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RESEARCH ARTICLE

A Capabilities-Based Theory of Technology Deployment in Diverse Teams: Leapfrogging the Pitfalls of Diversity and Leveraging Its Potential with Collaborative Technology*

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Abstract

Previous research on groups with diverse membership indicates that they generally exhibit high levels of conflict and experience low levels of cohesion; however, they also tend to outperform their homogeneous counterparts. We examine this apparent paradox and discuss a theory-based technology-oriented approach to resolving it. Based on an extensive review of three research streams—group diversity, group development, and collaborative technologies—we develop an integrated model of ongoing team interaction that describes how the purposeful deployment of certain collaborative technology capabilities, based on temporal milestones, can help leverage the positive aspects of diversity while limiting its negative aspects. We conclude by developing a set of propositions that can be tested empirically.

Keywords: Group diversity; group development; collaborative technologies; technology capabilities

Introduction

Managing diverse teams is fast becoming one of the most pressing challenges facing modern organizations. As a growing array of business activities involve people with varying skills, from

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different functional areas, and from varied backgrounds, organizational teams have, of necessity, become increasingly diverse. These teams are often supported by a variety of collaborative technologies including email, audio- and video-conferencing systems, project management tools, and decision support software.

Considerable research has been conducted to understand differences in the development and performance of diverse teams in comparison to their homogeneous counterparts, and much of the research effort in this area has been predicated on the belief that diversity in work teams, while difficult to manage, can be leveraged (Williams & O'Reilly, 1998). Empirical evidence presents an interesting paradox: Some studies (e.g., Hambrick, Cho & Chen, 1996; Dailey & Steiner, 1998) indicate a positive relationship between diversity and team performance, while others (e.g., Watson, Kumar & Michaelsen, 1993) indicate a negative relationship between diversity and group interaction processes. This paradox suggests that organizations seeking to exploit the performance advantages of diversity need to first address the inherent challenges facing such teams.

Drawing from the existing body of research on collaborative technologies, as well as the research on group diversity, we focus on developing a theoretical foundation for when and how different collaborative technology capabilities (CTC) can be useful in mitigating the negative aspects of diversity while simultaneously leveraging its positive aspects. Thus, collaborative technologies such as email and groupware are viewed as differing "bundles of capabilities" that enhance communication in some ways (increasing immediacy of response, for instance) and restrict them in others (such as limiting the types of information that can be exchanged). Further, previous research suggests that time plays a key role in moderating the impact of diversity on group outcomes (Harrison, Price, Gavin & Florey, 2002), and it takes time to integrate collaborative technologies into group processes (Gopal, Bostrom & Chin, 1992-3). Our focus is on integrating these previous streams of research to generate a normative theory of collaborative technology capability deployment over time. Specifically, in this paper we address the following two questions:

1. When should different collaborative technology capabilities first be utilized by a group?
2. Once introduced, how will different collaborative technology capabilities impact the group?

In an effort to better define the boundaries of our theoretical model, we consider the following contextual factors related to time, technology, and task:

- Given the importance of time in our model, the research propositions developed here may not apply to all work groups, but specifically to project teams with specific deliverables and deadlines. "Work groups" are composed of individuals who see themselves and are seen by others as an independent social entity embedded within an organization and whose performance impacts others (Hackman, 1987). Project teams, in contrast, are work groups with a shared working process who pursue a common goal that can only be achieved together (Armstrong & Peter, 2002; Hackman, 2000). The distinction is important. Work groups likely are less interdependent and often have a history, while project teams are more dependent in terms of performance, generally have little history of working together, and often have a finite life span.
- While we discuss the introduction of CTCs to a group, we recognize that some capabilities of collaborative technology (e.g., visual anonymity) will help diverse groups early in their life, while other capabilities (e.g., electronic record of transactions) will help later. We term the former "reductive capabilities" (given their ability to limit traditional

communication, e.g., the ability to see and be seen when communicating), and the latter "additive capabilities" (given their ability to enhance traditional communication, e.g., by providing a search-and-retrieve capability). From a prescriptive standpoint, such a distinction will assist organizations seeking not simply to deploy technologies per se, but to leverage current investments and exploit existing capabilities in these areas.

- We also recognize that the type of task a group is engaged in will affect interaction processes and outcomes. Thus, we highlight the interaction of task type, technological intervention, and group composition in the discussion section.

In the following sections we follow the steps laid out by Dubin (1976) in developing applied theory. Dubin provided clear guidance for theory building in applied areas, emphasizing that modeling the real world must start with the real world. To that end, we begin with what we know—a review of collaborative technologies and their capabilities. We then review empirical research on work group diversity, relational interaction processes (including conflict and cohesion), time, and group outcomes. From these findings we develop a theoretical framework for diverse team interactions and outcomes. Using this framework, we develop an applied theory and propositions about how CTC can be used to leverage the positive aspects of group diversity while at the same time limiting its negative impacts.

In this paper we propose the early use of reductive CTCs by a diverse team as a way to minimize the negative impacts of diversity during the formative stages of its life and quickly tap into its performance benefits. Later—after the team has developed a group identity—the addition of additive CTCs, we theorize, will help the team strengthen its relational ties while still leveraging its inherent informational diversity, which will ultimately lead to better task and relational outcomes. In essence, we develop an empirically testable theoretical model of purposeful CTC deployment in project teams.

Collaborative Technologies and Their Capabilities

Collaborative technologies (CT) refer to a variety of electronic tools—including email, group support systems (GSS), intranets, groupware, and computer-conferencing to name a few—used by members of groups to communicate with each other, coordinate activities and execute tasks. While these technologies vary in their specific capabilities, taken as a whole, they can be viewed as a collection of systems that offer overlapping capabilities. For instance, compared to face-to-face interaction, collaborative technologies permit the exchange of less rich information (e.g., groupware), typically do not engender instant feedback (e.g., email), may offer shades of anonymity (e.g., GSS), rely on written rather than verbal communication (e.g., groupware), and provide a level playing field where every member of a group can communicate freely (e.g., chat rooms).

Bundle of capabilities

From a theoretical perspective, then, one can view any CT as a "bundle of capabilities" available to group members in a given context. Traditionally, the media richness argument has suggested that the capabilities of electronic media curb people's natural communication patterns by reducing social presence, limiting the types of cues that can be exchanged, and constraining the content of discussions. A stream of current research challenges such deterministic assertions (Carlson & Zmud, 1999; Kanawattanachai & Yoo, 2002; Walther, 1992). Results from these studies suggest that media are malleable, and given enough time and experience, structural features of electronic media can enhance aspects of communication,

instead of just restricting them. Juxtaposing these views of CTs, one can conclude that each capability extant in a CT either curbs or enhances aspects of communication (especially over time).

In other words, viewing CTs as a "bundle of capabilities" suggests that some capabilities limit certain aspects of traditional face-to-face communication while other capabilities enhance them. We term those capabilities that curb normal communication and speech patterns "reductive capabilities" and include among them visual anonymity (which limits identification), equality of participation (which reduces normal turn taking), and asynchronous communication (which limits immediate feedback). Along similar lines, we term those capabilities of CTs that enhance normal communication exchanges "additive capabilities" and include among them coordination support (which helps track people, projects and priorities), electronic trail (which helps record and retrieve relevant information), and enhanced capabilities (that support decision making and rich messaging). Table 1 illustrates the extent to which these two sets of capabilities are present across a variety of commercially available CTs deployed in many organizations.

Table 1. Capabilities of Selected Collaborative Technologies

CAPABILITIES	**COLLABORATIVE TECHNOLOGIES**				
	Email	*Groupware (e.g., Lotus Notes)*	*Group Support Systems (e.g., GroupSystems)*	*Desktop Conferencing (e.g., NetMeeting)*	*Chat Rooms*
REDUCTIVE CAPABILITIES					
Visual Anonymity	High	High	High	Low (with Audio) None (with Video)	High
Equality of Participation	Moderate	Moderate	High	Low	High
Synchronous Interaction	No	No (in most cases)	Yes (in most cases)	Yes	Yes
ADDITIVE CAPABILITIES					
Coordination Support	No	Yes	Yes (in some cases)	Yes	No
Electronic Trail	Yes	Yes	Yes	Yes	No
Enhanced Capabilities	Image & File Transmission	Document Storage & Retrieval	Decision Support Features	Audio- & Video-Conferencing	Instant one-on-one Messaging

Reductive capabilities

As a key dimension of collaborative technologies, anonymity has a long record of inquiry - from its role in computer-mediated communication (Turoff, 1970) to its application in group support systems (e.g., Connolly, Jessup & Valacich, 1990), and more recently to its impact on Web-based communities (e.g., Turkle, 2002). In our view, the key attribute of anonymity that is likely to impact diverse groups is visual anonymity, i.e., the inability to "put a face" on a comment, idea, or question. Most collaborative technologies that rely on text-based communication provide such an environment, to a greater or lesser degree.

Researchers often claim that collaborative technologies create a level playing field for participants. Variations of this assumption have been investigated in different fields: in the computer-mediated communication literature (e.g., Sproull & Kiesler, 1991) as equality of participation, which has been shown to enhance open communication; in the GSS literature (e.g., Gallupe, Dennis, Cooper, Valacich, Bastianuti & Nunamaker, 1991) as parallel processing, which has demonstrated reduced production blocking during brainstorming; and in the study of virtual communities (e.g., Turkle, 2002) as freedom of expression, which has been associated with uninhibited and democratic dialog. However, some researchers (Sproull & Kiesler, 1991) have pointed out that the freedom of expression can lead to "flaming" and other dysfunctional behaviors.

Collaborative technologies differ along the dimension of synchronicity of communications. Some technologies, such as email, are geared to work in an asynchronous setting, while others, such as desktop conferencing, (including audio/video components) can only operate in synchronous settings. Instant feedback and immediate response—hallmarks of traditional face-to-face interactions—are characteristic of synchronous communication, while delayed feedback and deferred responses are characteristic of asynchronous communication. Thus, this capability can be viewed as one with dichotomous values—some CTs support real time communication while others support deferred communication.

Additive capabilities

Among the most important types of support that CTs can provide is the ability to coordinate people, projects, and priorities (Zigurs & Buckland, 1998). Such support ensures that groups can stay on track, prioritize goals, and stick to deadlines. Many CTs also offer the ability to remind people of appointments, schedule meetings with others, and maintain group calendars (Dennis, George, Jessup, Nunamaker & Vogel, 1988). Some theorists (e.g., Turkle, 2002) have warned that the universal tracking and ubiquitous monitoring abilities offered by the new media come at a price—reduced privacy along with increased intrusion into personal time and space.
The reliance on text-based communication in many CT environments suggests that an electronic trail exists for most, if not all communication. Thus, this form of communication can be easily archived and reviewed on demand by members of groups. However, as has been pointed out by communication theorists (e.g., Sproull & Kiesler, 1991), given the "leanness" of CTs, not all forms of communication can be easily stored and retrieved. Also, increasingly, organizational users of CTs are reluctant to document certain types of communication (Leach, 2002).

Enhanced capabilities of CTs include two categories: decision support capabilities and multi-media support. Starting with the earliest versions of CTs, support for group decision-making—including a variety of voting features, analytical capabilities, access to external data, and what-if scenarios—was integral to this genre of media (Dennis et al., 1988). Increasingly, many CTs

also include multi-media communication support for audio- and video- conferencing, shared white-boards, and other Web-enabled technologies (Turkle, 2002).

Impacts of Collaborative Technology Capabilities

Given the "bundle of capabilities" identified earlier, we theorize that not all capabilities will play an equally important role over the entire course of a group's life. For instance, given the importance of the interaction process during the first phase of a group's life (Gersick, 1988; 1989), those capabilities that are likely to impact group processes such as conflict and cohesion will play a key role. After the mid point—given the subsequent task-oriented nature of the group's activities—the focus will shift to deadlines and deliverables. Thus, during this phase, those capabilities that are likely to enhance task-interactions will take precedence. In other words, not all the capabilities of a collaborative technology, regardless of its type, are likely to "kick in" at the same time—some will prove more useful at the start, while others will prove more useful later.

In particular, the reductive capabilities such as visual anonymity, which are more likely to impact relational interactions, will add value early in a diverse group's life, while the additive capabilities, such as enhanced decision support, that impact group outcomes are likely to add value later in the group's life. This conceptualization is consistent with group development theories in general, and the diversity literature in particular, which suggest that the early stages of a group's life are focused more on relational interactions, while the later stages are focused more on task outcomes.

A key reductive capability that is likely to improve interaction processes and minimize process losses is the visual anonymity inherent in many collaborative technologies. This capability will reduce the immediate salience of surface-level diversity, the key source of process losses among such groups (Watson et al., 1993), thus minimizing group members' abilities to engage in categorization behaviors and disrupt the formation of compositional faultlines. In addition to visual anonymity, another reductive capability that many CTs offer is a level playing field to all participants. The combination of these capabilities has been shown to lower evaluation apprehension and increase participation (Dennis et al., 1988)—key elements in fostering a sense of belonging to the group.

During the early stages of a diverse group's life, the reductive capabilities of a CT suggest that, for the most part, members will focus on written messages (as opposed to visual or verbal cues), a factor that is likely to lower the salience of surface-level differences and thereby lower the level of inter-personal conflict. A related reductive capability that is likely to translate into process improvements is the asynchronous communication mode supported by many collaborative technologies. The slower, more deliberate pace of interactions suggests that members will have time to reflect on what to say *and* how to say it, thereby reducing knee-jerk or off-the-cuff remarks, which can be easily misconstrued in diverse groups.

During the later stages of a group's life, two factors related to our model are relevant. *First,* we propose deliberately broadening the media portfolio available to the group by introducing additive capabilities of CTs such as audio-/video- conferencing, which will increase the available bandwidth. Where warranted, we suggest then adding other channels of communication such as face-to-face interactions. *Second,* as suggested above and discussed below, we theorize that additive capabilities will be more salient in a group's interactions during this period. These

factors[1] in conjunction are likely to enable diverse groups to tap into their informational diversity (a deep-level trait), which has been linked conclusively to improved performance (Watson et al., 1993).

In line with Majchrzak et al.'s (2000) view, when a group encounters discrepant events, such as the logical mid point of its life (Gersick, 1988) its appropriation of technology will need to facilitate task accomplishment. At such a point, we suggest that changes in use may evolve internally—such as the gradual "broadening" of a medium as a natural consequence of repeated interactions with it—or be imposed externally—such as when a manager or team leader requires groups to use audio-/video-conferencing support or schedules face-to-face meetings. (Clearly, both possibilities may also occur simultaneously.) Whatever the mechanism, the effect of these changes would be to increase the bandwidth available for group members to communicate and enhance the capabilities of the technology to effectively tap into their informational diversity without preoccupying them with surface-level diversity (which would have occurred if such additional capabilities were available earlier—before their shared group identity was established).

Another symptom of the changes occurring later in a group's life is that a somewhat different "bundle of capabilities" (compared to the earlier phase) becomes relevant to the group, which is now focused on task performance. For instance, the significance of additive capabilities available in many collaborative technologies—including decision support and data analysis—will increase as the pace of the project picks up, a discrepant event that is typically driven by deadlines. Also, the ability of many collaborative technologies to record ongoing interactions and allow their easy retrieval can help groups develop a group memory that can inform new members (of the group's culture, interactions, and accomplishments) and help existing members review needed information. In summary, we expect these additive capabilities, which provide cognitive and communication enhancements, to help diverse groups tap into their inherent informational diversity upon encountering their discrepant event. The underlying assumption with the theoretical model presented here is that CTs offer a dichotomous "bundle of capabilities"— both reductive capabilities, which restrict normal communication patterns (and thereby limit the negative aspects of diversity early on) and additive capabilities, which offer enhanced communication and cognitive support (and thereby leverage the positive aspects of diversity later). Table 2 presents a summary of the above discussion.

Theory, Research Model, and Propositions

Diversity in work groups has been the focus of research for more than 40 years (Williams & O'Reilly, 1998), and researchers have sought to understand the implications of diversity using theories of organizational demography predicated primarily on the Theory of Social Categorization, and the Similarity/Attraction Paradigm. While evidence suggests that diversity impacts outcomes, researchers have been challenged in trying to develop a better understanding of the process by which this happens (Lawrence, 1997). Research on diversity in work groups suggests that the process of group development is affected by diversity in two ways: diverse groups are less cohesive (Harrison et al., 1998), and they exhibit more conflict (Pelled, 1996). Over time, after relational ties have developed, diverse work groups can perform

[1] A third factor may also become evident at this point in time. Members, having built up experience in using the collaborative technology, may begin adapting the once lean medium to make it richer (Walther, 1992) enabling a wider range of information to be exchanged. Such a process of adaptation may also involve testing out and using the additive capabilities of CTs.

Table 2. Effects of Collaborative Technologies on Diverse Teams

CAPABILITIES OF COLLABORATIVE TECHNOLOGIES	EFFECTS ON DIVERSE TEAMS	IMPACT IN INITIAL STAGES	IMPACT IN LATER STAGES
REDUCTIVE CAPABILITIES			
Visual Anonymity	• Reduces salience of surface-level diversity • Lowers evaluation apprehension • Forces members to articulate their ideas in writing	**High** (lowers possibility of sub-group formation)	(Is likely to have some, albeit, reduced impact)
Equality of Participation	• Provides a level playing field and allows minority opinions to be voiced • Removes constraints of turn-taking	**High** (improves interaction processes and perceptions by allowing open and free dialog)	
Asynchronous Interaction	• Slows down interactions • Reduces ability to coordinate • Enables members to think about issues before responding	**High** (by reducing off-the-cuff or knee-jerk reactions)	
ADDITIVE CAPABILITIES			
Coordination Support	• Enables group to keep track of people, projects and priorities • Helps coordinate complex multi-person projects	(Is likely to have some, albeit, reduced impact)	**High** (will help focus on task-related interactions)
Electronic Trail	• Enables easy retrieval of communications • Provides audit trail and helps in clarification of issues		**High** (based on improved efficiencies in task execution)
Enhanced Capabilities	• Decision support, data transmission, storage and retrieval can improve task performance • Audio- and video-support can support rich communication		**High** (given increased decision support, data access and additional bandwidth)

as well or better than homogeneous teams (Watson et al., 1993). In a nutshell, workgroup diversity affects group interaction processes (such as cohesion and conflict), which ultimately impact group outcomes. In the context of ongoing group work, these interactions and their outcomes are dynamic and evolve over time.

We present our research model in Figure 1. In the sub-sections below, we synthesize the empirical evidence and theoretical arguments related to each of the constructs referenced in our research model: workgroup diversity, interaction processes (including conflict and cohesion), outcomes, and time. Further, we discuss the role of collaborative technology capabilities (CTCs) and their impact on group interactions and task outcomes.

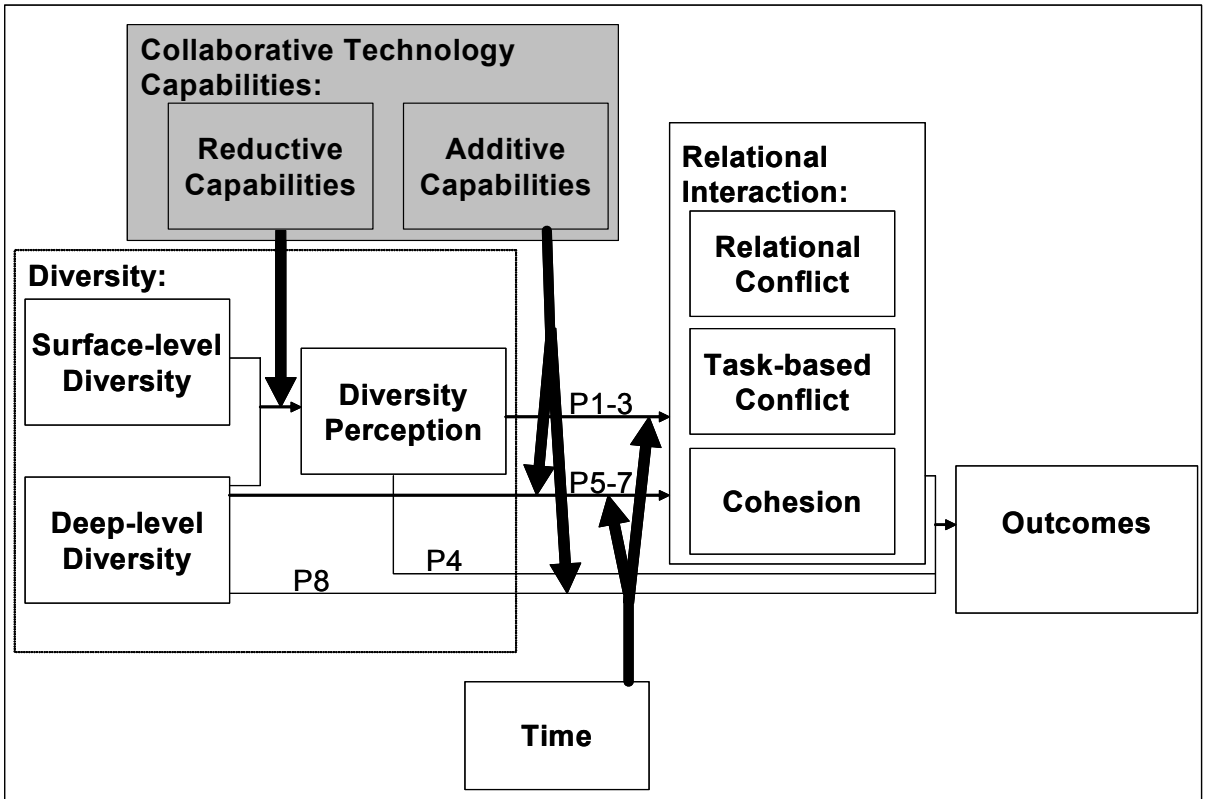

Figure 1. Research Model

Work group diversity

Many studies of diverse teams employ theories of relational demography, which refers to the comparative demographic characteristics of group members who engage in regular interactions with each other (Tsui & O'Reilly, 1989). Investigations into relational demography and its outcomes require the study of socio-psychological processes that intervene between groups and their outcomes. The most common theoretical bases applied to investigating this process are the Social Categorization Theory (Turner, 1987) and the Similarity/Attraction Paradigm (Byrne, 1971). While not mutually exclusive, these theories differ in an important way: the Similarity/Attraction Paradigm assumes that individuals interact *before* forming opinions, while Social Categorization Theory suggests that categorization happens *before* the process of interacting. Both assert that variations in the demographic composition of groups affect interaction processes (such as conflict and cohesion) and group outcomes due to the creation of "in-groups" and "out-groups."

Social Categorization Theory articulates that individuals, in a desire to achieve and maintain positive self identity, will seek to maximize inter-group distinctiveness and to perceive out-group

members as less attractive (Messick & Massie, 1989; Loden & Rosener, 1991). Without the benefit of interaction, individuals form groups or categories based on surface-level traits. Similarity/Attraction suggests that individuals are drawn to others with similar attitudes, a deep-level trait. Individuals may use a variety of physical, social, and status traits, though, to infer similarities (Tsui, Egan & O'Reilly, 1992).

Surface-level and Deep-level Diversity

For our purposes, diversity within a work group refers to the group's composition in terms of the distribution of demographic traits and cognitive differences manifested as surface-level or deep-level attributes (see Table 3). The relationship between surface-level (readily observable traits such as age and gender) and deep-level diversity (underlying cognitive differences) has been referred to as the black box of diversity research (Kilduff et al., 2000; Pelled, 1996). While some authors have argued that demographic variables may serve as proxies for underlying cognitive diversity (Pfeffer, 1985), recent studies have not found a relationship between demographic and cognitive diversity (Kilduff et al., 2000). Thus, in the absence of visible traits, interacting individuals in a work group may reach different conclusions about the similarity of other members of their group who, on the surface, are different. In effect, the subgroups that form, if any, will be based on cognitive (deep-level) differences. Further, Kilduff et al. (2000) found that members of successful groups become more cognitively similar over time (at least along the dimensions related to group work).

Table 3. Elements of Diversity

Type	Definition	Example
Surface-level	Characteristics that are overt (typically reflected in physical features that are generally immutable, immediately observable, and clearly measurable)	• Age • Sex • Race/ethnicity
Deep-level	Characteristics that are not readily observable (typically emerge through extended verbal and nonverbal communication)	• Individual values and attitudes • Work experience • Organizational tenure

Studies investigating the impact of diversity on work group development have found surface-level traits immediately salient and deep-level traits salient over time. For example, Harrison et al. (1998) found that gender diversity decreased group cohesion early in the group's existence, but it was the deep-level trait—organizational satisfaction—that impacted cohesion later in the group's life. However, the empirical findings are mixed regarding the impact of diversity on group outcomes. One possible explanation for the divergence in findings is the level of diversity in the groups studied. Recently, it has been suggested that the relationship between diversity and group processes and outcomes may be curvilinear – highly heterogeneous and highly homogeneous groups perform well, but moderately diverse groups do not (Webber & Donahue, 2001).

Similarly, Early and Mosakowski (2000), measuring diversity in terms of culture, found that highly homogeneous teams *and* highly diverse teams outperformed moderately diverse teams. The authors observed that in the moderately diverse teams some people were alike (versus the highly heterogeneous team where few if any individual characteristics were shared by team

members), and the authors ascribed the weaker performance to this sub-group critical mass and its salience. In the highly heterogeneous group, absent subgroup critical mass, an integrated full-group culture (frequently referred to as shared group identity) emerged. It might be argued that in these highly heterogeneous groups, members constructed a social impression of the group rather than engaging in individual categorization behavior.

Performance Advantages of Diversity

The rationale for the professed performance advantages of diverse groups is rooted in arguments that diverse groups possess more informational diversity than homogeneous groups. Researchers have used informational diversity, partly predicated on the Similarity/Attraction Paradigm, to examine how decision making is affected by variations in group composition (Wittenbaum & Stasser, 1996). Given that there is a propensity for individuals to communicate more with those who are similar, members of diverse groups may have greater access to informational networks outside their work group. Hence, diverse groups are able to access more diverse information compared to homogeneous groups. Further, the greater variety of perspectives can lead to more ideas being generated and more issues being explored (McLeod, Lobel & Cox, 1996). While access to additional information and perspectives can potentially enhance group performance, the information and perspectives must first be exchanged and used by the group—a far from easy task for many diverse groups (Ancona & Caldwell, 1992). Thus, the process of reaching a point where a diverse group can tap into the inherent informational diversity of its membership is likely to be fraught with difficulties (as discussed below).

Relational interaction processes

Research (e.g., Gersick, 1988) has suggested that the first meeting of a work group establishes lasting patterns of behavior, but for diverse work groups, Social Categorization Theory suggests that preconceptions about teammates form even before that first interaction. Getting any work group off to a good start is important, but diverse groups face the more daunting challenge of developing a productive pattern of behavior in spite of such preconceptions. In the following sections, we synthesize existing work on relational development in groups focusing on conflict and cohesion. Further, we articulate the proposed impact of CTC on the relational development of diverse teams.

Conflict

Conflict is an integral part of group development. It is generally defined as a process in which one or more group members perceive that their opinions or interests are being opposed or negatively affected by another (Wall & Callister, 1995). Conflict does not necessarily have a detrimental effect on group outcomes. Many theorists (e.g., Rahim, 1985) have argued that groups can benefit from conflict because it contributes to a critical review of options and increases the accountability of group members, while its absence can lead to negative consequences such as groupthink. Task-based conflict (frequently referred to as constructive conflict) helps prevent domination and stagnation, raises problems and encourages their resolution, stimulates interest and curiosity, and underlies creativity and innovation (Robey & Farrow, 1982). In contrast, socio-emotional conflict (frequently referred to as destructive conflict), reduces cooperation and teamwork, fuels hostility, and often results in a winner and a loser (Rahim, 1985; Robey & Farrow, 1982). Pelled (1996) found gender diversity and tenure diversity to be associated with higher levels of task-based conflict.

Several researchers (e.g., Montoya-Weiss et al., 2001) have investigated the relationship between using collaborative technologies and group conflict. The use of these technologies has been empirically linked to reductions in relational conflict and better management of conflict (Chidambaram, 1996). Previous studies (e.g., Pelled, 1996) have suggested that the relational conflict prevalent in diverse teams is closely related to social categorization behavior. For diverse teams, the early introduction of reductive CTCs provides the group an opportunity to avoid the emergence of subgroups—a key element of social categorization behavior—because the visual anonymity provided by electronic interaction rather than face-to-face interaction can lower the salience of surface-level differences. Without much surface-level information with which to categorize teammates, individuals are then afforded the opportunity to view group members' inputs and form opinions based on merit. In line with the empirical evidence and based on our theoretical expectations, we present:

> *Proposition 1: Among diverse groups, the accelerated deployment of reductive CTCs will minimize the formation of subgroups and lead to a subsequent reduction in relational conflict.*

In addition to relational conflict, groups frequently experience task-based conflict (Montoya-Weiss et al., 2001). Often, task-based conflict stems from differences in perspectives related to differences in personal experiences, available information, and backgrounds. While relational conflict has negative effects on outcomes and it is desirable to reduce it, task-based conflict helps groups explore more of the solution space and should be managed but not necessarily minimized (Williams & O'Reilly, 1998). Thus, free and open discussions among group members can help surface differing viewpoints.

Research (e.g., Montoya-Weiss et al., 2001; Sproull & Kiesler, 1991) has shown that collaborative technologies enable greater equality of participation in two ways. *First*, CTs allow communication to be freely exchanged without having to wait for one's turn (as in traditional face-to-face interactions), a reductive capability that has been referred to as parallel processing (Dennis et al., 1988). One potential result of parallel processing is the generation of more information, often by more people. For example, researchers (e.g., Dennis, Wixom & Vandenberg, 2001) have consistently found technology-supported groups to generate more ideas than their non-supported counterparts and with increased participation from all group members. The availability of such unrestricted channels of communication allows members to freely exchange information, giving all members an opportunity to provide input without contending for "air time." Among diverse teams, more information sharing means more diverse information sharing (given the inherently greater diversity of viewpoints) and consequently greater task-based conflict (McLeod et al., 1996).

Second, the visual anonymity and relative openness of CT environments, key aspects of reductive capabilities, typically reduce inhibitions associated with evaluation apprehension—especially important for a diverse group, given that minority opinions often do not get expressed for fear of social censure (McLeod, Baron, Marti & Yoon, 1997). As members of diverse teams become more active participants, their inherent differences (i.e., different life experiences, problem solving approaches, viewpoints, etc.) become more salient. These differences contribute to increased task-based conflict among diverse teams (Thatcher et al., 2003). Based on our discussion above, we present:

> *Proposition 2: Among diverse groups, the accelerated deployment of reductive CTCs will foster more participation from a diverse membership, resulting in greater task-based conflict.*

Cohesion

Group cohesion can be defined as the extent to which individual members feel a sense of belonging to the group and a corresponding increase in morale emerging from their feelings. The relational development of members—of which cohesion is a good indicator—plays a key role in improving group outcomes (Langfred, 1998; Seashore, 1954). Cohesion is generally believed to be lower in diverse teams, and some empirical research exists to support this belief (O'Reilly, Caldwell & Barnett, 1989; Harrison et al., 1998). However cohesiveness, which is closely related to Walther's (1992) "affiliation motive," can increase over time as members exchange relational information (Chidambaram, 1996).

Caouette and O'Connor (1998) found that collaborative technologies can neutralize the negative impact of group demography and improve cohesion by ensuring that surface-level diversity, the key catalyst in the appearance of subgroups, is not easily perceptible—a finding that is consistent with our discussion of reductive capabilities. With no readily apparent criteria by which they can segment themselves, members of technology-supported groups construct social impressions of the group (and not necessarily of individuals). The repeated electronic interactions (i.e., the accumulation of messages and opinions) among the members gradually reveal group feelings and attitudes leading to an increased sense of belonging (Walther, 1992). Research on trust in virtual teams adds additional insight into relational development without the benefit of face-to-face interaction. This literature proposes that when assigned to virtual teams, people adopt positive categories and exhibit swift trust (Crisp & Jarvenpaa, 2000; Jarvenpaa & Leidner, 1999). Further, as discussed earlier, collaborative technologies often reduce the seeking and disclosing of individuating information. The more limited the information, the more people over-attribute the minimal cues, and the more they tend to idealize other people and assume similarity (Lea & Spears, 1992; Lea et al., 1992).

Viewed differently, the visual anonymity of the CT environment shifts the basis of how relational ties are developed. Instead of forming bonds based on how others look, dress, or talk, they are now likely to be formed based on what they communicate (often the only basis of forming an opinion in such an environment), with group members potentially viewing any information exchanged through an idealized lens. Given the minimal surface-level cues, initially and over time deep-level traits (informational similarity), rather than surface-level traits (appearance similarity), will influence the development of relational ties. One can argue that such a basis for building cohesion is likely to be deep-rooted, and thus, longer lasting. Hence, we present:

> *Proposition 3: Among diverse groups, the accelerated deployment of reductive CTCs will minimize the formation of subgroups and lead to a subsequent increase in cohesion that is resilient.*

Outcomes

Many measures of group outcomes have been examined in the group behavior literature. In general, these measures are consistent with one or more dimensions of group outcomes suggested by Hackman (1987): the productive output meets or exceeds performance standards of the "customer," the social processes used in carrying out the work maintain or enhance members' capability of working together in the future, and the group experience satisfies rather than frustrates the personal needs of group members. Some researchers have argued that socio-emotional conflict, reflective of inter-personal hostility, reduces cooperation and lowers group performance, while task-based conflict stimulates positive outcomes such as creativity and increases group effectiveness (Montoya-Weiss et al., 2001; Rahim, 1985; Robey & Farrow, 1982).

Diverse groups possess greater informational diversity compared to homogeneous groups, which leads them to examine more alternatives and consider more issues (Ancona & Caldwell, 1992). Such groups also experience greater conflict—some related to the task, and some related to personalities—since they represent more points of view compared to their homogeneous counterparts (Rahim, 1985). Informational diversity and task-based conflict have both been associated with improved performance (Wittenbaum & Stasser, 1996). The early introduction of reductive CTCs will facilitate both aspects of diverse groups. Right from the start, members can freely exchange a variety of ideas and viewpoints (tapping into their informational diversity) and openly discuss and argue positions (engendering task-based conflict). Further, potential improvements in cohesion (compared to diverse teams without technology support) and reduction in relational conflict means that groups will need to spend less time on group maintenance and more time on the task, which is likely to improve group performance. Thus, we present:

> *Proposition 4: Among diverse groups, the accelerated deployment of CT, through its reductive capabilities, will lead to better group outcomes.*

Time

Because time plays a key role in the emergence (or disappearance) of subgroups, it is important to understand the research on group development. Many theorists have argued that groups pass through various stages of growth—referred to as group development—during the course of their lives (Hare, 1973). While early models of group development were deterministic, i.e., they proposed that groups follow a predefined sequence of stages (such as forming-storming-norming, described in Tuckman (1965)), later models proposed more flexible patterns of development. (For a complete review of research on group development, see Chidambaram & Bostrom (1996).)

An example of such a flexible model of group development is the punctuated equilibrium model proposed by Gersick (1988, 1989). Her study of groups in the field (Gersick, 1988) and in the lab (Gersick, 1989), indicated that groups did not necessarily develop in the traditionally accepted linear sequence of stages. Instead of relying on a strict stage model, Gersick (1988) proposed a more flexible, temporally defined model of group development called the punctuated equilibrium model. This model proposes that certain groups (i.e., those with a specific task deadline) go through two phases: an initial period of activity in which members get to know each other and work on the task and a subsequent period of activity characterized by a change in relational interactions and a flurry of task-oriented activity. The patterns of interaction for the initial phase—typified by Tuckman's (1965) forming activities—are established in the first meeting and persist until some logical midpoint of the group's life. From that point on, task considerations, looming deadlines, and other temporal constraints help accelerate group activities so groups literally race to the finish.

This model provides a temporal lens through which we can view the empirical findings on group diversity. In a team's early stages of development, the building of relational ties is not just "nice," but the foundation that a team needs for successful task completion in the future. Members must get to know and trust each other enough to share the workload in the next phase and achieve the desired outcomes by the required deadline. The dangers of sub-group formation during the initial stages come to light later when the group cannot focus solely on the task, but instead is forced to keep reinvesting time in developing a working relationship (to accomplish the group task).

A growing body of compelling evidence (e.g., Pelled, 1996; Harrison et al., 2002) suggests that time spent collaborating as a group plays a key role in moderating the interactions and outcomes of diverse groups. As groups accomplish their tasks and receive feedback, members' assessment of themselves and others evolve. Watson et al. (1993) conducted a longitudinal study and discovered that homogeneous teams outperformed diverse teams in the early stages, but as time went by, diverse teams improved to perform equally with their homogeneous counterparts, in general, and exceed significantly the homogeneous teams' ability to examine a wide range of perspectives. Other researchers (Harrison et al., 1998) found that surface-level traits became less salient over time and deep-level traits became more salient. Savicki, Kelley and Lingenfelter (1996) found groups with equal representation of men and women (compared to single gender groups) exchanged more messages in order to reach a decision, suggesting that group development in diverse teams may take longer (because it is potentially more challenging) than in homogeneous teams.

We argue that the technology-supported diverse group, presumably having already reached a certain level of relational development (by not engaging in negative behaviors), should begin adapting its media use by including richer channels such as face-to-face communication and audio-/video- conferencing and utilizing additional capabilities of the technology. In other words, a purposeful or adaptive use of additive capabilities offered by CTs is called for later in a diverse group's life. Thus, the portfolio of communication options may need to be diversified during this phase to facilitate the richer (and presumably more complex) communication that members are likely to exchange. As with the early-stages propositions, we discuss below later-stages propositions for each construct in our theoretical model (Notice that by this point, surface level traits do not play a role in the perceptions of diversity—a fact that is evident in our research model as depicted in Figure 2.)

Conflict in later stages of development

After group members have worked together for a period of time, the tendency to categorize others based on surface-level attributes recedes (Pelled, 1996). However, among diverse groups, the likelihood is high that perceptions of an individual's contribution to the group may be clouded by initial biases. Pettigrew (1979) refers to this as the "ultimate attribution error," whereby individual performance is interpreted in a way that confirms initial negative expectations. Such attribution errors can be avoided in diverse teams when reductive CTCs are used in the early stages of development, since individuals' views of others will be based more on informational diversity—evident in what they contribute—rather than appearance diversity—evident in how they look. After the initial opinions are formed, appearance will not play the important "first impression" role in subsequent face-to-face meetings.

Thus, based on our theoretical model, the subgroups that could have appeared without the use of reductive CTCs are less likely to have emerged in later stages. Coupled with this is the fact that the additive capabilities of CTs, such as coordination support, will help keep the group on track and help resolve differences that may arise in later stages. Previous research (e.g., Chidambaram, 1996) suggests that enhanced decision support capabilities can enable better management of conflict, particularly in the later stages of a group's life. With the increasing complexity of communication likely to emerge once a project starts in earnest, such additive capabilities may enhance a group's ability to deal with relational conflict.

In essence, we theorize that the introduction of additive capabilities at this juncture will help the group deal with the growing complexity of the task and use these capabilities to resolve

relational conflicts that may arise. Conversely, the early introduction of additive capabilities (such as video-conferencing) is likely to tap into their surface level diversity and may result in greater relational conflict, a result seen with many "traditional" diverse groups meeting in face-to-face settings. Delaying the introduction of additive capabilities in diverse groups takes advantage of their lack of sub-groups (resulting from the early introduction of reductive capabilities) and helps them exploit these capabilities when they are needed the most. Thus, we present:

> *Proposition 5: Among diverse groups, the introduction of additive CTCs in the later stages helps reduce relational conflict by better matching the group's needs and the capabilities of the technology.*

As groups evolve over time, they adapt their use of technology to meet their evolving needs (Majchrzak et al., 2000; Walther, 1992). Group development models suggest that the pace of activity picks up as deadlines draw closer (Chidambaram & Bostrom, 1996). At these points greater exchange of task-related information occurs, given the focus on deliverables and deadlines. The introduction of additive capabilities (and even the availability of traditional communication channels) at this juncture will enable groups to exchange rich and complex information easily. Additionally, the informational variety inherent in diverse groups will ensure a rich and lively debate, resulting in greater task-based conflict. Thus, we present:

> *Proposition 6: Among diverse groups, the introduction of additive CTCs in the later stages enables more task-related communication to be exchanged, thereby resulting in increased task-based conflict.*

Cohesion in later stages of development

Many theorists (e.g., Chidambaram, 1996; Walther, 1992) have argued that group cohesion increases over time with repeated interactions among group members. Thus, regardless of group composition and technology support, cohesion will likely be higher during later stages compared to earlier ones. However, the addition of additive CTCs will enable groups to develop closer relational ties than they would otherwise. For example, the ability to "put a face to a name"—an event that is likely to lower cohesion early in a diverse group's life—may, in fact, foster a sense of closeness once a relationship unaffected by surface-level diversity has been formed. Thus, the additive capabilities of CTs, which we argue will have a detrimental effect initially, will have a beneficial effect later. The combination of additive and reductive capabilities in later stages will enable groups to focus on the task at hand (as suggested by group development models) and continue to improve cohesion (as suggested here). Thus, we present:

> *Proposition 7: Among diverse groups, the addition of additive CTCs in the later stages helps strengthen ties established earlier, resulting in increased cohesion.*

Outcomes in later stages of development

The informational diversity inherent in diverse groups has consistently been associated with better performance (Shah & Jehn, 1993). We argue that the additive capabilities of CTs, such as enhanced decision support and data analysis features, will prove to be invaluable during this stage where the group is focused on and engaged in productive work (Gersick, 1989). The combination of better relational climate—higher cohesion and lower relational-conflict (due to the accelerated deployment of reductive CTCs)—coupled with the inherent informational

diversity, and the introduction of additive CTCs, will result in better task outcomes for technology-supported diverse groups. Thus, we present:

> *Proposition 8: Among diverse groups, the addition of CTCs in the later stages will enable them to effectively leverage their inherent informational diversity, resulting in better outcomes.*

Discussion and Conclusions

We propose a theoretical model that views collaborative technology as a way to improve diverse teams' development processes and performance. The central tenet of our theory proposed that the purposeful introduction of key collaborative technology capabilities can mitigate the negative aspects of diversity—thereby leapfrogging the pitfalls of diversity—and simultaneously leverage its positive aspects—such as informational diversity. Such a purposeful deployment takes into account group composition (i.e., diversity) and time (i.e., early introduction of reductive capabilities supplemented later with additive capabilities). This theoretical argument is consistent with prior arguments that as a group encounters discrepant events, such as reaching a temporal breakpoint in its life, the nature and tempo of its activities change. Thus, the group must adapt its use of available media and technologies as it progresses from initial stages of development to later ones. We argue that such adaptation should take into account group composition and involve a purposeful diversification of CT capabilities (which may be accompanied by an adaptive diversification as well). In Figure 2, we summarize graphically the propositions emerging from these ideas and discussed earlier. Thus, collaborative technologies perform a dichotomous role, consistent with their dichotomous "bundle of capabilities": reductive capabilities dampen the negative consequences of diversity early on, while additive capabilities help leverage the informational diversity inherent in such groups later. Taken together then, the bundle of capabilities offered by CTs can help diverse groups avoid the pitfalls of diversity while simultaneously leveraging its potential.

Conventional wisdom (e.g., Johansen, 1988) and case studies (e.g., Zack, 1993) suggest that groups will develop close relational ties and perform well if they *first* meet face-to-face and *then* use leaner media such as groupware, email, and other collaborative technologies. While this argument may work with homogeneous groups, we suggest that the reverse might work better with diverse groups, i.e., the early use of reductive collaborative technology capabilities will facilitate development in diverse groups. Once relational ties form—which takes time (Walther, 1992)—these groups can augment their communication with additional media capabilities (such as video conferencing) or richer media (such as face-to-face interactions). Thus, our model challenges the conventional wisdom and presents a theoretical counterpoint about <u>when</u> to begin using collaborative technologies and <u>how</u> to purposefully deploy different capabilities based on the composition of the group. Figure 3, shown below, illustrates this point.

Evident in Figure 3 is the previous treatment of collaborative technologies as a bundle. We address the question of how to deploy technology by providing a more fine-grained treatment of technology, opting for a capabilities-based approach. This approach is a departure from most previous work. In Table 4 we summarize the various conditions under which the impact of technology on group development might be studied.[2] Condition 1 represents the conventional

[2] We would like to thank our AE for suggesting this framing.

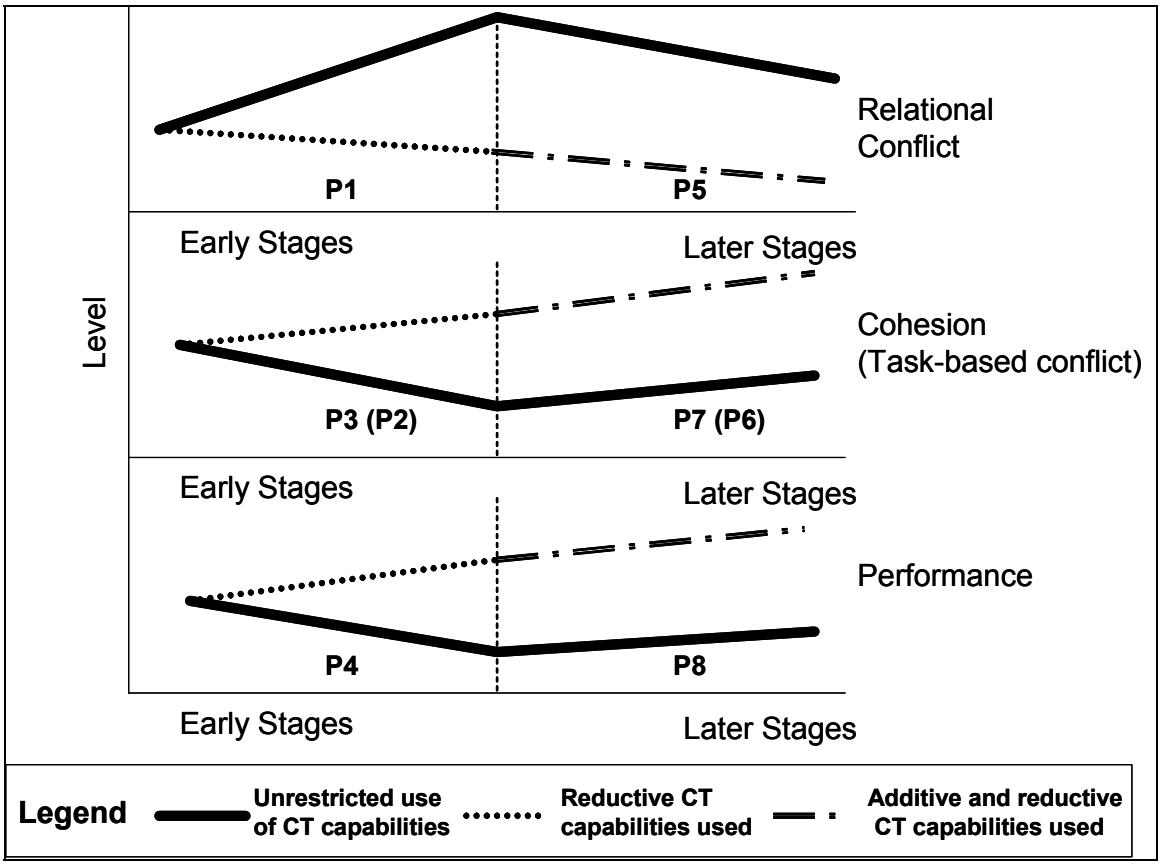

Figure 2. A Summary of Propositions

wisdom described above. Conditions 2 and 3 represent traditional research approaches, whereby collaborative technologies are bundled and treated as a whole or dissected and evaluated as one or few capabilities. Researchers adopting a coarse-grained approach treat technology as a black box where all capabilities are available in all stages (condition 2) (c.f., Dennis & Garfield, 2003). Alternatively, some GSS studies have focused on a specific capability without focusing on *when* in the group's development process it might be most useful (condition 3) (c.f., Zigurs & Buckland, 1998). While these are worthy pursuits, our theory is situated between them (condition 4), understanding that collaborative technologies are a bundle of capabilities that may prove useful at different points in a team's development. As such, we argue that adherence to our guidance on what capabilities to deploy when would produce a more productive team outcome for diverse teams (i.e., condition 4 is preferred to conditions 1-3 for diverse teams). Thus, our theory is aimed at providing normative advice to practitioners and guidance to academics for future research directions.

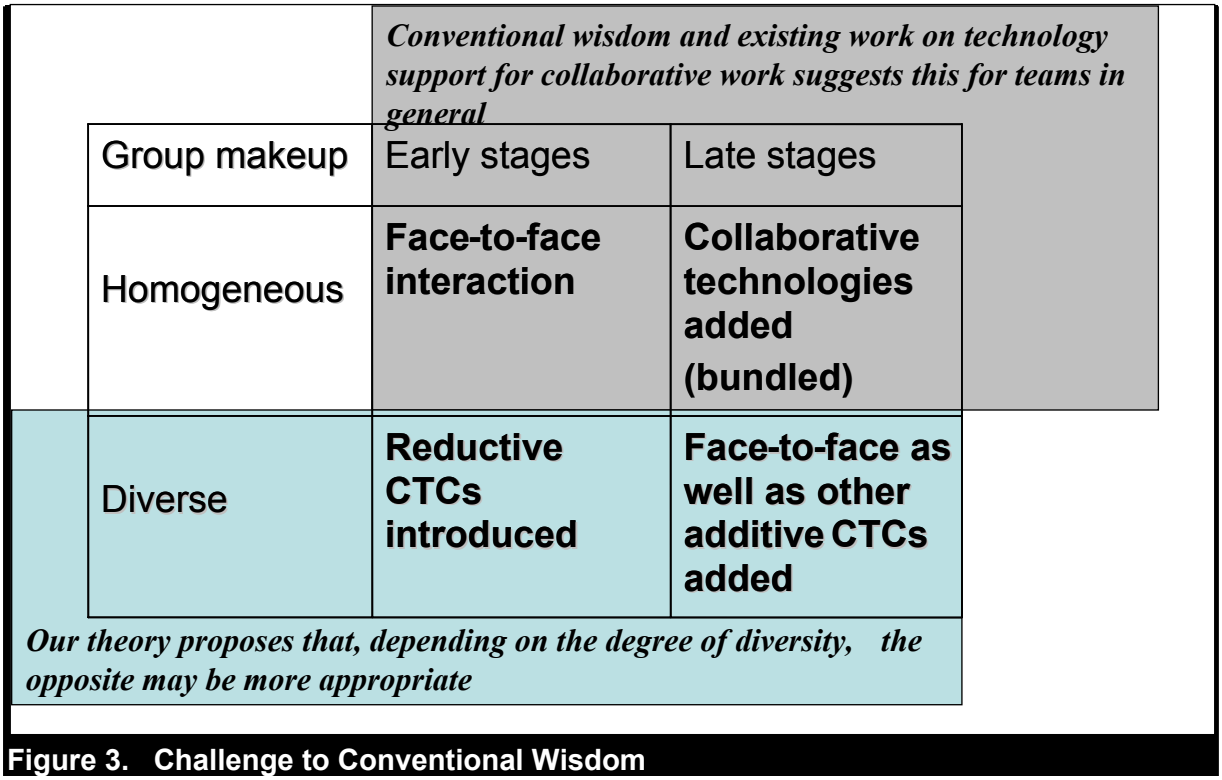

Figure 3. Challenge to Conventional Wisdom

Table 4. Technological Conditions

Condition	Early stages	Later stages
1	No technology	Technology (bundled – all capabilities)
2	Technology (bundled – all capabilities)	Technology (bundled – all capabilities)
3	Technology (one or few capabilities)	Technology (same capabilities available as in early stages)
4	Technology (reductive capabilities only)	Technology (reductive and additive, i.e., all capabilities)

Empirical testing of our model and propositions is an obvious next step. We have endeavored to articulate propositions that are testable. Our model should prove useful in understanding previous paradoxes in the literature, explaining failures in group development and/or outcomes, and in guiding managerial and group decision making about which technology capabilities to use and when.[3]

[3] We would like to thank one of our anonymous reviewers for this suggestion.

In addition to future tests of this theory, we suggest that areas for future extension also exist. For example, while our model and propositions apply to team processes as a whole, task differences are likely to exist. Much existing work (e.g., Reagan-Cirincione, 1994) has focused on how task differences can impact technology-mediated team outcomes. The theories of Task/Technology Fit (Zigurs & Buckland, 1998) and Task-Media Fit (Mennecke et al., 2000) argue that the efficacy of a group's use of collaborative technologies can be facilitated by a fit between the task characteristics and the capabilities of the CT and/or the media selected.

While we believe the theoretical model presented here provides an important first step, much work is still needed in this area. As the available workforce becomes increasingly diverse, understanding how to harness the inherent value of diversity while mitigating its potentially detrimental aspects is a vital issue for today's business leaders. We suggest how the capabilities of collaborative technology can be harnessed toward this dual purpose—leapfrogging the pitfalls of diversity while simultaneously leveraging its potential.

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