The Influence of Virtuality on Social Network: A Multi-level Approach

Ayoung Suh[a], Kyung-shik Shin[b] and Min Soo Kim[c]

[a b] *Ewha Womans University, College of Business Administration 11-1*
Daehyun-Dong, Seodaemun-Gu, Seoul 120-750, Korea
irenes@ewhain.net ksshin@ewha.ac.kr

[c] *Hanyang University, School of Business 17*
Haengdang-Dong, Seongdong-Gu, Seoul, Korea
kimmin@hanyang.ac.kr

Abstract
Virtuality is a product of the information age, and as it plays a larger role in the activities of individuals, groups and organizations, the issue of how human behavior varies between virtual and physical space has become one of the most important questions facing the management environment of today. The purpose of this article is to examine how virtuality shapes individuals' social relationships within and outside their work groups. We developed a conceptual framework that explores the links between virtuality and social network based on computer-mediated communication theory and social network theory. Using data from 172 individuals of 42 project teams in 5 global business consulting firms, we tested cross-level hypotheses. The results of hierarchical linear modeling (HLM) indicate that virtuality significantly influences individual's internal tie strength as well as external bridging ties. The results also show the effects of virtual process via CMC vary along with the virtual context.

Keywords: Virtuality, Computer-mediated communication, Social network, Multi-level analysis

Introduction

As dispersed group collaboration becomes increasingly common and unavoidable for organizations, many practitioners and researchers have focused on the potential of virtual works to overcome the space and time constraints that plague face-to-face (FtF) meetings (DeSanctis and Monge, 1999). In recent times, organizations have attempted to virtualize their structure by organizing a variety of virtual work such as telecommuting, distributed teams, virtual teams, virtual communities, and virtual corporation. Now, the term 'virtuality (being virtual)' is a ubiquitous metaphor that characterizes modern organizations.

Yet despite a growing body of research in virtual work, research findings often have been inconsistent, and many questions remain unsolved. Some researchers argue that virtuality creates new value by overcoming the logistical constraints and leads to the higher level of organizational bond with the electronic communication which is convenient, fast, allows for dynamic communication, and supports boundary spanning communication (Hinds and Kiesler, 1995). On the other hand, other researchers argue that virtuality generates various managerial risks such as communicational depersonalization, process dissatisfaction, and low cohesion (Hilts & Turoff, 1985; Sproull & Kiesler, 1986; Kock, 2005; Javenpaa & Leidner, 1999; Griffith et al., 2003). Studies point out that virtuality may limit an organization's ability to build social capital such as organizational commitment, trust, and obligation. It is posited that the majority of potential risks of virtuality mainly stem from a lack of capacity for individual social relationships because it hinders interpersonal social interaction (Sproull and Kiesler, 1986; Kahai and Cooper, 1999).

In this context, understanding the nature and influences of virtuality on individual's social relationships is critical (Okoli and Oh, 2007; Sherif et al., 2006; Hoffman et al., 2005). The questions to be addressed here involve the role of virtuality in shaping individuals' social relationships within and outside a work group. More specifically, we ask: does virtuality decrease internal cohesion by reducing the strength of individual's social interaction ties? Otherwise, does virtuality increase connectivity among organizational members by enabling people to expand their social ties? In answering these questions, this present study aims to understand how virtuality influences individuals' social networking, which can produce diverse social capital. We expect that this investigation will provide group managers and communication system developers with a more realistic understanding of how to virtualize their organizational structure, and how to maximize the benefits of their virtual resources by combining various information communication technologies and group practices.

The current study goes beyond previous research in three ways. First, we clarify the index of virtuality and provide a complete picture of multi-dimensional virtuality. While many scholars indicate finding a common method of measuring virtuality as a high research priority, existing studies do not completely capture the whole facets of virtuality (Kirkman and Mathieu, 2005; Watson-Manheim et al, 2002; Chudoba et al, 2005). This is partly because that there has been little investigation of the different effects of virtual process and virtual context. After a comprehensive

literature review of a variety of virtual works, we distinguish virtuality as process from virtuality as context at two different levels, in order to delve into how each dimension of virtuality influences individuals' social relationships.

Second, this study intends to accurately assess social relationships among individuals by utilizing the social network analysis (SNA) method. Most previous studies dealing with human interaction through technologies have relied on individual perception in the form of self-reporting for evaluating the relationships that are formed among people in physical spaces. Such evaluation places many limitations on examining network structures and characteristics. In this study, diverse network properties including the strength of ties among individuals, the network size and the structural hole are examined using SNA. We believe that this social network approach will provide more insightful understanding on the dynamics between IT and human behavior.

Third, this study adopts a multi-level modeling and overcomes the limits of the unit of analysis shown in existing studies which limit their view into a single level of analysis. By including both group-level and individual-level variables within one research model, we can develop cross-level hypotheses and examine the interaction effect between two different level variables. We test our cross-level hypotheses using appropriate analytical techniques (i.e., Hierarchical Linear Modeling: HLM) in order to provide a more integrated understanding of phenomena that unfold across levels in an organization

Theoretical Background

Measuring Virtuality

Studies show that traditionally, work can only be considered virtual when all interactions were mediated by distance, with no work completed in face-to-face mode. In these studies, concepts of virtual organizations and virtual teams are defined only as cases of cooperation over the computer network where there is a complete absence of face-to-face meetings. However, this simple dichotomous distinction of collocated versus distributed teams often fail to capture the nuances of many real-life teams that communicate and coordinate through both face-to-face meeting and computer technology (Watson-Manheim et al., 2002; Chudoba et al., 2005). Furthermore, this limited view of have severely restricted the potential scope for empirical studies. For instance, most of the previous studies have depended on artificial lab experiments (e.g., Zack, 1991; Walther, 1995; Chidambaram, 1996), provided descriptive explanations confined to a small number of cases (e.g., Turoff et al., 1994), or have reduced the scope of a virtual work to being only a global virtual team (e..g, Javenpaa and Leidner, 1999).

However, scholars have recently paid attention to the fact that the boundary between traditional and virtual work forms is becoming increasingly vague. This is because most organizations today actively utilize computer-based media, allowing employees to escape from the confines of time and space. In other words, most organizations today incorporate certain levels of virtuality in their work process. This implies that the traditional organization that relies entirely on face-to-face interaction and cooperation taking place at a singular time and place hardly exists any longer (Griffith et al., 2003). Whereas initial studies understood virtuality as a concept apart from the traditional organization, recent studies focus on the fact that virtuality should be treated as a "matter of degree". Accordingly, how virtuality should be measured has become a very important issue, and there have been efforts in academia over the past decade to develop the concept of virtuality as well as the means of its measurement. So far, consensual criteria for measuring virtuality have not yet been determined. However, thanks to in-depth research on literature related to virtual cooperation, this study has been able to elicit two contrasting perspectives in defining virtuality. Each perspective on virtuality can be described as follows.

Group-level Virtuality (Virtuality as Context)

Group-level virtuality is an attempt to assess virtuality at group level. Discussions from this viewpoint mainly focus on how the structural characteristics of virtual teams and virtual organizations affect collective achievements. A study conducted by Griffith et al., (2003) provides a comprehensive framework for explaining virtuality as a contextual element at a collective level. This study intends to assess virtuality as context based on the virtuality index at the collective level proposed by Griffith et al. (2003). Virtuality as context can be assessed on the following criteria: (1) how members are physically distributed in terms of distance among them, (2) the degree of work being performed at different times, and (3) the level of technological support for cooperative work and communication among group members.

Individual-level Virtuality (Virtuality as Process)

The other view is understanding virtuality as a task execution process of an individual rather than within the context of a group. Such individual-level virtuality varies according to the degree which an individual relies on computer-based media for carrying out given tasks. In other words, although context at group level is applied equally to the members of a group, the level of virtuality can vary for each individual of the group. For example, even with very strong cooperation taking place with members gathered at a single geographic location, an individual who performs a significant portion of his work using computer-mediated communication has a high level of individual virtuality despite a low group-level virtuality.

Generally, a virtual process is conducive to the computer -mediated communication modalities including (1) personalized communication media such as email and instant messenger services and (2) communal media as a collaborative tool such as video/audio conferencing, bulletin boards, and groupware. Personal media and

communal media are partly overlapping in terms of functionality and utility. Both types of media provide additional capabilities for supporting enterprise-wide communications and collaborative work. However, the characteristics of each type of computer-mediated communication modality differs as to whether it provide communal space to communicate collectively such as brain storming, group decision-making, and group scheduling. This study examines individual-level virtuality in (1) the use of PCMC (Personal computer-mediated communication) and (2) the use of CCMC (communal computer-mediated communication).

Social Network

Sociologists highlight the enhancing effects of social networks on the ability of individuals and organizations to attain their goals (Gargiulo and Benassi, 2000). The essence of the social network theory is that it can effectively explain both the 'behavior' of individuals that belong to a network and how that network's 'structure' produces diverse social capital which is defined as relational resources, inheres in social relations and networks. Yet, theoretical polarization still exists in terms of view on how social network structure produces such benefits. The network mechanism explained by the social network theory can be classified into two major categories. These two perspectives can be summarized as follows.

The Closure Mechanism

Traditionally, social network theorists have stressed the role of strong social ties or cohesive ties (network closure) in fostering a normative environment that facilitates cooperation (Coleman, 1988). Normally, closure relationships are based on strong, dense, and cohesive network. This echoes Bourdieu (1986)'s previous argument that strong communities have identities that distinguishes members from nonmembers. Such strong and dense relations between community or group members engender a specific social capital in terms of internal cohesion. From the closure perspective, a stronger ties among group members result in greater cooperation, greater conformity to agreed upon norms, greater information sharing, and less tendency to engage in social loafing and opportunism, thereby leading better group performance (Reagan and Zuckerman, 2001; Yoo and Alavi, 2001).

The Brokerage Mechanism

Granovetter (1973, 1983, 1993) theorized the strength of weak ties in social organization. He defines weak ties as not emotionally intense, infrequent, and restricted to one narrow type of relationship. Such weak ties enable the focal individual to reach beyond their small, well defined social circle to make connections with parts of internal and external social structure (Gubbins and Garavan, 2005). Thus, weak ties often facilitate the development of a larger and more diverse network and provide access to nonredundant information, ideas and resources (Granovetter, 1973). Burt (1992) extended the concept of weak ties, and theorized the concept of structural hole. Structural hole means the gap between disconnected people. Structural holes broker the flow of information between people like an insulator in an electric circuit (Burt, 2000).While weak tie theory concentrates on the strength of social ties, structural hole theory addresses the brokerage opportunities created by disperse ties. The brokerage mechanism considers cohesive ties as a source of rigidity that hinders the coordination of complex organizational tasks (Gargiulo and Benassi, 2000). This brokerage mechanism highlights the bridging capability in the macro level of social network rather than a locally limited strong social interaction.

Some researchers consider these two mechanisms as conflicting each other (e.g., Gargiulo and Benassi 2000). However, we suggest these two mechanisms of social network do not conflict, but complement each other. Our view is consistent with the arguments of Adler and Kwon (2002), who conceptualize social network as being external and internal ties. Integrating the two mechanisms, we developed one single unified research model. Within the proposed model, we examine how virtuality influences internal closure as well as external bridging.

Research Model and Hypothesis

Integrating social network theory with CMC theory, this research model extends the previous research on the effect of IT on individual's social relationship. Specifically, the proposed model examines the direct effect of virtual process via electronic communication media on intra-group tie strength as well as extra-group network development. Furthermore, this model explores the moderating effect of group-level virtuality on the relationship between virtual process and individuals' social network properties within and outside a work group.

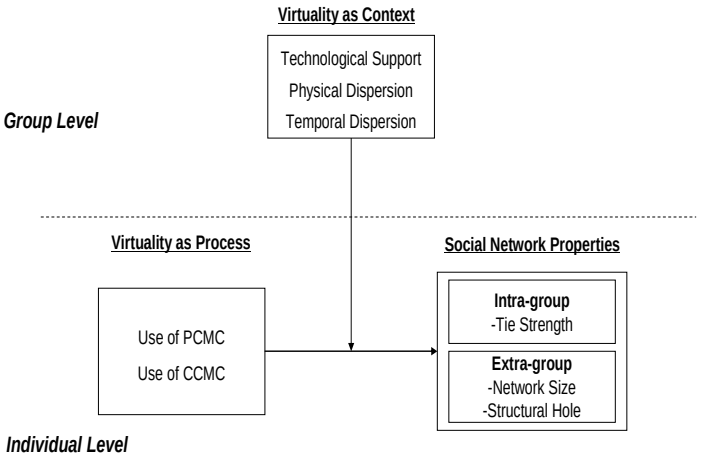

Figure 1 Research Model

Individual-level Virtuality and Internal Closure

Individual-level virtuality refers to the extent to which an individual completes his or her task in a virtual environment using communication technologies. An individual who has a higher degree of virtuality is more likely to prefer communicating via personalized media including e-mail and instant messaging, or communal media such as groupware and group decision support system, collaborative technologies to facilitate a collaboration process, such as idea generating, comprehensive decision making, and problem solving (Maznevski and Chudoba, 2000).

The dominant literature regarding the use of computer-mediated communication has traditionally viewed such communication as lean, having lower social presence, and relatively impersonal. More specifically, researchers have considered all kinds of computer-mediated communication system to be effective for task-oriented communication but not suitable for socio-emotional expression (Daft and Lengel, 1986; Short et al., 1976; Sproull and Kiesler, 1986). Consequently, they argue that virtual interaction hinders the development of a strong sense of cohesion and consequently reduces interpersonal tie strength within a work group (Hiltz et al., 1986; Warkentin et al., 1997; Kahai and Cooper, 1999). Further, it has been reported that more virtual interactions via CMC replete with a variety of boundaries adversely affects individual's level of closure relationships. Specifically, research suggests that boundary spanning activities via computer-mediated communication can decrease the group's internal tie strength (Keller, 2001). Thus, all else being equal, an individual who relies more on virtual interaction is less likely to have strong and cohesive social ties with other group members.

Hypothesis 1a: Use of PCMC is negatively related to an individual's intra-group tie strength
Hypothesis 1b: Use of CCMC is negatively related to an individual's intra-group tie strength

By contrast, there exists alternative theoretical perspective which complements and extends computer mediated communication theories by considering the effects of the social context (Markus, 1994; Wiesenfield et al., 1999). Social information processing theory, social identification theory, and hyperpersonal theory demonstrate that the computer-supported communication media are sometimes more effective in developing strong interpersonal ties (Walther, 1992; Walther et al., 1994; Warkentine et al., 1997). For example, text based electronic medium may break down perceived hierarchies and promote a feeling of equality and centrality (Walther, 1992; Wiesenfield et al., 1999). Indeed, some evidence has been reported that use of electronic medium facilitated communication frequency, and led to more close social interactions (Lee, 1984). Walther (1995) conducted a laboratory experiment to investigate the effect of text-based asynchronous CMC on person's interpersonal relations. According to Walther (1995) CMC users achieved more positive levels on several relational dimensions of interpersonal communication than did FtF groups. In the same vein, Chidambaram (1996) reported that the use of collaboration system positively affected group cohesiveness. Based on this discussion, we draw a rival hypothesis.

In the same line, use of collaboration tools such as groupware, group decision-making, voting, video/audio conferencing, or virtual simulation with limited time, instead of face-to-face meeting represents the reduced physical interaction between people. Many scholars depict the task effectiveness of collaboration tools in terms of overcoming human cognitive limitations and inducing a group consensus (e.g., Yoo and Alavi, 2001). Nevertheless, the lack of social presence, social context cues, and reduced media richness hinder communication richness and emotional closeness between people (Warkentin et al., 1997; Kahai and Cooper, 1999).

Rival Hypothesis 1a: Use of PCMC is positively related to an individual's intra-group tie strength
Rival Hypothesis 1b: Use of CCMC is positively related to an individual's intra-group tie strength

Individual-level Virtuality and External Bridging

Media theorists argue that well-connected electronic networks may build a broad range of social networks that extend far beyond the local area. This is because such electronic connectivity provides individuals more opportunities to communicate with people in an online network regardless of time and place restrictions. Along the same line, personal electronic mediums that enable diverse people to connect electronically, are oriented toward instrumental relationships rather than closed strong ties (Pickering and King, 1995; Constant et al., 1996). These personal electronic media do not restrict their connectivity to a locally limited work group; rather expand their connectivity outside work group. Accordingly, through their ability to enable rapid switching from one relationship to another, are more capable of addressing sparser networks (Wellman et al., 1996; Wellman and Gulia, 1999; Shapiro et al., 2002). Thus, the higher degree of virtual process generally leads to an increase relational links between individuals, and these relational links span the individual's boundary (Dixon and Panteli, 2007).

This discussion casts the same light on some of the arguments of social network theorists; increased connectivity via personal electronic mediums lead to increased weak ties (Pickering and King, 1995; Constant et al., 1996) in a social network. This implies that more virtual work structure replete with a variety of partial relationships affects individual's broad and nonredundant network (e.g., an individual could effectively span the range of social ties with well connected technological infrastructure). In particular, electronic communication is convenient, fast, allows for dynamic communication, and provides broad access to other members in an organization. Hinds and Kiesler (1995) also predict that computer-mediated communication will play a key role in supporting boundary spanning communication. Therefore we can infer that as

individuals have more virtual interaction via technology mediated communication, they are likely to achieve broader and more diverse relationships.

Hypothesis 2a: An individual's level of use of PCMC is positively related to their extra-group network size.
Hypothesis 2b: An individual's level of use of PCMC is positively related to their extra-group network structural hole.

The Moderating Effect of Group-level Virtuality

Group-level virtuality refers to the extent to which group members work in different location and different time zones with technological support. We consider group-level virtuality as contextual factors by which an individual's work processes and interactions are shaped. The group represents a social system embodying certain networking-related norms, directly and indirectly affecting the individual's networking behaviors (Hoegl et al., 2003; Levin and Moreland, 1990). In this vein, the degree of group-level vituality such as technological support, physical dispersion, and temporal dispersion may increase or decrease the extent to which group members have social ties with other people within and outside the group. For example, we can infer that a person's intra-group tie strength will be far more decreased if group members work at different locations and across different time zones with less FtF internaction.
Conversely, group-level virtuality may provide individuals with more opportunities to build non-redundant and broader ranges of social ties, thereby fostering interactions across other groups. In other words, group-level virtuality (e.g., physical and temporal dispersion, technological support) may foster the group members' ability to enable rapid switching from one relationship to another. Thus, individuals who belong to a more virtual context may be more capable of addressing sparser networks. The point is that individual-level virtuality is contingent to the degree of group-level virtual context. Therefore, we can infer that group-level virtuality has a moderating effect between individual-level virtuality, process via different electronic communication media on the individual social networking within and outside a workgroup.

Hypothesis 3: The effect of individual-level virtuality on intra-group tie strength will vary along with the group-level virtuality.
Hypothesis 4: The effect of individual-level virtuality on extra-group size and structural hole will vary along with the group-level virtuality

Sampling and Data Collections

We collected data from global business consulting firms in Korea. Since our study addresses virtuality, we needed to collect data from organizations whose structures and work processes are more virtual. In general, business consulting firms operate based on projects, and their employees (namely, business consultants) are often physically and temporally dispersed. Thus, we conclude that consulting firms suit our research purposes. We chose 5 global consulting firms in Korea for our survey. Pre-testing was conducted with 10 consultants and 2 executives in 2 global consulting firms. The pre-test respondents were asked to evaluate the relevance of the questionnaire items related to each variable in the study. After modifying the questionnaire based on pre-testing feedback, we first contacted high-level executives at 5 business consulting firms and asked them to participate in our study. Then we received 3~5 rosters of project teams from each of them. Project managers were requested to urge their team members to participate in our survey, and distribute the assigned questionnaires to them.
For this study, 270 people were requested to fill out a questionnaire regarding their work environment and their friendly relations with both team members and others. To facilitate this, the partners in charge of each business unit were given basic information about the nature of our research.
A total of 211 surveys were collected. The response rate of the individuals surveyed was 78%. For the social network analysis, at least 80% of team members should asked to the questionnaires. Otherwise the data from teams with response rates under 80% should be discarded. We discarded 39 questionnaires because they had a less than 80% response rate within their groups. 172 individuals and 42 project teams were used in the final analysis. The average response rate of teams was 81.5%.
Here, we should comment briefly on sample size. Based on hierarchical linear modeling research in educational settings, Snijders and Bosker (1999) suggested the rule of thumb should be a minimum of 30 groups for hierarchical linear modeling. In this regard, our sample size is acceptable.
Respondents' ages ranged from 25 to 47 years (M= 34.32 years, SD = 4.08). There were 33 women and 139 men. Job tenures ranged from 1 years to 23 years (M=7.10, SD = 4.493). Number of project team members ranged from 3 to 10 members (M= 4.71, SD = 1.6). Since project team is normally composed at need-base, the project tenure is equal to team tenure. Project tenure ranged from 1 month to 16 months (M=6.95, SD = 3.55).

Measures

Independent Variables

Measurement items were developed based on the definition provided by previous literature. All dimensions of individual-level virtuality were measured using a five-point Likert scale. Group-level technological support and temporal dispersion were also measured using five-point Likert sacle (1=strongly disagree, 5= strongly agree), while group-level physical dispersion was measured using socio-metric technique and derived numerical value from 0~1. We asked every group members "how often did you work at the same place with each of other members during the project?" Operational definition and each questionnaire

items are provided in Table 1.

Table 1 Operational Definition of Independent Variables

Level of Construct	Construct	Operational Definition	References
Group Level	**Technological Support**	The extent to which technological infrastructures support the team's communication, task and social interaction	DeSanctise et al. (2004) Chudoba et al. (2005)
	Physical Dispersion	The extent to which group members distributed over different geographical areas	Griffith (2003) Chudoba et al (2005)
	Temporal Dispersion	The extent to which group members work across different time zones	Hass and Wellman (2004)
Individual Level	**Use of PCMC** (Personalized Computer-mediated Communication)	The degree of individual's disposition to rely on personal electronic media (e.g. instant messaging, e-mail)	Watson-Manheim (1999)
	Use of CCMC (Communal Computer-mediated Communication)	The degree of use of communal media such we GSS, groupware and other collaboration tools for idea generation, problem solving, making group decision	Maznevski and Chudoba, (2000)

Dependent Variables

To measure intra-group tie strength, we asked "To what extent did you go out with this person for social activities outside work such as going out to informal lunch, dinner, or drinks" (Burt, 1992, p. 123). These network data were valued on a five-point scale ranging from "not at all" (1) to "very much" (5). We constructed matrices that represented all of the informal socializing relationships among members of each group. Next, intra-group tie strength was calculated by the average value of frequency of interaction with other group members.

To drive the numerical indices for extra-group network size and structural holes in each ego's network, we adopted the procedure of the Burt's work (1992). Network size refers to the number of contacts in an ego's network. As a measure of structural hole, we use a network constraint index, which describes the extent to which a person's network is concentrated in redundant contacts. The author argues that "more constraint means fewer structural holes and, so, less social capital (Burt, 1997, p. 347)." Thus, the high degree of network constraint means less structural hole (Burt, 1992). The index of network constrain begins with a measure of the extent to which all of manager i's network is directly or indirectly invested in his or her relationship with contact j (Burt, 1997, p.347).

$$\text{Constraint}_{ij} = (P_{ij} + \Sigma_q p_{iq} p_{qi})^2 \text{ , } q \neq i, j$$

where, p_{ij} = The proportion of *i*'s relations invested in contact *j*.

$\Sigma_q p_{iq} p_{qi}$ = The proportion of *i*'s relation invested in contact *q* who are in turn invested in contact *j*.

Control Variables

There are several other characteristics of the individual and its context that have been or may be shown to influence individual social network. While it is not possible to include all these variables in this study, we did control for individual's gender, age, and tenure that have been suggested to affect individual's social network. In the group level, we controlled for (1) the group size, and (2) group-level past work experience. The group size means the number of group members, and past work experience refers to the extent to which group members have experience work together each other in the past. Existing research demonstrates these can affect intra-group processes and network structure (Bettenhausen, 1991).

Validity of the Instruments

Since all most of the independent variables were measured by multiple items, a factor analysis was conducted to check the uni-dimensionality of the items. To test for the construct validity of the virtuality, a principle axis factoring analysis was conducted with direct oblimin. As we expected, the individual-level virtuality variables yield four distinct factors: use of PCMC, use of CCMC, temporal dispersion, and technology support. All items were loaded on each distinct factor as expected, and factor loadings for all items were greater than .600. Eigen values of the four factors were 3.967, 1.877, 1.242, and 1.010 respectively. These

four factors explained 67.463 percent of the total variance. The four factors emerged with no-cross construct loadings above 0.500, indicating the satisfactory level of discriminant validity. This instrument also demonstrated high convergent validity with all factors loading exceeding .700. These results imply that each of the constructs in our study is uni-dimensional and all items used to operationalize a construct are loaded onto a single factor. Table 2 shows the results of factor analysis

Table 2 Factor Analysis Results for Virtuality

Scale Items	Factor 1	Factor 2	Factor 3	Factor 4
TECHSP1	.940	.0220	.260	.444
TECHSP2	.905	.098	.313	.468
TECHSP3	.841	.106	.360	.440
APARTON1	.112	.866	.275	.156
APARTON2	.069	.815	.116	.101
APARTON3	.015	.719	.140	.056
RELIACMC1	.336	.117	.783	.215
RELIACMC2	.269	.096	.770	.222
RELIACMC3	.135	.207	.527	.115
USCOL1	.387	.106	.222	.931
USCOL2	.419	.156	.273	.852
USCOL3	.526	.053	.144	.784
Eigen Value	3.967	1.877	1.242	1.010
Percentage of Variance	33.057	15.639	10.353	8.414
Cummulative Percentage	33.057	48.696	59.049	67.463

The means, standard deviations, and Chronbach's alpha values of all the research variables are given in Table 3. The Chronbach's alpha values are generally acceptable; for the overall sample, all the values were well above 0.7, which is considered satisfactory for new measures. Two items of original sales were discarded due to the low-level reliability. Other variables such as physical dispersion, intra-group tie strength, extra group network size and structural hole did not included in Table 3, since these variables were measured using socio-metric technique. We induce the single network value ranged from 0~1.

Table 3 The Research Variables and Cronbach's alpha

Variables	Mean	S. D.	Cronbach's alpha	No. of Items (Orig.)
Technical Support	3.506	1.037	0.922	3 (4)
Temporal Dispersic	2.520	1.071	0.826	3
Use of PCMC	3.793	1.250	0.732	3
Use of CCMC	2.864	1.086	0.882	3 (4)

For group-level technological support and temporal dispersion, we aggregated individual response to the group level and used the mean to represent the collective interpretation. Since we conceptualized group-level variables as shared constructs, individual items should be aggregated only when individual judgments coincide (Hoffman, 1996). To determine whether they can be aggregated to the group level, interrater agreement was estimated using two indices: within group agreement (r_{wg}) and intraclass correlation (ICC). Following James et al.'s recommendations, the expected variance term used was a uniform distribution. Second, we computed two intraclass correlation statistics; ICC (1) represents a ratio of the between group variance (i.e., percentage of the total variance residing between groups). ICC (2) reflects the reliability of group mean value. According to Kozlowski and Klein (2000), all indices of r_{wg}, ICC(1), and ICC(2) for group-level variables in our study indicated acceptable agreement because r_{wg} was greater than .70 and because ICC (1) and ICC (2) was close to .30 and .70 respectively.

Analysis and Results

Multi-level Modeling

The general concept of multi-level modeling is that individuals interact with the social contexts to which they belong, and that the properties of those groups are in turn influenced by the individuals who make up that group (Hox, 2002). Generally, the individuals and the social groups are conceptualized as a hierarchical system, and defined at separate levels of this hierarchical system. Naturally, such systems can be observed at different hierarchical levels, and variables may be defined at each level. However, a single-level perspective can adequately account for organizational behavior. This leads to research into the interaction between variables characterizing individuals and variables characterizing groups.

Hierarchical Linear Modeling (HLM), a statistical technique, is gaining increased acceptance in the management literature (Hox, 2002). A main advantage of HLM is that it allows the examination of relationships at different levels while maintaining the appropriate level of analysis (Hoffman, 1996). Specifically, HLM explicitly models both individual and group-level residuals (unlike ordinary leas squares analysis). HLM acknowledges that individuals within one group may be similar to one another than to individuals in other groups (Bryk and Raudenbush, 1992).

The use of HLM requires a distinction between individual-level variables and other higher levels. Therefore, HLM is very useful when researchers want to test the effects of group properties both on team and individual level variables. Followings are an example of multi-level modeling.

Level 1 Model

Because individual's network building is the dependent variable of interest in the first part of this research, we denote network properties (i.e. intra-group tie strength, extra-group network size and structural hole) of a person *i*

in team *j* as $Y_{ij..}$ The following equation of level 1 predicts the individual-level network properties, where β_{0j} represents the mean level of individual-level intra-group tie strength, network size and structural hole, and the term γ_{ij} represents the residual within-group variance.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Use of PCMC}) + \beta_{2j}(\text{Use of CCMC}) + \gamma_{ij}$$

Level 2 Model

After the formulation of the level 1 model, it is necessary to construct a level 2 model. The level 2 model explains the impact of the team-level virtuality on the mean level of individual's network properties on each team. Consistent with HLM procedures, the individual effects, represented by the micro-level coefficient β, are presumed to vary across teams. Therefore, a between-team or macro-level model can be formulated where β are conceived as outcome variables that depend on a set of a team-level variables. Formally, the macro-level model is formulated as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Technology Support}) + \gamma_{02}(\text{Physical Dispersion}) + \gamma_{03}(\text{Temporal Dispersion}) + \mu_{0j}$$

In summary, at level 1, the "micro-level model," the units are individuals and each person's outcomes are represented as a function of a set of individual characteristics. The parameters (intercept and slope) explaining the relationships at level 1 become the dependent variables for the level 2 model. The level 2 model is an "intercept-as outcome model" with level 1 covariates. Slope-as-outcomes models address the issue of whether the context moderates the relationships between the individual-level predictors and the dependent variables (Hoegl et al., 2003).

The hypotheses of the present research require testing the cross-level effects; both group-level properties (i.e., technological support, physical dispersion, and temporal dispersion) and individual-level network properties (intra-group tie strength, extra-group network size and structural hole). To perform these analyses, we used an analytical technique which is capable of using data from both levels of analysis, hierarchical linear modeling (HLM). HLM allows researchers to analyze data from two or more levels of analysis while accounting for the nonindependence in observations that the nested structure of multilevel data tends to produce (Klein et al., 1994).

We followed Hox's (2002) suggestions for testing individual-and group-level data with hierarchical linear modeling. He suggests a process that begins by computing deviance for a baseline model of the dependent variable that includes only a random intercept to determine whether there is significant between-group variability. Following Hox's suggestion, we began using a null model (baseline model), examining whether groups varied significantly in average of individual's network properties (Hoffman and Gavin, 1998). The percentage of total variance that resides between groups was significant for intra-group tie-strength (ICC=0.601). We can say that 60.1 of the total variance in the intra-group tie strength is accounted for by differences between group members tie strength on average. However, ICC of extra-group network properties (network size and structural hole) is close to zero. It means that there is no significant difference between groups. Some argue that Multi-level modeling is not necessary if ICC is sufficiently close to zero, as this implies that level-1 units are statistically independent. However, just how close to zero is "sufficiently close" depends on a number of things, and there are benefits to the use of multi-level modeling even when the ICC is near zero (Hayes, 2006).

Intra-group Tie Strength

Table 4 shows the results of hierarchical linear modeling analysis on intra-group tie strength. We controlled gender and job tenure at the individual-level. Our results show that gender and job tenure do not influence tie strength within a group. At the group level, we controlled the past work experience and group size. The results show that past work experience has positive influence intra-group tie strength while the group size has no influence on tie strength.

Hypotheses 1a and 1b address the relationship between individual-level virtuality and individual's intra-group tie strength. The results show that use of CCMC (communal computer-mediated communication) positively influence the individual's intra-group ties strength ($\gamma 40 = .086$, SE = .048, $p < .1$). However, use of PCMC (personalized computer-mediated communication) does not influence intra-group tie strength. Accordingly the rival hypothesis 1a was supported.

Even though use of PCMC does not have direct influence on intra-group tie strength, as shown in the cross level section, the effect of use of PCMC on intra-group tie strength is significantly moderated by group-level virtuality (physical dispersion) supporting hypothesis 3. Figure2 shows that every group has different slope which represents the relationship between personal reliance on CMC and intra-group tie strength. Figure3 demonstrates that the effect of use of PCMC is positive when the degree of physical dispersion is high. By contrast, the figure shows that use of PCMC negatively affects intra-group tie strength, when the degree of physical dispersion is low.

Extra-group Network Size

The results show that job tenure, as a control variable, significantly influence individual's extra-group network size while gender has no influence on them. Hypothesis 2a addresses the relationship between individual-level virtuality and extra-group network size. As we expected, use of PCMC positively influenced on individual's network expanding in terms of extra-group network size ($\gamma 30 = .750$, S.E. = .312, $p<.05$) supporting hypothesis 2a. On the other hand, the use of PCMC on extra-group network size is significantly moderated by group-level technological support ($\gamma 33 = .747$, S.E. = .425 $p< .05$). The results also show that use of CCMC does not influence individual's

extra-group network size, which was moderated by the degree of group-level temporal dispersion (γ45 = -.763, S.E. = .418, p< .1). This demonstrates that the use of CCMC decrease individual's extra-group network size when the group members work across different time zones. This implies that a person's extra-group network size decreased when the overall degree of virtuality was too high (high degree of virtuality at the both levels).

Extra-group Structural Hole

The use of PCMC positively influenced on individual's external bridging ties in terms of extra-group structural hole (γ30 = .055, S.E. = .024, p<.05) supporting hypothesis 2b. The influence of the use of PCMC on extra-group structural hole was moderated by group-level technological support (γ33 = .076, S.E. = .035 p< .05). While the degree of the use of CCMC does not influence individual's extra-group structural hole, it was moderate by the degree of group-level temporal dispersion (γ45 = -.085, S.E. = .041, p< .05). This demonstrates that the use of CCMC decrease individual's extra-group structural hole when the group members work across different time zones. The results partly support the hypothesis 4.

Table 4 The Results of Hierarchical Linear Modeling Analysis

				Intra-group Tie Strength		**Extra-group Network Size**		**Extra-group Structural Hole**	
		Fixed Effect		Coef.	SE	Coef.	SE	Coef.	SE
Individual Level		INTRCPT	γ_{00}	**3.630*** **	0.076	**5.194*** **	0.211	**0.407*** **	0.020
	Control Varaibles	Gender	γ_{10}	-0.200	0.105	0.491	0.549	0.033	0.059
		Tenure	γ_{20}	0.005	0.017	**-0.112***	0.065	**-0.009** **	0.006
		Use of PCMC	γ_{30}	-0.012	0.054	**0.750** **	0.312	**0.055** **	0.024
		Use of CCMC	γ_{40}	**0.086***	0.048	0.098	0.236	-0.001	0.017
Group Level	**Control Varaibles**	Past Work Experience	γ_{01}	**0.565** **	0.231	1.510	0.622	0.154	0.051
		Group Size	γ_{02}	-0.043	0.040	-0.083	0.096	0.002	0.011
		Technological Support	γ_{03}	0.019	0.122	-0.334	0.309	-0.031	0.027
		Physical Disperison	γ_{04}	**-0.842** **	0.327	0.623	0.890	0.031	0.088
		Temporal Disperison	γ_{05}	-0.118	0.133	-0.198	0.357	0.024	0.036
Cross Level		Use of PCMC							
		x Technological Support	γ_{33}	0.060	0.104	**0.747** **	0.425	**0.076** **	0.035
		x Physical Dispersion	γ_{34}	**0.707** **	0.294	0.714	1.795	-0.107	0.130
		x Temporal Disperison	γ_{35}	0.017	0.122	0.598	0.611	0.084	0.045
		Use of CCMC							
		x Technological Support	γ_{43}	-0.002	0.101	0.102	0.278	0.001	0.020
		x Physical Dispersion	γ_{44}	-0.013	0.280	0.616	1.150	0.100	0.072
		x Temporal Disperison	γ_{45}	-0.016	0.134	**-0.763***	0.418	**-0.085** **	0.041

* p< .1; ** p< .05; *** p<.01

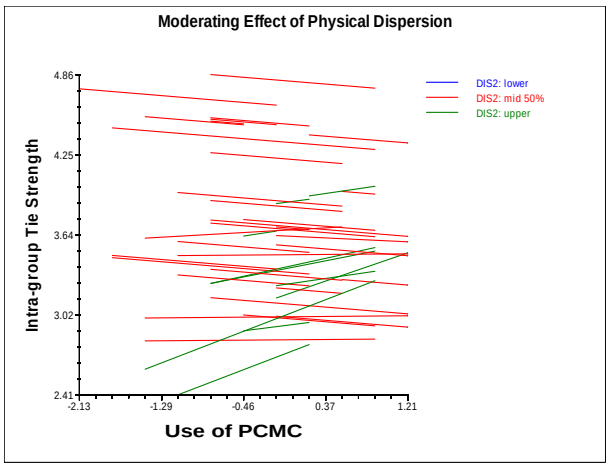

Figure 2 The Moderating Effect of Physical Dispersion (All groups)

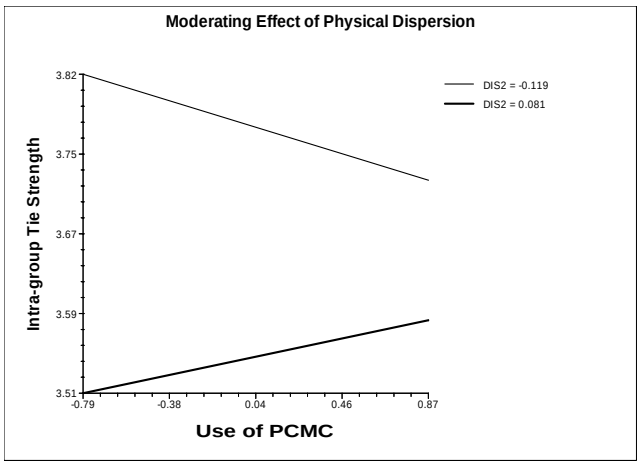

Figure 3 The Moderating Effect of Physical Dispersion (High/Low Groups)

Limitations

Before discussing the implications of our findings, we note that our findings must be interpreted in light of the studies' limitations. First, we measured intra-group tie strength by frequency of contact. The present study did not include emotional closeness as a measure of tie strength. Although it has been reported that frequency and closeness are highly correlated (Hansen, 1999), including emotional closeness among group members would provide a more comprehensive understanding of the relationship between virtuality and social networks. Second, we collected data from global business consulting firms. Business consulting firms are known as highly knowledge intensive organizations and are unique in that they are moving toward a more virtual structure. Although these samples are adequate for our study and provide valuable insight for future organization, the results of this study should be cautiously interpreted.

Discussion and Implications

Our results lend further support to the results of previous research which have found that the electronic communication plays a key role in maintaining social relationships among people. The present research extends these findings into the arena of computer-mediated communication as well as social network. Traditionally, CMC has been considered as an inferior medium since it is inappropriate for information exchanges when messages are complex and equivocal (Daft and Lengel, 1986; Daft et al., 1987). However, some other theories have called this argument into question. Social information processing theory (SIP) argues that medium does not matter to develop social ties, but other social factor influence the effect of communication medium (Walther, 1992; Warkentin et al., 1997). Both of these contradictory arguments still leave critical gap between theory and reality. Our findings support SIP theory in that people can develop close social relationship via electronic communication media. However our findings do not fully support the SIP theory in that use of personal media decreases individual's intra-group tie strength when the level of physical dispersion is low. Furthermore, we add empirical implication in that the use of personal medium has significant influence a person's social network development in terms of external bridging ties.

One of the most interesting findings of this study is the moderating effect of group-level virtuality. Use of PCMC positively influenced intra-group tie strength when group members were highly geographically dispersed. However, PCMC negatively affected intra-group tie strength when group members work together at the same place. In addition, our results substantiated the idea that PCMC far more positively influences individuals' extra-group networking in terms of network size and structural holes when the degree of group-level technological support is high. Based on the results, our study argues that virtuality provides new and alternative ways for communication in that it facilitates internal closure (i.e., intra-group tie strength) as well as external bridging (i.e., extra-group network size and structural holes). With this finding, we can also argue that virtuality can be seen as a social-capital building enabler for two reasons. First, members of existing social networks can take advantage of the information distribution aspects of networks to become more effective and connected communicators. Second, a more lateral and flexible structure can facilitate partial and multiple relationships, and it leads to increased brokerage capability by expanding external networks outside locally limited work groups.

Academic Implications

The academic significance of this study is that it is the first empirical study to analyze the effects of information technology on human relationships from the hybrid perspective of social networks. Although a number of studies have investigated the effects of information technology on the field of MIS, there have been insufficient empirical approaches to how information technology influences various individual behaviors. For these reasons, this study has redefined the concept of virtuality and combined the previously separate strands of computer-mediated media theory with social network theory. The significance of this study therefore lies in the fact that it proposes a theoretical foundation regarding human interaction in the technology-mediated virtual environment and the effects of this environment on social relationships in the physical world.

Second, microscopic phenomena within an organization have frequently been used as dependent variables in studies on social networks. In other words, whereas social network theory has focused on the benefits created by the network, there has been hardly any study of antecedent variables of the network. By validating the statement 'Interactions in virtual space through electronic media changes the behavior and structure of personal networks', this study has contributed to the development of social network theory in that it provides antecedent elements for forming social networks.

Practical Implications

This study explains how different types of computer-mediated communication media can be utilized to strengthen the internal ties of a work group and to increase external bridging. Moreover, the effectiveness of each medium was analyzed according to the chronological and physical distances between team members. This was done to provide strategies for utilizing computer-mediated communication media based on circumstances surrounding the work group. This study also provides a practical suggestion as to how a virtual team should be composed so as to better promote virtual interaction to produce more social capital. This study has suggested elements for maximizing social capital such as internal cohesion and the brokerage capability from the outside. Furthermore, this study has provided strategic implications for composing a

virtual group that strengthen unity from the macroscopic perspective at not only unofficial policy levels, but also official ones and increase accessibility to resources. Already, a recent corporate trend has been the active implementation of integral communication systems to support social networks within companies. In the future therefore, taking advantage of virtuality to maximize social capital by bringing internal cohesion based on strong ties and increasing external bridging based on weak ties will not be limited to the operation of virtual teams. As organizational flexibility is emphasized and interaction in virtual space becomes more commonplace, organizational support and interest will be essential for implementation and utilization of communication systems that support virtual collaboration.

Conclusion

Over the past decade, interest in human behavior in virtual worlds has increased rapidly among both academics and the public. Diverse virtual works raise challenges for managing employees' social interaction ties. The very technologies that offer individuals the freedom to work anytime and anywhere also detract from establishing or maintaining close social relationships. Consequently, there is a danger that the social capital which produces implicit benefits such as group cohesion, trust, and commitment may decrease. Our results suggest that managers in virtual organizations should monitor the communication media used. Specifically, the virtual process (e.g., personal electronic communication and use of collaboration tools) is more determinant of social ties both in and outside the group. Thus, IS managers or system developers should reconcile the balance between virtuality as process (e.g., individual-level virtuality) and virtuality as context (e.g., group-level virtuality).

References

Adler, P. and Kwon, S. "Social Capital: Prospects for a New Concept," Academy of Management Review (27:1), 2002, pp. 17-40.

Bettenhausen, K. L. "Five Years of Group Research: What Have We Learned and What Needs to be Addressed," Journal of Management (17:2), 1991, pp. 345-381.

Blau, P. M. Exchange and Power in Social Life, Wiley, New York, 1964.

Bourdieu, P. The Forms of Capital, In Richardson, J. (Ed.), Handbook of Theory and Research for the Sociology of Education, New York: Greenwood, 1986.

Burt, R. S. Structural Holes: The Social Structure of Competition, Cambridge, Harvard University Press, MA, 1992.

Chidambaram, L. "Relational Development in Computer-Supported Groups," MIS Quarterly (20:2), Jun 1996, pp. 143-165.

Chudoba, K. M., Wynn, E., Lu, M., and Manheim, M. B. "How virtual are we? Measuring Virtuality and Understanding its Impact in a Global Organization," Information Systems Journal (15), 2005, pp. 279-306.

Coleman, J. S. "Social Capital in the Creation of Human Capital," American Journal of Sociology (94), 1988, pp. 95-120.

Constant, D., Sproull, L., and Kiesler, S. "The Kindness of Strangers: The Usefulness of Electronic Weak Ties for Technical Advice," Organization Science (7:2), 1996, pp. 119-135.

Daft, R., and Lengel, R. "Organizational Information Requirements, Media Richness and Structural Design," Management Science (32), 1986, pp. 554-571.

Daft, R., Lengel, R., and Trevino, L. "Message Equivocality, Media Selection and Manager Performance: Implications for Information Systems," MIS Quarterly (17) 1987, pp. 355-366.

DeSanctis G., and Jackson, B. "Coordination of Information Technology Management: Team-based structures and Computer-based Communication Systems," Journal of Management Information Systems (10:4), 1994, pp. 85-110.

DeSanctis, G., and Monge, P. "Introduction to the Special Issue: Communication Process for Virtual Organizations," Organization Science (10:6), 1999, pp. 693-703.

Gargiulo M., and Benassi, M. "Trapped in Your Own Net? Network Cohesion, Structural Holes, and the Adaptation of Social Capital" Organization Science (11:2), 2000, pp. 183-196.

Granovetter, M. "The strength of Weak Ties," American Journal of Sociology (78:6), 1973, pp. 1360-1380.

Granovetter, M. "The Strength of Weak Ties: A Network Theory Revisited," Sociology Theory (1), 1983, pp. 201-233.

Granovetter, M. "Economic Action and Social Structure: The Problem of Embededness" American Journal of Sociology (91), 1993, pp. 481-510.

Griffith, T., Sawyer, J. E., and Neal, M. "Virtualness and Knowledge in Teams: Managing the Love Triangle of Organizations, Individuals, and Information Technology," MIS Quarterly (27:2), 2003, pp. 265-287.

Gubbins, M. C., and Gravan, T. N. "Studying HRD Practitioners: A Social Capital Model," Human Resource Development (4:2), 2005, pp. 189-218.

Hansen, M. T. "The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge across Organization Subunits," Administrative Science Quarterly (44), 1999, pp. 82-111.

Hayes, A. F. "A primer on Multilevel Modeling," Human Communication Research (32), 2006, pp. 385-410.

Hiltz, S. R., Johnson, K., and Turoff, M. "Experiments in Group Decision Making: Communication Process and Outcome in Face-to-Face Versus Computerized Conferences," Human Communication Research (13: 2), 1986, pp. 225-252.

Hinds, P., and Kiesler, S. "Communication across Boundaries Work, Structure, and Use of Communication Technologies in a Large Organization," Organization Science (6:4), 1995, pp. 373-393.

Hoffman, D. A. "An Overview of the Logic and Rationale of Hierarchical Linear Models," Journal of Management (23), 1996, pp. 723-744.

Hoffman, D. A., and Gavin, M. B. "Centering Decisions in Hierarchical Linear Models: Implication for Research in Organizations," Journal of Management (24), 1998, pp. 623-641.

Hoffman, J. J., Hoelscher, M. L., and Sherif, K., "Social Capital, Knowledge Management, and Sustained Superior Performance," Journal of Knowledge Management (9:3), 2005, pp. 93-100.

Hoegl, M., Parboteeah, K., and Munson, C. "Team-Level Antecedents of Individuals' Knowledge Networks," Decision Science (34:4), 2003, pp. 741-770.

Hox, J. Multilevel Analysis: Techniques and Application, Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, London, 2002.

Javenpaa, S. L., and Leidner, D. E. "Communication and Trust in Global Virtual Team," Organization Science (10:6), 1999, pp. 791-815.

Kahai, S., and Cooper, R. B. "The Effect of Computer-mediated Communication on Agreement and Acceptance," Journal of Management Information Systems (16:1), 1999, pp. 165-188.

King, R., and Xia, W. "Media Appropriateness: Effects of Experience on Communication Media Choice," Decision Science (28:4), 1997, pp. 877-910.

Kirkman, B. L., and Mathieu, J. "The Dimensions and Antecedents of Team Virtuality," Journal of Management (31:5), 2005, pp. 700-715.

Klein, K. J., Dansereau, F., and Hall, R. J. "Levels Issues in Theory Development, Data Collection, and Analysis," Academy of Management Review (19), 1994, pp. 195-229.

Kock, N. "Media Richness or Media Naturalness? The Evolution of Our Biological Communication Apparatus and Its Influence on Our Behavior toward E-Communication Tools," IEEE Transaction on Professional Communication (48:2), 2005, pp. 117-130.

Kozlowski, S. W. J. and Klein, K. J. A multilevel Approach to Theory and Research in Organizations: Contextual, Temporal, and Emergence Processes, In K. K. Klein & S. Kozlowski (Eds.) San Francisco: Jossey-Bass, 2000.

Lee, A. S. "Electronic Mail as a Medium for Rich Communication: An Empirical Investigation Using Hermeneutic Interpretation," MIS Quarterly (18:2), 1994, pp. 143-157.

Levine, J. M., and Moreland, R. L. "Progress in Small Group Research," Annual Review of Psychology (41), 1990, pp. 585-634.

Markus, M. L. "Electronic Mail as the Medium of Managerial Choice," Organization Science (5), 1994, pp. 502-527.

Maznevski, M. L. and Chudoba, K. M. "Bridging Space Over Time: Global Virtual Team Dynamics and Effectiveness," Organization Science (11:5), 2000, pp. 473-492.

Okoli, C., and Oh, W. "Investigating Recognition-based Performance in an Open Content Community: A Social Capital Perspective," Information and Management (44:3), 2007, pp. 240-252.

Pickering, J. M., and King, L., "Hardwiring Weak Ties: Interorganizational Computer Mediated Communication, Occupational Communities and Organizational Change," Organization Science (6), 1995, pp. 479-504.

Reagans, R., and Zuckerman, E. "Network, Diversity, and Productivity: The Social Capital of Corporate R&D Teams," Organization Science (12:4), 2001, pp. 502-517.

Shapiro, D. L., Furst S. A., Spreitzer, G. M., and Von Glinow, M. A. "Traditional Teams in the Electronic Age: Are Team Identity and High Performance at Risk?" Journal of Organizational Behavior (23), 2002, pp. 455-467.

Sherif, K., Hoffman, J., and Thomas, B. "Can Technology Build Organizational Social Capital?: The Case of a Global IT Consulting Firm," Information and Management (43), 2006, pp. 795-804.

Short, J., Williams, E., and Christie, B. The social psychology of telecommunications, John Wiley & Sons, Ltd., London, 1976.

Sproull, L., and Kiesler, S. B. "Reducing Social Context Cues: Electronic Mail in Organizational Communication," Management Science (32:11), 1986, pp. 1492-1512.

Yoo, Y., and Alavi, M. "Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus," MIS Quarterly (25:3), 2001, pp. 371-390.

Walther, J. B. "Relational Aspects of Computer-mediated Communication: Experimental Observations over Time." Organization Science (6:2), 1995, pp. 186-203.

Warkentin, M. E., Sayeed, L., and Hightower, R. "Virtual Teams versus Face-to-Face Teams: An Exploratory Study of a Web-based Conference System," Decision Science (28: 4), 1997, pp. 975-996.

Watson-Manheim, M. B., Chudoba, K. M., and Crowston, K. "Discontinuities and Continuities: a New Way to Understand Virtual Work," Information Technology & People (25:3), 2002, pp. 191-209.

Wellman, B., Salaff, J., Dimitrova, D., Garton, L., Gulia, M., and Haythronthwaite, C. "Computer Networks as Social Networks: Collaborative Work, Telework, and Virtual Community," Annual Review of Sociology (22), 1996, pp. 213-238.

Wellman, B., and Gulia, M., Net Surfers Don't Ride Alone. In. B. Wellman (Ed.), Networks in the Global Village (pp. 331-366). Boulder, CO: Westview, 1999.

Wiesenfeld, B. M., Raghuram, S., and Graud, R. Communication Patterns as Determinants of Organizational Identification in a Virtual Organization," Organization Science (10:6), 1999, pp. 777-790.

Yoo, Y., and Alavi, M. "Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus," MIS Quarterly, (25:3), 2001, pp. 371-390.

Zack, M. H. "Interactivity and Communication Mode Choice in Ongoing Management Groups," Information Systems Research (4:3), 1991, pp. 207-