaction, cohesiveness, and team commitment, as suggested by Jehn and Chatman (2000). Thus, we posit the following:

> *Proposition 4a:* Virtual teams that use ICTs that are high in feedback, symbol variety, and parallelism (e.g., videoconferencing) for managing process conflict during early team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

> *Proposition 4b:* Virtual teams that use ICTs that are low in feedback and symbol variety, and high in parallelism, rehearsability, and reprocessability (e.g., e-mail) for managing process conflict at later team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

Motivating and Confidence-Building Processes

Individual team members are embedded within the group, and their perceptions and attitudes toward the group stem from their interactions with group members. Hence, the nature of the interaction between individual group members and the overall group can have a significant impact on team members' assessment of the group experience (Seers, 1989). The emergence of a sense of collective or team efficacy (group potency) can positively shape individual perceptions of the team experience, facilitate the development of greater cohesion among team members, and develop greater commitment to the team's goals and ideals (Crant, 2000; Hyatt & Ruddy, 1997). Such collective efficacy emerges when individual team members develop confidence in the collective abilities of their teammates to effectively accomplish team goals (Gibson, 1999).

Motivating or confidence building involves the continuous encouragement of team members to maintain high levels of performance and is instrumental in achieving a sense of collective confidence (Marks et al., 2001). Teams can motivate individuals by communicating positive perceptions of the collective abilities of team members or by communicating positive feedback about team successes (Marks et al., 2001). Moreover, such motivation helps instill a strong sense of team and social identity, greater commitment to team goals, and greater overall satisfaction with the team (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002). Failure to engage in confidence building can often result in poor team effectiveness over time (Lindsley, Brass, & Thomas, 1994; O'Hara-Devereaux & Johansen, 1994) and shirking (Jones, 1984).

Continuous member support through the team's responsiveness to individual social needs, nurturing of team identity, and maintenance of a sense of inclusion are all ways of motivating and building confidence in individual team members (Marks, Mathieu, & Zaccaro, 2001; McGrath, 1991). In a recent study of Sabre Inc., Kirkman et al. (2002) found that careful attention to the social needs of virtual team members helps to successfully overcome feelings of alienation, isolation, and detachment. Addressing these aspects of member support is instrumental in gaining the commitment and participation of team members to achieve group goals (Marks et al., 2001; McGrath, 1991). Additionally, attention to social needs helps keep virtual team members "in the loop" and provides a sense of inclusion.

ICTs and the Motivation and Confidence-Building Processes

Motivation and confidence-building behaviors are enacted over the life span of the team (as opposed to a specific phase) and are thus executed in parallel to group tasks (Marks et al., 2001). Self-efficacy theory (Bandura, 1977) suggests that frequent feedback is an important element of developing confidence in one's abilities. In essence, this constitutes the positive reinforcement that not only recognizes a team member's strengths and competencies in specific areas; it identifies opportunities for growth and development that can propel a virtuous cycle of self-improvement and learning. Further, theories of performance management and feedback note the importance of communicating such feedback in a personalized, rich manner (Hackman & Walton, 1986; Kozlowski, Gully, Salas, & Cannon-Bowers, 1996) so as to minimize misinterpretations and permit dialogue and clarifications, as appropriate. Thus, feedback is best delivered face-to-face, where a variety of visual cues can be used to supplement the information provision, rather than impersonally through a lean medium such as a memo. Finally, feedback has been noted to be more efficacious when there is an agreed upon closure to the feedback session, where both parties have reached a shared understanding of the exchange that has occurred.

Early and persistent feedback can be valuable for developing confidence and self-efficacy in the initial stages of team development. Once such efficacy has been established, it is less important to imbue the feedback processes with extensive symbol variety; thus, even leaner communications may be equally effective in motivating team members and giving them a sense of belonging. The key consideration here is the feedback and persistence of the communication in documented form, rather than its use of visual cues. These arguments suggest the following:

> *Proposition 5:* Virtual teams that use ICTs that are high in feedback, symbol variety, and reprocessability (e.g., Instant Messaging with video capabilities) for managing motivation and confidence-building processes at early team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

> *Proposition 6:* Virtual teams that use ICTs that are high in feedback and reprocessability (e.g., Net Meeting) for managing motivation and confidence-building processes at later team developmental stages will be more effective than virtual teams that use ICTs with other functionalities.

Affect Management Processes

The final interpersonal process, affect management, involves the regulation of team member emotions that may arise for a variety of reasons, including stress, isolation, and frustration (Marks et al., 2001). Unregulated negative emotions often lead to negative attitudes toward the team if the source of emotional distress is of a task-related or interpersonal nature (Jehn, 1997). Ultimately, unresolved emotional distress can result in poor team effectiveness as a result of low member satisfaction, reduced group cohesion, and reduced team commitment. Further, emotionally charged team members work less effectively (Argyris, 1962; Ross, 1989), and a negative emotional disposition impairs the objectivity and cognitive attention required to complete tasks (Thomas, 1992). It can also precipitate a breakdown in communication with other team members, thus, leading to a reduction in short-term indicators of team viability. Jehn (1997) found that emotionality in process- or task-related conflict led to poor team effectiveness.

Team member emotions may be regulated through such activities as calming the individual down, boosting team member morale through pep talk, or being empathetic toward the individual's emotional concerns (Caruso, Mayer, & Salovey, 2002; Druskat & Wolff, 2001). Recent work has begun to focus on the emotional intelligence of teams, which reflects the team's sensitivity to its members' emotional state and the ability to regulate those emotions (Druskat & Wolff, 2001). Marks et al. (2001) also observed that activities such as joking, relaxing, and complaining can be effective affect management strategies if they are directed toward cohesion building, tension breaking, morale boosting, or venting of frustrations. Successful affect management not only ensures continued individual effectiveness, but also positively shapes team members' perceptions of the team as well as the overall affect of the team (Kelly & Barsade, 2001). Affect management processes that create a positive emotional disposition help to increase group cohesion and can also amplify members' commitment to the team (Jehn, 1997).

ICTs and Affect Management Processes

As argued above, the essence of affect management is in the regulation of team member emotions (Marks et al., 2001). Thus, to the degree that conflict yields negative emotions, at a fundamental level, affective issues arise as a result of the existence of task- and relationship-based conflict. One strategy for managing affect, then, is to simply preempt the existence of conflict by, among other things, using appropriate ICTs (Hinds & Bailey, 2003). A second key strategy for regulating emotions, ensuring that any frustration is addressed as soon as it arises, is also worthy of attention. Here, immediacy or synchronicity of communication becomes paramount. Frustrations that are left unresolved for extended periods of time can burgeon and fester and, ultimately, lead to dysfunctional behavior such as absenteeism or shirking, simply because the member no longer feels committed to the goals of the team (O'Hara-Devereaux & Johansen, 1994). Social and non–work-related communication also helps regulate emotions in a positive direction; for instance, social communications such as jokes and personal anecdotes help dispel tensions and stresses that inevitably arise in the accomplishment of instrumental goals (Mechanic, 1991). For affect management, spontaneity and variety in communication is essential; a perception of extensive planning and orchestration and rehearsal in anticipation of the communication may result in it being perceived as deliberate rather than natural. Finally, to the extent that collective as opposed to dyadic social interactions provide greater connectedness and identity for the team, such interactions may also be efficacious in dispelling negative emotions and engendering greater excitement. High parallelism would support such collective interactions. Therefore, we suggest the following:

> *Proposition 7:* Virtual teams that use ICTs that are high in feedback, symbol variety, and parallelism (e.g., video-

conferencing) for managing affect management processes will be more effective than virtual teams that use ICTs with other functionalities.

Summary

Building on the theory of task–technology fit, we have argued that teams that use ICTs with functionalities that match the communication requirements of the interpersonal process the team is attempting to manage will perform better than teams that select ICTs with alternative functionalities. We used the tenets of media synchronicity theory to help us understand the range of functionalities that ICTs can offer. As depicted in Figure 2, the outcomes yielded by this match are higher levels of team member satisfaction, group cohesion, and team commitment. These outcomes are relevant to our theory because they emanate from interpersonal interactions among team members and, as such, successful management of these interactions enables teams to achieve these outcomes. For instance, task conflict and relationship conflict have been found to negatively affect team member satisfaction with the group experience (Jehn, 1995), whereas activities such as motivating and affect management are expected to yield higher levels of satisfaction (Marks et al., 2001). Further, these activities are expected to improve group cohesion and commitment to the team (Jehn & Chatman, 2000; Marks et al., 2001). Finally, prior research suggests that satisfaction, group cohesion, and team commitment require attention because they are proximal antecedents of team performance (e.g., Jehn, 1995; Mullen & Copper, 1994).

One important consideration that is not explicitly incorporated into the theoretical model is the notion that the interpersonal interactions that occur among virtual team members do not produce discrete processes.[1] In other words, the interpersonal processes outlined in our model do not necessarily emerge separately from each other. Rather, these processes can, and in many cases do, emerge concurrently. For instance, communication that occurs around the management of task conflict might uncover underlying relationship conflict among team members. Indeed, Marks et al. (2001) suggested that many team processes occur in parallel rather than being discrete. However, the core of our theory is focused on matching the best ICT for each interpersonal process at various stages of virtual team development. In so doing, we have had to simplify what in reality is a highly complex system of team processes. Hence, an opportunity exists for future research to extend our theoretical model by studying how virtual teams can manage transitions between interpersonal processes.

An additional observation related to Figure 2 is important. Although not depicted in the model, implicit in our theory is the notion that communication functionality is not an inherent, objective characteristic of the ICT. Rather, consistent with the basic tenets of structuration theory (DeSanctis & Poole, 1994; Giddens, 1984; Orlikowski, 1992), teams may appropriate ICTs in a variety of ways, thereby imbuing them with differential degrees of functionality. For instance, it has been widely acknowledged that a seemingly lean medium such as e-mail can be embellished with greater social information by the use of shared symbols (Carlson & Zmud, 1999; Lee, 1994). Thus, the specific functionality of an ICT that is available to address the communication needs of a virtual team cannot be examined in isolation of the team's appropriation of it.

Discussion

The motivation for this work lies in the recognition that although empirical research suggests that virtual teams are vulnerable to mismanagement of interpersonal processes (Adrianson & Hjelmquist, 1991; Straus & McGrath, 1994), little has been done to investigate how such teams may formulate strategies for managing these processes through electronic communication media. In this article, we outlined a theoretical model of how virtual teams can manage interpersonal processes and ensure favorable team outcomes such as increased team member satisfaction, team commitment, and team cohesion. As empirical research has shown, achieving such outcomes has proved difficult for virtual teams (Cramton, 2001; Jarvenpaa & Leidner, 1999).

Our theoretical model specifies that matching the media functionalities of ICTs to specific tasks will enable virtual teams to achieve greater levels of effectiveness. Furthermore, we have argued that the temporal stage of team development will temper the effectiveness of a team's chosen communication medium. In our propositions we related specific technological functionalities as opposed to the technologies themselves. Table 1 summarizes the essence of the theory and provides examples of both salient communication needs and technologies that can support these needs across all the interpersonal team processes. Figure 3 illustrates the temporal aspect of the theory and identifies the specific technological functionalities that are best suited for specific stages of team development.

As shown in Table 1, we argue that virtual teams ought to use technologies that provide multiple avenues for expression to manage relationship conflict during the early stages of team development. The communication of nonverbal cues is particularly salient here. Furthermore, such conflict is best managed through synchronous communication so that team member concerns are addressed in a timely manner. Technologies such as video-conferencing are best suited for managing this type of conflict.

Task-related conflict is best managed through synchronous communication technologies that are low in symbol variety but capable of supporting deliberation and documentation. The use of such technologies is expected to enable effective management of task conflict for virtual teams that are in the advanced stages of development. Technologies that enable structured decision making encourage participation by team members and minimize the emotive content of communications. Such consensus-generating activities allow participants to gain a sense of ownership over final decisions and hence improve individual assessments of the group experience. Group decision support systems are one example of a suitable communication technology for managing task conflict. On the other hand, virtual teams that are still in the early stages of their development may require the use of communication media with high symbol variety and immediacy of feedback so that misunderstandings of task-related discussions can be avoided.

We outlined a similar strategy for managing process conflict, although the synchronicity of communication enabled by the technology is less of a concern. Managing process conflict does not require the same sense of urgency and responsiveness as task conflict; rather, it entails reaching agreement on how tasks are to

[1] We thank an anonymous reviewer for raising this point.

Table 1
A Summary of Task–Technology Fit for Managing Virtual Team Interpersonal Processes

Variable	Relationship conflict	Task conflict	Process conflict	Motivating/Confidence-building	Affect management
Media richness requirements	Early development stage Immediacy of feedback (high) Symbol variety (high) Parallelism (low) Later development stage Immediacy of feedback (low) Symbol variety (low) Parallelism (low)	Early development stage Immediacy of feedback (high) Symbol variety (high) Parallelism (high) Later development stage Immediacy of feedback (low) Symbol variety (low) Parallelism (high) Rehearsability (high) Reprocessability (high)	Early development stage Immediacy of feedback (high) Symbol variety (high) Parallelism (high) Later development stage Immediacy of feedback (low) Symbol variety (low) Parallelism (high) Rehearsability (high) Reprocessability (high)	Early development stage Immediacy of feedback (high) Symbol variety (high) Reprocessability (high) Later development stage Immediacy of feedback (high) Symbol variety (low) Reprocessability (high)	Immediacy of feedback (high) Symbol variety (high) Parallelism (high)
Examples (salient needs)	Emotional content of communication Communication of nonverbal cues	Facilitate active discussion and evaluation of alternatives Structured communication protocols	Facilitate active participation in delegation of responsibilities	Provide encouragement and positive feedback to team members	Calm down emotional team members Regulate team member emotions Dispel tensions that build up around accomplishment of team goals
Examples (technologies)	Videoconferencing Telephone E-mail (later stages of development)	Group decision support system E-mail (later stages of development) Instant messaging Net meeting	Group decision support system E-mail (later stages of development) Instant messaging Net meeting	Instant messaging Net meeting	Videoconferencing Telephone

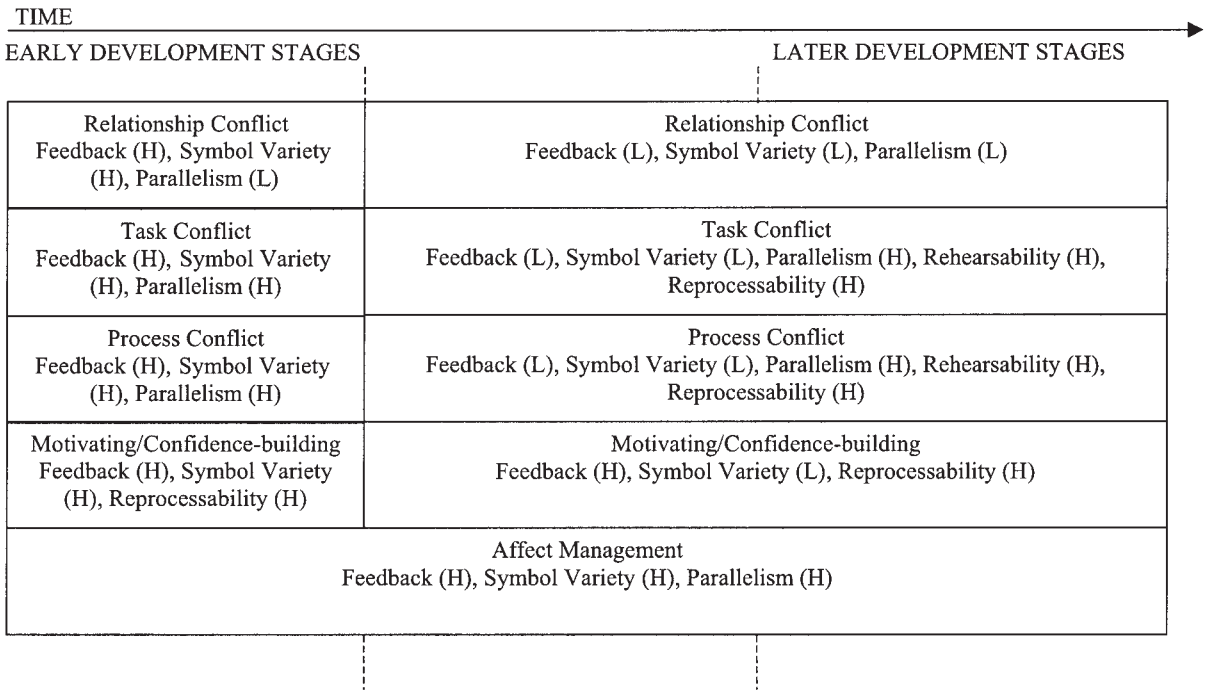

Figure 3. A temporal model of task–technology fit for managing interpersonal processes. H = high; L = low.

be executed and how responsibilities are delegated. Asynchronous communication technologies such as e-mail can be quite efficacious for handling process conflict. As long as the communication medium has the capacity to document the team's agreements regarding tasks and responsibilities, immediacy of feedback is not as much of a concern. Virtual teams in the early stages of their development are better off using communication media with high symbol variety.

Finally, motivation and confidence-building as well as affect management processes need ICTs that allow synchronous communication and support a variety of visual and emotive cues, although the variety of cues is less important for motivation and confidence building at later team developmental stages when a baseline level of efficacy has been established. However, although motivation and confidence building demand some level of documentation (via the reprocessability functionality), affect management is also about the development of an esprit de corps among team members. Technologies that support parallelism help create such a group identity.

From a temporal perspective, one key activity that is worth underscoring is the development of trust in virtual teams. Establishing trust early in the development of a virtual team is particularly critical to the functioning of the group and the ability to manage the various social activities outlined in our model. Jarvenpaa and Leidner (1999) found that virtual teams that established trust early were able to solve problems and resolve conflicts better than teams with low trust. Trust was established by engaging in exchange of social messages among team members. Similar conclusions were drawn by Kirkman et al. (2002) in their study of Sabre Inc.'s virtual teams. Initial messages were instrumental in setting the tone for relations between team members (Jarvenpaa & Leidner, 1999). This finding parallels developmental patterns in naturally occurring teams identified by Gersick (1988). Establishing trust helps virtual teams to limit relationship conflict to minimal levels and also facilitates efficient management of other forms of intragroup conflict (Jehn & Mannix, 2001). From this perspective, as shown in Table 1, our model suggests that virtual teams ought to build trust among team members by communicating through high symbol variety communication media in the early development stages.

In summary, this work contributes to the literature in three important ways. First, we extend prior work on virtual teams by highlighting the importance of achieving a fit between the functionalities of communication technologies and type of interpersonal process the team is engaged in. Although the application of task–technology fit to managing group tasks is not new, our incorporation of this paradigm into a framework for managing interpersonal processes is new. In addition, our model is sensitive to the temporal dimension of process execution and team developmental stage (Marks et al., 2001). We point to the importance of managing the focal interpersonal interaction by using the right technology at the right time. Finally, our model proposes strategies for reducing the dysfunctional behaviors associated with virtual team members. By improving social interactions and conflict management in virtual teams, individuals realize higher levels of satisfaction, team commitment, and team cohesion and mitigate the emergence of dysfunctional behaviors.

Implications and Future Research Directions

The model developed here offers several opportunities for future research. First, our model would benefit from empirical testing to

refute or validate the propositions that have been stated. The theoretical model could be tested through a longitudinal study in an experimental or quasi-experimental setting. Specifically, future research can restrict experimental groups to using a single technology to manage communication over the period of the study. Variations in conflict could be measured at various intervals throughout the study, and team effectiveness measures, such as satisfaction, team commitment, and team cohesion could be measured at the end of the study.

Any empirical test of the model would require researchers to develop conceptual definitions and operational measures for each construct in the theory. We provide some guidance here on how this may be accomplished. Measures of ICT functionality are available in Dennis and Valacich (1999); these measures have exhibited adequate psychometric properties in other studies (e.g., Carswell, 2001; Dennis et al., 1998). Researchers can manipulate the various functionalities outlined in media synchronicity theory through their choice of ICT. Immediacy of feedback, which represents the synchronicity of the communication medium, can be manipulated by choosing between a chatlike function (for synchronous communication) and e-mail (for asynchronous communication). For instance, Dennis et al. (1998) operationalized and manipulated immediacy of feedback by assigning subjects to group decision-making conditions using face-to-face communication versus written communication. Similarly, the experimental conditions served as operationalizations of parallelism, with the face-to-face communication condition representing low parallelism, and the written communication condition exhibiting high parallelism. Symbol variety can be manipulated through enabling voice and video in communication versus text only. ICTs such as instant chat enable multiple communications to occur concurrently while audio communication restricts individuals to single conversations at a time, thus enabling one to manipulate parallelism. Similarly, text-only ICTs can be used to enable higher rehearsability, whereas audio- or video-conferencing provide less rehearsability. Finally, text-based communications generally provide a record of communications. Therefore, researchers testing the theoretical model are in a position to manipulate ICT functionalities through their choice of communication media conditions.

Researchers can also measure perceptions of these functionalities using Carswell (2001) for teams under different experimental conditions. Carswell developed and validated measures for media characteristics in the context of technology-mediated learning using the World-Wide Web as the communication platform. Sample items for immediacy of feedback characteristics include the following: "The responses I receive to my class contributions are not received quickly enough to be helpful," and "I receive responses to my class contributions in a timely manner." The following is an example of an item for reprocessability: "The online learning environment permits me to review messages from my instructor and classmates over and over again," whereas statements of the form "In our online discussions, there are several threads of conversation that are occurring simultaneously" are used to assess parallelism.

Team outcomes are extensively discussed in the literature on teams, and researchers can use measures for satisfaction, group cohesion, and team commitment as presented in these studies. For instance, Jehn (1995) includes items for measuring individual satisfaction with the team. A number of studies have measured group cohesion (e.g., Jehn & Chatman, 2000; Tesluk & Mathieu, 1999; Zaccaro & McCoy, 1988). In their study of team empowerment, Kirkman and Rosen (1999) measure team commitment as an outcome. Finally, because the theory is process-focused in nature, specific uses of ICTs would need to be mapped to the stage of team activity as well as the particular process on which the ICT use is focused. In other words, every ICT use episode would need to be characterized in terms of the specific interpersonal process (conflict management, motivation and confidence building, or affect management), and the team's development stage. Such measurement can be accomplished by requiring team members to maintain a log of their communication activities, recording when and why an ICT was used. In such a design, outcomes would be measured at specific points in time as defined by the researcher on the basis of the tenure of the team and its work.

Second, our model does not explicitly specify the role of the team leader in facilitating the management of interpersonal processes in the virtual team setting. It would be of theoretical and practical interest to understand what actions team leaders can take to (a) foster trust among virtual team members, (b) coordinate the discussion and content of team tasks, and (c) delegate responsibilities to team members in a way that ensures commitment to team goals and achievement of favorable effectiveness outcomes. Further, an understanding of the ability of team leaders and team members to recognize how to use technology to facilitate critical interpersonal processes would be valuable. Additionally, identifying specific stages at which leaders should intervene to manage social interactions and conflict management would be a valuable research contribution. Although research on leadership in virtual teams is lacking, trust has been identified as a critical element of leadership (Tyran, Tyran, & Shepard, 2003).

Third, we do not directly address the issue of the level of virtual communications of teams (Bell & Kozlowski, 2002). Virtual teams differ on the degree to which they are virtual, from co-located teams that interact through a mixture of face-to-face meetings and computer-mediated communication to teams that are geographically or temporally dispersed and communicate solely through ICTs. The degree of virtual communications certainly has implications for the need to use ICTs of varying degrees of richness. For instance if face-to-face interaction is a viable option for certain teams, then the need for high symbol variety ICTs is eliminated. Additionally, the type of dispersion is also an important consideration. Some teams are geographically dispersed, whereas others are temporally dispersed (time zones, work shifts, etc.) and yet others are dispersed on both dimensions. Future research should take such elements into consideration.

Fourth, in our propositions we do not relate the fit between task, media choice, and stage of team development to specific short-term indicators of team viability, that is, satisfaction, commitment, and cohesion. Rather, propositions are stated to assert that the fit will yield greater effectiveness, which is viewed as a downstream outcome of short-term team viability. Our goal in this article was to theorize about media characteristics and task requirements, and we treated the development of causal linkages between fit and specific outcomes as beyond the scope of the current effort. An opportunity therefore exists here to refine and extend the theory by developing more granular propositions.

Finally, the role of individual differences in the management of social interactions within virtual teams also warrants further in-

vestigation. Studies of deep- and surface-level diversity in traditional teams have established a link between individual differences and team performance (Harrison, Price, Gavin, & Florey, 2002; Watson, Kumar, & Michaelson, 1993). Staples, Hulland, and Higgins (1999) found that individuals' remote work self-efficacy was positively linked to job satisfaction, productivity, and remote work performance among other things. Differences in computer anxiety and information technology capabilities were identified as important antecedents of remote work self-efficacy. These findings have important implications for interactions between virtual team members and the role of leadership in identifying qualified individuals for virtual work (Kirkman et al., 2002). Therefore, further study is warranted. Individual differences may influence the ability of teams to manage different types of conflict given various levels of discomfort associated with working in a virtual environment.

In conclusion, the management of interpersonal interactions in virtual teams continues to be a promising and rich area for research. The theoretical model developed here suggests that team leaders and managers need to be deliberate in their consideration and selection of ICTs to manage virtual team communication. Considerations such as the richness of the medium and the synchronicity of communication should help managers make informed choices. Simple decisions such as choosing between e-mail and decision support systems become critical under such considerations. As technologies continue to evolve and greater communication capabilities are invented, models of virtual team coordination will need to evolve to accommodate these new functionalities (Agarwal, 2003). Empirical research continues to show that extant theory in traditional teams cannot be directly applied to virtual team settings. This research takes a step toward addressing some of the challenges of managing interpersonal processes in virtual teams.

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