ELSEVIER

J. Eng. Technol. Manage. 20 (2003) 141–159

Journal of ENGINEERING AND TECHNOLOGY MANAGEMENT JET-M

www.elsevier.com/locate/jengtecman

Recognition and reconciliation of differences in interpretation of misalignments when collaborative technologies are introduced into new product development teams

Gerald I. Susman*, Barbara L. Gray, John Perry, Candace E. Blair

Smeal College of Business Administration, The Pennsylvania State University, 404 Beam Business, Administration BI, University Park, PA 16802-1914, USA

Abstract

This article synthesizes and extends existing theories of how teams adopt and adapt to collaborative technology (CT) by recognizing misalignments between technology, task, organization, and the group (TTOG), and then devising appropriations to deal with them. Existing theories give inadequate attention to differences among team members in recognition of these misalignments, interpretation of their origin, proposed corrective actions, and reconciliation of differences. Lack of trust and increased diversity among team members exacerbate such differences. Propositions that relate to recognition of misalignments, and their reconciliation are developed. The capability to recognize and resolve differences is as important as eliminating or reducing misalignments themselves.
© 2003 Elsevier Science B.V. All rights reserved.

JEL classification: O32: management of technological innovation and R&D

Keywords: New product development teams; Collaborative technology; Virtual; Structuration; Misalignment

1. Introduction

Contrary to popular opinion, the introduction of collaborative technology (CT) in the work place does not necessarily enhance collaboration among employees. Although this statement seems obvious, many companies currently do not seem to appreciate these distinctions. They behave as if they believe, or hope, that all they have to do to create collaboration among employees is to introduce software and/or communication tools marketed as “collaborative”.

* Corresponding author. Tel.: +1-814-863-2382; fax: +1-814-863-7261.
E-mail address: gis1@psu.edu (G.I. Susman).

0923-4748/03/$ – see front matter © 2003 Elsevier Science B.V. All rights reserved.
doi:10.1016/S0923-4748(03)00008-0

Collaborative technology vendors, generally software and telecommunication companies, are partly responsible for generating this misguided belief. In their marketing, CT vendors implicitly claim that their products will naturally enhance workgroup collaboration. Their marketing information, however, fails to outline the team and organizational level changes that may be necessary in order to create successful collaboration with CT.

In this paper, we examine the processes of CT implementation in new product development (NPD) teams. Within the NPD literature, only a handful of studies have examined the recent introduction of software applications aimed at helping work teams electronically collaborate (Ciborra and Patriotta, 1998; Ngwenyama, 1998; Majchzrak et al., 2000; Wierba et al., 2002). Of these studies, however, only one (Majchzrak et al., 2000), has helped to advance theoretical understanding of how CT introduction affects workgroup collaboration. According to McDonough et al. (2001), because many organizations will become increasingly more reliant on geographically dispersed NPD teams in the future, companies will need to understand how to most effectively implement and utilize CT. We expect that the introduction of CT may represent an opportunity for NPD teams to overcome traditional communication and information access problems, and eventually improve team performance. For this reason, researchers should study how NPD teams implement and utilize CT. We expect that the introduction of CT into NPD teams will generate new research issues or lead to re-formulation of existing ones, such as the following.

First, research will increasingly focus on geographically dispersed NPD teams as their number will grow faster than will collocated NPD teams. McDonough et al. (2001) suggest that NPD teams that are geographically dispersed and culturally diverse are growing the fastest. Competitive strategies are forcing companies to deploy their NPD resources globally, thus making collocated NPD teams prohibitively expensive and logistically difficult to manage. CT can cut expenses considerably and facilitate communication in such teams, but these teams also must overcome formidable behavioral and management challenges.

Second, the introduction of CT into NPD teams may broaden or alter the set of skills that members of successful teams require. Majchzrak et al. (2000) studied an NPD team that successfully implemented a CT. They found that team members developed new communication, information gathering, information sharing, and decision-making skills. Successful implementation also may require team members to develop conflict management skills because their interpretations of new technology and preferred accommodations to it may differ.

Third, the introduction of CT will often lead to changes in the structure of NPD teams and the organizations in which they function. In the case of NPD, when a team adopts a new CT, the team's information flows and decision-making routines may change. Barley's (1986) study of the introduction of a new technology, computer tomography scanners, into two hospital radiology departments showed how the social order of the radiology departments was transformed as a result of new technology introduction. The introduction of CT into NPD teams will strengthen interest in applying this research perspective, e.g., structuration theory, to this new setting.

Fourth, the criteria that organizations use to evaluate NPD teams may broaden. McDonough et al. (2001) report that companies have lower performance expectations for geographically dispersed NPD teams than they do for collocated ones. In spite of this, most of the companies that McDonough et al. studied indicated that they intended to increasingly

utilize such teams in the future. This suggests that companies may be using criteria other than traditional NPD ones (e.g., quality, cost, schedule) to judge project success. For example, strategic objectives (e.g., market presence, first mover advantage, etc.) may be considered in evaluating project performance. Also, process measures, such as the team's capability to introduce and use CT successfully may need to be considered along with outcome measures.

In examining the introduction of CT in NPD teams, we have taken a theoretical approach that builds on adaptive structuration theory (AST) (DeSanctis and Poole, 1994). Consistent with adaptive structuration theory, we argue that the introduction of technology into an NPD team generates opportunities for adjustments in the social structure in which the team operates. Adaptive structuration theory, a derivative of structuration theory, focuses on how work groups and organizations respond when new technology is introduced. However, like Majchzrak et al. (2000), we disagree with DeSanctis and Poole (1994) about what constitutes a successful appropriation of technology. The latter contend that successful appropriation results when changes to the social structure are faithful to the spirit of the technology itself. Instead, we subscribe to the theory that successful technology adoption relies, not on faithfulness, but on the resolution of misalignments that occur between the technology, the task, and the social structure during the appropriation process (Majchzrak et al., 2000).

We also go beyond Majchrzak et al. by suggesting that the process of recognition and resolution of misalignments is itself a social process. That is, NPD team members will not necessarily experience the same misalignments or interpret them in the same way. These differences are likely to pose communication problems for NPD team members. Therefore, the process of reconciling these differences and agreeing on an appropriation requires a team effort and may be conflictual. Successful technology adoption, therefore, depends on the capability of team members to reconcile their different interpretations of misalignments and to reach agreement about how to correct the misalignment between the technology, the task, the team and/or the organization. Our paper presents a conceptual model of the technology appropriation process. Our model stresses the importance to NPD teams of anticipating differences in team members' interpretations of misalignments and developing capability within the team to constructively resolve conflicts over technology appropriation.

We begin in the next section of this paper by reviewing the existing technology adoption literature. Then, we introduce our CT appropriation model. After introducing the model, we further define CT and explain our model of the technology appropriation process in greater detail. Finally, in Section 4, we summarize our contribution, discuss how CT will change the way NPD teams work, and offer suggestions for future research.

2. Theoretical approaches to technology adoption and appropriation

When new technologies are introduced into organizations, they provide opportunities for sensemaking (Weick, 1995; Griffith, 1999) and for structuration (Barley, 1986; Orlikowski, 1992). Sensemaking is the process of noticing, interpreting, and acting in response to a stimulus (Weick, 1979). Sensemaking occurs when new technologies are introduced into organizations because the team members must make interpretations about

what the technology is intended to do and how it should be incorporated into their work processes (Barley, 1986). Structuration also occurs because, in the process of adopting and adapting the technology, existing social processes must be reconsidered and possibly revised to accommodate the technology. This process of considering and adjusting (or affirming) the existing social structure (e.g., norms, routines, status differences, communication patterns, rewards) is called structuration (Giddens, 1979; Barley, 1986; Orlikowski, 1992).

Adaptive structuration theory (DeSanctis and Poole, 1994) specifically focuses on how groups interact with technology and stresses the importance of appropriation. DeSanctis and Poole (1994, p. 128) consider appropriations to be "immediate, visible actions" that are assumed to have fairly immediate consequences. For example, appropriations occur when a group "makes judgments about whether to use or not use certain structures, directly uses (reproduces) a . . . structure, relates or blends a . . . structure with another structure, or interprets the operation or meaning of a . . . structure" (DeSanctis and Poole, 1994, p. 129). Appropriation involves the process of interpreting and selecting features of the technology and/or adapting them to suit one's own purposes (DeSanctis and Poole, 1994). Thus, the decisions and actions of system designers and users that result in adoption or adaptation of a technology's features or adjusting social systems to accommodate technology are all appropriations. Appropriations can be physical actions or speech that are intended to change one or more elements of task, technology, organization or the group (TTOG) doing the appropriating.

We agree with DeSanctis and Poole (1994) and other structuration theorists (e.g., Barley, 1986; Orlikowski, 1992) that both technology and social systems provide opportunities for structuration in that both constrain and create opportunities for social interaction. The structure that emerges is developed jointly by technology and social systems through both deliberate and unconscious actions of system designers and participants. Moreover, different forms of technology may be more or less amenable to modification. The constraints and opportunities, or "rules and resources" (DeSanctis and Poole, 1994, pp. 128–129), of information technology may seem less obvious than those of manufacturing technology because those of the latter are often embedded in physical objects. Information technology therefore may be more amenable to reconfiguration than manufacturing technology. Nonetheless, both technology and social systems play a similar role in the evolution of structure. For example, in IT adoptions, Tyre and Orlikowski (1994) and Purvis et al. (2001) showed how existing systems of knowledge constrained the assimilation of computer-aided software engineering (CASE) technology. Therefore, structuration theory argues that appropriations select and reinforce specific constraints and opportunities that technology and social systems present and lead to their institutionalization.

According to DeSanctis and Poole (1994), an ideal technology appropriation occurs when an appropriation is faithful to the technology's spirit (the goals sought and values promoted by its designers). Faithfulness is the central theoretical explanation in AST, accounting for how technology adoption affects performance—the more faithful the appropriation, the more effective the decision process. Unfaithfulness leads to less effective decision processes because of process losses (i.e., the team operates less efficiently than if it had scrupulously followed the technology designer's intent). Deviations from the designer's intent are viewed as indications that the team is having trouble organizing itself or needs to organize itself differently (DeSanctis and Poole, 1994). The latter effect is consistent

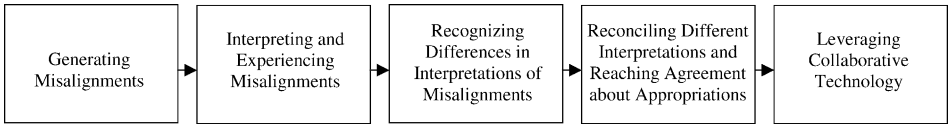

Fig. 1. Model of collaborative technology appropriation processes.

with another criterion of an ideal appropriation. That is, according to DeSanctis and Poole (1994), an ideal appropriation requires the least number of appropriation moves.[1]

In our view, while fewer appropriation moves may be beneficial, what is more important is how the team responds to discrepant events. Discrepant events occur when an individual confronts an aspect of a new technology that does not perform as he or she expected (Majchzrak et al., 2000). This may create a sense of discomfort for the individual and serve as a catalyst to search for an explanation for the problem. These discrepant events reflect misalignments between the technology and any of three other elements (i.e., the task, the group structure and/or the organizational structure). These misalignments can generate conflicts that have the potential to erode the team's performance and derail or limit the successful introduction of the technology.

We introduce a five-step model of technology appropriation within new product development teams by which misalignments must be generated, recognized and reconciled if the team is to successfully leverage the collaborative technology (see Fig. 1). The first step involves the generation of misalignments. The second step involves a sensemaking process in which one or more team members recognize a misalignment—that is, come to appreciate that a problem exists (Vickers, 1965; Griffith, 1995). The third step involves recognition of differences in sensemaking about the misalignment among the team members since not all team members are likely to focus on the same misalignment, or, if they do, to experience it the same way. In fact, some team members may not notice it at all. The fourth step requires reconciliation of the differences among team members and agreement about what appropriations are necessary. These appropriations may constitute modification of any of the four elements (technology, task, group or organizational structure). Finally, the fifth step is leveraging of the technology by the team.

Our model extends the work of Majchzrak et al. (2000) because we suggest that team members differ in their interpretations of what is misaligned and may enact or propose

[1] We argue that faithfulness plays a less prominent role in the adoption of CT since CT is often less comprehensive and restrictive (Silver, 1991; Abualsamh et al., 1990; Cats-Baril and Huber, 1987) than group decision support system (GDSS) technology, the technology studied by DeSanctis and Poole (1994). With CT, companies are likely to mix and match technologies (e.g., telephones, email, simulations, and whiteboards), and there is less likely to be a coherent message regarding spirit conveyed about the CT. Also, GDSS designers are more likely to unilaterally impose technology on users who frequently are subjects in lab experiments and willing to comply with the designers' directives. On the other hand, commercial CT vendors are more willing to modify their software based on customer feedback (Majchzrak et al., 2000). In such cases, vendors modify their technology's spirit (albeit less likely) or add or modify features to match organizational and group preferences rather than vice versa. We consider the coherence and consistency of a CTs spirit to be a variable rather than a constant in settings in which CT is introduced. Moreover, in NPD teams, what does matter is that misalignments arise between the technology (as intended) and the social system into which it is introduced.

different approaches to eliminating the misalignments. Consequently, it becomes essential that the model acknowledges these potentially different interpretations and captures the process by which NPD teams wrestle with and, hopefully, reconcile their differences about what is misaligned and what should be done about these discrepancies. We argue that, for successful technology adoption, teams must develop the capability to reconcile their different interpretations of misalignments and to reach agreement about how to correct the misalignment between the technology, the task, the group and/or the organization. In Section 3, each of the steps in Fig. 1 is discussed in more detail. Propositions associated with each step in the process are also presented.

3. A model of collaborative technology appropriation in new product development teams

Before we present each of the steps in our model of technology appropriation, it is important to explain the particular type of technology adoption that we are considering. The information technology that interests us is collaborative technology (CT). We focus on this technology because it is especially designed to assist new product development teams and other global teams that are collocated to coordinate their efforts virtually.

3.1. Collaborative technology

CT has two major components, a communication medium and a database. A communication medium (e.g., audio, video, data, graphics, or text) transfers different types of information either synchronously or asynchronously and from one person-to-another, or one person-to-many. Databases are repositories of technical information (e.g., product properties, cost, quality), and management information (e.g., plans, schedules, resource allocations, status reports, team minutes, etc.). Applications (e.g., simulation and evaluation tools) that manipulate information in databases and display it to organization members in various ways are also important components of CT, but will not be discussed in depth here.

The information content that is transferred by a communication medium or stored in a database may be different, but it also may be similar. The relationship between these two CT components is analogous to the random access memory (RAM) and the hard drive of a computer. Information is processed in a communication medium for current use, and is stored in a database for later retrieval and use. Finally, a communication medium serves different purposes. Following Maznevski and Chudoba (2000), these purposes include information gathering, problem-solving, idea construction, decision-making, and obtaining commitment.

3.2. Generation of misalignments

The first step in our model of collaborative technology appropriation processes that we consider is how misalignments are generated. A misalignment can be generated by changing the technology, task, organization or group of an existing organization or by creating a new organization in which TTOG accommodations are underway, but incomplete. A change

in any one of these four elements (i.e., technology, task, organization structure, or group structure) would likely change the other elements, or, more specifically, some attributes of them. As CT is the catalyst for change in this paper, examples will be taken from that perspective (i.e., from the technology perspective). If another element had been the catalyst, we would merely shift the emphasis between change trigger and the consequences.

Changes in CT can take many forms. Change can occur by introducing new media (e.g., chat rooms, teleconferences) or features of existing media (e.g., three-dimensional graphics, priority, alerts), redistribution of information flows (access and sharing of what and by whom), capture and retrieval (what is captured and who does it), and/or intervention rights (edit versus read-only).

CT change can affect many attributes of tasks, organizations, or groups, but the attributes that most interest us relate to information flows and decision-making. For example, CT changes can affect the structure (e.g., roles and chain of command) and norms (e.g., regarding communication and decision-making) of organizations and groups. Also, CT changes can make it harder or easier to manage task attributes that relate to information flows, such as uncertainty, complexity, and interdependence (see Fig. 2).

Whenever CT is changed without any complementary changes in tasks, group or organization structure and norms, the potential exists for the generation of misalignments between the new technology and the task, organization, and/or group. Many propositions concerning misalignments could be generated. A few will suffice for illustrative purposes.

First, the introduction of CT may affect organizational norms. If CT introduces a database that serves as a "common repository" (Majchzrak et al., 2000) for technical and management information, then allowing team members to access and share such information may lead them to question management decisions or allow the team to manage itself to a greater

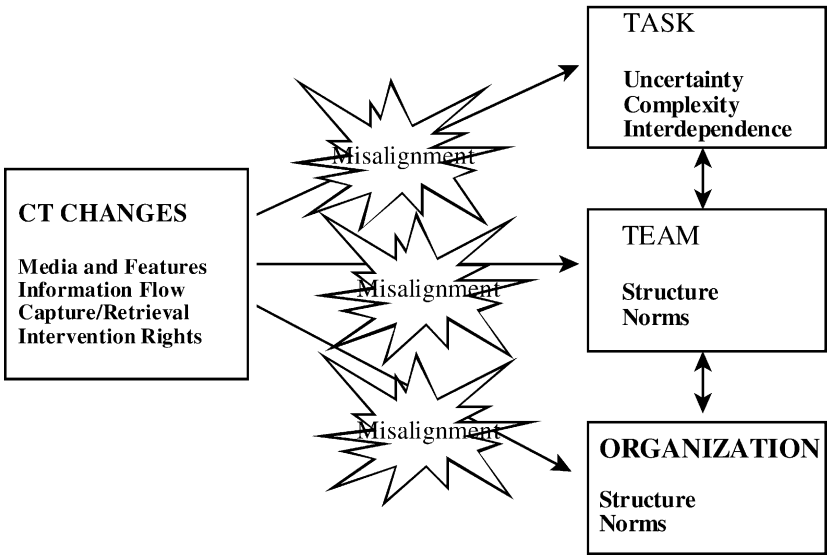

Fig. 2. Generation of misalignments.

extent than currently. In the case of a CT that may initially increase information access to team members, a misalignment between a new CT and organizational norms may occur. For example, a misalignment may arise when a new technology is introduced that gives NPD team members access to management information they previously had not known. With access to this management information, team members may begin to upset status quo managerial norms and make suggestions for how to better manage the NPD process. In reaction, the managers who supervise the team may view the suggestions as a threat to their authority and may therefore revoke team members' access. The implications of this example apply for access and sharing of technical and management information. If organization norms are not consistent with these implications, and senior management and team leaders have not given adequate attention to the implications of access and sharing of types of information, then misalignments will be generated.

Proposition 1. *CT changes that violate organization norms about appropriate subject matter for team members to access and share will generate misalignments.*

The introduction of CT may also affect organizational norms about roles and reporting relationships. Such norms include the degree to which team leaders and team members engage in external boundary activities to acquire or share information with individuals outside the team (Green et al., 2000; Ancona and Caldwell, 1992). The literature on NPD teams has established that effective boundary management includes identifying a champion in top management to protect the team from outside pressures, soliciting external resources, and lobbying for technical assistance (Ancona and Caldwell, 1992). The introduction of CT may alter these roles. For example, CT may democratize the boundary management role in teams in that the team leader may no longer be the sole gatekeeper between team members and senior managers. In the organization that Majchzrak et al. (2000) studied, team members with varying functional expertise communicated directly with their counterpart managers to obtain the technical information they needed. While these changes may enhance the ability of the team to meet its performance goals, it may fly in the face of the existing hierarchy, challenging expectations about who controls information and who has authority to answer questions that arise. Democratization also may remove the advantage that teams previously enjoyed from having a single champion, and threaten the existing leadership structure.

Proposition 2. *CT changes that allow team members to communicate directly with a greater number of persons inside and outside the organization may create misalignments by violating norms concerning reporting relationships and boundary management roles.*

Team members may not always choose the media or features that are most appropriate for the tasks that they have to perform often because doing so involves steep learning curves (Saga and Zmud, 1995; Fichman and Kemerer, 1997; Maznevski and Chudoba, 2000). However, limiting their choice reduces the likelihood of an appropriate match between medium and task. Existing literature supports a relationship between task attributes and type of medium (Daft and Lengel, 1984; Susman and Ray, 1999). Generally speaking, the more complex, uncertain, and interdependent task attributes are, the richer the medium (e.g., multimedia, synchronous) required to deal with them. Moreover, mismatches can occur in

both directions. Lean media may be inappropriate for complex and uncertain tasks, but rich media also may be inappropriate for clear and simple tasks.

Proposition 3. *CT changes that limit team members' choice of media and features will generate misalignments if these choices do not match the levels of task uncertainty, complexity, and interdependence associated with each NPD phase.*

3.3. Interpreting and experiencing misalignments

In step 2 of our model, the key issue turns on how misalignments are apprehended by team members. As noted earlier, technology users engage in a sensemaking process when they encounter new technology (Weick, 1990). This sensemaking process involves making interpretations about the technology by focusing on selected features (Griffith and Northcraft, 1994; Griffith, 1999). What becomes salient for users and causes them to shift from unconscious to conscious processing of information (e.g., to pay attention to the feature) depends on whether the cues signal novelty, discrepancy or require deliberate initiative (Louis and Sutton, 1991; Griffith, 1999).[2]

We are interested here in how team members experience a misalignment and whether and how they communicate it to others in the team. We are also interested in differences in team members' interpretations of the technology. We discuss each of these in turn.

Team members' recognition of misalignments is likely to occur when they are using the CT for one or more of the communication purposes identified previously. A misalignment is identified when the team member's experience with the technology fails to match their expectation about what should occur. That is, they may find use of the technology (or another team member's response to their use) as unsatisfactory, frustrating or incomplete. Their experience signals a discrepancy between what they expected and what is actually happening (Majchzrak et al., 2000). Once a misalignment is recognized, the team member may or may not communicate the recognition and his/her experience of it with other members of the team. They may also try to decipher the reason for the misalignment and attempt to solve the problem. We address the implications of these choices under "Recognition of Differences in Interpretations" below. For the moment we are more interested in the fact that their interpretations will likely differ.

Although the process of sensemaking about misalignments (e.g., determining salience, recognition and interpretation) is similar among NPD team members, we expect that, in a team setting, the salience of features for team members is also likely to vary, causing them to notice and attend to different aspects of the technology, or to interpret the same feature differently. There already is evidence that users' and implementers' perceptions of technology differ (Griffith and Northcraft, 1993; Orlikowski and Gash, 1994). Moreover, Louis and Sutton (1991) proposed that "active thinking" about a situation can vary with an individual's experience and training (pp. 68–69).

In NPD teams, we expect that the activities that different functions perform will lead their representatives to attend to different CT attributes and therefore notice different types

[2] For a detailed discussion of how four features of a technology (e.g., those core versus tangential and those that are abstract versus concrete) influence sensemaking see Griffith (1999).

of misalignments. Some team members may notice misalignments between the technology and the task. Others may notice misalignments between the technology and group or organization attributes. Additionally, team members' different functional expertise may lead them to prefer different CT attributes. These differences in focus and preference arise because representatives of different functions occupy different "thought worlds" (Dougherty, 1992) with varying goals, values, time horizons, interpersonal styles, and professional languages (Lawrence and Lorsch, 1967). A thought world refers to a "community of persons engaged in a certain domain of activity who have a shared understanding about that activity" (Dougherty, 1992, p. 182). Members of different thought worlds often look at opportunities from very different vantage points (Eisenhardt et al., 1997). Differences in the perception of misalignments may arise because team members from different functional areas vary in their sensitivity and response to the impact of CT on status and influence within the team (Barley, 1986). For example, function representatives whose responsibilities primarily involve communication across the group's boundary (e.g., marketing) are more likely to recognize misalignments that will affect their relationship with other functional areas and with the customer (e.g., misalignments between the new CT and the organization). Function representatives whose responsibilities primarily involve communication about the task (e.g., design engineers) are more likely to recognize misalignments between the new CT and the task.

In one team we observed, for example, a manager who regularly shared customized engineering prototypes with customers failed to use a new CT to communicate with his teammates because the technology was not yet equipped to penetrate the firm's firewall—a misalignment that prevented him from capturing the major advantage of the technology from his market-oriented perspective. For others on the team (i.e., engineers who designed the products) this issue was not as salient. Thus, the context of the manager's work was different from that of the engineers, and this difference caused one to attend to the misalignment while the others were oblivious to it. This leads us to offer Proposition 4.

Proposition 4. *In NPD teams, representatives of different functions will (a) focus their attention on different CT attributes, (b) experience different types of misalignments, (c) experience the same misalignments as others, but interpret them differently.*

An additional consequence of functional diversity on CT introduction arises because of potential threats to status differences among team members. When technology is introduced, it has the potential to change the work routines and status relationships among those using the technology (Barley, 1986). In Majchzrak et al.'s (2000) study of the introduction of CT into an interorganizational virtual team, the role of the lead engineer as information gatekeeper was changed. Information was distributed in a more decentralized fashion following the technology introduction. The net result was questioning of "What had initially been accepted as management-imposed technical requirements" and a reduction in the control exerted by the lead engineer (p. 589). This leads us to offer Proposition 5.

Proposition 5. *Function representatives vary in their preferences for how much information is accessed and shared within the group. For example, higher status functions (e.g., designers) are more likely to experience a misalignment between a new CT and the group*

if the CT allows broader access and sharing of information among group members that threatens existing status differences within the team.

3.4. Recognizing differences in interpretations of misalignments

Once a team member concludes that a misalignment exists, the recognition may or may not result in team level attention to the issue. For example, some actions require no cooperation from others. A team member may attempt to rectify the misalignment by taking a unilateral action without consulting anyone else. However, it is more likely that a team member will bring the misalignment to the attention of others because cooperation is required to rectify it. Cramton (2001) offers some important insights into the kinds of challenges to collective sensemaking that arise in distributed teams. According to Cramton, the lack of mutual knowledge, "knowledge that communicating parties share in common and know they share" (p. 346) is a common problem among virtual teams. She identifies five types of communication problems that impede mutual knowledge generation.

Although the teams Cramton (2001) studied consisted of students working on a team project, NPD teams attempting to build a common base of knowledge about misalignments are likely to suffer from at least some of the same impediments to shared understandings. In particular, three of the problems identified by Cramton may prevent NPD team members from recognizing and building awareness that others are experiencing misalignments. First, team members had difficulty in communicating information about how their own context might affect their joint task and in remembering contextual information offered by other members of the team. These problems inhibited members of geographically dispersed teams from developing mutual knowledge. Thus, we expect that failure to communicate information about one's context, or to appreciate another's context (e.g., because of functional differences) will impede NPD teams from developing joint awareness of a misalignment.

Proposition 6. *The greater the contextual differences among team members, the less likely that these members will recognize differences in their interpretations of misalignments.*

The second reason Cramton's teams failed to generate mutual knowledge occurred because team members perceived the salience of informal cues differently and neglected to communicate about these differences in salience. If NPD team members recognize a misalignment and take unilateral action to correct it without directing others' attention to it, the misalignment will either go unnoticed or come to others' attention when and if they notice the correction. Thus joint recognition may occur when one takes action to eliminate or reduce a corresponding misalignment, or if the correction of the misalignment requires cooperation from team members.

Cramton (2001) also noted that teams failed to develop mutual knowledge because of their inability to correctly interpret silence. In the teams she studied, silence was erroneously interpreted as assent on the part of the silent members or as intentional slacking. In either case, incorrect attributions were made. In order for team members to raise misalignments to the level of group discussion, they need to feel free and encouraged to share these issues when they arise. Team members who experience freedom from censorship and encouragement

to explore differences are able to work effectively with these differences (Van de Ven and Chu, 1989). Therefore, we conclude that open communication among team members about misalignments and vigilance in responding to communication from others is necessary for joint recognition of misalignments. (Although it may still be possible that team members weigh the importance of the issue differently or prefer to take different actions to remedy it, which we discuss further.) The more accustomed the team is to open sharing of information, the more likely they will come to joint awareness of misalignments.

Proposition 7. *Team members will be more likely to recognize and jointly acknowledge differences in their interpretations of misalignments when norms supporting open exchange of information exist within the team.*

3.5. Reconciling different interpretations and reaching agreement about appropriations

Once team members become aware of differences in their interpretation of misalignments, they need to find a way to reconcile them and reach agreement about what appropriations to make and how to correct the misalignments. In the present section we consider how functional diversity affects these activities and the need for NPD teams to develop the capability to handle their differences.

3.5.1. The effect of functional diversity

Functional diversity among team members not only leads to differences in their interpretations of misalignments, as discussed previously, but may also make it more difficult for team members to reconcile these differing interpretations. That is, we expect functional diversity will affect the team's ability to handle the conflicts that arise among the members.

Although research on the impact of functional diversity on team performance has produced equivocal results (see Milliken and Martins, 1996, for a review), there is increasing evidence of a link between functional diversity and team conflict. For example, (Ancona and Caldwell, 1992) found that NPD teams with high functional diversity were less innovative, and Milliken and Martins (1996) suggested that such performance problems may be related to the team's inability to handle the conflict generated by its diversity.

It makes sense that greater functional diversity within a team would generate increased conflict among the members. Not only are different aspects of the overall task likely to be salient for members from different functional areas, but these members also exhibit different belief structures (Dearborn and Simon, 1968; Walsh, 1988; Dougherty, 1992; Waller et al., 1995) and express different action preferences (Lawrence and Lorsch, 1967; Eisenhardt et al., 1997). It is also quite likely that their reward structures also reinforce these differences (Donnellon, 1993). Therefore, it is reasonable to expect that their group interactions would frequently be conflictual. In fact, in their examination of the effects of various kinds of diversity on task and emotional conflicts in teams, Pelled et al. (1999) showed that functional diversity was the primary source of task conflict in teams. Thus, in general, we expect that team members from different functional areas will have more difficulty finding a way to reconcile the different misalignments they perceive and to reach agreement about eliminating them.

Proposition 8. *The greater the functional diversity among team members, the more difficult it is for team members to reconcile their differences in interpretation of misalignments and reach agreement about appropriations.*

3.5.2. Team process capability (TPC)

Success in reconciling misalignments and agreeing upon appropriations to correct them requires that the team cope with its functional diversity as well as any differences among members in perceptions of the misalignments between the CT and the task, the organization, and the team. Doing so requires a set of skills we refer to as team process capability (TPC). This refers to a team's ability to recognize differences in interpretations of misalignments, reconcile these differences, and take concerted action to reduce or eliminate the misalignments. Teams that possess TPC can recognize misalignments, diagnose their origin, and make timely and appropriate changes to resolve them.

TPC is a more comprehensive concept than either structuration or fit. Structuration and fit are analogous to what Argyris and Schon (1974) call Model I behavior. They are "first-order" concepts. They result from tactical adjustments to localized or specific misalignments that arise between technology, group structure, organizational structure, and task. Structuration tries to satisfy social, political, and economic criteria through action, while "fit" is focused more narrowly on satisfying economic criteria (Zigurs and Buckland, 1998). TPC is analogous to what Argyris and Schon (1974) call Model II behavior. It is a "second-order" concept and is more than simply the ability to recognize misalignments. In the context of our model, TPC refers to a team's ability to recognize differences in interpretations of a misalignment, reconcile these different interpretations, and reach agreement about what action to take regarding the misalignment. Therefore, TPC is strategic in orientation because it requires NPD teams and organizations that are introducing CT to concurrently examine their norms, values, and goals as well as their current actions, and modify any or all of them as necessary.

Some of the skills inherent in TPC have been implicitly acknowledged by others. For example, in their description of "decision process improvements", DeSanctis and Poole (1994) mention behaviors, such as "expanded idea generation", "more even participation", "effective conflict management behavior", "more even influence", and "greater focus on the task" (p. 130). Majchzrak et al. (2000) also implicitly recognize TPC by defining a team's "ideal technology implementation" as "based on the ability to resolve its own misalignments and the range of structures available to appropriate" (p. 596). We concur with Majchrzak et al.'s conception of "ideal" since it does not require users to "faithfully hew to the technology's spirit" (p. 596). However, neither DeSanctis and Poole nor Majchrzak et al. identify the strategic importance of these skills for effective technology implementation.

We argue that TPC is especially critical if NPD teams are to prevent the communication problems and attribution errors identified by Cramton (2001, 2002). In her studies, Cramton noted that, in addition to not understanding each others' interpretations and/or downplaying the importance of others' interpretations, team members often fall prey to the fundamental attribution error. That is, they attribute the differences in interpretation to dispositional rather than situational factors. For example, when they encounter silence, they assume that their teammates either concur or are indifferent, when, in fact, other team members may not have received the information or may be focusing on a different, but equally vexing problem.

The net effect of these attributional errors is that team members fail to develop the level of trust necessary to handle their differences effectively. Trust is based on the expectation that another party will perform a particular action important to the trusting person, irrespective of the latter's ability to monitor or control that party (Mayer et al., 1995, p. 712). Trust is necessary in NPD teams assessing CT so that team members agree on which appropriation action to take.

In order for NPD team members to develop TPC, we contend that they need to engage in open disclosure of information, foster trust and successfully work through their differences in interpretation of misalignments. Both trust and open disclosure of information can be expected to improve NPD teams' ability to reconcile their differing interpretations about misalignments, reach agreement about appropriations and, ultimately perform well (which here means effectively leveraging the CT).

Various team studies have proposed or demonstrated links between trust, open disclosure of information, constructive conflict resolution and team performance. However, these studies propose different relationships among these variables and none of them has considered all four of these variables in the same study. For example, several researchers have shown that when task conflicts arise (e.g., over misalignments) teams that can express their doubts openly, will be more innovative, and presumably more successful in the long run, in meeting their team goals (Van de Ven and Chu, 1989; Poole et al., 1991; Jehn, 1995; Lovelace et al., 2001). Additionally, teams that develop a practice of constructive debate to deal with their heterogeneity, perform better than those that do not (Simons et al., 1999). Additionally, research on trust in teams has suggested that greater trust leads to less conflict and more cooperation among team members (Porter and Lilly, 1996; DeDreu et al., 1998; Williams, 2001). However, others have argued that, because of the limited amount of contextual information available in virtual teams, trust moderates (rather than directly affects) the relationship between one party's behavior and another's response to it (Dirks and Ferrin, 2001).[3] For example, some researchers argued that lack of trust moderated virtual team members' ability to use open and honest communication that was necessary for resolving their differences (Griffith et al., 2003).

We propose that trust plays a mediating (rather than a moderating) role between openness of communication and a virtual NPD team's ability to engage in constructive conflict to resolve their differences. That is, open communication increases the degree of trust among team members, which, in turn increases their cooperative behavior. We argue for a mediating relationship because trust development is encouraged by behaviors, such as replying promptly and reliably to messages, expressing enthusiasm for the task, frequent and informal communication, and revealing personal information about oneself (Madhavan and Grover, 1998; Jarvenpaa and Leidner, 1999; Cramton, 2001).[4] Additionally, open disclosure of information helps to compensate for the kinds of problems inherent in virtual teams (e.g., infrequency of face-to-face meetings, feedback delays, reliance on lean media (Walther, 1996) and lack of prior experience working together, that discourage initial trust

[3] Note that Dirks and Ferrin (2001) have also proposed a direct effect for trust on response variables, such as cooperation in weak circumstances where other dominant effects are not present.

[4] Loehr (1991) argued that the level of trust influenced the level of disclosure whereas others (e.g., Jarvenpaa and Leidner, 1999) have treated trust as the dependent variable.

development (Wilson, 2000)). Consequently, the amount of information that NPD team members share with each other is directly related to the level of trust among them (Loehr, 1991).

Furthermore, the more open and disclosing that team members are with each other, the less prone they will be to make misattributions about each other's behavior (Cramton, 2000). Finally, without trust team members' ability to reconcile their differences will decrease because they simply suspend efforts to work through their disagreements (Loehr, 1991; Griffith et al., 2003; Cramton, 2001) or they transform their task conflicts into relationship conflicts (Simons and Peterson, 2000). Therefore, we conclude that the greater the openness within the team (e.g., freedom from censorship and willingness to express doubts) the higher the level of trust among team members, which, in turn, increases the likelihood that team members will reconcile their differences in interpretation of misalignments and reach agreement on appropriations (i.e., resolve their task conflict). This mediating relationship is captured in Proposition 9.

Proposition 9. *Trust mediates the relationship between openness within the team (e.g., freedom from censorship and willingness to express doubts) and the team's ability to reconcile their differences on misalignments and reach agreement about appropriations.*

3.6. Leveraging collaborative technology

Teams that possess TPC can find their own way to accommodate to misalignments rather than rely on designers to get it right for them. In this way, CT can reach its full potential, whereby, it is leveraged to enhance team performance. Full potential means allowing geographically dispersed teams to increase their ability to achieve traditional NPD goals, such as cost, quality and schedule. Because companies report lower performance expectations for geographically dispersed teams than for collocated ones (McDonough et al., 2001) there is clearly room for improvement in meeting these criteria. CTs full potential, however, also should allow NPD teams to do something that it might not otherwise be able to do. Herein lies CTs potential for achieving competitive advantage in global markets.

It's clear that competitive forces are leading companies to globalize. Most companies have little choice in this matter. If they expect to remain competitive, they must and will seek new growth opportunities around the globe even if designing and developing new

Team members must perceive advantage in specific CT features if they are to use them. Wierba et al. (2002) suggest that team members perform informal cost-benefit analyses prior to deciding whether to use a newly introduced CT tool. These analyses involve weighing the perceived value of the proposed benefits against the effort of learning, adopting, and using the new tools. For example, if a virtual team were currently using email to discuss frequent changes to fairly complex CAD drawings, then the introduction of an electronic whiteboard tool might enjoy a high likelihood of success. However, if changes were infrequent, the drawings were not complex, and team members met face-to-face monthly, the team probably would not use this CT tool or use it infrequently.

Successful CT implementation also requires organizational support for the implementation outside of the targeted team (Ciborra and Patriotta, 1998; Karsten, 1999; Majchzrak et al., 2000; Wierba et al., 2002. In a study of eighteen Lotus Notes implementations, Karsten (1999) observed that the teams that had the highest Notes adoption rates also enjoyed the greatest support from outside of the team during the CT implementation. Team members also must have the authority to act on the appropriations on which they agree or have the support of those who can act on them. For example, team members of an NPD team that we studied considered sharing of CAD drawings with customers via the Internet to be a critical CT feature. Although they initially embraced this feature enthusiastically, they learned within a short time that the company's information systems department would not allow the team members to penetratersteam

surface, and constructively discuss misalignments, and reach consensus on appropriate actions to take.

The identification of these previously unarticulated processes led us to generate a set of propositions that need to be operationalized and tested in future research. We have explored new theoretical terrain that now must be investigated within NPD teams in field settings. In particular, future research needs to determine whether team members from different functional areas do recognize different misalignments and whether teams with superior TPC skills are ultimately better at realizing the benefits of CT than those that lack these skills. On a practical level, we need to understand whether TPC can be developed through training, and, if so, what kind of training should team members and their leaders receive to enhance this capability. Additionally, should differences in interpretation among team members actually be encouraged as long as they ultimately have the capability to reconcile them? Finally, can managers effectively anticipate misalignments, and will such anticipatory efforts to recognize and resolve misalignments between system elements enhance the speed and effectiveness of CT adoption? Our predictions are that more comprehensive, effective and innovative CT appropriations may result from teams with the capability to synthesize a broader range of interpretations and from organizations that anticipate CT misalignments and have the requisite flexibility to restructure for CT adoption.

Acknowledgements

The authors gratefully acknowledge financial support for this research from the Center for Innovation Management Studies, North Carolina State University and the Smeal Research Grants Program, The Pennsylvania State University. They also thank co-editor, Ann Majchrzak, and anonymous reviewers for their thoughtful comments and suggestions.

References

Abualsamh, R.A., Carlin, A.B., McDaniel, R.R., 1990. Problem structuring heuristics in strategic decision-making. Organization Behavior and Human Decision Processes 45, 159–174.

Ancona, D.G., Caldwell, D.F., 1992. Bridging the boundary: external activity and performance in organizational teams. Administrative Science Quarterly 37, 634–665.

Argyris C., Schon, D.A., 1974. Theory in Practice: Increasing Professional Effectiveness. Jossey-Bass, San Francisco.

Barley, S.R., 1986. Technology as an occasion for structuring: observations on CT scanners and the social order of radiology departments. Administrative Science Quarterly 31, 78–108.

Cats-Baril, W.L., Huber, G.P., 1987. Decision-support systems for ill-structured problems: an empirical study. Decision Science 18, 350–372.

Ciborra, C.U., Patriotta, G., 1998. Groupware and teamwork in R&D: limits to learning and innovation. R&D Management 28, 43–52.

Cramton, C.D., 2001. The mutual knowledge problem and its consequences for dispersed collaboration. Organization Science 12, 346–371.

Cramton, C.D., 2002. Attribution in distributed work groups. In: Hinds, P., Keisler, S., (Eds.), Distributed work: new ways of working across distance using technology. The MIT Press, Cambridge, MA.

Daft, R.L., Lengel, R.H., 1984. Information richness: a new approach to managerial behavior and organizational design. Research in Organizational Behavior 6, 191–233.

Dearborn, D.C., Simon, H.A., 1968. Selective perception: a note on the department identifications of executives. Sociometry 21, 140–144.

DeDreu, K., Giebels, C.E., Van de Vliert, E., 1998. Social motives and trust integrative negotiation: the disruptive effects of punitive capability. Journal of Applied Psychology 83, 408–423.

DeSanctis, G., Poole, M.S., 1994. Capturing the complexity in advanced technology use: adaptive structuration theory. Organization Science 5, 121–147.

Dirks, K.T., Ferrin, D.L., 2001. The role of trust in organizational settings. Organization Science 12 (4), 450–467.

Donnellon, A., 1993. Cross-functional teams in product development: accommodating the structure to the process. Journal of Product Innovation Management 10, 377–392.

Dougherty, D., 1992. Interpretive barriers to successful product innovation in large firms. Organization Science 3 (2), 179–202.

Eisenhardt, K.M., Kahwajy, J.L., Boufrgteois, L.J., 1997. Conflict and strategic choice: how top management teams disagree. California Management Review 39 (2), 42–62.

Fichman, R.G., Kemerer, C.F., 1997. The assimilation of software process innovations: an organizational learning perspective. Management Science 43 (10), 1345–1363.

Giddens, A., 1979. Central Problems in Social Theory. University of California Press, Berkeley.

Green, S.G., McComb, S.A., Compton, W.D., 2000. Promoting effective linkages between cross-functional teams and the organization. Advances in the Management of Organizational Quality 5, 29–70.

Griffith, T.L., 1999. Technology features as triggers for sensemaking. Academy of Management Review 24, 472–488.

Griffith, T.L., Northcraft, G.B., 1993. Promises, pitfalls, and paradox: cognitive elements in the implementation of new technology. Journal of Management Issues 5, 45–482.

Griffith, T.L., Northcraft, G.B., 1994. Distinguishing between the forest and the trees: media, features, and methodology in electronic communication research. Organization Science 5, 272–285.

Griffith, T.L., Mannix, E.A., Neale, M.A., 2003. Conflict and virtual teams, In: Cohen, S.G., Gibson, C.B. (Eds.), Virtual Teams that Work. Jossey-Bass, San Francisco, pp. 335–352.

Jarvenpaa, S.L., Leidner, D.E., 1999. Communication and trust in global virtual teams. Organization Science 10, 791–815.

Jehn, K.A., 1995. A multimethod examination of the benefits and detriments of intragroup conflict. Administrative Science Quarterly 40, 256–282.

Karsten, H., 1999. Collaboration and collaborative information technologies: a review of the evidence. The Data Base for Advances in Information Systems 30, 44–65.

Lawrence, P.R., Lorsch, J.W., 1967. Differentiation and integration in complex organizations. Administrative Science Quarterly 12, 1–47.

Loehr, L., 1991. Between silence and voice: communicating in cross-functional project teams. IEEE Transactions on Professional Communication 34, 51–56.

Louis, M.R., Sutton, R.I., 1991. Switching cognitive gears: from habits of mind to active thinking. Human Relations 44, 55–76.

Lovelace, K., Shapiro, D., Weingart, L.R., 2001. Maximizing cross-functional new product teams' innovativeness and constraint adherence: a conflict communications perspective. Academy of Management Journal 44 (4), 779–793.

Madhavan, R., Grover, R., 1998. From embedded knowledge to embodied knowledge: new product development as knowledge management. Journal of Marketing 62, 1–12.

Majchzrak, A., Rice, R.E., Malhotra, A., King, N., Ba, S., 2000. Technology adaptation: the case of a computer supported inter-organizational virtual team. MIS Quarterly 24, 569–600.

Mayer, R.C., Davis, J.H., Schoorman, F.D., 1995. An integrative model of organizational trust. Academy of Management Review 20, 709–734.

Maznevski, M.L., Chudoba, K.M., 2000. Bridging space over time: global virtual team dynamics and effectiveness. Organization Science 11 (5), 473–492.

McDonough, E.F., Kahn, K.B., Barczak, G., 2001. An investigation of the use of global, virtual, and collocated new product development teams. The Journal of Product Innovation Management 18, 110–120.

Milliken, F.J., Martins, L.L., 1996. Searching for common threads: understanding the multiple effects of diversity in organizational groups. Academy of Management Review 21 (2), 402–433.

Ngwenyama, O., 1998. Groupware, social action, and emergent organizations: on the process dynamics of computer mediated distributed work. Accounting, Management, and Information Technology 8, 123–143.
Orlikowski, W.J., 1992. The duality of technology: rethinking the concept of technology in organizations. Organization Science 3, 398–427.
Orlikowski, W.J., Gash, D.C., 1994. Technological frames: making sense of information technology in organizations. ACM Transactions on Information Systems 12, 20–174.
Pelled, L.H., Eisenbardt, K.M., Xin, K.R., 1999. Exploring the Black Box: an analysis of work group diversity. Administrative Science Quarterly 44, 1–28.
Poole, M.S., Holmes, M., DeSanctis, G., 1991. Conflict management in a computer-supported meeting environment. Management Science 37 (8), 926–953.
Porter, T., Lilly, B., 1996. The effects of conflict, trust, and task commitment on project team performance. International Journal of Conflict Management 7, 361–376.
Purvis, R.L., Sambamurthy, V., Zmud, R.W., 2001. The assimilation of knowledge platforms in organizations: an empirical investigation. Organization Science 12 (2), 117–135.
Saga, V., Zmud, R., 1995. The Nature and determinants of information technology acceptance, routinization and infusion. In: Levine, L., (Ed.), Diffusion, Transfer and Implementation of Information Technology. North Holland, Amsterdam, pp. 67–86.
Silver, M.S., 1991. Systems That Support Decision Makers: Description and Analysis. Wiley, New York.
Simons, T.R., Peterson, R., 2000. Task conflict and relationship conflict in top management teams: the pivotal role of intra-group trust. Journal of Applied Psychology 85, 102–111.
Simons, T.R., Pelled, L.H., Smith, K.A., 1999. Making use of difference: diversity. Academy of Management Journal 42, 662–673.
Susman, G.I., Ray, J.M., 1999. Test of a model of organizational contributors to product development team effectiveness. Journal of Engineering and Technology Management 16, 223–245.
Tyre, M.J., Orlikowski, W.J., 1994. Windows of opportunity: temporal patterns of technological adaptation in organizations. Organization Science 5 (1), 98–118.
Van de Ven, A.H., Chu, Y., 1989. A psychometric assessment of the Minnesota Innovation Survey. In: Van de Ven, A.H., Angle, H.L., Poole, M.S. (Eds.), Research on the Management of Innovation: The Minnesota Studies. Harper & Row, New York, pp. 55–103.
Vickers, G., 1965. The Art of Judgment: A Study of Policy Making. Basic Books, New York.
Waller, M.J., Huber, G.P., Glick, W.H., 1995. Functional background as a determinant of executives' selective perception. Academy of Management Journal 38, 943–974.
Walsh, J.P., 1988. Selectivity and selective perception: an investigation of managers' belief structures and information processing. Academy of Management Journal 31, 873–896.
Walther, J.B., 1996. Computer-mediated communication: impersonal, interpersonal, and hyperpersonal interaction. Communication Research 23, 3–43.
Weick, K.E., 1979. The Social Psychology of Organizing, 2nd ed. Addison-Wesley, Reading.
Weick, K.E., 1990. Technology as equivoque: sensemaking in new technologies. In: Goodman, P.S., Sproull, L.S. (Eds.), Technology and Organizations. Jossey-Bass, San Francisco.
Weick, K., 1995. Sensemaking in Organisations. Sage, Thousand Oaks, CA.
Wierba, E.E., Finholt, T.A., Steves, M.P., 2002. Challenges to collaborative tool adoption in a manufacturing engineering setting: a case study. In: Proceedings of the 35th Hawaii International Conference on System Sciences.
Wilson, J.M., 2000. The development of trust in distributed groups over time. Dissertation proposal, Carnegie Mellon University.
Williams, M., 2001. In whom we trust: group membership as an affective context for trust development. Academy of Management Review 26 (3), 377–396.
Zigurs, I., Buckland, B.K., 1998. A theory of task/technology fit and group support systems effectiveness. MIS Quarterly 22, 313–334.