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# The Dimensions and Antecedents of Team Virtuality<sup>†</sup>

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*Team virtuality is an important factor that is gaining prominence in the literature on teams. Departing from previous research that focused on geographic dispersion, the authors define team virtuality as the extent to which team members use virtual tools to coordinate and execute team processes, the amount of informational value provided by such tools, and the synchronicity of team member virtual interaction. The authors identify the key factors that lead groups to higher levels of team virtuality and the implications of their model for management theory and practice.*

**Keywords:** teams; virtual; virtuality; technology

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During the past 15 to 20 years, organizations have increasingly used *work teams*, defined as groups of individuals with mutual accountability that work interdependently to solve problems or carry out work (Guzzo & Dickson, 1996). More recently, attention has turned to vir-

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tual teams, which are typically defined as “groups of geographically and/or organizationally dispersed coworkers that are assembled using a combination of telecommunications and information technologies to accomplish a variety of critical tasks” (Townsend, DeMarie, & Hendrickson, 1998: 17). Although virtual teams research has grown considerably with theoretical work (Griffith & Neale, 2001; Griffith, Sawyer, & Neale, 2003; Shin, 2004), laboratory investigations (Jarvenpaa, Knoll, & Leidner, 1998; Jarvenpaa & Leidner, 1999; Montoya-Weiss, Massey, & Song, 2001; Warkentin, Sayeed, & Hightower, 1997), empirical field studies (Kirkman, Rosen, Tesluk, & Gibson, 2004, *in press*), practitioner articles (Cascio, 2000; Coutu, 1998; Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002; Majchrzak, Malhotra, Stamps, & Lipnack, 2004), case studies (Majchrzak, Rice, Malhotra, King, & Ba, 2000; Maznevski & Chudoba, 2000), and popular books (Duarte, & Snyder, 2001; Lipnack & Stamps, 2000), recent reviews conclude that much remains to be done to enhance the theoretical understanding of virtual teams (Bell & Kozlowski, 2002; Martins, Gilson, & Maynard, 2004).

We attempt to address several theoretical limitations in the virtual teams literature, and our purpose is threefold. First, given the lack of a widely accepted definition of virtual teams and perhaps due to the futility of attempting to pigeonhole these teams into a single definition, we advance a multidimensional view of “team virtuality” as an important construct for future research. Our second contribution is the removal of member geographic dispersion as a prerequisite for team virtuality. In contrast to previous work that includes geographic dispersion as a defining characteristic of virtual teams (e.g., Bell & Kozlowski, 2002; Cohen & Gibson, 2003; Griffith et al., 2003), we suggest that co-located (i.e., physically face-to-face) teams can also exhibit high levels of virtuality and that moving beyond geographic dispersion will enhance our theoretical and practical understanding of virtual teams and their antecedents.

Our final contribution is our delineation of virtuality antecedents. We offer three major categories of antecedents to team virtuality derived from integrative frameworks of team effectiveness (Gully, 2000; Kozlowski & Bell, 2003), describe specific antecedents within each category, and build propositions linking the antecedents and team virtuality. Research on what makes teams more or less virtual is needed because, as Kiesler and Cummings recently lamented, “The absence of an analysis of the antecedents [of virtuality] in the literature is worrisome” (2002: 73). Our overall goal is to develop an integrative framework for such investigations.

## The Construct of Virtual Teams

A wide variety of disciplines and literatures have addressed the idea of virtual teams. One of the most frequently asked questions across disciplines, however, is, What are the differences between virtual and co-located teams (e.g., Driskell, Radtke, & Salas, 2003; Kayworth & Leidner, 2001; Potter & Balthazard, 2002; Warkentin et al., 1997)? Some researchers have argued that virtual teams cannot simply be integrated into existing typologies of teams and as a result represent an entirely new type of team (Bell & Kozlowski, 2002). Others have recently argued that the distinction between purely virtual teams and co-located teams is unrealistic and artificial and that all teams can be described in terms of their virtuality (Cohen & Gibson, 2003; Griffith & Neale, 2001; Griffith et al., 2003; Martins et al., 2004).

Most current definitions of virtual teams describe them in terms of multiple dimensions. A common feature of virtual team definitions is that their membership crosses geographic boundaries. For example, Cohen and Gibson stated, "Members of the [virtual] team are geographically dispersed" (2003: 4), and Bell and Kozlowski noted, "The most critical and important feature of virtual teams is that they cross boundaries of space" (2002: 22). Moreover, Driskell et al. stated, "The core feature of a virtual team is that it is one in which interdependent group members work together on a common task while they are spatially separated" (2003: 297). The implicit assumption in these definitions is that when team members are co-located, they are not likely to interface through virtual means. We contend that geographic and other forms of member dispersion are indeed likely to *lead* teams to adopt more virtual means of coordination but that member geographic dispersion is not a prerequisite for team virtuality. In other words, a team with co-located members does not automatically preclude members from interacting virtually or even prevent the team from being highly virtual.

For example, sometimes co-located team members may *choose* to employ virtual means of coordinating their actions for a variety of reasons. Financial audit team members, sitting in the same room, may choose to exchange various reports and information with one another over wireless networks, rather than directly, to make digital copies of information available (cf. Griffith et al., 2003; Straus & Olivera, 2000). Air-traffic controllers sitting side by side will transfer responsibility for aircraft to one another and reallocate airspace completely through virtual means. In fast-food restaurants, employees usually work in a sequential fashion where an order taker enters selections using a touch screen, which displays items to others in the chain. In turn, each employee completes his or her portion of the order, which is then assembled and given to a customer. The entire transaction is coordinated digitally even though employees were standing merely feet apart. Verbal instructions are usually reserved for exceptions.

These examples show that even co-located team members can communicate and coordinate in a highly virtual manner even though they are in close physical proximity. Thus, we define *team virtuality* using three dimensions: (a) the extent to which team members use virtual tools to coordinate and execute team processes (including communication media such as e-mail and videoconferencing and work tools such as group decision support systems [GDSS]), (b) the amount of informational value provided by such tools, and (c) the synchronicity of team member virtual interaction. The notion here is that teams are less virtual to the extent that their direct (e.g., communications) or indirect (e.g., contributing to and accessing knowledge bases) exchanges with each other resemble those that would occur if mediating technologies were not employed. More important, no existing models of team virtuality include these latter two dimensions (cf. Cohen & Gibson, 2003; Griffith & Neale, 2001; Griffith et al., 2003). Thus, previous models have not taken into account key differences in how the informational value and synchronicity of virtual tools influence team virtuality. Note that we use the term *virtual tools* to refer to interaction modes where members communicate virtually such as videoconferencing. Although videoconferencing approaches the communication richness (i.e., the information-carrying capacity of a communication medium) afforded by physical face-to-face communication, researchers agree that videoconferencing cannot fully substitute for, and is less rich than, physical face-to-face communication (for a

discussion, see [Straus & Olivera, 2000](#)). We elaborate on each of our three virtuality dimensions below.

### *Extent of Reliance on Virtual Tools*

Given the modern-day proliferation of information technologies, many teams that have previously been considered “face-to-face” may now incorporate a high reliance on virtual tools (e.g., our fast-food example). Furthermore, many teams that are often referred to as “virtual” meet face-to-face, at least initially (e.g., Geber, 1995). Even many global virtual teams schedule periodic face-to-face meetings (e.g., [Maznevski & Chudoba, 2000](#)). Most certainly, at one extreme, there remain some types of teams that employ no virtual means of interacting. At the other extreme, there are a small number of teams that coordinate their efforts completely through virtual means. Far more teams, however, fall between these extremes and occupy middle ranges on a continuum of virtuality. Thus, all teams can be described in terms of their level of virtuality. Specifically, the more teams rely on virtual tools to work and communicate as opposed to face-to-face interaction, the higher the level of virtuality. Therefore, consistent with previous work ([Bell & Kozlowski, 2002](#); [Cohen & Gibson, 2003](#); [Griffith & Neale, 2001](#); [Griffith et al., 2003](#)), we consider the extent of members’ reliance on virtual means of coordinating as an important, but not the only, dimension of virtuality.

### *Informational Value*

Our conceptualization of informational value comes from the media richness literature ([Daft & Lengel, 1986](#); [Venkatesh & Johnson, 2002](#)) and concerns the extent to which virtual tools send or receive communication or data that are valuable for team effectiveness. While Griffith and colleagues ([Griffith & Neale, 2001](#); [Griffith et al., 2003](#)) incorporated communication richness as a subcomponent of their technology support dimension of virtuality, it referred only to the carrying capacity of a *communication* channel. The authors reasoned that the richer the media used to communicate, the lower the level of virtuality. For example, videoconferencing would be richer than e-mail because the former allows for both nonverbal and verbal communication, whereas the latter only allows for verbal communication. We agree with this basic premise, but we also recognize that not all technologies in virtual teams are used for direct communication between team members, and thus the richness continuum does not apply to these exchanges.

For example, consider an effort to convey the spatial relationships among a set of objects, as is commonly done by engineering or architect teams. Attempting to do so by text alone would represent a highly virtual exchange. This follows from the fact that text does not adequately convey three-dimensional relationships (i.e., offers relatively little informational value in this case). In contrast, conveying the same relationships via joint authoring three-dimensional computer animations would represent an exchange that is lower in virtuality. The value of the information that is conveyed by these joint authoring tools is much higher than text, and therefore, reduces the virtuality of the exchange. The general theme here is that not all technologies

are the same. In some instances, mediated exchanges are quite impoverished as compared to what could be done face-to-face or via other means. In other instances, leveraging technologies offers advantages as compared to more traditional means of team exchanges. We argue that when the members employ technologies that convey rich, valuable information, then their exchanges are less virtual than when they employ technologies that provide less valuable information. Accordingly, although our concept of informational value is similar to that of media richness, it is much broader and concerns the extent to which the combination of virtual tools being used conveys communication *and* data that are important for the team to be effective. Informational value recognizes that teams use virtual tools for much more than communicating. Thus, the lower the informational value of virtual tools, the higher the level of virtuality.

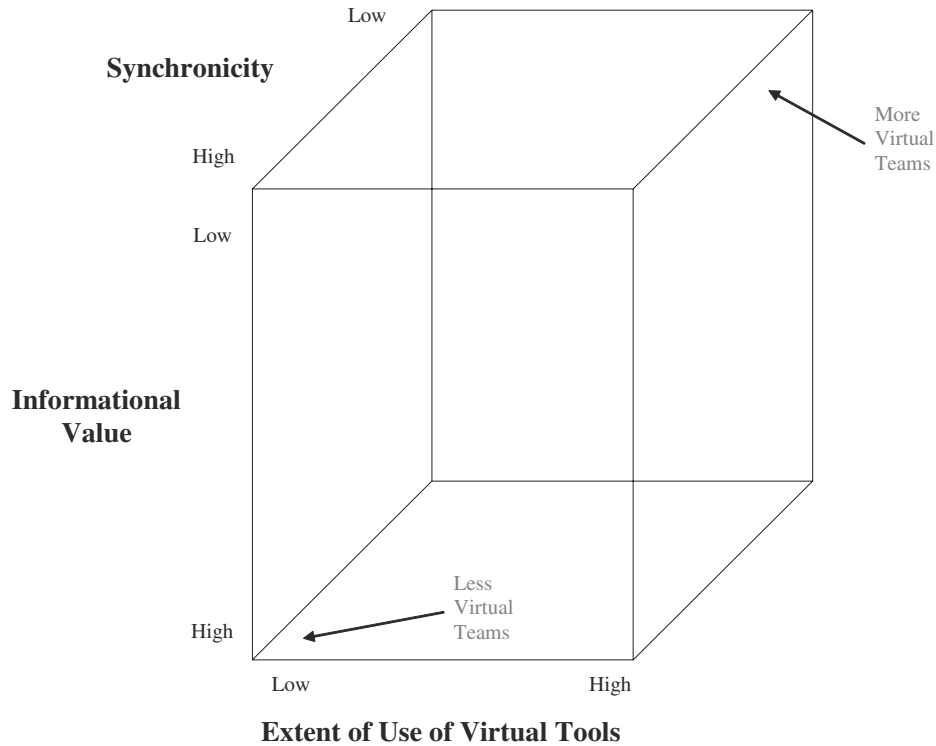
### *Synchronicity*

Researchers have chronicled the coordination implications of synchronous versus asynchronous modes of exchanging information (Goel, Sharda, & Taniar, 2003; Jarvenpaa & Leidner, 1999; Massey, Montoya-Weiss, & Hung, 2003; Mennecke, Valacich, & Wheeler, 2000; Navarro, 2001; Pinelle, Dyck, & Gutwin, 2003). Synchronous exchanges occur in real time, whereas asynchronous exchanges involve a time lag (Goel et al., 2003; Pinelle et al., 2003). Although some have assumed that asynchronous exchanges degrade communication quality and detract from team member coordination (Warkentin et al., 1997), asynchronous communication allows members to take time to consider both the message and their response, perhaps consult other resources or consider extenuating circumstances, as well as minimize time and location constraints (cf. Borges, Pino, Fuller, & Salgado, 1999; Rasters, Vissers, & Dankbaar, 2002).

Whether it is advantageous for members to be exchanging information in real time or lagged in time hinges on the nature of their performance environment. For example, it would be counterproductive to interrupt the activities of audit team members simply to provide them with background information. Face-to-face conversations or chat discussions would be less effective than an asynchronous threaded discussion list if participants need time to consult background sources and formulate their positions. In sum, asynchronous exchanges represent greater virtuality than do synchronous ones because members are unable to engage in simultaneous exchanges with fellow members as is the case with face-to-face interaction, videoconferencing, or instant messaging. More important, this dimension must be considered in concert with the other two virtuality aspects.

Figure 1 shows the three dimensions of team virtuality advanced by our definition and how they combine to determine various levels of team virtuality. As shown in Figure 1, the extent to which team members use virtual tools to both communicate *and* work, the informational value provided by such tools, and the synchronicity of interactions combine to constitute a team's virtuality. For example, if a team relies heavily on asynchronous technology of low informational value (e.g., email), the team is relatively high in virtuality. In this case, members work and communicate almost exclusively using technology, and the tools used allow few opportunities to experience interpersonal subtleties such as tone of voice, body language, or immedi-

**Figure 1**  
**A Three-Dimensional Model of Team Virtuality**



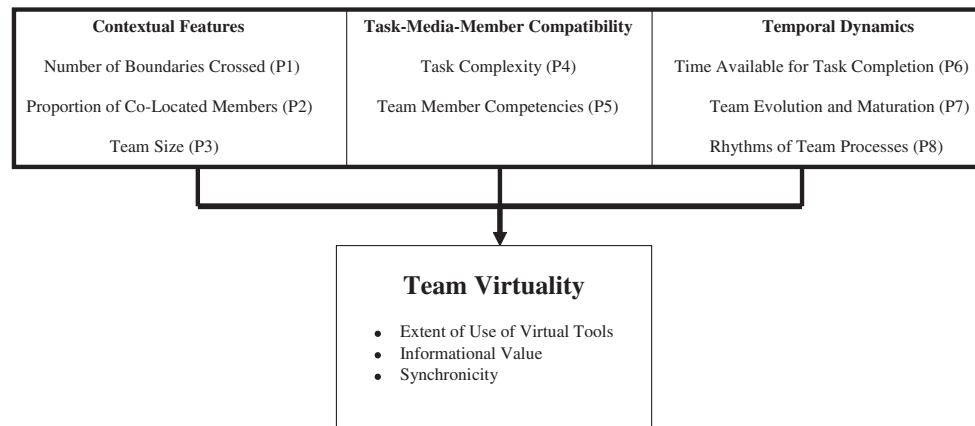
ate feedback. In contrast, if a team meets or works more frequently face-to-face and tends to use information-rich, synchronous technology (e.g., videoconferencing), the team is lower in virtuality. Low to moderate levels of virtuality would exist as a result of moderate combinations of the three dimensions. Thus, our conception of team virtuality goes beyond simple additive frameworks and suggests that team virtuality emanates from a combination of antecedent conditions and can be manifest in a variety of forms.

### **Antecedents of Team Virtuality**

Our literature review yielded surprisingly little in terms of a systematic, theoretical discussion of the antecedents of virtuality. Figure 2 illustrates theoretically derived antecedents to our three-dimensional conceptualization of virtuality. Teams operate within and sometimes across organizational boundaries, have histories, and need to perform multiple tasks and employ different technologies. This implies that traditional small-group research, conducted with short-term, ad hoc groups, performing contrived tasks, will not be particularly applicable



**Figure 2**  
**Antecedents of Team Virtuality**



(Gully, 2000). Rather, one must consider the “presses” that operate on real-world teams that make interacting face-to-face or virtuality more conducive for effectiveness.

We reviewed the work team effectiveness literature to develop parsimonious theoretical categories of the antecedents of virtuality including research on team context (e.g., Gladstein, 1984; Guzzo & Shea, 1992), task and technology characteristics (e.g., Goodman, 1986; McGrath, 1984), and time (e.g., Gersick, 1988; Kozlowski, Gully, Salas, & Cannon-Bowers, 1996; Marks, Mathieu, & Zaccaro, 2001). Thus, we developed a model of the three categories of antecedents that are likely to lead to lower or higher levels of virtuality including a team’s (a) contextual features, (b) task-media-member compatibility, and (c) temporal dynamics. Such a categorization allows us to draw a conceptual linkage to the dominant themes that most teams researchers agree are critical for successful virtual team performance.

### *Contextual Features*

Contextual features refer to the larger system within which teams are embedded. Evolving work arrangements and forms such as networks, alliances, partnerships, cellular designs, virtual arrangements, and multiteam systems suggest that teams are no longer insulated within a single, traditionally designed organization. Team members now need to manage a wide variety of external relationships. Guzzo and Shea (1992), among others (Gully, 2000; Sethi, 2000), have argued that contextual features of teams represent a critical, yet underresearched, driver of effectiveness. Here, we focus our attention on contextual features that lead team members to employ more virtual means of coordination than they might otherwise.

The first contextual feature is *number of boundaries crossed*. Research has shown that when members from the same organization work more than 30 meters apart, they have much-reduced daily contact and less frequent informal, face-to-face contact (Kiesler & Cummings,

2002). By extension, crossing organizational boundaries suggests that multiorganizational team members will rely more on electronic, relative to informal face-to-face, interaction than same-organization teams. Naturally, working across different cultures, countries, or time zones will necessitate a higher reliance on virtual tools over face-to-face contact (Straus & Olivera, 2000). Some global teams do manage to assemble face-to-face periodically (Maznevski & Chudoba, 2000). For example, a global virtual team at Whirlpool consisting of members from the United States, Brazil, and Italy met face-to-face every 4 months in the development of a chlorofluorocarbon-free refrigerator over a 2-year period (Geber, 1995). However, because of the high cost and time required to travel, global virtual teams will likely assemble face-to-face much less frequently than teams with members from the same country. In addition, these teams will be more likely to use less rich, asynchronous modes of interaction (e.g., e-mail) rather than richer, synchronous forms (e.g., videoconferencing) that could simulate “psychological co-presence” (Pratt, Fuller, & Northcraft, 2000: 238) than teams whose members are all located in the same time zone (DeSanctis, Poole, & Dickson, 2000). Consequently, we propose the following:

*Proposition 1:* As the number of boundaries (e.g., organizational, country/cultural, time zones) crossed increases, team virtuality likely increases.

The second contextual feature is the *proportion of co-located team members*. Many modern-day team configurations have some members co-located and others situated elsewhere. In fact, there may be “clusters” or subgroups of team members that are co-located in different places yet link through virtual means (Straus & Olivera, 2000). For example, Sabre, a travel reservation service organization based in the Dallas–Fort Worth, Texas area, has the majority of its team members spread throughout the United States and Canada (Kirkman et al., 2002). However, team members in charge of billing, servicing customers, and setting up installation appointments (typically two to three members of each team) are co-located at the Dallas–Fort Worth, Texas headquarters. Subgroups are characteristic of hybrid teams that have elements of both face-to-face and virtual teams (Griffith & Neale, 2001). Clearly, co-located team members increase the chance (but do not guarantee) that at least some of the team members will rely more on face-to-face interaction than those teams whose members are all geographically dispersed. Indeed, in a test of adaptive structuration theory, DeSanctis et al. (2000) found that more geographically distributed administrative teams were more likely to use advanced communication technologies than more geographically proximate teams. Thus, we propose the following:

*Proposition 2:* As the proportion of co-located team members decreases, team virtuality likely increases.

The third contextual feature is *team size*. Team size will likely affect the level of team virtuality for several reasons. First, as teams grow in size, there are fewer opportunities for *entire intact teams* to assemble face-to-face and coordinate due to logistical problems and the high costs of assembling members. This argument does not apply as much to co-located subgroups within a virtual team that could assemble periodically (Kirkman et al., 2002; Majchrzak et al.,

2004). Nevertheless, larger teams would make coordinating face-to-face meetings more difficult. Second, research has shown that as teams grow in size, the quality of team interaction processes decreases (Hare, 1981). Third, the inability to interact face-to-face would also imply that members would use more asynchronous communication. Finally, group size has been positively linked to higher absenteeism rates (Markham, Dansereau, & Alutto, 1982), thereby making it less likely that all team members will be present when face-to-face interaction occurs, even in co-located subgroup meetings. Thus, when team members do interact electronically, larger teams will be more likely to employ technology with less informational value (e.g., e-mail) than smaller teams due to the difficulty of assembling all team members in a synchronous fashion necessary for richer tools (e.g., videoconferencing). Thus, we propose the following:

*Proposition 3:* As team size increases, team virtuality likely increases.

### *Task-Media-Member Compatibility*

By task-media-member compatibility, we refer to the resulting synergy between the nature of team tasks, the available technologies, and the relative competencies of team members. Clearly, some technologies are better suited for accomplishing certain tasks than others (McGrath & Hollingshead, 1993), assuming that those technologies are aligned with team members' competencies and preferences (Carlson & Zmud, 1999). Generally, to the extent that the task(s) at hand lends itself to virtual means of coordination, members are capable and willing to use technology, and the team has appropriate virtual tools at their disposal, they will choose to function more virtually.

The first aspect of task-media-member compatibility is *task complexity*. Team tasks can range from simple to complex (Jehn, Northcraft, & Neale, 1999) and are critical to understanding team effectiveness (Goodman, 1986). Thompson (1967) offered a valuable taxonomy that has been used to describe task complexity (cf. Bell & Kozlowski, 2002). At one extreme is *pooled interdependence* in which team effectiveness is essentially the sum of the members' contributions. Sales teams often operate in this fashion and share, perhaps, only a database of products, services, and client information. *Sequential interdependence* depicts a classic assembly line where one member's inputs are the outputs of another. Assuming little temporal pressures, this could imply that technology of relatively low informational value is beneficial (Bell & Kozlowski, 2002) and might well be superior to face-to-face. Synchronicity of exchanges is, however, important to maintain. *Reciprocal interdependence* represents a situation in which work is passed back and forth between members. Depending on the time issues surrounding exchanges, these are likely to be better done with technologies of higher informational value and synchronous member interactions.

*Intensive interdependence* requires members to work in real time with one another and places pressures on them to continuously maintain situation awareness, monitor each other, balance workloads, and execute back-up behaviors (Van de Ven, Delbecq, & Koenig, 1976). Clearly, these actions are optimized with high informational value and synchronous technol-

ogy. Thus, for interpersonally sensitive issues, technologies such as videoconferencing or virtual reality applications would be most suitable. Alternatively, such situations may be optimized by using smart technologies that are not designed to approximate member copresence, such as those used in nuclear power plants and by air traffic control systems. Furthermore, technology with lower informational value may still be used during such exchanges. Being able to reference a hospital patient's history, a previous document on an intranet, or the recorded flight path of a troubled aircraft all enables team members to better execute tasks at hand. Overall, however, the demands of an intensive interdependent task will require the use of less virtual interaction between team members. Consequently, we propose the following:

*Proposition 4:* As the level of task complexity increases, team virtuality likely decreases.

*Team member competencies* constitute the second aspect of task-media-member compatibility. Team member competencies will have an impact on the success of any type of team, and virtual ones are no exception. In terms of types of competencies, however, virtual team members require sophistication in three general areas: (a) task work; (b) teamwork; and (c) virtuality-related knowledge, skill, ability, and other (e.g., personality or disposition) characteristics (KSAOs). Specifically for operating effectively in virtual teams, members must be comfortable with various technologies (Blackburn, Furst, & Rosen, 2003; Shin, 2004; Staples, Hulland, & Higgins, 1999). Carlson and Zmud (1999) found some support for their contention that as user experience with e-mail increased, so did perceptions of e-mail media richness (although other factors such as experience with the communication partner and organizational context were found to be more important, especially over time).

Unfortunately, team virtuality-related KSAOs are often limited to teaching members how to use the virtual tools, but not necessarily why or when to use such tools (Hess & Hess, 2000). Whereas Hess and Hess (2000) acknowledged that members must be proficient in the use of virtual tools, they further argued that training also needs to include rules of use and the development of shared mental models regarding what types of information would be conveyed through which mean(s), at what time(s), and for what purpose(s). Stated simply, it is not enough to simply know "how" to use technology but team members must also know how to leverage technology to facilitate processes related to team tasks. To the extent that members possess team virtuality-related KSAOs required for employing virtual means of coordination and execution of team processes, the team is better able to leverage virtual interactions (Shin, 2004). Therefore, we propose the following:

*Proposition 5:* To the extent that team members possess virtuality-related KSAOs, team virtuality likely increases.

### *Temporal Dynamics*

Below, we consider three of the more influential attributes of time on team processes and performance and their influence on the three dimensions of virtuality. Here, we are dealing with how time influences teams' choices about the extent to which they employ different types

of virtual tools. In terms of Ancona, Okhuysen, and Perlow's (2001) types of time, Proposition 6 concerns *clock time* or simply how quickly work can be accomplished. In contrast, Proposition 7 concerns team *life cycles* and the fact that there are different demands on teams at different stages of their evolution. Finally, Proposition 8 concerns task-based *cyclical time*, representing the ebbs and flows of recurring performance episodes (see also Marks et al., 2001; Perlow, 1999). Whereas the unifying theme is that time matters, the nature of the temporal demands means teams will base decisions to employ technology on different temporal dynamics.

The first aspect of time is *time available for task completion*. Previous researchers have bemoaned the fact that it takes longer for teams to function via virtual means than it does face-to-face (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Straus, 1997). The bulk of this research comes from comparisons of ad hoc groups completing fairly simple tasks face-to-face or through computer-mediated means. Yet, recall that virtuality allows organizations to comprise teams that span geographic time zones and organizations (Lipnack & Stamps, 2000). In these kinds of instances, there is little to be learned from comparisons between virtual versus face-to-face teams. Such teams would not exist were it not for electronic communication tools.

Perhaps a more accurate comparison would be to contrast how easily and quickly team members coordinate their efforts electronically versus how long it would take them to coordinate schedules, travel to a common location, and discuss the matter face-to-face. The core issue is whether, given a particular composition of individuals, work can be coordinated more quickly through virtual means than otherwise. To the extent that meeting face-to-face would slow cycle times, members are more likely to employ virtual means of coordination and vice versa. For example, the effectiveness of many sales teams would be hampered if members met face-to-face rather than virtually. Adaptive structuration theory posits that the more team members view advanced technologies as capable of reducing coordination burdens and improving the team's work, the more likely they will adopt them (DeSanctis et al., 2000). Consequently, we propose the following:

*Proposition 6:* To the extent that available virtual tools enable the team to complete work more quickly and efficiently, team virtuality likely increases.

The second aspect of time is *team evolution and maturation*. It has long been recognized that teams evolve over time akin to a life cycle. Temporal models include Tuckman's (1965) forming-storming-norming-performing-adjourning framework; Gersick's (1988) punctuated equilibrium conception; Morgan, Salas, and Glickman's (1993) team evolution and maturation approach; and Kozlowski and colleagues' theory of team compilation (e.g., Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996; Kozlowski, Gully, Nason, & Smith, 1999). The underlying logic from these models is that teams have life cycles that present implications regarding the role of virtuality. Specifically, these models suggest that different forms of interaction may be better suited for coordinating actions at different stages of team maturity.

The general issue with regard to team development is, At what stage should different virtual tools be employed? Walther (2002) warned researchers not to assume that teams with greater degrees of technology-based interaction follow the same timing and sequences as teams with

more face-to-face interactions do. We would submit that, from a social-psychological perspective, synchronous virtual tools with higher levels of informational value that convey subtle cues (e.g., videoconferencing) would best be employed during early stages of group formation (Kiesler, Zugrow, Moses, & Geller, 1985). Following from Alge, Wiethoff, and Klein (2003) and others (e.g., Chidambaram, 1996; Townsend et al., 1998), it may well be that members can effectively employ asynchronous and leaner means of coordination once the team has established processes for interacting and accomplishing tasks, and once trust has developed.

The general principle here is not whether interacting electronically is always better or worse than working face-to-face or that synchronous virtual tools or tools of higher informational value are always better than the alternatives. Rather, the issue becomes *when* it is advantageous to work in what manner. A corollary to this is that different virtual tools will be more beneficial at different periods of team development. As a general rule, we anticipate that virtuality will be lower during the early stages of team development as members seek to develop task-related strategies and to determine how they will organize themselves. We expect that their level of virtuality will likely increase over time as the team evolves from early “forming and storming” activities and moves into “norming and performing stages” (Tuckman, 1965). Therefore, we propose the following:

*Proposition 7:* Teams’ virtuality will vary as a function of their stages of development. In general, teams will likely be lower on virtuality throughout their early stages of development and higher on virtuality during the latter stages of their life span.

The final aspect of time we discuss is *rhythms of team processes*. Marks et al. (2001) outlined an episodic framework and argued that teams execute different processes at different times. They suggested that teams execute processes such as mission analysis, goal specification, and strategy formulation when they are *transitioning* from one period to another. Such transition phases are likely to call for less virtual means of coordination such as more frequent face-to-face meetings to develop team strategies and processes. In contrast, Marks et al. (2001) submitted that teams execute processes such as coordination, monitoring the environment, and performing back-up behaviors during *action phases* when task work is being accomplished. Compared to transition phases, action phases are most likely carried out using more virtual means of coordination such as e-mail. Teams will be less focused on strategy and planning and more concentrated on accomplishing tasks.

Rhythms of team processes are akin to a form of temporal entrainment in teams. In a team context, entrainment refers to the process by which one cyclic team process rhythm becomes “captured by and set to oscillate with another” (Perlow, 1999: 58). Cycling between periods of action and transition depends, to some extent, on the level of interdependence needed at different points during a team’s activities related to task accomplishment (Marks et al., 2001; Perlow, 1999). The key point is that teams will adopt different virtual tools to varying degrees as they seek to accomplish different tasks as prompted by their pattern of entrainment. The rhythms of team task demands will place premiums on interacting in different ways on the basis of whether virtual or face-to-face means of coordination are warranted. Therefore, we propose the following:



*Proposition 8:* Team virtuality will vary depending on the nature of the tasks that teams are performing at any given time. In general, virtuality will likely be lower during *transition* periods and higher during *action* periods.

## Discussion

Advances in information technology and the rise of virtual teams have led to a shift away from face-to-face interaction to increased reliance on virtual tools (Bell & Kozlowski, 2002; Lipnack & Stamps, 2000; Townsend et al., 1998). We attempted to integrate existing literature and extend previous research by incorporating different aspects of technology into the virtuality construct and illuminating reasons why teams become more or less virtual. As a result, we make three contributions to the literature. First, we argued that not all virtual tools are created alike. Simply assessing a team's *reliance* on virtual tools to determine its virtuality is overly simplistic and ignores the fact that the tools themselves differ in fundamental ways that alter a team's virtuality. Second, we argued that geographic dispersion is an antecedent to, and not a defining dimension of, a team's virtuality. Finally, we specified eight antecedents of virtuality to begin to establish the nomological network of virtuality antecedents. We now turn to theoretical and managerial implications.

### *Theoretical Implications and Directions for Future Research*

Our discussion of team virtuality has several implications for researchers interested in the study of virtual teams. We argue that researchers and practitioners need to reach beyond simply the *extent* to which team members use virtual tools but also consider the fact that different virtual technologies offer different advantages and disadvantages for enhancing team effectiveness (Bell & Kozlowski, 2002; Cohen & Gibson, 2003; Griffith & Neale, 2001; Griffith et al., 2003). Because many teams rely on virtual tools to communicate and carry out work, it is imperative to more rigorously examine and eventually understand how the attributes of informational value and synchronicity enrich our conception of team virtuality. Along those lines, we urge future researchers to focus their attention on empirical operationalizations of our three-dimensional virtuality construct and move beyond overly simplistic, unidimensional measures (e.g., Kirkman, Rosen, Tesluk, and Gibson 2004). Moreover, although we have depicted the relationship between each of the three dimensions and virtuality as linear and additive, it may well be that more complex relationships between the dimensions exist. In other words, future research should also consider whether the three dimensions that we articulated combine in additive or more complex fashions as related to team virtuality.

Clearly, researchers will need to understand the various levels of informational value afforded by virtual tools that seem to change and become more sophisticated by the minute. Assessing the informational value of virtual tools is a highly complex task. For example, in attempting to determine the communication richness of various technologies, channel expansion theory suggests that it is *perceptions* of communication richness rather than objective assessments that are critical to understanding how individuals choose and experience different

technologies (Carlson & Zmud, 1999). Indeed, there have been conflicting results when respondents were asked to place e-mail along the channel richness continuum (Rice & Love, 1987; Schmitz & Fulk, 1991). Thus, the *perceived* informational value of a virtual tool most likely depends on knowledge acquired from experience with the tool, other users of the tool, the tool's purpose, the specific organizational context, and even social influence processes over time (cf. Carlson & Zmud, 1999). Undertaking such an agenda will be complex and challenging for researchers and will most likely benefit from a multidisciplinary approach that incorporates the fields of information technology, communication studies, and human factors.

A rich area for future research concerns how levels of virtuality affect previously examined relationships in traditional input-process-output (IPO) models of team effectiveness, particularly as a moderator. For example, using a unidimensional measure of virtuality as a moderator, Kirkman et al. (2004) found that team empowerment was a stronger predictor of team performance when teams were higher, rather than lower, in virtuality. Researchers need accurate empirical assessments of virtuality to determine whether previously supported relationships are affected by varying levels of virtuality.

Regarding geographic dispersion, we showed that a team might be very high in virtuality (i.e., interact almost exclusively using asynchronous virtual tools with low informational value) but be very low in geographic dispersion (i.e., members may all be located in the same facility). Conversely, a team may be high in geographic dispersion (i.e., all members located in different cities) but low in virtuality (i.e., team members may physically meet face-to-face regularly or in a rich videoconferencing or virtual reality environment). We encourage researchers to seek out and study these types of teams that challenge the conventional wisdom of labeling teams as "virtual" or "face-to-face"—and reframe future investigations toward questions as to *why teams choose* to employ differing degrees of virtuality and how such choices influence team effectiveness. Such research will likely take the form of ethnographic, qualitative efforts to inductively uncover the range of underlying causes of team member technology choices and their performance effects.

The points outlined above lead to the inevitable conclusion that issues surrounding team virtuality are complex and contingent on a wide variety of factors. And, although we believe that the general propositions we advance should prove valuable, we recommend that researchers and practitioners modify them as needed as they pertain to particular team contexts. For example, Propositions 7 and 8 suggested that team virtuality would vary as a function of team developmental phases and task-related cycles, respectively. Thus, consider a newly formed quality-improvement team. Early in the team's development and using Tuckman's (1965) terminology, during the "storming" stage, one might anticipate that meeting face-to-face would be most beneficial for their effectiveness. In addition, perhaps group decision support tools would be valuable for helping to identify common ground, to prioritize work projects, and to set agendas. Once the team's agenda has been established and members move from the "storming" to the "norming" and "performing" stages, task scheduling and organization tools such as "Microsoft Project" should help members to maintain focus and to coordinate their efforts and deliverables. A grounded theory approach such as this may lead to different specific hypotheses than would be evident from our general propositions.



### *Managerial Implications*

The managerial implications of our construct of team virtuality are numerous. First, our assertion that co-located team members may be high on virtuality should reframe managers' thoughts about the use of team technologies. Rather than viewing virtuality as a necessary evil of linking people at a distance and overcoming the degradation of interacting through virtual means, our view of team virtuality challenges managers to consider how team virtuality can be *leveraged* to enhance team effectiveness, even with co-located team members. Naturally, some managers will have control over how virtual their teams are, whereas others may not. Controlling virtuality may depend on the variables we characterized as antecedents to virtuality. For example, team leaders may have less control over the extent of virtuality if all members are geographically dispersed in many different countries around the world and budget constraints severely limit face-to-face interaction. Similarly, the choices about how much to use lean versus rich synchronous or asynchronous technologies might be constrained by technology availability. In many other instances, however, the extent and nature of virtuality will be more of a strategic choice than a necessity of working together.

Therefore, the role of managers might transform more toward being a coach, monitoring team demands, and cuing when the use of certain virtual tools is most warranted (Hackman & Wageman, 2005). Moreover, their role should also ensure that teams have the necessary resources to exploit virtual means of coordination when it is adopted. This would include securing appropriate hardware/software, arranging for training and development *before* it is needed, and helping to shield the team from other pressures and demands as they learn new ways of working together (Kirkman et al., in press).

A final implication of our position may be obvious yet is not always appreciated. Clearly, we are advocating that a thorough needs analysis be conducted before virtuality, as a strategic choice, is thrust on teams. In contrast to some managers who tolerate technology use as a necessary evil, more often we fear that virtual means of coordination are employed because someone perceives that *the technology is available and can be exploited* (Schunn, Crowley, & Okada, 2002). Blackburn et al. (2003) outlined many important considerations in terms of training virtual teams to use technology, including *what to train*, *when to train it* (e.g., before they work in virtual teams vs. embedded training), *how to train it* (e.g., to individuals or teams), and what *delivery systems* to employ (e.g., in person vs. virtually). These questions underscore the more general principle that a thorough needs analysis must be conducted that identifies (a) what is trying to be accomplished through virtual means, (b) what competencies are required to execute the virtual processes, and (c) who needs to be trained. The answers to these questions defy simple yes-no answers and are inextricably intertwined. The answer to the technology paradox, that the use of technology does not always yield the productivity gains anticipated (Bruque & Medina, 2002), lies in this web of questions.

### *Conclusion*

We hope that our conceptualization of virtuality as a multidimensional construct will continue to move researchers away from viewing teams as either virtual or not. Although research

comparing virtual to face-to-face teams has generated interesting insights (e.g., Potter & Balthazard, 2002; Warkentin et al., 1997), the classification of modern-day teams seems less relevant given that most of these teams have attributes of both traditional and virtual teams (Griffith et al., 2003). Although classification schemes such as traditional, hybrid, and virtual (Griffith & Neale, 2001) can be useful in creating general descriptions and for exemplary purposes, we urge researchers to drop references to “virtual” or “traditional” teams. As we have stated, adaptive structuration theory suggests that teams make choices about virtuality on the basis of a confluence of factors including group structure, task, and interaction frequency. Thus, definitions of virtual teams that specify that they must be “geographically dispersed” (Bell & Kozlowski, 2002: 15; Townsend et al., 1998: 17) or rely on “technology-mediated communications *rather than* [italics added] face-to-face interaction” (Cohen & Gibson, 2003: 4) are far too deterministic. Instead, we argue that teams would be better described using our continuum of virtuality.

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