

## 가상협업을 위한 프로세스 모형\*

서 아 영\*\*, 신 경 식\*\*\*

### A Process Model for Virtual Collaboration: Theoretical Synthesis and Empirical Exploration

Ayoung Suh, Kyung-shik Shin

When individuals collaborate in virtual settings, communication is mediated through a variety of communication technologies, and is associated not only with communication effectiveness but also with socio-emotional interactions among group members. In this regards, scholars have examined how technology-mediated communication systems can be designed and used to facilitate communication interaction. However, the empirical results of the previous studies have revealed inconsistencies in the effects of communication media on users' behavioral or attitudinal responses, and on their viable effectiveness in organizations.

Some studies claim that computer-mediated communication (CMC) is task-oriented but not suitable for emotional expression since it hinders close interpersonal interaction. On the other hand, some studies argue that individuals are able to develop interpersonal relationships more effectively in a CMC environment than in an FtF environment. Due to the different perspectives, a theoretical gap exists, and it leads to the inconsistent research findings. The purpose of this paper is to combine the two different perspectives into a single unified model, thereby providing a more realistic and comprehensive understanding about virtual collaboration.

The present study here sought to answers the following questions with organizational communication perspective: What are the major components of virtual collaboration? What factors affect the performance of virtual collaboration? And what kind of managerial efforts should organization make in order to facilitate CMC media effectiveness in virtual collaboration?

---

\* This research is supported by the Ubiquitous Autonomic Computing and Network Project, the Ministry of Information and Communication (MIC) 21st Century Frontier R&D Program in Korea.

\*\* 한국과학기술원 테크노경영대학원 박사후 연구원

\*\*\* 교신저자, 이화여자 대학교 경영대학 부교수

Although there is a certain belief that new media, namely technology-mediated communication support would create new opportunities, the problem of "how" or "why" has been an important question that is still not fully addressed. In this regards, we collectively reexamined previous literatures with major issues which are still controversial and integrated various theoretical activity within computer-mediated communication domain: task-oriented approach, socio-emotional approach, and evolutionary psychological approach.

Our first contribution is to develop a framework for virtual collaboration by combining two different perspectives into a single unified model, providing a more realistic and comprehensive understanding. The second main contribution is the joint modeling of both social presence and cognitive effort, and the effects on two distinct but important communication outcomes (i.e., task performance and relational development).

We tested the research hypotheses which were developed based on the various CMC theories using data gathered through a self-administered mail survey of 127 individuals of 69 virtual workgroups. The proposed model was supported, providing preliminary evidence that the tension between two opposite view should be integrated. The results show that the individual's psychological processes (social presence and cognitive effort) in a virtual environment significantly mediated the effect of CMC inputs (media richness, user adaptation, and shared context) on the CMC outputs (task performance and relational development). Furthermore, this study shows that the lack of perceived media richness of CMC media can be complemented by user adaptation and shared context.

Based on the results, we discuss how communication system should be designed and implemented so as to promote virtual interaction as well as how a virtual workgroup should be composed to complement the lack of media richness. A virtual collaboration using CMC media may create new value by overcoming the logistical constraints. On the other hand, it may also generate various managerial risks such as communicational depersonalization, process dissatisfaction, and low cohesion. Therefore, this study suggests that organization managers should carefully choose the CMC mediums and monitor individual member's cognitive and affective psychological processes during virtual collaboration to reduce potential risks in virtual collaboration.

**Keywords :** Virtual Collaboration, Computer-mediated Communication, Media Richness, Social Presence, Process Model,

## I . Introduction

As dispersed group collaboration becomes increasingly common and unavoidable for organizations, many practitioners and researchers have focused on the potential of information communication technologies to overcome the space

and time constraints that plague face-to-face (FtF) meetings. In this context, business paradigms are moving toward emphasizing flexibility with more virtual structure[DeSanctis and Jackson, 1994; DeSanctis and Monge, 1999] by adopting diverse communication technologies to facilitate virtual collaboration[Gemino *et al.*,

2005]. Virtual collaboration is defined as an environment in which the people working together are interdependent in their tasks, share responsibility for outcomes, are geographically dispersed, and rely on mediated, rather than face-to-face, communication to produce an outcome [Gibson and Cohen, 2003].

Earlier studies show that work can only be considered virtual when all interactions were mediated by distance, with no work completed in face-to-face mode. However, few pure virtual collaboration where people never meet face-to-face exists in the real world [Griffith *et al.*, 2003]. Similarly, few pure traditional environments exist in organizations today that do not use any communication technologies [Dutton 1999; Leidners *et al.*, 2003; Martines *et al.*, 2004]. More recently, one finds that most modern organizations have added virtual characteristics to their overall operational structure.

When individuals collaborate in virtual settings, communication is mediated through a variety of communication technologies. Thus, most previous studies have focused on comparing a given communication medium with FtF communication or compares different media for specific tasks, such as negotiations. However, the empirical results of the previous studies have revealed inconsistencies in the effects of communication media on users' behavioral or attitudinal responses, and on their viable effectiveness in organizations. Some studies claim that virtual collaboration is task-oriented but not suitable for emotional expression since it hinders interpersonal interaction [Daft and Lengel, 1986; Short *et al.*, 1976; Sproull and Kiesler, 1986]. This task-oriented perspective mainly focuses

on how technology-mediated communication enhances task performance in a virtual environment. On the other hand, some studies argue that individuals are able to develop interpersonal relationships more effectively in a technology-mediated environment than in an FtF environment [Walther and Burgoon, 1992, Walther, 1992, Walther, 1995, Walther, 1996]. This relationship-oriented perspective mainly focuses on how individuals develop interpersonal relationships using communication technologies.

After a comprehensive review of prior research on a variety of virtual works, we identified that these distinct research categories should be integrated since virtual collaboration is associated not only with communication effectiveness but also with socio-emotional interactions among group members. Given purpose, we developed a multi-purpose model that predicts task performance and relational development utilizing an input → process → output framework to describe our model. Within this framework, we explain (1) we examine how technological, individual, contextual factors interplay with individuals' cognitive and affective processes, (2) how they influence outcomes of virtual collaboration.

Our first contribution is to develop a framework for virtual collaboration by combining two different perspectives into a single unified model, providing a more realistic and comprehensive understanding. The second main contribution is the joint modeling of both social presence and cognitive effort, and the effects on two distinct but important communication outcomes (i.e., task performance and relational development).

## II. Theoretical Foundation

### 2.1 Task-oriented Perspective

The task-oriented perspective is primarily based on three theories: social presence theory[Short *et al.*, 1976], media richness theory[Daft and Lengel, 1986; Daft *et al.*, 1987], and social context cues theory[Sproull and Kiesler, 1986; 1991]. According to these theories, all technology-mediated environments can be viewed as less personal and less socially emotional than FtF environments due to the constraints on perceiving cues during interactions[Liu and Ginther, 1999]. This implies that virtual interaction via electronic communication media lacks the capacity to convey socio-emotional cues and personal information. Therefore, it is less emotional and more task-oriented, depersonalized, impersonal, and cold[Daft and Lengel, 1986, Daft *et al.*, 1987, Short *et al.*, 1976].

The task-oriented perspective presumes that the mechanical properties of media are inherent and that the fit between these properties and the type of task determines task performance. Further, it notes that people select a communication medium based largely on the technical attributes of the medium. In this regard, numerous studies using various forms of electronic communication media, such as group support systems and e-mail, have found that media with limited cues and communication channels tend to “depersonalize” communication interactions [Rice, 1984; Sproull and Kiesler, 1986], deter from trust and liking, and sometimes negatively affect group performance[Wilson *et al.*, 2005]. In this research category, effectiveness of virtual collaboration is mainly discussed in terms of de-

cision time, decision quality and overall task effectiveness

### 2.2 Relationship-oriented Perspective

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]. 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]. This relationship-oriented perspective attempts to explain how people adapt to new media, overcome the limitations of media constraints, and develop interpersonal relationships in different communication environments [Burke and Chidambaram, 1999]. While the task-oriented perspective argues that the reduction of cues leads to inhibited and depersonalized perceptions of users, the relationship-oriented perspective argues that the reduction of non-verbal and relational cues sometimes benefits the user in interpersonal relationship management. Relationship-oriented perspective assumes that individuals will adapt to their behaviors to the cues that are available, including conventional message content features and linguistics, but also draw on available chronemic factors, which force them to imbue their messages with social information, as well as instrumentally ori-

<Table 1> A comparison of two different perspectives

	Task-oriented Perspective	Relationship-oriented Perspective
Theoretical Foundation	<ul style="list-style-type: none"> <li>◦ Media Richness Theory</li> <li>◦ Social Presence Theory</li> <li>◦ Social Context Cues Theory</li> <li>◦ Media-Task Fit Theory</li> </ul>	<ul style="list-style-type: none"> <li>◦ Social Information Processing Theory</li> <li>◦ Social Construction Theory</li> <li>◦ Social Identification Theory</li> <li>◦ Hyperpersonal Theory</li> </ul>
Research Trend	<ul style="list-style-type: none"> <li>◦ Typically involved short-term laboratory experiments, often with an FtF control group</li> <li>◦ Focused on direct relationship between media condition and task performance</li> </ul>	<ul style="list-style-type: none"> <li>◦ Involved longitudinal observation considering time based interaction(3~4 laboratory experiments)</li> <li>◦ Focused on the inter-action between media properties and social factors</li> </ul>
Media Properties	<ul style="list-style-type: none"> <li>◦ Media properties are considered to be invariant and mechanical</li> <li>◦ CMC is regarded as a lean medium</li> </ul>	<ul style="list-style-type: none"> <li>◦ Media properties are considered to be variant and socially constructed</li> <li>◦ CMC is regarded as neither rich nor lean</li> </ul>
Individual Behavior	<ul style="list-style-type: none"> <li>◦ Individuals seek to match the richness of a communication medium with the complexity of the task for which it is used.</li> </ul>	<ul style="list-style-type: none"> <li>◦ The choice of medium by individual is neither objective nor reasonable.</li> <li>◦ Individuals modify their behavior in ways that are independent of the degree of media properties</li> </ul>
Contextual Factors	Task characteristics are considered as substantial factors to influence communication interaction	Organizational culture, social norm, and established group cohesion are considered as factors which profoundly influence media use in organization
Communication Outcomes	Mainly focused on task performance such as; <ul style="list-style-type: none"> <li>◦ Decision time</li> <li>◦ Decision quality</li> <li>◦ Group consensus</li> <li>◦ Group agreement</li> </ul>	Mainly focused on socio-emotional communication capability of CMC such as; <ul style="list-style-type: none"> <li>◦ Relational link</li> <li>◦ Impression formation</li> <li>◦ Intimacy</li> <li>◦ Trust</li> <li>◦ Group cohesion</li> </ul>

ented content[Walther, 1992]. Thus, stylistic aspects of messages such as timing, length, and grammar appear equally as important as the content of message itself because when non-verbal cues are decreased, the remaining cues become more salient to users[Ellison *et al.*, 2006].

The relationship-oriented perspective differs from the task-oriented perspective in two critical propositions. First, it states that every me-

dium does not have inherent physical properties; second, it argues that the choice of a medium by individuals is neither objective nor reasonable. According to this perspective, it is not the media properties but other factors such as social context or group affection that lead users to adapt their behavior in ways that are independent of the degree of the inherent media properties and that compensate for the prob-



lems associated with media “leanness” [Fulk *et al.*, 1990, Lee, 1994; Ngwenyama and Lee, 1997].

A comparison of the two perspectives in terms of research trend, technical support, personal factors, group structure, and group outcomes is presented in <Table 1>.

### 2.3 Bridging a Conceptual Chasm

As discussed above, given the theoretical polarization, most studies have attempted to understand the end-to-end causal relationship between media condition and communication outcomes, rather than the communication process. In this sense, the importance of individuals’ cognitive and affective psychological states have been emphasized in several studies[Te’eni, 2001, Kock, 2004], a relatively small number of studies have focused on the communicative process. We identified that the lack of consideration for the communicative process might have resulted in inconsistent research findings. In this sense, we need to adopt a psychological approach to explain how individuals’ communicative process interact communication inputs and outputs. We believe this approach will be helpful to account for the role of communicative process when individuals collaborate in virtual environment and thereby it bridges existing theoretical chasm.

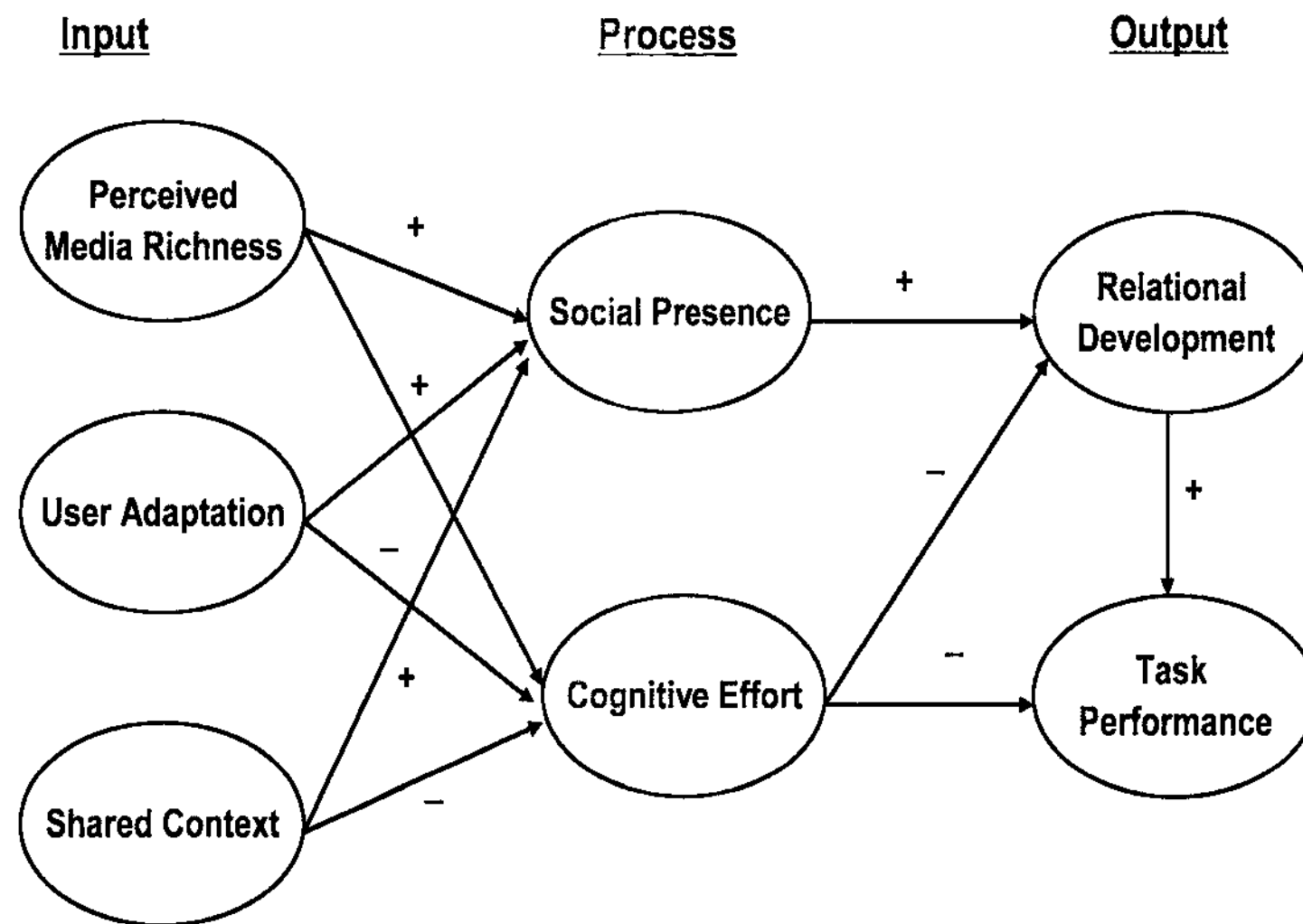
Kock[2004, 2005] proposed a new approach - a psychological model based on the principles derived from a modern version of Darwin’s theory of evolution by natural selection. The focus of this psychological model lies in the negative causal link between the “naturalness” of a technology-mediated communication medium, which is the similarity to the FtF medium, and the cognitive effort required of an individual us-

ing the medium for knowledge transfer. The primary presumption of this psychological model is that human beings need to invest greater cognitive effort when they communicate in a mediated environment, and the required cognitive effort determines the communication outcomes.

Cognitive effort refers to the individual’s cognitive psychological state, and is defined as the mental workload, which reflects the total amount of cognitive resources(including perception, memory, and judgment) required to complete a task[Kock, 2004]. By contrast, social presence refers to the individual’s affective psychological state. Social presence is defined as a psychological state in which individuals feel that the communication interaction is warm, sociable, and personal rather than impersonal, cold, and unsociable[Hiltz and Johnson, 1990]. Altogether, we have identified two constructs-cognitive effort and social presence-as an individual’s psychological states that consequently influence the communication outcomes.

## III. Research Model

We have developed an integrative theoretical framework based on the task-oriented, relationship-oriented, and psychological perspectives <Figure 1>. From the task-oriented perspective, we derived perceived media richness as one of the input variables of the proposed research model. This is because that media richness theory, social presence theory, and social context cue theory commonly argue that the media richness mainly influences the outcomes of virtual interaction. From the relationship-oriented perspective, we derived personal adaptation and shared context as the other input variables. Social infor-



<Figure 1> Research Model

mation theory, social construction theory, and social identification theory commonly highlight the role of social influences as well as user adaptation in shaping individual's behavior and attitude.

By adopting social presence and cognitive effort from the psychological perspective, we link CMC input and individual's psychological processes. <Figure 1> represents the research model.

### 3.1 Perceived Media Richness

According to media richness theory, every media has own capacity in terms of feedback immediacy, multiplicity of cues, language variety, and personal focus[Short *et al.*, 1976]. In many studies, such inherent properties of each communication medium have been represented by the concept of media richness. However, today's technological development leads us to reconsider the conventional media richness that individuals perceive and experience in a virtual

environment. For example, e-mail, which has been considered as a text-based asynchronous medium, may no longer remain such a lean medium. This is because technical function such as automatic messaging, the notifying function, and voice mail blur the perceived differences in the richness of e-mail and other synchronous media[McKinney and Whiteside, 2006]. Furthermore, by managing and varying diverse electronic communication media, individuals could achieve the different level of richness with the same distance communication process[Majchrzak and Malhotra, 2005]. This implies that media richness is evolving along with technological development. When workgroup members collaborate in a virtual environment, they use diverse technology-mediated communication systems. Accordingly, overall media richness that individuals perceive in a virtual workspace also varies along with technological support in each workgroup. If individuals perceive their virtual workspace as providing high richness with high

degree of technological support, they would feel that the mediated communication is warm, personal, and sociable[Short *et al.*, 1976]. Therefore, we hypothesize the following:

**H1:** *Increases in the degree of media richness that individuals perceive in a virtual workspace will lead to increases in the degree of social presence.*

According to the psychological perspective, media richness refers to a medium's naturalness, which is its similarity to the FtF medium. Media naturalness is determined by two factors-the space-time dimension and the expressive-perceptual dimension. The space-time dimension comprises the degree to which a medium supports collocation and synchronicity, and the expressive perceptual dimension comprises the degree of facial expressions, body language, and speech. The media naturalness proposition[Kock, 2004; Kock, 2005] presumes that a medium that is low in media richness makes interaction "less natural," since our biological communication apparatus has been developed through evolutionary adaptation over millions of years. Thus, technical support for high degree of feedback immediacy, number of cues, personalization, and language variety(e.g., high media richness) leads to a less difficulty and decreased cognitive demands on an individual to use the medium for communication to accomplish a collaborative task[Kock, 2004].

**H2:** *Increases in the degree of media richness that individuals perceive in a virtual workspace will lead to decreases in the degree of perceived cognitive effort.*

### 3.2 Personal Adaptation

Social information processing theory suggests that the repeated use of a lean medium-even with all its attendant restrictions-can change its perceived media richness and its nature[Chidambaram, 1996]. In a virtual environment, communicative outcomes are the result of users interacting repeatedly with the technology and thereby defining its meaning[Fulk *et al.*, 1990]. In the same perspective, Carlson and Zmud[1999] argue that users' accumulative experience with the communication channel and communication partner influences their perception of that particular medium. They explained, for example, that a group of geographically distributed users who have been heavy and regular users of e-mail over many years for work-related collaboration will be more cognitively adapted to using e-mail for this purpose than a group of users who, during the same period, engaged primarily in FtF work-related collaboration.

Kock[2004] also used the same concept- cognitive adaptation-as a part of personal characteristics in his media naturalness hypothesis. A high degree of cognitive adaptation to mediated communication is particularly associated with the repeated use of a specific medium. In a virtual environment, cognitive adaptation was found to exert a significant influence on an individual's emotional reactions to a medium(affect and anxiety) as well as the outcome expectations. This argument implies that individuals fear and avoid threatening situations when they perceive themselves as lack the necessary coping skills; on the other hand, they do engage in activities that they feel capable of handling-situations that would otherwise be intimidating. In summary, personal



adaptation to the virtual collaboration determines not only their affective perception but also their cognitive perception of the virtual environment they are working in. This leads to the following hypotheses:

*H3: Increases in the degree of an individual's adaptation to the virtual collaboration will lead to increases in the degree of social presence.*

*H4: Increases in the degree of an individual's adaptation to the virtual collaboration will lead to decreases in the degree of cognitive effort.*

### 3.3 Shared Context

According to social identification theory, effective communication requires participants to share sufficient background knowledge or interpretive context to render their messages mutually meaningful. From the social cognitive theory, greater differences or distances between sender-receiver worldviews, values, languages, and other common factors pertinent to information processing will increase the cognitive complexity of communication and lower the chances of mutual understanding[Te'eni, 2001]. In this regard, the sharing of context has been identified as a major need of individuals in virtual collaboration[Majchrzak *et al.*, 2005]. Particularly, when individuals perceive a higher potential for misunderstanding arising from the confusion over conflicting and multiple interpretations, there is a greater need for contextualization[Goffman, 1981]. Thus, it can be inferred that a shared context reduces the cognitive effort required to understand communicated messages. A greater cognitive distance may also be asso-

ciated with a higher uncertainty about what the receiver knows and, therefore, a higher cognitive complexity[Kraut and Higgins, 1984]. Thus, the degree of cognitive distance between two or more individuals engaged in communication will impact the degree of cognitive effort required of each individual using a CMC medium to collaborate with others[Kock, 2004].

*H5: Increases in the degree of shared context with workgroup members will lead to decreases in the degree of cognitive effort.*

From the psychological perspective, shared understanding between individuals is commonly known to produce feelings of attraction and intimacy. This implies that as individuals develop experience communicating within a specific context, they develop a knowledge base for that context enabling the encoding of messages with richer meanings for similarly knowledgeable communication partners-through, for instance, the use of shared symbols or cultural references[Carlson and Zmud, 1999]. Chidambaram [1996] also found that as group members spent more time their communication partner within a shared context increased social presence. Since the concept of shared context encompasses the degree of shared understanding by sharing knowledge on a specific context, this argument allows us to infer that shared context among workgroup members may increase affective communicative processes. The discussion leads to the following hypothesis:

*H6: Increases in the degree of shared context with workgroup members will lead to increases in the degree of social presence.*

### 3.4 Social Presence and Communication Outcomes

Since social presence is the feeling that the medium is warm, personal, and sociable, it is a strong predictor of socio-emotional information exchange among individuals within a mediated communication environment. Social presence theory suggests that the level of virtual interaction is limited when the level of social presence is low[Short *et al.*, 1976]. This is because people do not exchange socio-emotional information to build close relationship when they feel the communication is cold and impersonal[Lee and Nass, 2004; Nowak and Rauh, 2005]. This argument leads to the inference that increased socio-emotional communication is a necessary condition for developing deeper interpersonal relationships. As Yoo and Alavi[2001] noted, social presence refers to the degree of the other person's salience in communication interactions and the consequent salience of the interpersonal relationship.

*H7: Increases in the degree of perceived social presence will lead to increases in the degree of relational development with communication partners.*

### 3.5 Cognitive Effort and Communication Outcomes

Cognitive effort refers to the mental workload, which is defined as the total amount of cognitive resources(including perception, memory, and judgment) required to complete a task. Since it is often difficult to measure the brain activity associated with cognitive processes,

cognitive effort can be assessed based on the perceived levels of difficulty of communicative tasks[Todd and Benbasat, 1999]. Normally, mediated communication requires more cognitive effort from individuals rather than FtF, and the degree of cognitive effort in virtual environment determines the group outcomes. This argument implies that the perceived cognitive effort required of individuals working in virtual environment has a negative influence on the task performance.

*H8: Increases in the degree of perceived cognitive effort will lead to decreases in the degree of relational development with workgroup members.*

Further, cognitive effort is usually associated with the perceived level of difficulty in using a certain medium for social interaction and satisfaction[Kock, 2004]. Therefore, we can infer that a greater cognitive effort leads to less socio-emotional interactions.

*H9: Increases in the degree of perceived cognitive effort will lead to decreases in the degree of task performance in the workgroup.*

### 3.6 Relational Development and Task Performance

Relational communication refers to members' intimacy, trust, and attraction with regard to the group[Chidambaram, 1996; Walther, 1995]. Relational links, trust, and group cohesion among group members have been associated with a number of positive outcomes, including a heightened awareness of problems, a proclivity to

change, enhanced motivation, increased morale, better decisions, and greater creativity[Keller, 1986]. In a virtual environment, relational development in a workgroup increases the sociable, warm, and personal interactions between members, thereby enhancing the group's collaboration. This leads to the following hypothesis:

*H10: Relational development among workgroup members in a virtual environment positively affects task performance in the workgroup.*

## IV. Research Method

### 4.1 Data Collection

We collected data from global business consulting firms located in Korea. Since our study addresses virtual collaboration, we need to collect data from the respondents who are frequently exposed to the virtual collaboration and have virtual characteristics in their work processes. In general, business consulting firms operate based on projects, and their employee (namely, business consultants) are often physically and temporally dispersed with other colleagues. Thus, we identify that business consulting firms are adequate to address our research purpose. We chose 5 global consulting firms in Korea, and send 200 questionnaires for survey. A total of 135 surveys were collected. The response rate of the individuals surveyed was 67.5%. After eliminating uncompleted questionnaires, 127 individuals working in 69 workgroups were used for hypotheses test.

We identified that the workgroups(e.g., project teams of business consulting firms) used a wide variety of IT applications to facilitate col-

laboration, including e-mail, instant messaging, video/audio conferencing, electronic bulletin boards, or diverse groupware such as Lotus Notes, Microsoft products, and in-house group communication support systems. Some workgroups used communication systems encompassing a variety of functions ranging from instant messaging to discussion threads and from application-sharing software to calendaring. Some workgroups independently used diverse communication technologies including e-mail, bulletin boards, instant messaging, or video conferencing. All respondents were asked to answer questions on the overall communication condition they experienced during virtual collaborations, regardless of the type of communication media they used. Our unit of analysis was the individual.

### 4.2 Instrument Development

We developed the items in the questionnaire either by adapting measures that had been validated by other researchers or by converting the definitions of constructs into a questionnaire format. In particular, the items for user adaptation, cognitive effort, and relational development were created based on relevant theories and prior studies. The items measuring media richness were adapted from Carlson and Zmud's [1999] research. In order to assess the overall media richness perceived in a virtual workspace, we prefaced each of the items with a stem, for example, "The virtual workspace used by the team allows my communication partner and me to(give and receive timely feedback)." Shared context was measured by modifying the items of organizational context used by Carlson and

<Table 2> Scale Development

Construct		Operational Definition	Abbreviated Items	References
Input Variables	Perceived Media Richness	The extent to which an individual perceive the capability of the communication medium to transfer rich information	<ul style="list-style-type: none"> <li>◦ Immediacy of feedback</li> <li>◦ Symbolic cues</li> <li>◦ Personalization</li> <li>◦ Number of cues</li> <li>◦ Language variety</li> </ul>	Carlson and Zmud[1999]
	Personal Adaptation	The extent to which an individual adapt CMC media using for virtual collaboration	<ul style="list-style-type: none"> <li>◦ Comfort with media</li> <li>◦ Perceived competence</li> <li>◦ Media experience</li> <li>◦ Self-efficacy</li> </ul>	Kock[2004]
	Shared Context	The extent to which an individual share the contextual information about the participants, task, and group	<ul style="list-style-type: none"> <li>◦ Shared group norm</li> <li>◦ Use of group-specific jargon and language</li> <li>◦ Shared set of symbols and terminology</li> <li>◦ Familiarity with group culture</li> </ul>	Carlson and Zmud[1999]
Process Variables	Social Presence	The extent to which an individual feels the communication interaction is warm, sociable, and personal rather than impersonal, cold, and unsociable	<ul style="list-style-type: none"> <li>◦ Impersonal----Personal</li> <li>◦ Hot-----Cold</li> <li>◦ Distant-----Close</li> <li>◦ Expressive- Inexpressive</li> <li>◦ Emotional---Unemotional</li> </ul>	Burke and Chidambaram[1999]
	Cognitive Effort	The extent to which an individual perceives the mental workload, which reflects the total amount of cognitive resources required to complete a task	<ul style="list-style-type: none"> <li>◦ Mental demand</li> <li>◦ Temporal demand</li> <li>◦ Frustration level</li> </ul>	Kock[2004]
Outcome Variables	Task Performance	The extent to which an individual effectively accomplish the given task via CMC media	<ul style="list-style-type: none"> <li>◦ Decision Time</li> <li>◦ Decision Quality</li> <li>◦ Overall task effectiveness</li> </ul>	Dennis and Kinney[1998] Warkentin[1997]
	Relational Development	The extent to which an individual develop interpersonal relationship with other work group members	<ul style="list-style-type: none"> <li>◦ Better impression</li> <li>◦ Intimacy</li> <li>◦ Trust</li> <li>◦ Group cohesion</li> </ul>	Walther[1995] Chidambaram[1996] Walther and Bunz[2005] Chidambaram[1996]

Zmud[1999] to the context of workgroup. Social presence was measured using instruments that had been tested by Burke and Chidambaram [1999]. For measuring task performance, we ad-

apted instruments that had been tested by Dennis and Kinney[1998]. All the items used a five-point Likert-type scale(1 = Strongly Disagree, 3 = Neutral, and 5 = Strongly Agree). The initial

version of the survey instruments was then refined through pilot tests with 43 responses from 8 work groups. One item from the shared context was dropped due to its low item-to-total correlation (less than 0.50). The source and abbreviated items of each of the scales are shown in <Table 2>.

## V. Results

To test our hypotheses, we used a structural equation modeling technique known as partial least squares (PLS). We selected PLS from among several structural equation modeling tools, including EQS and LISREL, because unlike other tools, PLS does not require a large sample size [Fornell and Bookstein, 1982]. Considering the sample size of 127 individuals, which does not fully meet the requirement of scholarly recommendations to use a 10:1 ratio of the sample size to the number of parameters estimated, we opted to use PLS.

### 5.1 Measurement Model

The test of the measurement model includes the estimation of internal consistency and the

convergent and discriminant validity of the instrument items. We assessed the individual item reliability by examining the loading of the measures on their corresponding constructs. Internal consistency was examined using the composite scale reliability index developed by Fornell and Larcker [1982], which is a measure similar to Cronbach's alpha. Fornell and Larcker recommend using a criterion cutoff of 0.7 or higher. <Table 3> presents internal consistency reliabilities. All reliability measures were 0.8 or higher, well above the recommended level of 0.7, indicating adequate internal consistency.

To assess discriminant validity, we examined the average variance extracted (AVE) value. For satisfactory discriminant validity, the AVE from the construct should be greater than the variance shared between the construct and other constructs in the model [Chin, 1998]. <Table 3> lists the correlation matrix, with correlations among constructs and the square root of AVE on the diagonal. The results from <Table 3> indicate that the AVE for each construct is larger than the correlation of that construct with all the other constructs in the model. This means that all the items demonstrated a satisfactory convergent and discriminant validity.

<Table 3> Correlation of Constructs and Internal Consistency

	MERC	UADP	SCON	SPRE	COGE	TASP	REDV	Internal Consistency
MDRC	0.804							0.878
UADP	0.314	0.892						0.961
SCON	0.089	0.106	0.651					0.848
SPRE	-0.455	-0.412	-0.280	0.690				0.941
COGE	0.602	0.234	0.036	-0.361	0.760			0.870
TASP	0.687	0.386	0.297	-0.522	0.603	0.832		0.893
REDV	0.409	0.508	0.250	-0.436	0.310	0.581	0.735	0.952



Discriminant and convergent validity of the measurement model were further confirmed when individual items loaded more than 0.6 on their associated factors and when the loading within constructs was higher than those across constructs.

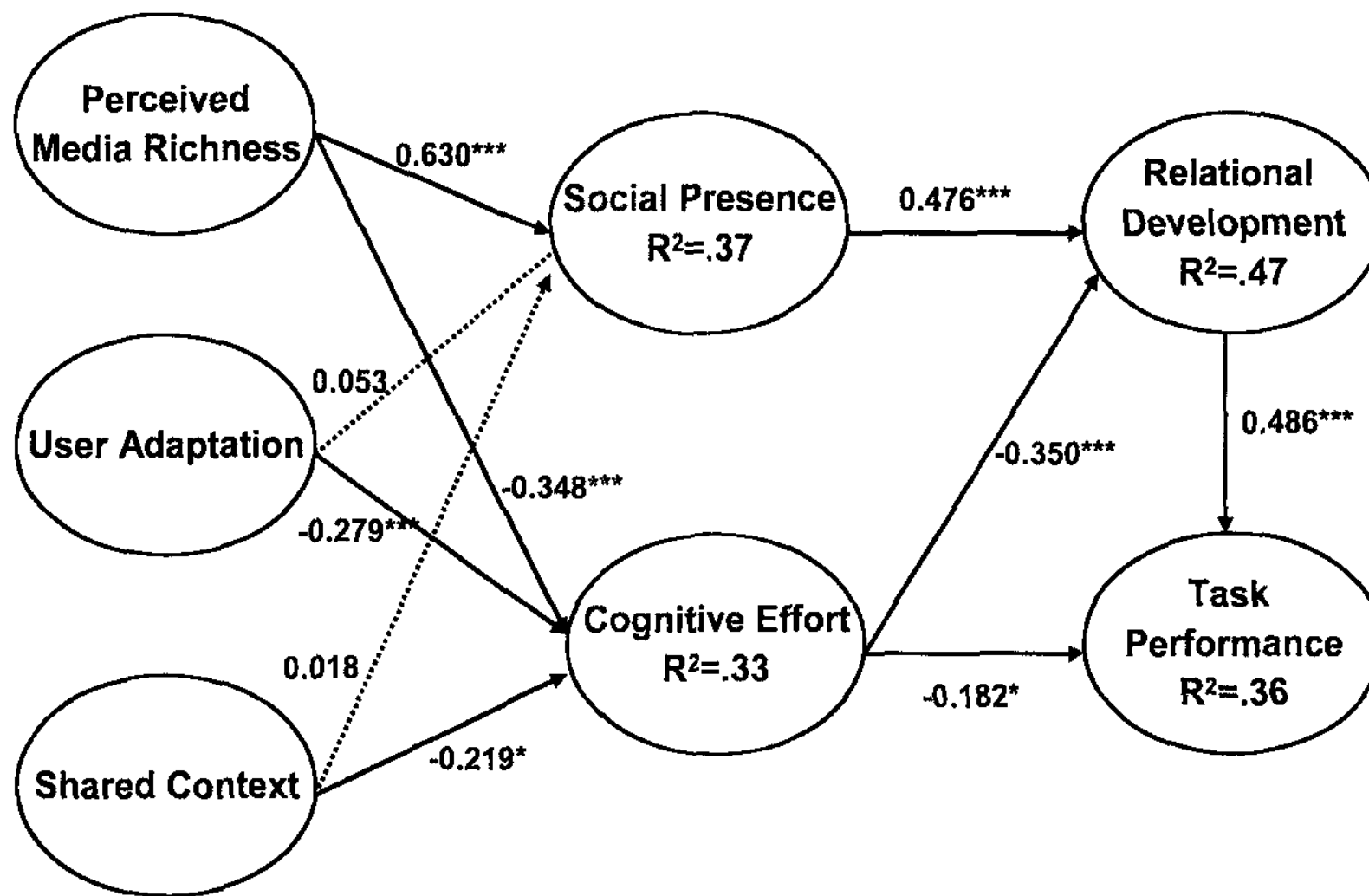
<Table 4> contains the loadings and cross-loadings for items used in this study; all items loaded more highly on their own construct than they did on any other construct.

### 5.2 Test of Structural Model

The test of the structural model includes an estimation of the path coefficients, which indicate the strengths of the relationships between the dependent and independent variables, and the R<sup>2</sup> value, which represents the amount of variance explained by the independent variables. Together, the R<sup>2</sup> and the path coefficients(loadings and significance) indicate how well the data

<Table 4> Loading and Cross Loadings of Measures

		MDRC	UADP	SCON	SPRE	COGE	TASP	REDV
Media Richness	1	<b>0.637</b>	0.260	0.028	0.372	-0.250	0.319	0.464
	2	<b>0.885</b>	0.252	0.036	0.564	-0.358	0.307	0.628
	3	<b>0.853</b>	0.293	0.050	0.533	-0.329	0.367	0.584
	4	<b>0.820</b>	0.218	0.160	0.451	-0.501	0.334	0.526
User Adaptation	1	0.300	<b>0.935</b>	0.085	0.227	-0.375	0.475	0.349
	2	0.253	<b>0.948</b>	0.042	0.214	-0.346	0.471	0.345
	3	0.328	<b>0.950</b>	0.160	0.223	-0.435	0.491	0.394
Shared Context	1	0.100	0.036	<b>0.793</b>	0.031	-0.195	0.124	0.183
	2	0.077	0.091	<b>0.813</b>	-0.038	-0.178	0.160	0.219
	3	0.049	0.117	<b>0.815</b>	0.068	-0.277	0.282	0.292
Social Presence	1	0.437	0.209	0.039	<b>0.844</b>	-0.356	0.258	0.472
	2	0.450	0.224	0.078	<b>0.864</b>	-0.357	0.244	0.476
	3	0.556	0.133	-0.010	<b>0.880</b>	-0.294	0.209	0.486
	4	0.563	0.209	-0.003	<b>0.899</b>	-0.280	0.221	0.552
	5	0.588	0.244	0.057	<b>0.871</b>	-0.304	0.401	0.615
Congitive Effort	1	-0.314	-0.320	-0.224	-0.327	<b>0.791</b>	-0.305	-0.416
	2	-0.334	-0.327	-0.277	-0.239	<b>0.846</b>	-0.346	-0.352
	3	-0.465	-0.373	-0.205	-0.328	<b>0.853</b>	-0.421	-0.514
Task Performance	1	0.313	0.504	0.240	0.286	-0.376	<b>0.874</b>	0.456
	2	0.300	0.416	0.156	0.184	-0.307	<b>0.847</b>	0.418
	3	0.416	0.393	0.235	0.307	-0.419	<b>0.850</b>	0.588
Relational Development	1	0.601	0.291	0.297	0.569	-0.487	0.547	<b>0.905</b>
	2	0.607	0.389	0.292	0.503	-0.433	0.498	<b>0.892</b>
	3	0.646	0.342	0.280	0.527	-0.464	0.499	<b>0.929</b>
	4	0.650	0.390	0.220	0.591	-0.514	0.569	<b>0.923</b>



\*  $p < .1$ ; \*\*  $p < .05$ , \*\*\*  $p < .01$

◦ Group size and task characteristics are controlled.

<Figure 2> A Summary of PLS Analysis

support the hypothesized model. <Figure 2> shows the results of the test of the hypothesized structural model. The results of the PLS suggest that perceived media richness significantly influenced social presence of communication, accounting for 37% of the variance in social presence. User adaptation and shared context do not significantly influence social presence; however, they significantly reduce cognitive effort. The three factors-media richness, user adaptation, and shared context-collectively accounted for 33% of the variance in cognitive effort. Thus, H1, H2, H4, and H5 are all supported; H3 and H6 are not.

As expected, both social presence and cognitive effort were significant determinants of relational development and accounted for 47% of the variance in that measure. Additionally, the results showed that cognitive effort negatively influences task performance in workgroups, whe-

reas social presence does not directly influence task performance. Taken together, H7 and H8 are supported.

Finally, we hypothesized that a high degree of relational development and a low degree of cognitive effort would lead to better performance in workgroups. The results suggest that relational development achieved in a virtual environment significantly enhances task performance in workgroups. Accordingly, 36% of the variance in task performance was accounted for by relational development and cognitive effort. Therefore, H9 and H10 are supported.

## VI. Discussion and Implication

The findings of this research serve as a preliminary test of the viability of the research framework within the context of virtual collaboration. As we hypothesized, perceived media

richness had a significant influence on social presence and cognitive effort. This finding supports the task-oriented perspective in that increased media richness is linked to decreased cognitive effort, which leads to heightened task performance, i.e., the time taken to complete the task, task quality, and overall task effectiveness. However, this finding is not consistent with the presumption of the task-oriented perspective that mediated communication has inherently low media richness and is not conducive to interpersonal relationship development. Our findings suggests that technical support enhances perceived media richness and it provides added social context by making available information about participants' surroundings, attention, gesture and demeanor. In sum, our findings partly support task-oriented perspective in that media richness influences person's cognitive effort and social presence, and through that process, positively affect task performance.

On the other hand, we found that task performance in a workgroup is significantly influenced by relational development in a virtual environment. Furthermore, the results show that the impact of relational development on task performance is significantly higher than that of cognitive effort. This finding supports the relationship-oriented perspective in that individuals achieved positive levels on several relational dimensions of interpersonal communication. Our findings are consistent with those of previous studies, which found that both technology and social factors are important and complementary in influencing users' perceptions and the use of communication media[Yoo and Alavi, 2001; Carlson and Zmud, 1999; Te'eni, 2001].

## 6.1 Limitations

Before discussing the implications of our findings, we note that our findings must be interpreted in light of the studies' limitations. First, based on a sample of 127 respondents, several significant results have been obtained. However, a larger sample that produces more statistical power would have allowed more sophisticated statistical analysis.

Second, since the measures of all constructs in the study were collected at the same point in time and via the same instrument, and all the data are self-reported, potential for common method variance exists.

Third, 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 virtual collaboration, the results of this study should be cautiously interpreted.

## 6.2 Academic Implications

The academic significance of this study is in that it integrates diverse computer-mediated communication theories by applying Kock's[2004] conceptualizations of the psychological process model. It bridged the two conflicting theoretical visions, developed a research framework, and conducted an empirical test. Overall, the results are largely consistent with the hypothesized model and demonstrate its potential to integrate concepts related to the task-oriented and relationship-oriented perspectives into a single uni-

fied model. This provides an opportunity to integrate two streams of research that, until now, have been largely treated as distinct and to build on the unique strengths of each.

Second, the present study provides the empirical evidences explaining individual's psychological processes involved in virtual collaboration. Most of the previous studies have limited their view into the direct effect of the media selection on the communication outputs. Whereas previous studies focused on the media properties, there has been hardly any study of mediation variables reflecting individual's cognitive and affective psychological processes. By validating the effects of the social presence and cognitive effort, this study has contributed to the development of computer-mediated communication theory in that it provides mediating elements for virtual collaboration. Therefore the significance of this study therefore lies in the fact that it proposes a theoretical foundation regarding individual's psychological processes in the technology-mediated virtual collaboration and the effects of this environment on task performance and relational development.

### 6.3 Practical Implications

Managers are struggling to identify the ways to effectively manage and leverage the opportunities provided by virtual work forms. Based on the results, we propose several ways to increase effectiveness of virtual collaboration as followings:

collaboration via diverse CMC mediumsop-  
ment.cess'ties or into the direct effect of the me-  
dia on communication ouputs.First, this study  
shows how an individual achieves better per-

formance in virtual collaboration. As we pro-  
posed in the research model, it can be achieved  
by (1) facilitating media richness, (2) enhancing  
user adaptation with CMC media, and (3) en-  
couraging context sharing with group members.  
Research suggests that media richness in a  
workspace can be raised by increasing specific  
technical features of communication media or by  
varying the media individuals use[KcKinney and  
Whiteside, 2006; Majchrzak *et al.*, 2005]. There-  
fore manager should encourage group members  
to use diverse CMC media to increase perceived  
media richness and to use more advanced tech-  
nology to exchange more rich information. User  
adaptation can be enhanced by adequate train-  
ing or repeated use of technology-mediated com-  
munication systems. Collaboration in a virtual  
environment requires individuals to be equip-  
ped with additional technical expertise and com-  
puter self-efficacy, instead of expertise derived  
from traditional offline collaboration. Shared  
context can be also considered by orchestrating  
the group members on a regular basis. Weekly  
video/audio conferencing might be an example.

This study also provides a practical sugges-  
tion as to how communication system should be  
designed and implemented so as to promote vir-  
tual interaction. The results indicate that social  
presence and cognitive effort are the determi-  
nants to increase task performance and rela-  
tional development. Therefore, IS managers sho-  
uld consider the way to increase social presence  
and to decrease cognitive effort when they de-  
velop information communication systems. Alre-  
ady, a recent corporate trend has been the active  
implementation of integral communication sys-  
tems to increase social presence by using emoti-  
cons or providing visual cues so that individuals

fees more comfortable, warm, personal, and close in virtual space.

Virtual collaboration using CMC media may create new value by overcoming the logistical constraints. On the other hand, it may also generate various managerial risks such as communicational depersonalization, process dissatisfaction, and low cohesion. To reduce potential risks in virtual collaboration, organization managers should carefully choose the CMC mediums and monitor individual member's cognitive and affective psychological processes during virtual collaboration. Furthermore, the communication system to increase social presence and to decrease cognitive efforts should be implemented in organizations.

## VII. Conclusion

The core concern of virtual collaboration research should no longer be the features of the communication medium. Instead, there exists a worthwhile two-fold challenge. First, to determine how technological support for organizational communication interacts with social and cognitive factors in collaborative work environments; second, to understand how technology-mediated communication systems reduce com-

municative uncertainty and lead to better communication outcomes. We proposed a framework for group collaboration in a virtual environment. With the proposed model, we examined the dynamic interactions among the communication inputs, processes, and outcomes. Since work-group collaboration is closely associated with not only task effectiveness but also relational communication with group members, we developed a multi-purpose model that predicts both task performance and relational development. These multiple purposes are very important in the field of virtual collaboration research since a more realistic view of communication behavior is required in order to design communication systems in modern organizations[Te'eni, 2001].

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. We believe that our framework is an important step toward achieving conceptual clarity on virtual collaboration research. However, additional research is required to develop a refined understanding of the relationships proposed in the integrated model.

## 〈References〉

- [1] Burke, K., and Chidambaram, L., "How Much Bandwidth Is Enough? A Longitudinal Examination of Media Characteristics and Group Outcomes," *MIS Quarterly*, Vol. 23, No. 4, 1999, pp. 557-580.
- [2] Carlson, J.R., and Zmud, R.W., "Channel Expansion Theory and the Experimental Nature of Media Richness Perceptions," *Academy of Management Journal*, Vol. 42, No. 2, 1999, pp. 153-170.



- [3] Chidambaram, L., "Relational Development in Computer-Supported Groups," *MIS Quarterly*, Vol. 20, No. 2, 1996, pp. 143-165.
- [4] Chin, W.W., "Issues and Opinion on Structural Equation Modeling," *MIS Quarterly*, Vol. 22, No., 1, 1998, pp. 52-151.
- [5] Daft, R., and Lengel, R., "Organizational Information Requirements, Media Richness and Structural Design," *Management Science*, Vol. 32, 1986, pp. 554-571.
- [6] Daft, R., Lengel, R., and Trevino, L., "Message Equivocality, Media Selection and Manager Performance: Implications for Information Systems," *MIS Quarterly*, Vol. 17, 1987, pp. 355-366.
- [7] Dennis, A.R., and Kinney, S.T., "Testing Media Richness Theory in the New Media: The Effects of Cues, Feedback, and Task Equivocality," *Information Systems Research*, Vol. 9, No. 3, 1998, pp. 256-274.
- [8] DeSanctis, G., and Monge, P. "Introduction to the Special Issue: Communication Process for Virtual Organizations," *Organization Science*, Vol. 10, No. 6, 1999, pp. 693-703.
- [9] DeSanctis G., and Jackson, B. "Coordination of Information Technology Management: Team-based structures and Computer-based Communication Systems," *Journal of Management Information Systems*, Vol. 10, No. 4, 1994, pp. 85-110.
- [10] Ellison, N., Heino, R., Gibbs, J. "Managing Impressions Online: Self-Presentation Processes in the Online Dating Environment," *Journal of Computer-Mediated Communication*, Vol. 11, No. 2, 2006, article 2.
- [11] Fornell, C., and Bookstein, F., "Two Structural Equation Models: LISRELS and PLS Applied to Consumer Exit-Voice Theory," *Journal of Marketing Research*, Vol. 19, 1982, pp. 39-50.
- [12] Fornell, C., and Larcker, D., "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, Vol. 18, 1981, pp. 39-50.
- [13] Fulk, J., Schmitz, J., and Steinfield, C.W., *A Social Influence Model of Technology Use, Organizations and Communication Technology*, J. Fulk and C.W. Steinfield (eds.), Sage, Newbury Park, CA, 1990, pp. 117-140.
- [14] Gemino, A., Parker, D., and Kutzschan, A., "Investigating Coherence and Multimedia Effects of a Technology-Mediated Collaborative Environment," *Journal of Management Information Systems*, Vol. 22, No. 3, 2005, pp. 97-121.
- [15] Gibson, C., and Cohen, S., *Virtual Teams That Work: Creating Condition for Effective Virtual Teams*, San Francisco, CA: Jossey-Bass (eds.) Wiley, 2003.
- [16] Goffman, E., *Forms of Talk*, University of Pennsylvania Press, Philadelphia, PA, 1981.
- Hiltz, S.R., and Johnson, K., "User Satisfaction with Computer-mediated Communication Systems," *Management Science*, Vol. 36, No. 6, 1990, pp. 739-764.
- [17] Hinds, P.J., and Bailey, D.E. "Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams," *Organization Science*, Vol. 14, No. 6, 2003, pp. 615-632.
- [18] Keller, R.T., "Predictors of the Performance of Project Groups in R&D Organizations," *Academy of Management Journal*, Vol. 29, No. 4, 1986, pp. 715-726.
- [19] 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*, Vol. 48, No. 2, 2005, pp. 117-130.
- [20] Kock, N., "The Psychological Model: Towards a New Theory of Computer-Mediated Communication Based on Darwinian Evolution," *Organization Science*, Vol. 15, No. 2, 2004, pp. 327-348.
- [21] Kraut, R.E., and Higgins, E.T., "Communication and Social Cognition," in Handbook of Social Cognition, R.S. Wyer Jr. and T.K. Sproull (eds.), Lawrence Erlbaum Associates, Hillsdale, NJ, 1984, pp. 437-453.
- [22] Lee, K.M., and Nass, C., "The multiple Source Effect and Synthesized Speech: Doubly Disembodied Language as a Conceptual Framework," *Human Communication Research*, Vol. 30, 2004, pp. 182-207.
- [23] Lee, A. S., "Electronic Mail as a Medium for Rich Communication: An Empirical Investigation Using Hermeneutic Interpretation," *MIS Quarterly*, Vol. 18, No. 2, 1994, pp. 143-157.
- [24] Liu, Y., and Ginther, D., "A Comparison of the Task-oriented Model and the Social-emotion-oriented Model in Computer-mediated Communication," Southwestern Psychological Association's Conference in Albuquerque, New Mexico, USA, 1999.
- [25] Majchrzak, A., Malhotra, A., and John, R., "Perceived Individual Collaboration Knowledge Development through Information Technology-Enabled Contextualization: Evidence from Distributed Teams," *Information Systems Research*, Vol. 16, No. 1, 2005, pp. 9-27.
- [26] Majchrzak, A., and Malhotra, A., "Virtual Workspace Technologies," *MIT Sloan Management Review*, Winter 2005, pp. 131-137.
- [27] McKinney, V.R., and Whiteside, M.M., "Maintaining Distributed Relationships," *Communications of the ACM*, Vol. 49, No. 3, 2006, pp. 82-86.
- [28] Ngwenyama, O.K., and Lee, A.S., "Communication Richness in Electronic Mail: Critical Social Theory and the Contextuality of Meaning," *MIS Quarterly*, Vol. 21, No. 2, 1997, pp. 145-167.
- [29] Nowak, K.L., and Rauh, C., "The Influence of the Avatar on Online Perceptions of Anthropomorphism, Androgyny, Credibility, Homophily, and Attraction," *Journal of Computer-mediated Communication*, Vol. 11, No. 1, 2005, pp. 1-24.
- [30] Rice, R.E., *The New Media: Communication, Research, and Technology*, Sage, Newbury Park, CA 1984.
- [31] Short, J., Williams, E., and Christie, B., *The Social Psychology of Telecommunications*, John Wiley and Sons, Ltd., London, 1976.
- [32] Sproull, L., and Kiesler, S.B., "Reducing Social Context Cues: Electronic Mail in Organizational Communication," *Management Science*, Vol. 32, No. 11, 1986, pp. 1492-1512.
- [33] Sproull, L., and Kiesler, S.B., *Connections: New Way of Working in the Networked Organization*, MIT Press Cambridge, MA, 1991.
- [34] Te'eni, D., "Review: A cognitive-affective Model of Organizational Communication for Designing IT," *MIS Quarterly*, Vol. 25, No. 2, 2001, pp. 251-312.
- [35] Todd, P., and Benbasat, I., "Evaluating the Impact of DSS, Cognitive Effort, and Incentives on Strategy Selection," *Information Sys-*

- tems Research*, Vol. 10, No. 4, 1999, pp. 356-374.
- [36] Walther, J. B., and Burgoon, J. K., "Relational Communication in Computer-mediated Interaction," *Human Communication Research*, Vol. 19, 1992, pp. 50-88.
- [37] Walther, J.B., "Interpersonal Effects in Computer-mediated Interaction: A Relational Perspective," *Communication Research*, Vol. 19, 1992, pp. 52-90.
- [38] Walther, J.B., "Relational Aspects of Computer-mediated Communication: Experimental Observations over Time," *Organization Science*, Vol. 6, No. 2, 1995, pp. 186-203.
- [39] Walther, J.B., "Computer-mediated Communication: Impersonal, Interpersonal, and Hyperpersonal Interaction," *Communication Research*, Vol. 23, 1996, pp. 3-43.
- [40] Wilson, J.M., Straus, S.G., and McEvily, B. "All in Due Time: The Development of Trust in Computer-mediated and Face-to-face Teams," *Organizational Behavior and Human Decision Performance*, 2005, Vol. 99, pp. 16-33.
- [41] Yoo, Y., and Alavi, M., "Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus," *MIS Quarterly*, Vol. 25, No. 3, 2001, pp. 371-390.

◆ 저자소개 ◆



서아영 (Suh, Ayoung)

이화여자대학교에서 학부 및 석사과정을 마쳤으며, 동 대학원에서 경영학 박사학위를 취득하였다. 서울은행과 CSFB에서 근무하였으며, 현재 KAIST 테크노경영대학원 박사후 연구원으로 일하고 있다. 주요관심분야는 가상 협업, 가상 팀, 컴퓨터 기반 매체이론, 사회 연결망 분석 등이다.



신경식 (Shin, Kyung-shik)

연세대학교 경영학과를 졸업하고 대우증권에서 근무하였다. 1991년 미국 George Washington University에서 MBA, 1998년 한국과학기술원에서 경영정보 공학박사를 취득하였으며, 현재 이화여자대학교 경영학부에 재직 중이다. 주요 연구분야는 지능형 기술을 활용한 지식기반 정보시스템의 구축, U-Computing 등이다.

◆ 이 논문은 2008년 02월 13일 접수하여 1차 수정을 거쳐 2008년 05월 24일 게재 확정되었습니다.