

## Conceptualizing and measuring the virtuality of teams

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**Abstract.** *Virtual teams (VTs) are teams whose members do not share a common workspace all of the time, and must therefore collaborate using communication and collaboration tools such as email, videoconferencing, etc. Although the body of research on VTs is quickly expanding, to date, the field has yet to produce a comprehensive and coherent foundation upon which future research can be based, and empirical findings based on a substantive sample of real VTs remain limited at this time. This study fills a void in the VT literature with respect to defining and operationalizing the construct of degree of virtuality, and responds to calls for research that studies ongoing VTs, under real conditions. Data were collected from 30 VTs working in a Canadian technology-based organization.*

*Degree of virtuality was defined to include three dimensions: the proportion of work time that the VT members spend working apart (team time worked virtually), the proportion of the team's members who work virtually (member virtuality) and the degree of separation of the team's members (distance virtuality). The VTs in this study were found to have varying degrees of virtuality, and although the three dimensions were not highly intercorrelated, all were found to be significantly correlated to variables that have been previously linked to VT effectiveness. The correlations were all in the expected direction (negative), indicating that higher degrees of virtuality are associated with perceived decreases in the quality of team interactions and performance. The results of this research would suggest that the more that teams move away from the proximate form, the more the traditional measures of team effectiveness are negatively impacted.*

**Keywords:** virtual teams, teams, virtuality, distributed teams

### INTRODUCTION

Virtual teams (VTs) are a form of organization that allow teams to be composed according to qualifications and expertise without limitations of time, space, and the costs and disruptions of relocation (Geber, 1995; Townsend *et al.*, 1996). Although statistics on the exact number of

VTs currently in existence are unavailable (Cascio & Shurygailo, 2003), a study commissioned by WorldCom in 2001 reports that 61% of employees in large companies have worked on VTs (WorldCom, 2001). In the United States, 8.4 million employees were estimated to work in VTs or groups (Furst *et al.*, 2004). These numbers can only be expected to increase with corporate globalization, partnerships, and joint ventures and technological complexity requiring specialization (Henry & Hartzler, 1997; Kanawattanachai & Yoo, 2002). Unfortunately, the body of knowledge on VTs has not kept pace with the use of this structure.

The empirical VT research has been criticized for a heavy reliance on student projects and laboratory studies (Martins *et al.*, 2004; Hertel *et al.*, 2005; Staples & Webster, 2007). It has also been noted that 'there is a lack of clarity on what we know and the direction that future research should take' (Martins *et al.*, 2004, p. 806). This lack of understanding of the VT construct is consistent with the projection made in 2002 by the Gartner Group – that 50% of VTs will fail because of the lack of management knowledge and expertise.

A possible reason for the limitations in this field of research is the lack of a clear definition of VTs, making comparative and cumulative research difficult (Gibson & Gibbs, 2006; Martins *et al.*, 2004). Related to the definitional issues is the fact that, historically, the literature has defined VTs as a single, identifiable phenomenon whereby a team is classified as either being virtual or not (Bell & Kozlowski, 2002). As such, much research has been conducted comparing wholly virtual and wholly proximate teams (usually in laboratory settings), when in reality, most real teams would fall between the two extremes (Griffith *et al.*, 2003; Martins *et al.*, 2004). This extant research offers limited insight into the concept that there are varying degrees that a team may be virtual, as suggested by a growing number of authors. However, there is no agreement as to the nature or dimensions of the concept of degree of virtuality and the effects it may have on a team's effectiveness (Martins *et al.*, 2004; Gibson & Gibbs, 2006). Research that quantifies degree of virtuality is still rare, and research that examines the dimensionality of virtuality is rarer still (Gibson & Gibbs, 2006). As such, there have been calls for research that explores the relationship between different dimensions of virtuality and VT outcomes (e.g. Axtell *et al.*, 2004; Martins *et al.*, 2004). Only two studies including the empirical measurement and testing of virtuality were found in the existing literature (Chudoba *et al.*, 2005; Gibson & Gibbs, 2006).

The above discussion indicates that there remains a need for an in-depth exploration of what it means for a team to be virtual and how its virtuality might be defined and measured. This need stems from both a theoretical gap and a practical requirement of those designing, implementing and managing VTs. We designed this study to help fill this void in the current body of VT research by providing answers to the following three questions, using real ongoing VTs in a field setting:

- 1 What makes a team virtual?
- 2 How can a team's degree of virtuality be defined and measured?
- 3 What is the relationship between a team's degree of virtuality and its effectiveness?

The second section of this paper reviews the extant body of literature on VTs, with a view to defining and operationalizing the constructs at the centre of this research: VTs, degree of

team virtuality and VT effectiveness. The methodologies that were used in this study to test the proposed measure of degree of team virtuality are summarized in the third section of the paper. Key findings from this research are presented and discussed in section four. Our conclusions and suggestions for future research are provided in the fifth section.

## LITERATURE REVIEW

The increasing use of VTs has led to a rapidly expanding area of research. For this review, we conducted a search of the practitioner and scholarly literature using *Business Source Complete*, *Web of Science* and *Google Scholar*, using the search term 'virtual teams'. Our goal was to identify research that focused on the use of VTs in organizations. Although the great majority of the papers identified in our literature search was determined to be extraneous to the topic explored in this study as they dealt with virtual reality, virtual medical procedures, virtual libraries and museums, virtual classrooms, virtual organizations, teleworking, and virtual learning, a number of studies relevant to this research were identified. A 'snowball' approach was then used to identify other publications on the subject of VTs by searching the reference lists of the papers identified through the first method. The following observations can be made by looking at the papers identified, using the two approaches.

First, the VT literature hails from a wide range of disciplines including organizational behaviour, human resources, communication, psychology, information systems, production and operations, education, project management, medicine, strategy, and small group research.

Second, there has been a proliferation of papers and books on VTs in the past several years. Half of the literature on VTs has been published since 1999 (Hertel *et al.*, 2005).

Third, despite the newfound popularity of VT research, the field is still 'maturing' (Saunders & Ahuja, 2006, p. 663), and the extant literature in the area is struggling with both empirical and conceptual issues. Empirically, the research on VTs consists largely of laboratory studies carried out on student populations. Much of the existing literature on VTs is also anecdotal and descriptive, documenting the characteristics, costs, benefits and challenges of VTs (Bal & Teo, 2000; Martins *et al.*, 2004; Gibson & Gibbs, 2006).

Conceptually, there are ongoing debates with respect to the meaning of 'virtuality' and arguments as to whether VTs are distinct from traditional, proximate teams (Chudoba *et al.*, 2005; Saunders & Ahuja, 2006). The lack of a clear definition of the phenomenon has made it difficult to measure the predominance of VTs, and has made cumulative and comparative research difficult. The classification of VTs as a single, identifiable phenomenon (i.e. a team is either virtual or not) has meant that much of the research in this area has focused on comparing virtual and proximate teams (e.g. Andres, 2002; Potter & Balthazard, 2002; Alge *et al.*, 2003) and determining which are more effective (Martins *et al.*, 2004). The results, for the most part, have been contradictory (Martins *et al.*, 2004).

### What makes a team virtual?

In defining the term 'virtual team', one needs to clarify what is meant by 'team' and separate that from what makes a team virtual. This is consistent with Cohen & Gibson's (2003) observation that VTs are 'first of all, teams'. In general terms, teams are groups of individuals who are working together interdependently with a common purpose for which they are mutually accountable (Hackman, 1990; Cohen & Bailey, 1997; Powell *et al.*, 2004).

What then are VTs? Table 1 presents the most common VT conditions found in the literature. The most frequently cited criteria for virtuality are as follows:

- 1 enabled by communication technology (i.e. use technology to communicate, make decisions, etc.);
- 2 geographically dispersed (i.e. not collocated, not working at the same location);
- 3 boundary spanning (i.e. there must be cross-boundary collaboration; there must be members from different organizations or organizational units); and
- 4 asynchronicity (i.e. members work at different times, either across different time zones or at the same location, but with different work hours/shifts).

A few authors also list temporality (limited team duration) as a required criterion of VTs (e.g. Jarvenpaa & Leidner, 1999; Watson-Manheim *et al.*, 2002; Martins *et al.*, 2004). Additionally, authors doing research in the area of global or transnational VTs add the requirement of members who are culturally diverse and/or who work and live in different countries (e.g. Jarvenpaa & Leidner, 1999; Maznevski & Chudoba, 2000; Watson-Manheim *et al.*, 2002; Gibson & Gibbs, 2006).

It should be noted that Watson-Manheim *et al.* (2002) define virtuality (although not virtual teamwork specifically) in terms of discontinuities. They identify six types of discontinuity that contribute to virtuality: temporal, spatial, work group, organizational, relationship and cultural. Although four of these discontinuities are in keeping with other researchers, work group and relationship discontinuities are unique. Work group discontinuity refers to individuals from differing workgroups interacting. Relationship discontinuity refers to whether the individuals are permanent, temporary, self-employed, etc.

In a similar vein, Espinosa *et al.* (2003) identified five boundaries that might characterize any team, rather than VTs, specifically: geographical, organizational, temporal, functional and identity. Although the first three are familiar, the last two need clarification. The term *functional boundaries* refer to team members from differing areas of expertise working together. Identity boundaries describe teams whose members belong to more than one team.

In addition, the research occasionally notes that VTs must be driven by a common purpose, be interdependent and/or mutually accountable (e.g. Bal & Teo, 2000; Hertel *et al.*, 2005). In the interest of defining VTs in a parsimonious fashion, it should be noted that this criterion falls within what may be considered a general definition of *all* teams. Under the assumption that VTs are a subset of teams, this component was considered in this research as redundant in our exploration of what makes a team virtual.

**Table 1.** Criteria for virtuality

Authors	Space/geographic dispersion	Organization/ boundary-less	Time/ asynchronicity	Term/ lifespan	Cultural/national diversity	Enabled by/rely on communication technology
Bal & Teo (2000)	X	X				X
Powell <i>et al.</i> (2006)	X	X	X			X
Martins <i>et al.</i> (2004)	X	X	X	X		X
Hertel <i>et al.</i> (2005)	X	X	X			X
Gibson & Gibbs (2006)	X	X			X	X
Powell <i>et al.</i> (2004)	X	X	X			X
Watson-Manheim <i>et al.</i> (2002) (discontinuities)	X	X		X	X	
Staples & Webster (2007)	X					X
Espinosa <i>et al.</i> (2003) (boundaries).	X	X	X			X
Saunders & Ahuja (2006)	X		X			X
Kirkman <i>et al.</i> (2004)	X		X			X
Griffith <i>et al.</i> (2003)	X					X
Cohen & Gibson (2003)	X					X
Bell & Kozlowski (2002)	X					X
O'Leary & Cummings (2007)	X		X			
Lurey & Raisinghani (2001)	X					
Maznevski & Chudoba (2000)	X				X	X
Jarvenpaa & Leidner (1999)	X			X	X	X
Kristof <i>et al.</i> (1995)		X				

X: criteria were included in the study.

### Identification of critical criteria for defining virtuality

When developing our definition of the VT construct, we considered two things. First, we needed to decide whether or not to include each of the six potential criteria identified in the previous section (i.e. enabled by communication technology, geographic dispersion, boundary spanning, asynchronicity, temporality and cultural/national diversity) in our requirement of what makes a VT. Second, we had to determine if all six criteria were necessary in order for a team to be considered virtual or if each circumstance, on its own, could be considered a sufficient condition for team virtuality. There is no consensus with respect to this second question in the literature. Bal & Teo (2000), for example, stated that all of their criteria must be met in order for a team to be considered virtual. George (1996) specified that any one of his criteria was sufficient to identify a team as virtual. Similarly, Martins *et al.* (2004) defined VTs as having varying degrees of all criteria.

To establish whether any or all of these six potential criteria should be used to distinguish between a proximate and a VT, it is necessary to look at each criterion in isolation and to determine if teams that have this single characteristic would be considered virtual. Under the assumption that all teams must be interdependent and must have a common goal, the remaining six potential criteria were explored as necessary conditions for VTs. In the tradition of Shaw's (1971) investigation of the definition of groups, in the following sections, we examine each of the six potential criteria in isolation.

#### *Geographic dispersion*

Geographic dispersion is one of the few almost universally used criteria of VTs found in the literature (Arnison & Miller, 2002). Even the most minimalist definitions of VTs generally include geographic dispersion as the prime example of how VTs differ from proximate teams (Bell & Kozlowski, 2002). Is a team whose members work at different locations (regardless of their work hours, organizational membership, cultural diversity, etc.) a VT? This situation inherently implies that the members are not working face-to-face at least some of the time. In our opinion, geographic dispersion should be sufficient to warrant the term *virtual team*.

#### *Asynchronicity*

Is a team whose members work at the same location, but have work hours that do not overlap, a VT? The classification of the team in this second scenario is less obvious. However, the practical difference between the first two scenarios is not so great: in neither case are the team members actually working *together* in the literal sense (i.e. not working together at the same place at the same time). Furthermore, the logistics of such a scenario are not so different from that of a team whose members work in time zones that differ to the extent that their workdays do not overlap. Thus, this second criterion would also seem to be a sufficient condition for virtualness.

### *Temporality*

Is a team whose members have the exact same work hours and work at the same location all the time, but which has a short-term mandate, a VT? It would seem counter-intuitive to classify the team in this third scenario as a VT. If team members are working together, for the same organizational unit, at the same place, at the same time, the length of the mandate should not determine virtualness. Just as some proximate teams may have a short-term mandate, so might some VTs (Powell *et al.*, 2004). Saunders & Ahuja (2006) provide evidence of this view in their recent study of VTs of varying temporalities. Thus, for the purposes of this research, temporality was not considered a sufficient condition nor a criterion for classification as a VT.

### *Boundary spanning*

Is a permanent team whose members work at the same location all the time and have the exact same work hours, but belong to differing organizations or organizational units, a VT? As in the third scenario, it does not follow that the team in this fourth scenario is a VT despite the fact that it describes a team that may not be considered traditional, nor does it seem to describe a VT. It is of interest to note that the term 'virtual team' has also been used to describe proximate but 'fuzzy' teams (i.e. teams that are not really teams in that they have no fixed set of members or boundaries) (e.g. Kristof *et al.*, 1995). These authors, although frequently cited in the VT literature, include *only* this characteristic in their definition of VTs. It is our contention that these authors were, in fact, describing a different phenomenon than that focused on in this study.

For the purposes of this research, boundary spanning was not considered a sufficient condition nor a criterion for classification as a VT. If team members are working together, at the same place, at the same time, their organizational origin should not determine virtualness.

### *Cultural diversity*

Is a permanent team whose members work at the same location all the time and have the exact same work hours, but have differing cultural or national backgrounds, a VT? As in the two previous scenarios, cultural diversity alone does not seem to be sufficient nor necessary to classify a VT. Furthermore, it should be noted that a team that has geographic dispersion (the first criterion) across different countries would be likely to have members of different nations and cultures.

### *Enabled by communication technology*

The requirement that VTs are enabled by, rely on or are dependent upon communication technology is found in almost all definitions and descriptions of VTs. This condition is also the most varied in terms of its use in the literature. Simply the use of communication technology, however, does not seem sufficient a condition to determine virtuality. If communication technology can be interpreted to include such things as the telephone, fax, email and internet, it

would be difficult to envision any modern team (particularly knowledge workers) functioning without any of these tools. As noted by Cohen & Gibson (2003), 'just the use of technology does not make a team virtual, because all teams use technology'.

Cohen & Gibson (2003) further noted that it is a *dependence* on electronic means that defines virtuality rather than its use. The question of virtuality and communication technology then becomes this: Is a team virtual because it depends on communication technology or does it depend on communication technology because it is virtual? In other words, is it the reliance on technology that defines virtuality or is technological dependence a consequence or coping mechanism for teams that collaborate without meeting face-to-face? Bell & Kozlowski (2002) concluded that it is the *absence* of face-to-face interaction that makes teams virtual (rather than the use of technology). Similarly, Griffith *et al.* (2003) noted that teams that never meet face-to-face are virtual regardless of their use of technological support. On the other hand, Cohen & Gibson (2003) describe a collocated team that chooses to work virtually (rather than face-to-face) as a VT. Thus, it is not necessarily the use of technology that defines virtuality, but the lack of face-to-face interaction (which is usually compensated for by technology) (Fiol & O'Connor, 2005). In the absence of face-to-face communication, the use of communication technology would seem to be an inevitable and practical *consequence* of VTs rather than a necessary condition (Fiol & O'Connor, 2005).

For the purposes of this study, the use of communication technology is assumed to be a characteristic of all teams, whereas dependence on technology is likely a consequence of virtual teamwork. We contend that neither of these circumstances is, however, sufficient to define a VT.

#### *Summary of criteria for defining virtuality*

To summarize, three of the criteria used in the literature to define team virtuality, temporality, boundary spanning and cultural/national diversity were determined to be inappropriate requirements for defining team virtuality. Furthermore, although VTs can be expected to rely on communication technology, this reliance was deemed to be a consequence of virtuality, rather than a criterion. Only geographic dispersion and asynchronicity were considered to be criteria for differentiating VTs from proximate teams. Furthermore, as both criteria were deemed sufficient, on their own, to ensure virtuality, it was concluded that both need not be present to determine virtuality (i.e. *either* geographic dispersion *or* asynchronicity *or* both determine virtuality).

The above review and critical analysis lead us to put forward the following definition of a VT. A VT is first and foremost a team, which means that it is made up of individuals working together interdependently with mutual accountability for a common goal. In addition, in order to be considered virtual, a team must have members who do not work in either the same place and/or at the same time, and therefore cannot collaborate face-to-face all of the time. As such, VT members must rely on communication technology to get their work done. As with proximate teams, VTs would likely have varying lifespans and degrees of diversity with respect to organizational/national boundaries, culture, nationality, expertise, profession, etc.



### How can a team's degree of virtuality be defined and measured?

In the past, the literature has defined VTs as a single, identifiable phenomenon (Bell & Kozlowski, 2002). The underlying assumption is that virtual and proximate teams form two distinct groups, and researchers assumed that a team should be identified as either one or the other. For example, a number of authors (Geber, 1995; Henry & Hartzler, 1997; Jarvenpaa & Leidner, 1999; Lurey & Raisinghani, 2001) have identified VTs as those that work apart 'most of' or 'the majority of' the time (Maznevski & Chudoba, 2000).

A growing number of authors (e.g. Bell & Kozlowski, 2002; Cohen & Gibson, 2003; Kirkman *et al.*, 2004) have suggested, however, that this view of VTs found in the literature may be too simplistic. These authors have posited that the identification of VTs may not be simply a matter of classifying a team as either proximate or virtual, as the earlier literature might imply. In other words, the question is not whether a team is virtual, but rather, 'how virtual is the team?'

Some authors have highlighted the concept that some teams are more virtual than others (George, 1996; Joy-Matthews & Gladstone, 2000; Ratcheva & Vyakarnam, 2001; Kirkman *et al.*, 2002; Griffith *et al.*, 2003). In discussing his criteria, George (1996) implied that team virtualness is not a condition, but a degree: the greater the extent of each characteristic, the more virtual a team becomes. As Joy-Matthews & Gladstone (2000) summarized, 'the extent to which team members collaborate proximately as opposed to virtually across distance, and perhaps time, is a continuum' (p. 25).

When viewed as a continuum, virtuality can be seen as a variable state rather than a dichotomy (Griffith *et al.*, 2003). The concept of *degree of virtuality* can then be used to describe any team. A team with zero degree of virtuality would be a wholly proximate team: a team that conducts 100% of its collaboration face-to-face. A team that never works together in the same place at the same time, whose members *never* meet face-to-face, would be wholly virtual. Although the extreme form of VTs (teams with members who never meet face-to-face) undoubtedly exists, most teams would fall between these two extremes (Griffith *et al.*, 2003). As Joy-Matthews & Gladstone (2000) noted, 'virtual team working has always existed because team workers can rarely do the whole of a team's tasks together' (p. 25). Even those extremely virtual teams, who never share a workspace, may occasionally need (or choose) to meet face-to-face (Bal & Foster, 2000).

In order to fully explore all VTs, rather than identifying a threshold of virtuality, it might be appropriate to 'explore what happens along the continuum between proximate and wholly virtual teams' (Joy-Matthews & Gladstone, 2000, p. 25), in what have been referred to as 'hybrid teams' (Griffith *et al.*, 2003). As shown in Table 2, five dimensions of virtuality are commonly used in the literature: the distance between team members, the extent that the members work face-to-face, the amount of work or interaction that is asynchronous, the configuration of team member locations and the extent that the team relies on information technology.

As would be expected given the definitions of virtuality in the literature, distance between team members is the most commonly cited dimension of virtuality, followed by the extent that the team interacts face-to-face. These two dimensions are likely related as the farther apart

Table 2. Dimensions of degree of virtuality

Authors	Distance/spatial dispersion	Degree of collocation/configuration	Temporal/degree of asynchronous work	Extent of face-to-face contact	Degree of electronic dependence/technological support	Other
Gibson & Gibbs (2006)	X				X	Structural dynamism, national diversity
Griffith <i>et al.</i> (2003)	X			X	X	
Hertel <i>et al.</i> (2005)	X	X		X		
Leenders <i>et al.</i> (2003)	X			X		
Cohen & Gibson (2003)	X				X	
Kirkman & Mathieu (2005)	X		X		X	Informational value of tools
Martins <i>et al.</i> (2004)	X		X		X	Diversity
Chudoba <i>et al.</i> (2005)	X		X		X	Organization, culture, work practice diversity
O'Leary & Cummings (2007)	X	X	X			
Fiol & O'Connor (2005)				X		
Kirkman <i>et al.</i> (2002)				X		
Kirkman <i>et al.</i> (2002)		X		X		Proportion of time spent on team tasks
Staples & Webster (2007)		X		X		

X, criteria were included in the study.

that team members are located, the more likely they are to be working virtually (see Lipnack & Stamps, 1997). To some extent, the distance between team members may represent the degree of choice (or ease) that team members have to meet face-to-face. A third dimension, the degree that team members work asynchronously, is also closely related, as any work or interactions that are asynchronous are highly unlikely, in practical terms, to be face-to-face. Similarly, the configuration of team members (i.e. the extent to which some team members are collocated) would also determine, to some extent, the amount of face-to-face interaction and collaboration within the team. Finally, degree of virtuality is often defined as the extent that a team relies on information technology to communicate and collaborate. Based on the discussion in the previous section, it would be expected, however, that the degree of dependence on telecommunications would depend upon the degree of virtuality, rather than a measure of it.

In addition to these common dimensions of virtuality, Kirkman & Mathieu (2005) and Kirkman *et al.* (2004) introduce an additional aspect of virtuality: the richness or the informational value of the technological tools used by the team. Although it could be argued that media richness and informational value would have a considerable effect on a VT's interactions, would a team whose members have access to very rich media be more or less virtual than one whose members only use the telephone or email? We contend that the study of the type of tools used could be relevant to any team, rather than a dimension of virtuality.

Martins *et al.* (2004) included aspects of team diversity as a dimension of virtuality. Although Cohen & Gibson (2003) similarly discussed virtuality in terms of degree of differences in profession, function, business unit, organization, country and culture, they kept these variables separate from degree of virtuality in their model. Chudoba *et al.* (2005) not only included similar dimensions of diversity, but also added work practice diversity to their determination of virtuality. Gibson & Gibbs (2006) also included national diversity and structural dynamism (changing team membership) in their empirical study of virtuality and innovation. We agree that all of these characteristics are not only relevant to the study of teams and team effectiveness, but could also be used to describe the diversity and challenges (or discontinuities) of any type of team, not just VTs, and therefore should not be considered to uniquely measure virtuality.

Chudoba *et al.* (2005) used their aspects of virtuality to develop a three-dimensional index of virtuality: team distribution, workplace mobility and variety of work practices. Their results have some relevance to this study in that the original dimensions quantifying virtuality contained items such as different time zones, never meeting and different locations, which are consistent with how team virtuality was conceptualized in this study. Unfortunately, their three-dimensional index includes items that are inconsistent with how virtuality is defined in this research. Team distribution, for example, included items such as the extent to which individuals work with people who speak different languages or use different communication technologies. Speaking different languages and using different technologies may be more prevalent in VTs and would surely provide challenges to any type of team, but do not measure virtuality. The second dimension, workplace mobility, included items such as using mobile devices and working with people from other organizations. As noted earlier, the use of mobile devices and working while travelling would seem to be a hallmark of the modern workforce and likely a by-product of virtuality, rather than a defining dimension. The final dimension, variety of

practices, included the extent to which individuals experienced such things as working on projects with changing members, working on teams that track work differently and working with people who use different technologies to collaborate. The challenges quantified by this last dimension are those faced by any team or workgroup, be they proximate or virtual. As such, these discontinuities would not seem to reflect the concept of virtuality as defined in this research.

Kirkman *et al.* (2002) identified three dimensions of virtuality: the proportion of time members work virtually, the proportion of members who work virtually and the proportion of the workday each member dedicates to the VT (as opposed to other duties). Whereas the first two dimensions (proportion of time and proportion of members) might determine team virtuality, the third dimension is concerned with the extent to which each member is dedicated to the VT. Would a VT whose members dedicate 10% of their time to the team's work be *less* virtual than a VT whose members dedicate 50% of their time to the team's work? This dimension would seem to be more closely related to the degree of virtual work carried out by the *individual* members as opposed to the virtuality of the team. At the team level, this dimension would seem to hinge on the size of the team mandate (or the resources required), as opposed to the degree of their virtuality (i.e. a team working on a large-scale project, requiring greater resources and time, would have a greater degree of virtuality than a team working on a small-scale mandate).

#### *Summary of dimensions of degree of virtuality*

To summarize, degree of virtuality has been conceptualized most often to include the degree of distance between members, the extent that they work face-to-face, the extent of their collocation and the amount of asynchronous work that they do. All of these aspects are expected to be related. We suggest that these dimensions are different, however, as proximity and collocation reflect a degree of convenience and choice in virtual work (i.e. a collocated team might choose to work virtually; a highly dispersed team may not have that choice). Although many authors include degree of reliance on technology as a dimension of virtuality, we contend that this is a characteristic or consequence of virtuality rather than a measure of it.

The above review leads us to identify the following dimensions of virtuality: the extent that the team members do not work face-to-face, the distance between team members, their configuration or collocation patterns, and the extent that they work asynchronously.

#### **What is the relationship between a team's degree of virtuality and its effectiveness?**

To a great extent, the interest in and allure of teams in the organizational setting are based on the assumption that individuals can be more effective when working in a group: that a group or team can accomplish something that a mere collection of individuals cannot. Similar to the proximate team research, VT research is often focused on effectiveness.

### *VT effectiveness*

In general, proximate team effectiveness has been defined as the degree to which a team satisfies all of its objectives, be they productivity, behaviour or attitude related. Research on proximate team effectiveness overwhelmingly uses one or more of Hackman & Morris' (1975) three dimensions of team effectiveness: productivity/performance, member satisfaction and the capability to work together in the future. Similarly, much VT research uses these conceptualizations to explore what makes VTs effective and/or how VT effectiveness compares to proximate team effectiveness. The results of the latter, for the most part, have been contradictory, although the general impression is that VTs are not as effective as proximate teams, and that given the choice, proximate teams would seem to be the best bet. As confirmed by Overholt (2002), 'if companies had unlimited travel budgets and teams had endless amounts of time, then face-to-face meetings would be the best way to work, right?' (p. 4).

Most studies of VT effectiveness include only the first two measures: performance and/or satisfaction (e.g. Warkentin *et al.*, 1997; Lurey & Raisinghani, 2001; Andres, 2002; Kanawattanachai & Yoo, 2002; Alge *et al.*, 2003; Furst *et al.*, 2004; Kirkman *et al.*, 2004). We could not find any instance in the empirical VT literature where the third traditional dimension of team effectiveness, the capability for the members to work together in the future, was used. It may be that this dimension of effectiveness is less relevant to VTs who are often formed and reformed quickly.

In addition, much of the research on VT effectiveness ignores the fact that VTs have been widely touted as providing a number of benefits over traditional teams. As such, conceptualizations of effectiveness that are based on proximate team constructs may not effectively reflect the success of VTs as they do not assess the key areas of strength of VTs (Furst *et al.*, 1999).

### *Effects of degree of virtuality*

In the extant literature, the variable condition of virtuality was rarely found to be applied in an evaluative way to aid in identification of subjects and in sample selection, or to be included as a variable of interest. As such, there is very limited research exploring the relationship between virtuality and team outcomes.

Although Cohen & Gibson (2003) included degree of virtuality as a moderator of the relationship between team inputs (or design factor) and team processes in their conceptual model of VT effectiveness, their research has not yet extended to empirical testing of the model. Gibson & Gibbs (2006) investigated the relationship between their four dimensions of virtuality (geographic dispersion, electronic dependence, structural dynamism and national diversity) and a single outcome (innovation). Each of the four dimensions was found to be negatively correlated with the outcome.

Kirkman *et al.* (2004) also defined virtuality as a continuum, but included only the number of face-to-face meetings as a variable representing virtuality in their study of empowerment in VTs. The number of face-to-face meetings was found to moderate the relationship between

team empowerment and team outcomes. Leenders *et al.* (2003) described virtuality as a continuum, but included only teams with low virtuality in their study. Maznevski & Chudoba (2000) included member distribution as a variable in their case study of VTs, but drew no conclusions specific to member dispersion.

Chudoba *et al.* (2005) used their index of virtuality (team distribution, workplace mobility and variety of work practices) to test the relationship between virtuality and team performance. They concluded that both workplace mobility and variety of work practices had 'significant negative implications' (p. 297) for team outcomes such as trust, communication, commitment and team performance. The final dimension of virtuality, team distribution, was reported to have no relationship to team outcomes. Several aspects of Chudoba *et al.*'s (2005) research design suggest, however, that the results from this study cannot be generalized to the team level (e.g. each dimension included aspects not in keeping with our definition of virtuality and a focus on individuals who were members of multiple teams with varying degrees of virtuality).

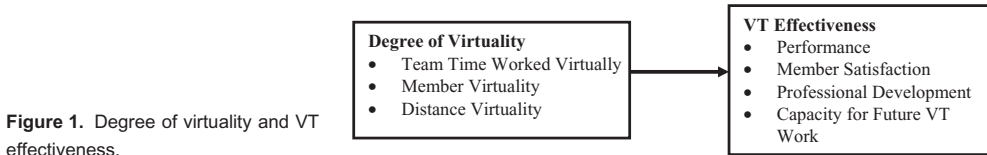
#### *Summary of relationship between degree of virtuality and effectiveness*

In keeping with the proximate team literature, VT effectiveness has been conceptualized to include behavioural and/or attitudinal outcomes: most commonly, performance and member satisfaction with the VT experience. Despite the fact that VTs and proximate teams differ in significant ways, the methods used to evaluate VTs are almost always based on proximate team models, with little or no adaptation of the constructs (Furst *et al.*, 1999).

Empirical research that operationalizes virtuality in a meaningful way is still rare and, as such, research that measures its relationship with team effectiveness is rarer still. In general, virtuality has been found to have a negative relationship with team outcomes.

## **METHODOLOGY**

The objective of this research was to determine what makes a team virtual, attempt to measure that virtuality and determine the relationship between a team's degree of virtuality and its effectiveness. In the following sections, we describe our operationalization and measurement of the construct of degree of virtuality, as defined in the previous sections. In addition, we operationalize and measure VT effectiveness and explore the relationship between the two constructs. Degree of virtuality has been found to have both a direct relationship with VT outcomes (Chudoba *et al.*, 2005) and a moderating relationship between empowerment and VT outcomes (process improvement and customer satisfaction) (Kirkman *et al.*, 2004). The latter study was focused on empowerment and used a very simplistic measure of virtuality (number of face-to-face meetings). Given the early stages of this area of research, we chose to follow Gibson & Gibbs (2006) and Chudoba *et al.* (2005) and to explore the direct relationship between virtuality and team effectiveness (see Figure 1). Although we expected the three dimensions of virtuality to be related, we also wanted to analyse each separately for the purpose of isolating the potential effects of each dimension.



## Measuring degree of team virtuality

Given the above literature and the two criteria of team virtuality (time and distance) discussed in the previous section, we theorize that a team's degree of virtuality can be defined as a three-dimensional construct: the proportion of team work time that the team members spend working apart, the proportion of team members who work virtually, and the degree of separation of the team members. Each dimension is examined separately in sections below.

### *Proportion of team work time spent working virtually (WV)*

This dimension of virtuality represents the proportion of time that team members work virtually on the team's tasks (i.e. the proportion of the team's task that is performed virtually). This dimension addresses the possibility that team members who are working at the same location may not always be present at the same time (i.e. shift work or flex hours). In addition, it recognizes that even highly dispersed members (many locations) may meet frequently to work proximately. We conceptualize working virtually as a continuum, with a wholly VT (i.e. a team that performs all team-related activities without ever meeting face-to-face – 100% virtual on this dimension) on one end of the continuum and a wholly traditional team (i.e. a team that performs all of their team-related activities face-to-face, either through collocation or travel – 0% virtual on this dimension) on the other end of the continuum. We hypothesize that most VTs would likely fall between the two extremes (e.g. a team that works at different locations but meets once a week). To calculate working virtually, we asked VT members to report: (1) the number of weekly hours spent on work activities related to the particular VT; and (2) the number of weekly hours spent working *virtually* (i.e. not face-to-face) on work activities related to the VT. The team's working virtually was calculated as the total number of hours the team's members spent working virtually (the sum of all of the team members' responses) divided by the total number of the members' team-related work hours (the sum of all of the team members' responses) and multiplied by 100. A team that performs the entire team task without ever meeting would score 100% on this dimension. A team that performs all of the team's tasks face-to-face would score zero.

### *Proportion of member virtuality (MV)*

The second dimension of virtuality represents the degree to which VT members are dispersed or collocated. It can be conceptualized as the proportion of team members stationed

at different locations. This aspect of virtuality allows for the real possibility that the collocation or dispersion of a team's members is not a dichotomy, but rather a continuum with traditional teams (i.e. all members working in one location – 0% virtual) at one end and teams that are wholly virtual at the other end (i.e. each of the team's members working at a different location – 100% virtual). Again, we feel that it is most likely that the majority of VTs would fall between the two extremes (e.g. a team of six members working from three locations, where the members are collocated in pairs). The data used to calculate MV were collected from the team managers who were asked to provide the locations of each of the members on their VTs. MV was then calculated as the total number of different member locations divided by the number of team members and multiplied by 100. A team whose members each work at different locations (i.e. the number of locations equals the number of team members) would score 100% on this dimension. A team of four members who worked in pairs at two locations would receive an MV score of 50%.

#### *Degree of separation [distance virtuality (DV)]*

The third dimension of virtuality represents the geographic distance between team members (i.e. the spatial distance between members, or the amount of effort or travel time necessary to meet as a team). This dimension distinguishes between the virtuality of a team whose members are all located in the same city and one whose members are dispersed throughout the globe. As the cost and difficulty in organizing face-to-face meetings increase concomitant with DV, this dimension can be used to represent the degree of choice a team has over working virtually vs. proximately (i.e. the closer the team members, the more their virtuality might be considered a choice). A team with a low degree of separation could meet regularly if they so chose. A team with a high degree of separation might never be able to meet. This dimension is consistent with the work carried out by Robey *et al.* (2003), who described a VT whose members chose to communicate solely through electronic means. Because of their physical proximity, however, coincidental and then informal meetings began to take place between team members. Finally, formal team meetings were scheduled.

DV is operationalized as a measure of the distance team members must travel in order to meet, allowing for the number of collocated team members, the number of locations and the distance between those locations (adapted from Gibson & Gibbs, 2006). Distance scores were established to represent travel time and effort required to meet (planning and cost). Teams with multiple collocated team members and/or locations that are fairly proximate (same city) can have inexpensive, impromptu meetings, where travel time and method are less of an issue. Teams requiring airplane travel require greater planning (reservations, accommodations) and resources (money) to meet. Potentially, the greater the distance, the more lead time and money required for a meeting. The coding scheme used to calculate distance scores is presented in Table 3.

Unlike the other two dimensions of virtuality, DV is not a proportion. In order to calculate the DV, it was necessary to choose a hypothetical meeting location for each team, as the distance



**Table 3.** Distance scores used in calculation of distance virtuality

Example travel distances	Score
Same city (1/4 day – walk, car, public transit)	0.25
Different cities – same region (1/2 day – car, train)	0.50
Different regions (1.5 days – car, train, airplane)	1.50
Same continent (2 days – airplane)	2.00
Different continents – same hemisphere (2 days – airplane)	3.00
Different hemispheres (3 or 4 days – airplane)	5.00

scores would vary according to where a meeting would take place. For each team, the location that would require the least total amount of travel by the members was chosen (i.e. the location that would minimize the DV score).

As conceived in this study, the degree of DV is dependent on the size of the team (i.e. a highly dispersed, two-member team would be able to meet face-to-face much more easily than a very largely dispersed team). A team whose members are all located at great distances from one another (scattered throughout the globe), such that they all would be required to travel a great distance to meet, would score the highest on this dimension. A small team with collocated members and/or locations in fairly close proximity would score the lowest.

The data used to calculate the DV for each team were collected from the team managers who were asked to provide the locations of the team members with respect to their proximity to one another. For each team, the total DV score was calculated as a sum of individual members' distance scores. For example, the DV for a team with a total of four members, two located in city A (different buildings), one in city B (different city, same region) and one in city C (same continent), would be as follows (assuming the meeting was in city A):

- 1 Score for host member (first member in city A) = 0.
- 2 Score for second member in city A = 0.25.
- 3 Score for member in city B = 0.5.
- 4 Score for member in city C = 2.0.

For this example, the DV for the team would be 2.75.

#### *Summary of the measurement of degree of virtuality*

Theoretically, the three measures of degree of team virtuality measure three different dimensions of virtuality. A summary of the calculations for the three dimensions is presented in Appendix B. A principal components factor analysis of the three dimensions produced only one factor but resulted in fairly low factor loadings of 0.652, 0.760 and 0.534 for working virtually, MV and DV, respectively. The factor explained only 43% of the variance, and when grouped together in one scale, the three dimensions of degree of virtuality had a Cronbach's  $\alpha$  of only 0.33. Although these three dimensions of virtuality are theoretically related, the results indicate that these items do not measure the same construct. These results support the contention of

O'Leary & Cummings (2007) that virtuality has importantly differing dimensions, and the findings of Gibson & Gibbs (2006), who determined that their dimensions of virtuality were not as related as they had expected.

### Measuring VT effectiveness

For this study, we included the two dimensions of proximate team effectiveness most often found in the VT literature: performance and member satisfaction with their VT experiences. Given that the third dimension of effectiveness most typically found in the proximate team literature, member capacity to work together in the future, may not reflect the realities of VT work, and no dimension was found to measure the unique benefits of VTs, we chose to include two additional dimensions that are more reflective of the challenges and benefits of VTs.

First, we evaluated the VT members' capacity to work on a VT in the future, rather than their capacity to work on a particular VT again. This reflects the ability of VTs to be formed and reformed quickly, rather than focusing on long-term team member relationships. Second, we chose to include an aspect of VT work that reflects the unique potential benefit that VTs provide to the team members and, indirectly, to the organization. One of the most commonly cited benefits of VTs is the opportunity to select members based on qualifications rather than on location. From an individual standpoint, VTs allow members to choose projects of interest, regardless of location, providing the opportunity for development and collaboration with experts that would otherwise not have been available (Van der Smagt, 2000; Johnson *et al.*, 2001). We conceptualized VT effectiveness to include the extent to which the team members develop professionally as a result of their work on the VT.

To summarize, we operationalized VT effectiveness to include the following performance-related objectives and attitudinal outcomes:

- 1 Performance: the achievement of the team's task (quality, budget, schedule) was measured using a scale developed by Lurey & Raisinghani (2001). The questions comprising this measure are presented in Appendix A.
- 2 Satisfaction: the satisfaction of VT members with respect to their perceptions that the VT experience contributes to their growth and personal well-being was measured using a scale developed by Lurey & Raisinghani (2001). This scale was augmented with a global team-satisfaction item used by Gladstein (1984). The questions comprising this measure are presented in Appendix A.
- 3 Capacity for future VT collaboration: as no existing measure was found in the literature, the contribution that the VT experience made to the members' ability and desire to work on VTs in the future was measured with a two-item measure developed for this study. VT members were asked the extent to which their experiences on the VT had increased their ability and desire to work on VTs in the future.
- 4 Professional development: again, as no existing measure was found in the literature, the VT members' perceptions of the professional development provided by their VT work were measured using a scale adapted from two existing studies: Lurey & Raisinghani (2001) and

Duxbury *et al.* (1999). The resulting four-item scale asked members to assess the degree to which their experiences on the VT provided them with challenging work, the opportunity to increase their knowledge and skills, and the progress towards reaching their goals in terms of their profession and position.

All of these variables were measured on a five-point scale (1 = strongly agree, 5 = strongly disagree), with higher scores representing greater perceived effectiveness. The measures had reliabilities (Cronbach's  $\alpha$ ) of 0.88, 0.80 and 0.85, respectively (no reliability was tested for the two-item measure of professional development).

A principal components factor analysis of the variables of VT effectiveness showed all four dimensions loading onto a single factor, with a minimum loading of 0.78. The resulting factor explained 68% of the variance and had a reliability (Cronbach's  $\alpha$ ) of 0.83.

### Sample

This study of VTs was undertaken at a large private sector technology firm with numerous locations across Canada. The organization agreed to participate in the study with the understanding that their identity would be protected and that they would receive access to the results. As the organization did not have a comprehensive list of all VTs, we distributed information regarding the study throughout the organization by way of a letter and word of mouth. Managers of VTs were asked to contact the researchers. We then set up interviews with those managers who agreed to be in the study. In all, 25 managers, who were responsible for a total of 32 VTs, agreed to participate in the study. The great majority of managers (19) managed only one VT. Three managers were responsible for two VTs, one was responsible for three, and one manager was responsible for four VTs.

Data to calculate the three dimensions of team virtuality and VT effectiveness were collected from VT managers and VT members. The VT managers were asked in an interview to provide information on the team size and longevity (i.e. years in operation), as well as information on where the various members of the VT were located.

Based on the contact information provided by the VT managers, 171 individuals representing all of the members of the 32 VTs were sent an invitation to complete an online questionnaire. A total of 108 team members from 31 different VTs completed the questionnaire, with an individual response rate of 63%. One team manager withdrew his team from this study shortly after the invitation was distributed because of workload pressures. The survey included questions related to the members' work hours (i.e. weekly work hours, weekly hours spent on the team's task and weekly hours spent working *virtually* rather than face-to-face on work activities related to the VT), demographic variables and their perceptions of VT effectiveness.

In order to ensure that the individual data reflected that of the team, it was critical that a sufficient proportion of the members of each team provide data on the variables of interest. 'Sufficient' was operationally defined in this study to include those teams in which approximately half of the VT members completed the survey. This requirement, although arbitrary, seems to make sense from a research perspective. Thirty of the 31 VTs met the requirement.

Data from the other team were excluded from the sample. The final sample was therefore made up of 107 VT members working in 30 ongoing VTs.

### Data analysis

As the primary focus of this study was the virtuality of teams, the team was the level of analysis. This approach is consistent with the advice offered by McGrath (1986), who strongly suggested that those studying groups focus on the group as the level of analysis. He stated that to understand groups, 'We need to ask, "What goes on at the group level?"' (p. 368).

Although some of the team data were collected from the managers, the majority was collected from the VT members. This required us to create aggregate team scores for each variable measured at the individual level. In each case, team-level data were calculated as the summed average of the individual responses. Within-team agreement was tested using James *et al.*'s (1984) method for measures using discrete scales.

The relationship between each of the dimensions of virtuality and VT effectiveness was explored using Pearson's two-tailed correlation analysis.

## RESULTS

### Description of team members

A summary of the sample description is presented in Table 4. The team member sample was almost evenly split on gender (56.5% female), with a mean age of 42.63 years. Most respondents were between the ages of 26 and 55 years. Given the nature of their industry, it was expected that all of the team members would be knowledge workers in fairly technical areas. As can be seen in Table 4, this expectation was borne out by the data. As expected with knowledge workers, the great majority (75%) of the respondents had a post-secondary education. Just over a third (34%) had a graduate degree as well. The great majority of team members (87%) worked in three cities located in two adjacent Canadian provinces. The remaining members were split evenly between other cities and rural areas in the region (the latter were teleworkers).

### Description of the VTs

A summary of the teams in the sample is presented in Table 5. The 30 teams ranged in size from 2 to 14 members, with a mean of 5.45 members. The members of the VTs were located in an average of 3.2 locations. Most VTs (80% of the sample) had some collocated members. Finally, it should be noted that the teams had been in existence for an average of 2.0 years.

As noted in the previous section, details on team member tenure, work hours and area of expertise were collected from the team members. Team-level data on these three variables were calculated as the summed average of the individual responses for each VT. The teams

**Table 4.** Sample description

Demographic	
Gender (female) (%)	56.5
Age (years)	42.63 (SD 5.41)
Area of expertise (%)	
IT/IS, R&D/engineering	47
Operations	12
HR	11
Project management	9
Marketing	8
Other	13
Education (%)	
High school diploma	7
Post-secondary	18
Post-secondary degree	41
Graduate degree	34
Location (%)	
City A	36
City B	37
City C	14

IT, information technology; IS, information systems; R&D, research and development; HR, human resources.

**Table 5.** Team sample description

Demographics	Categories	% of sample	Mean (SD)
Team size	Less than 5	43	5.45 (3.00)
	5–9	43	
	10–14	13	
Number of locations of team members	2	37	3.2 (1.32)
	3	33	
	4 or more	30	
Team age (years)			2 (2.13)
Tenure (years)			
With employer			14.08 (5.87)
With virtual team			1.62 (1.09)
Areas of expertise			1.93 (0.70)

had average member tenure in the company of 14.08 years with the company and 1.62 years with the VT. The VTs were comprised of members from an average of 1.93 different areas of expertise.

### Virtuality of the teams in the sample

The means and standard deviations (SDs) of the three measures of degree of virtuality for the teams in this study are included in Table 6. The proportion of time that the VTs in this

study spent working virtually on team activities averaged 83.4% (i.e. the VT members spent 83.4% of the time spent on the team's activities working apart). The results for this dimension of virtuality indicate that most of the work of the VTs in this study were performed virtually. Conversely, only a small amount of work was carried out face-to-face, either through meetings or the collocation of some of the members of the team (as is shown in the next dimension).

The second dimension of degree of virtuality, MV, was calculated as the proportion of VT members who work in different locations. The mean level of MV of the VTs included in this study was 64.9%. This can be interpreted to mean that the VTs in this sample had two locations for every three team members. That means that most of the teams had members who were collocated *and* worked virtually with other dispersed team members. Only six teams were 100% dispersed – no two members working in the same location.

The third dimension of degree of virtuality, distance virtuality, had a mean of only 14.2%. This result indicates that the team members were not dispersed at great distances from one another and could orchestrate face-to-face team meetings without a great deal of trouble and expense. In fact, most of the VTs in this study had members in the major cities of two neighbouring provinces.

Despite the fact that most of the teams in this study had some collocated members and were relatively close to one another in terms of distance, they worked virtually the great majority of the time. Although the extent to which a team works virtually would be expected to be related to the geographic dispersion of its members (the farther apart the members, the more they would be expected to work virtually), as suggested by Lipnack & Stamps (1997), the measure of distance alone does not reflect the likelihood that some teams may choose to work virtually (Cohen & Gibson, 2003). The results of this study support the conceptualization of virtuality as multidimensional. This is supported by the fact that the two-tailed Pearson correlations between the three dimensions of degree of virtuality were not statistically significant (see Table 6).

**Table 6.** Means, SDs and correlations between variables

	Mean (SD)	WV	MV	DV	Performance	Satisfaction	Development
WV	83.4% (20.00)	–					
MV	64.9% (22.07)	0.208	–				
DV	14.2% (6.45)	0.155	0.055	–			
Performance	3.97 (0.481)	–0.357*	–0.340*	–0.452**	–		
Satisfaction	4.06 (0.378)	–0.411**	–0.279	–0.363**	0.669***	–	
Development	3.84 (0.402)	–0.155	–0.205	–0.211	0.537***	0.540***	–
Collaboration	3.85 (0.462)	–0.248	0.040	–0.299	0.393**	0.525***	0.741***

\*Correlation significant at  $P < 0.10$ . \*\*Correlation significant at  $P < 0.05$ . \*\*\*Correlation significant at  $P < 0.01$ .

Collaboration: future collaboration. Development: professional development. Performance: member's perception of performance. WV, working virtually.

### Perceived effectiveness of the VTs in the sample

The means and SDs of the four measures of VT effectiveness are presented in Table 6, along with their correlation with the variables included in this study. Overall, the VT members perceived their teams to be effective, with a mean of 3.97 on the performance measure (SD 4.81). Most of the VTs in the study (70%) rated their VT's performance as effective, whereas 13% considered their VT to be very effective. The VT members also tended to be satisfied with their experience on their VT (mean score of 4.06, SD of 0.402 on VT member satisfaction). Again, the majority (83%) rated their team as effective with respect to this outcome, and 1 in 10 rated their team as highly effective.

The VT members' perceptions of their opportunities for professional development (mean of 3.84, SD of 0.378) and their capacity for future VT work (mean of 3.85, SD of 0.462) were slightly lower than their perceptions with respect to productivity and satisfaction. Although the vast majority (77%) felt that their VT was effective at meeting their professional development needs and improving their capacity to work on VTs in the future, none of the teams in the sample rated their team as highly effective with respect to professional development, whereas only 7% gave this rating with respect to capacity for future VT work.

The different measures of VT effectiveness demonstrated significant positive associations and high factor loadings, suggesting that perceptions of employees' VT performance are associated with the extent that their VT experience contributes to their growth, personal well-being and professional development. These findings also suggest that their ability to work on a VT in the future is highly related to the other dimensions of effectiveness.

### Relationship between measures of virtuality and VT effectiveness

The following observations can be made with respect to the link between the three measures of virtuality and VT effectiveness. First, all three of the dimensions of virtuality developed for this study were found to be significantly correlated to variables that have been previously linked to VT effectiveness (performance and satisfaction). The correlations were all in the expected direction (negative), indicating that higher degrees of virtuality are associated with perceived losses in the quality of performance and member satisfaction. This result supports the previous research that indicates that virtuality has negative implications for team effectiveness (Gibson & Gibbs, 2006). These results contradict those of Chudoba *et al.* (2005), who found no relation between team distribution and outcomes. As noted previously, however, Chudoba *et al.* (2005) included measures significantly different from ours, and the results reflect the overall experiences of individuals working on multiple teams of potentially varying virtuality.

The proportion of time that team members spent working virtually was significantly correlated with two measures of effectiveness: satisfaction ( $r = -0.411$ ;  $P < 0.05$ ) and member perceptions of VT effectiveness ( $r = -0.357$ ;  $P < 0.1$ ). The degree of distance between team members (DV) was significantly correlated with two measures of team performance: member perceptions of VT performance ( $r = -0.542$ ;  $P < 0.01$ ) and satisfaction ( $r = -0.363$ ;  $P < 0.05$ ). The third dimension of virtuality, the proportion of team members who are not collocated (MV), was

significantly correlated with member perceptions of VT performance ( $r = -0.340$ ;  $P < 0.1$ ). All of the correlations were in the expected direction (i.e. negative).

It should be noted that two of the measures of VT team effectiveness, professional development and future collaboration on a VT, were not significantly correlated to any of the dimensions of degree of virtuality examined in this study. This would suggest that neither of these outcomes is associated with working virtually *per se*. This is a positive finding given the importance of VTs in today's work environment, suggesting that working on a VT does not hinder future VT work or the professional development of team members. On the other hand, the lack of association between professional development and virtuality suggests that it may not be a benefit of VTs, as projected in the literature.

## CONCLUSIONS

This study fills a void in the VT literature with respect to what it means for a team to be virtual and how its virtuality might be measured. In addition, it provides insights into the implications of different dimensions of virtuality on team effectiveness, for both those studying VTs as well as those designing, implementing and managing VTs. This study reflects the data collected from 30 VTs working in a Canadian technology industry.

Based on their effectiveness scores (3.86–4.05 on a five-point scale), the VTs in this study were relatively successful. They had been in operation for an average of 2 years and were relatively small, suggesting that smaller VTs may be more prevalent than bigger ones. It is likely that unsuccessful VTs or larger ones, if they did exist, but were not successful, would have been disbanded by the organization.

The VTs in this study were comprised of highly educated, experienced professionals, who were in specialized areas. The fact that they work long hours suggests that they are committed to either their organization and/or their jobs. Taken together, the results suggest that these VTs are, as the literature indicates, used to pool the resources of specialized individuals who may not be able to collaborate proximately and who can be relied upon to work hard without direct face-to-face supervision or close personal contact.

Our major objective in this research was to define and operationalize the construct of degree of virtuality, which has emerged in the recent literature on VTs. We developed a definition of degree of virtuality that reflects virtuality as a continuum rather than a dichotomy. Using the literature as a basis, we developed a working definition of degree of virtuality that conceptualized this construct to include three dimensions: the proportion of work time that the VT members spend working apart (team time worked virtually), the proportion of the team's members who work virtually (MV), and the degree of separation of the team's members (DV). The three dimensions were not found to be significantly correlated to one another, indicating that they represent different aspects of virtuality. All of the three dimensions of virtuality were shown to be associated with one or more measures of VT effectiveness.

The VTs in this study were found to have varying degrees of virtuality, supporting the contention that virtuality is a matter of degree, and the wholly VTs studied in the past do not



necessarily reflect what is found in practice. The VTs were found to be highly virtual in terms of the amount of time they spent working virtually, but were less virtual if one considered the distance team members were from one another or the number of teams with some collocated members. This suggests a certain amount of choice in the virtuality of these teams (they chose to work virtually rather than meet face-to-face) and supports a conceptualization of virtuality that includes multiple dimensions.

The results indicated that the degree that a team is virtual is associated with a reduction in two key dimensions of team effectiveness: member perceptions of performance and member satisfaction, suggesting that the more that teams move away from the proximate form, the more the traditional measures of team effectiveness are negatively impacted.

Degree of virtuality was not shown to be associated with two of the unique aspects of VT effectiveness included in this study: VT members' perceptions of future development and VT members' perceptions of capacity for future VT work. These results indicate that factors such as career development are not affected by team virtuality and may be more likely to be affected by other factors not included in this study rather than the virtuality of the work.

Although these results suggest that some of the aspects of the effectiveness of VTs might be improved by reducing the virtuality of the team, in situations where VTs are necessary or appropriate, organizations and managers may be able to compensate for the negative effects of virtuality. For example, team perceptions of performance and satisfaction might be monitored and compared to manager or client perceptions. Organizations might provide training in virtual work or ensure additional managerial support. In addition, if teams are choosing to work virtually, managers might encourage occasional face-to-face meetings to improve team satisfaction.

### Contributions and suggestions for future research

In this study, we make three contributions to the research in the area of virtuality of teams. First, we have developed a conceptual framework that clarifies what makes a team virtual. Second, we have developed a measure that can be used to determine any team's degree of virtuality along three dimensions. This allows teams of varying virtuality to be better studied and compared. Third, we have provided some insight into the relationship between team virtuality and team effectiveness.

In addition to the above, we responded to appeals for research that is field based and specifically designed for VTs, rather than adapted from proximate team research. This study collected data from actual VTs who have performed real work for a private sector organization under real conditions over a relatively long period of time. As such, there is greater confidence that the findings of this research reflect the circumstances of real VTs than do findings obtained under the simulated conditions that dominate the current research. The results from this study can be used by researchers as well as by managers who design and manage VTs.

The fact that the VTs in this study were all within a single organization means, however, that the generalizability of the study might be somewhat limited. The organization has some very distinct characteristics, which showed themselves in the data. First, because the organization

under study operates in the high-technology industry, the VTs in this sample were highly educated and dedicated knowledge workers. Second, this research included VTs from within one region of Canada. The ability of this organization to provide access to a relatively large number of VTs was, however, a rare opportunity. Future research should make the attempt to collect data from intact VTs working at different types of organizations and working within teams that are dispersed across a greater range of distances.

Another limitation in this study is its small sample size. A sample size of 30 teams, although representing a relatively large sample in the area of VT research, is limiting in terms of the analysis that can be used. As such, only correlations could be calculated. A small sample size also increases the critical values for significant correlations, making it very difficult to find significant correlations. In addition, because of limitations with respect to the analyses performed, only linear relationships were explored. Studies including larger sample sizes should be undertaken to permit more sophisticated analysis.

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## Biographies

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**Linda Duxbury** is a Professor at the Sprott School of Business, Carleton University. She received an MASc in Chemical Engineering and a PhD in Management Sciences from the University of Waterloo. Within the past decade, she has completed major studies on balancing work and family in the public, private sectors and not for profit sectors; human resources and work–family issues in the small business sector; management support (What is it and why does it matter?); career development in the public sector and in the high-technology sector; and generational differences in work values. Dr. Duxbury has published widely in both the academic and practitioner literatures in the area of work–family conflict, change management, supportive work environments, stress, telework, the use and impact of office technology, managing the new workforce, labour force demographics, generational cohort and supportive management. Dr. Duxbury has received numerous awards for both her research and teaching.

## APPENDIX A: MEASURES OF VIRTUAL TEAM EFFECTIVENESS

### Measure of VT performance (Lurey & Raisinghani, 2001)

- 1 In the past, this VT has been effective in reaching its goals.
- 2 The VT is currently meeting its business objectives.
- 3 When the VT completes its work, it is generally on time.
- 4 When the VT completes its work, it is generally within the budget.

### Measure of VT satisfaction (Gladstein, 1984; Lurey & Raisinghani, 2001)

- 1 There is respect for individuals on my team.
- 2 I feel that my input is valued by the members of the team.
- 3 Team member morale is high in the team.
- 4 In the future, I would be interested in participating in another VT.

- 5 I enjoy being a member of this team.
- 6 All in all, I am satisfied with my experiences with this VT.

## APPENDIX B: SUMMARY OF MEASURE OF DEGREE OF VIRTUALITY

### Proportion of team work time spent working virtually

$$WV = \frac{\sum \text{hours members spent working virtually}}{\sum \text{hours members spent on team tasks}} \times 100\%$$

### Proportion of member virtuality

$$MV = \frac{\text{Number of different member locations}}{\text{Number of team members}} \times 100\%$$

### Degree of separation

DV =  $\Sigma$  members' distance scores\* from hypothetical meeting point

\*Distance scores are presented in Table 1.