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Virtual Teams versus Face-to-Face Teams: An Exploratory Study of a Web-based Conference System*

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ABSTRACT

Many organizations are forming "virtual teams" of geographically distributed knowledge workers to collaborate on a variety of workplace tasks. But how effective are these virtual teams compared to traditional face-to-face groups? Do they create similar teamwork and is information exchanged as effectively? An exploratory study of a World Wide Web-based asynchronous computer conference system known as MeetingWeb™ is presented and discussed. It was found that teams using this computer-mediated communication system (CMCS) could not outperform traditional (face-to-face) teams under otherwise comparable circumstances. Further, relational links among team members were found to be a significant contributor to the effectiveness of information exchange. Though virtual and face-to-face teams exhibit similar levels of communication effectiveness, face-to-face team members report higher levels of satisfaction. Therefore, the paper presents steps that can be taken to improve the interaction experience of virtual teams. Finally, guidelines for creating and managing virtual teams are suggested, based on the findings of this research and other authoritative sources.

Subject Areas: Collaboration, Computer Conference, Computer-mediated Communication Systems (CMCS), Internet, Virtual Teams, and World Wide Web.

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INTRODUCTION

Do teams that collaborate online suffer from constraints in their ability to communicate? Can companies implement virtual teams with the same confidence they have when they assign workers to collaborate on group tasks through traditional face-to-face meetings? Questions like these are increasingly important for managers as virtual teams become more common. The findings of research in recent years are not encouraging. Much of this research suggests that groups using computer-mediated communication systems (CMCS) communicate less effectively in many circumstances than groups meeting face-to-face. For example, Hightower and Sayeed (1995, 1996) found that virtual teams exchange information less effectively than face-to-face groups.

However, many of these recent studies are limited in two important aspects. First, they used ad hoc groups or did not give their groups sufficient time to adapt to one another or the communication medium. Recent evidence suggests that when virtual teams are given sufficient time to develop strong intragroup relationships and to adapt to the communication medium, they may communicate as effectively as face-to-face groups (Chidambaram, 1996). A second limitation of the CMCS literature is the predominance of studies using synchronous (same time) rather than asynchronous (different time) technologies. Asynchronous technologies, which include email and discussion forums, are probably more common in the business world than synchronous technologies (Kinney & Panko, 1996). Further, asynchronous technologies offer certain advantages for groups exchanging information and may allow group members to concentrate on message content. For example, individuals can take time to reflect on the message they receive and to carefully consider their responses.

In this study, teams using an asynchronous system are compared to teams meeting face-to-face. All teams are engaged in a specific information exchange task. The primary research question is whether teams using an asynchronous system develop social links or relationships (relational links) as strong as those in face-to-face groups. In the next section, computer-mediated communication systems are briefly described, focusing on the differences between synchronous and asynchronous systems. Next, the relevant literature on the effects of CMCS on groups is summarized, followed by the development of a set of hypotheses. The results of an experiment designed to test the hypotheses is described and, finally, the implications of the results are discussed.

COMPUTER-MEDIATED COMMUNICATION SYSTEMS

Computer-mediated communication systems (CMCS) are sociotechnical systems that support and enhance the communication-related activities of team members engaged in computer-supported cooperative work. The communication and coordination activities of team members are facilitated by technologies that can be characterized along the three continua of time, space, and level of group support (Alavi & Keen, 1989; DeSanctis & Gallupe, 1987; Johansen, 1988). Teams can communicate synchronously or asynchronously; they may be located together or remotely; and the technology can provide task support primarily for the individual

team member or for the group's activities. These computer-based communication technologies are utilized to overcome space and time constraints that burden face-to-face meetings, to increase the range and depth of information access, and to improve group task performance effectiveness, especially by overcoming "process losses" (McGrath & Hollingshead, 1993, 1994). Further, CMCS increase the range, capacity, and speed of managerial communications (Culnan & Markus, 1987). They can also "reduce or eliminate the expense and inconvenience associated with distributed work" (Galegher & Kraut, 1994, p. 111). One objective of using these technologies is to create comparable levels of communication speed and effectiveness as those achieved at traditional meetings.

CMCS provide support for either synchronous or asynchronous meetings. Synchronous meetings are spontaneous, where ideas are exchanged with little structure. Participants communicate with each other in such a way that it is sometimes difficult to attribute an idea to one participant or to establish the reason behind a particular decision. It is estimated that managers spend 60% of their communication time in synchronous meetings (Panko, 1992), which include face-to-face meetings, telephone calls, desktop conferencing, Web-based "chat rooms," and the Internet Relay Chat (IRC).

On the other hand, asynchronous meetings are more structured than synchronous meetings. These meetings rely more on documents exchanged among participants. Compared to synchronous meetings, asynchronous meeting participants have longer to compose their messages and, therefore, it is easy to attribute an idea to its originator and establish the reason behind a particular decision. However, asynchronous meetings require more time than synchronous meetings because information exchange takes longer. Asynchronous meetings are frequently used by groups in which at least one participant is in a remote location (Kinney & Panko, 1996). CMCS technologies that facilitate asynchronous meetings include electronic mail (email), Electronic Document Management, bulletin board systems, and Internet Usenet newsgroups. One study (Straub & Karahanna, 1990) indicated that email (the most popular medium of communication in the workplace) users who share pre-meeting information report more effective communication during the meeting.

Computer conferencing, which is a "structured form of electronic mail in which messages are organized by topic and dialogues are often mediated" (Baecker, 1993, p. 1; see also Hiltz & Turoff, 1978), can be asynchronous (such as bulletin board systems and Internet Usenet newsgroups) or synchronous (such as "chat rooms" and the IRC). The technology explored in this paper (MeetingWeb™) is an asynchronous computer conference technology and is explained in detail below.

VIRTUAL VERSUS FACE-TO-FACE TEAMS: THE IMPACT OF CMCS ON GROUPS

The effects of the reduced "communication modalities" on virtual team members and the circumstances in which these effects occur has been the focus of much of the CMCS research (McGrath & Hollingshead, 1994). Although not definitive in terms of specific effects, the research in this area suggests that CMCS groups

communicate differently than face-to-face groups (Chidambaram, 1996; Hightower & Hagmann, 1995; Hightower & Sayeed, 1995; Hiltz, Johnson, & Turoff, 1986; Kiesler & Sproull, 1992; McGrath & Hollingshead, 1994; Siegal, Dubrovsky, Kiesler, & McGuire, 1986; Wiseband, Schneider, & Connolly, 1995). While there is a plethora of research describing various technologies for computer-mediated communications, there is a lack of studies examining "sustained, project-oriented teamwork of the sort that is important in most real-world organizations" (Galegher & Kraut, 1994, p. 111). An analysis of CMCS communication characteristics is warranted.

The present study explores the role of a CMCS in facilitating communication among members of virtual teams. CMCS impose constraints on communication that are likely to affect a group's performance. People rely on multiple modes of communication in face-to-face conversation, such as paraverbal (tone of voice, inflection, voice volume) and nonverbal (eye movement, facial expression, hand gestures, and other body language) cues. These cues help regulate the flow of conversation, facilitate turn taking, provide feedback, and convey subtle meanings. As a result, face-to-face conversation is a remarkably orderly process. In normal face-to-face conversation, there are few interruptions or long pauses and the distribution of participation is consistent, though skewed toward higher status members (McGrath, 1990). CMCS preclude these secondary communication modes, thus altering the orderliness and effectiveness of information exchange (Hightower, Sayeed, Warkentin, & McHaney, 1997). Such communication modalities are constrained to a varying extent depending on the characteristics of the technological system. For example, electronic mail prevents both paraverbal and nonverbal cues, telephone conference calls allow the use of most paraverbal cues (but not nonverbal ones), while videoconferencing enables extensive use of both paraverbal and nonverbal cues.

Virtual teams are not able to duplicate the normal "give and take" of face-to-face discussion. For example, comments of group members using a synchronous CMCS sometimes appear to be out of context, or the conversation may appear to lack focus because multiple group members are "talking" at once. This is exacerbated by the inefficiency inherent in the use of a keyboard and the fact that people type and read at different rates (Siegal et al., 1986). Group members who type slowly or edit more thoroughly may find their comments are no longer relevant when they are ready to transmit them. Moreover, because everyone can transmit their comments simultaneously, group members may be required to process a large number of comments in a short period of time. For asynchronous CMCS, considerable delays typically occur between the time a message is sent and the time a reply is received. This may make it difficult to maintain a train of thought or a discussion theme.

The lack of nonverbal and paraverbal cues also reduces the richness of the information transmitted by virtual team members. Daft and Lengel (1986) defined media richness as "the ability of information to change understanding within a time interval (p. 560)." Rich media allow multiple information cues (the words spoken, tone of voice, body language, etc.) and feedback. It takes more time and effort by group members to achieve the same level of mutual understanding in a lean medium, such as CMCS, than in a rich one such as face-to-face communication.

There is substantial evidence that virtual teams communicate less efficiently than face-to-face groups (McGrath & Hollingshead, 1994; Hightower & Sayeed, 1995, 1996). Because exchanging information is more difficult, virtual teams tend to be more task oriented and exchange less social-emotional information, slowing the development of relational links (Chidambaram, 1996). Development of relational links is important because researchers have associated strong relational links with many positive outcomes including enhanced creativity and motivation, increased morale, better decisions, and fewer process losses (Walther & Burgoon, 1992).

McGrath's TIP theory (Time-Interaction-Performance) offered a means for understanding the development of relational links in groups (McGrath, 1990). According to TIP theory, groups perform three functions: (1) production, (2) member support, and (3) group well-being. The functions are achieved by carrying out activities in one of four modes:

Mode I: Activities related to choosing goals and objectives.

Mode II: Activities related to solutions of technical issues with regard to how to achieve the group's goals.

Mode III: Activities related to conflict resolution.

Mode IV: Activities related to execution of the requirements of the group's task.

Developing relational links involves performing activities related to the member support and group well-being functions. These activities include, for example, establishing position or group status of members, defining task roles of group members, and establishing norms for group interaction. Activities that define relational development are most common after a group experiences a significant transition, such as the group's inception or a change in membership. Established groups spend less time on relational activities and more time on task-oriented activities, and should be more efficient in accomplishing tasks. Because CMCS reduce the amount and richness of the information that can be exchanged, it is more difficult for virtual teams to complete relationship-developing activities compared to face-to-face teams.

A question that has been raised by some researchers relates to whether the limitations of computer-mediated communication systems prevent groups from developing relational links as strong as face-to-face groups or whether the limitations simply increase the time it takes for these relational links to develop (Chidambaram, 1996; Burke & Chidambaram, 1995; Chidambaram & Bostrom, 1993). These researchers argued that, with time, CMCS groups would overcome the limitations of the media and achieve the same level of relational links and, therefore, the same level of performance as face-to-face groups.

Therefore, comparative research studies should allow virtual teams sufficient time to develop the same level of relational links as face-to-face groups. Further, much of the research that has investigated relational links in virtual teams has used synchronous systems such as computer conferencing and group support systems with "colocated groups" (Chidambaram, 1996). In a synchronous meeting,

the effect of an inefficient communication medium would be felt to a greater extent than in an asynchronous meeting. Time pressures present in synchronous meetings are not necessarily present in asynchronous meetings. A participant in an asynchronous meeting has more time to consider his or her message, decide what to say, take the time necessary to convey his or her thoughts, and edit the message as much as necessary to achieve clarity. The receiver of the message can read it at his or her leisure and consider it carefully before responding. This allows more time to include social-emotional information in the message in addition to the information required to accomplish the task. However, due to the leanness of the medium and the limited modes of communication, it should still be more difficult to form strong relational links in groups using asynchronous CMCS than for face-to-face groups. Thus, our first hypothesis is:

H1: Face-to-face teams will exhibit stronger relational links than virtual (CMCS) teams.

Stronger relational links in groups have been associated with higher performance. The task used in this study is one that requires the groups to exchange information effectively. Previous studies have shown that both face-to-face groups and groups using synchronous CMCS exchange information poorly (Hightower & Sayeed, 1995, 1996; Stasser & Titus, 1985, 1987). Asynchronous CMCS provide a distinct advantage for this type of task over both synchronous CMCS and face-to-face communication. Group members can take the time necessary to compose clear and complete messages. As a result, time pressures or information load should not affect the group's performance.

Information exchange is also affected strongly by the group's internal dynamics or relational links. Two factors that affect information exchange are opportunity and motivation to contribute information (Hightower & Sayeed, 1996). Opportunity is affected in part by the effects of social status; group members of lower social status often don't have the same opportunities to contribute as higher status members. Motivation is affected by the willingness of group members to contribute information that may contradict their own opinions or those of other group members. Motivation is also affected by whether the group member feels he has a stake in the group's outcome. Despite the advantages that asynchronous CMCS offer for exchanging information, stronger relational links will allow face-to-face groups to exchange information more effectively. Our second hypothesis is divided into two parts:

H2a: Face-to-face teams will exhibit higher performance results, as indicated by information exchange effectiveness, than virtual (CMCS) teams.

H2b: Information exchange effectiveness will be positively associated with relational links.

The measure of information exchange effectiveness used in this study is identical to the one used by Hightower and Sayeed (1995, 1996), described in the Instrument section below.

THE STUDY

This research study used teams comprised of three members who completed an information-sharing task. Teams used either asynchronous CMCS or face-to-face communications. The following sections describe the task, the subjects, the CMCS itself, the research procedure, and the research instrument.

The Task

We adapted a case from one described by Pfeiffer and Jones (1977), which involves choosing the most likely suspect in a murder mystery. The subjects were supplied with the case description and information about three suspects in a murder. The subjects were told that the descriptions were the result of their initial investigation, and that they were now asked to collaborate with two other investigators who have also performed preliminary investigations in order to solve the crime. Examples of the information contained in the case are shown in Table 1. This established task was selected rather than a business-oriented case because it does not require background functional knowledge such as accounting, finance, marketing, etc., and therefore, isolates the communication aspects of solving the simple task. The case can be solved using common sense, and our experience has shown that this type of case engenders a high level of interest and motivation among the students used in this experiment (Hightower & Sayeed, 1995, 1996).

The case description was a half page in length and mentioned eight attributes considered important for identifying the murderer. The suspect descriptions listed attributes about the suspects that were consistent with the suspect having committed the crime and attributes that were not consistent with the suspect having committed the crime. The exchange of unique information was a key research variable. Some of the items appeared on all three subjects' descriptions within one team (common information) while other items appeared on only one team member's description (unique information). The unique information could not be known and considered by the entire team unless the member who was privy to it chose to share it with the rest of the group. This information exchange was a key research variable.

This task was an "intellective task" according to Laughlin's (1980) typology, which is a task with a correct answer to be found by the group. Further, because the correct answer can be found using common sense, the task can be categorized as relatively low on the complexity continuum—once the team members each "lay their cards on the table," the solution is apparent. In other words, the fundamental requirement to solve the problem is effective communication.

Subjects

The subjects, who were undergraduate students at three different large universities, completed the experiment as part of a course requirement. The participating universities included Northeastern University, which is a large private university in Boston; and Kansas State University and San Francisco State University, both of which are large state universities. The course grade the subjects received was based, in part, on their participation in the experiment, providing incentive to solve the mystery, which required collaboration among the team members. Thirty-three subjects (comprised entirely of students at Northeastern University) collaborated

Table 1: Information contained in the Murder Mystery Case.

Case Characteristic	Incriminating	Vindicating
Your initial investigation has revealed that the murderer entered the house through a secret passage that bypassed the security system.	Suspect was one of the contractors for the original construction.	Suspect had no apparent knowledge of the house.
The victim's allergic reaction to bee stings was not common knowledge.	Suspect was the victim's doctor.	Unknown if suspect had any knowledge of the allergy.

in face-to-face meetings two days after their clues were disclosed to them. These three-person face-to-face team members were randomly assigned to their respective teams. Another 39 subjects (three-person virtual teams comprised of one student randomly assigned from each university) collaborated with the support of MeetingWeb™ software, described below. A total of 13 virtual teams and 11 face-to-face teams participated in the study, comprised of 72 individual team members who completed the survey instrument. Thus, the sample size was 72. These individuals and their teams were comparable in all meaningful ways, as discussed below.

Procedure and Teams

Subjects in the face-to-face groups were provided with the case description two days before their meeting time and were told to study the clues carefully. On arrival to their meeting, subjects surrendered the case description (with the suspect clues) to the experimenter. The groups were told that their goal was to discuss the case and to try to form a consensus as to the most likely suspect in the crime. They then met for approximately 25 minutes, until each team reached a consensus decision. A post-test was administered at the end of the meeting.

The virtual teams (or "CMCS groups") obviously required considerably more than 25 minutes to complete their collaboration due to the asynchronous medium, which required "turnaround time" to read and respond to messages posted to their computer conferences. The need for additional time was exacerbated by differences in time zones and class schedules, and the need to access the conference from university computer labs. The virtual teams were provided with the case descriptions and were given three weeks to complete their collaboration and solve the murder mystery. They were told that their partners may be at other universities, but no information concerning the location of their partners was provided by the researchers, the software, or by their usernames. As they collaborated, subjects were allowed to retain their case descriptions (with the suspect clues). At the completion of their three-week interval, the post-test was administered.

These 72 individuals and their 24 teams were comparable based on several factors. All 72 subjects were undergraduate business majors who were given a course grade incentive to succeed in solving the murder mystery. Beyond the individual demographic parity and motivational equality, the teams themselves were

very similar except for the communication medium. All teams were comprised of three individuals with no assigned leader. All teams engaged in discussion concerning the murder and the available clues. All subjects were given sufficient time to evaluate the clues individually and to collaborate with teammates. Although the face-to-face teams were given only two days to evaluate the clues versus the three-week time allowance given the virtual teams (to compensate for the constraints imposed by time differences and technology), all participants reported that they had sufficient time to evaluate the clues and consider the mystery.

The System

The asynchronous CMCS used in this study was MeetingWeb™, a secure, moderated bulletin board system accessible from the World Wide Web. MeetingWeb™ is a custom proprietary collaboration software system residing on the Northeastern University College of Business Administration (CBA) web server and accessible to anyone with a connection to the Internet (such as an ISP), any web client (browser) software (such as Netscape), a valid username, and a valid password. It is a computer conferencing system that provides textual and graphical communication capabilities to its users.

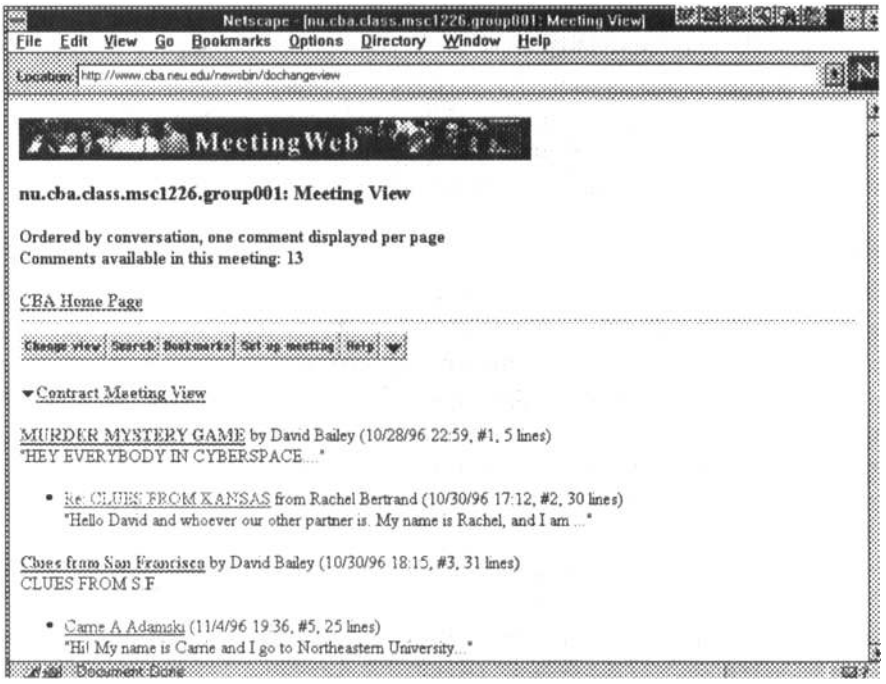
MeetingWeb™ was designed to have a familiar look and feel to users of the World Wide Web, a new standard platform for computer communications. "The interface *is* the system for most users. However well or poorly designed, it stands as the representation of the system" (Kendall & Kendall, 1995, p. 635). The MeetingWeb™ system is easy to use; pilot tests confirmed that the participants could learn and use the system with only a brief introduction. The system permits group members to communicate by "posting" messages in a hierarchical manner. A "comment" (message) can be posted as a new "topic" (leftmost in the hierarchy), as a reply to a topic (indented under that topic), or as a reply to a reply. Usenet newsgroups term this structure a "threaded discussion." The indenting scheme appears as a familiar outline format. This intuitive structure makes the organization of the messages clear and unambiguous. Furthermore, the source of each message is clearly identified; the system provides eponymity.

Characteristics of the system other than its ability to facilitate communication among team members did not appear to be a factor in the study. Parenthetically, the system's default feature of displaying only *<new or previously unread>* comments, unless reconfigured to show *<all>* comments, may have slowed the adoption of the software by a few participants until the feature was demonstrated to them. (They thought their previously read messages were "gone!") This unanticipated anecdotal factor, however, no longer created a distinction among groups once all participants were "retrained" to reconfigure their views.

MeetingWeb™ was developed by and licensed from CitySource Inc., and has been further customized for CBA's use with custom extensions. Figure 1 shows a representative screen of the MeetingWeb™ conference system. More information about MeetingWeb™ can be found at http://www.cba.neu.edu/MeetingWeb.

The near ubiquity of the World Wide Web today makes MeetingWeb™ (and other web-based CMCS) extremely accessible to a broad audience. Further, the

Figure 1: Sample screen from MeetingWeb™.



protocol of the web (hypertext transfer protocol, or HTTP) is hardware independent, so it provides an essentially universal platform for communication support among virtual team members.

The Instrument

Three sets of variables were measured using the post-test instrument: Measures of Relational Links, Group Performance Measures, and User WWW Use variables. Three relational variables were measured: Group Cohesiveness, Perceptions of Group Interaction Process, and Satisfaction with Group Outcomes (see Table 2).

Cohesiveness is defined as the extent to which the group members are attracted to the group and each other, and has been found to be related to many desirable traits in groups (Chidambaram, 1996). Perceptions of a group's interaction process include such aspects as trust, openness, and participatory equality. Positive perceptions of the interaction process have been associated with process gains while negative perceptions are associated with process losses (Steiner, 1972). Satisfaction with outcomes is related, in part, to the attitudes of the group members towards one another (Chidambaram). As group members develop more positive attitudes towards one another, their satisfaction with the group's work increases. Cohesiveness was measured using Seashore's (1954) Index of Group Cohesiveness, while the remaining variables were measured using an instrument developed by Chidambaram.

Table 2: Factors influencing relational links among team members.

Relational Variable	Definition
Perceptions of group cohesiveness	The extent to which the group members are attracted to the group and to each other
Perceptions of group interaction process	Includes aspects of trust, openness, and participatory equality
Satisfaction with group outcomes	Related to positive attitudes of group members toward one another

Source: Chidambarum (1996)

Two types of data were collected to measure group performance. Each of the subjects also individually indicated who they thought was the most likely suspect and rated the certainty of this preference on a 7-point Likert scale. First, each group's choice of the most likely suspect was indicated. Second, subjects individually wrote down everything they knew about the three suspects, including what they learned from their own material and what they learned through group discussion. A measure of information exchange effectiveness was obtained by counting the number of unique information items on each subject's post-test that they could not have known prior to discussion. This number was then divided by the total possible number of unique information items the subject could not have known before discussion, the result being the unique information-exchanged variable. The measure of information exchange effectiveness is identical to the one used by Hightower and Sayeed (1995, 1996).

Data were also collected from the CMCS group members to measure the subjects' level of experience with CMCS and the WWW. An excerpt of the instrument used for the virtual teams appears in the Appendix. The instrument used for the face-to-face teams was nearly identical.

RESULTS

H1 proposes that face-to-face groups will have stronger relational links than CMCS groups. Data analysis supported this hypothesis. A MANOVA indicated a difference in the three relational variables between the two team categories (F=3.05, p=.0422). Table 3 shows the results of ANOVA performed for each of the relational variables. Cohesion, Perceptions of Group Interaction Process, and Satisfaction with Outcomes are all significant. The means for the three relational variables are shown in Table 4. Face-to-face groups reported a higher degree of cohesion, were more satisfied with the decision process followed by the groups, and were more satisfied with the team's outcome.

H2a states that face-to-face groups will exchange information more effectively than CMCS groups. Data analysis did not support this hypothesis. An ANOVA indicated no statistically significant difference in the proportion of unique information items exchanged between the two team types or categories (F= 3.84, p= .065). The mean of the dependent variable (the proportion of unique

Table 3: Results of ANOVA for Hypothesis 1.

Variable	F (df=1, 24)	p-value
Cohesion	7.78	.0107
Perceptions of Group Interaction Process	7.36	.0127
Satisfaction with Outcomes	11.64	.0025

Table 4: Means of relational variables.

Dependent Variable	Remote (n=13)	Face-to-Face (n=11)
Cohesion (25)	16.7	19.7
Perceptions of Group Interaction Process (35)	23.8	29.0
Satisfaction with Outcomes (28)	19.8	25.2

Values in parentheses show maximum values for each dependent variable.

information items exchanged) for the face-to-face groups (.439) was higher than the mean for the virtual teams (.318). Although not statistically significant, face-to-face groups exchanged more unique information in one meeting than CMCS groups did in three weeks of online communications.

H2b proposes that information exchange will be higher for groups with stronger relational links. A stepwise regression analysis, with the unique information exchanged as the dependent variable and the four relational links as the independent variables, was conducted to test this hypothesis. The results are shown in Table 5. The only significant predictor to enter the model at a .05 level of significance was the Perceptions of Group Interaction Process variable (F=5.57, p=.021). The coefficient indicates that groups with higher cohesion exchanged information more effectively than groups with lower cohesion. However, the resulting R^2 was only .072, indicating that a substantial proportion of the dependent variable remained unexplained by the relational links.

DISCUSSION AND CONCLUSIONS

The findings of the present study provide several insights into the communication process of virtual groups. First, the advantages of collaboration technologies may not always outweigh their disadvantages. While collaboration technologies have the capability of creating a communication environment for virtual partners who are separated by time and/or space, they may hinder the development of a strong sense of cohesion and satisfaction with the group's interaction process. Second, the strength of relational links is positively associated with the effectiveness of information exchange.

Therefore, the loss of relationship building in virtual teams implies that the use of traditional meetings as a supplement to the use of CMCS might be useful

Table 5: Results of regression analysis of relational variables on unique information exchanged variable.

Variable	Coefficient	Partial R^2	t-Statistic	p-value
Perceptions of Group Interaction Process	0.01	.072	5.57	.021

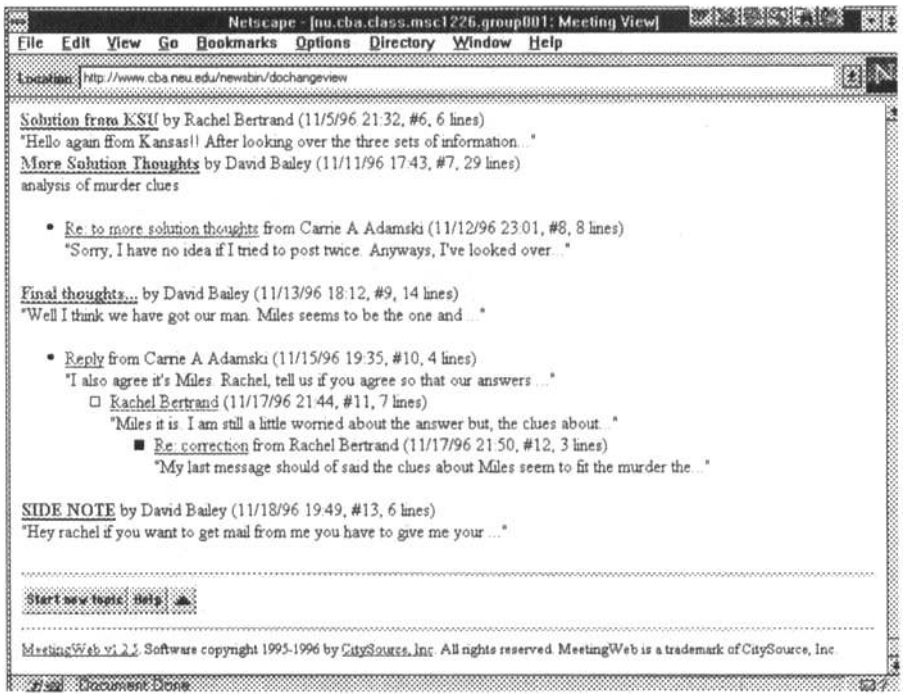
(preferably in an early stage) for creating a sense of belonging to a group. McGrath (1990) suggested that teams spend proportionally more time on relationship development activities during periods of significant transition, such as the group's inception or a change in membership. Established groups spend more time on task-oriented activities. In the absence of the ability to have an initial face-to-face meeting, other avenues for building strong relationships are advised to ensure the cohesiveness and effectiveness of the team's interaction. Figure 2 shows both task-oriented communication and relational development messages for one virtual team.

The findings of this study are exploratory in nature. Using a CMCS was a unique experience for most of these participants. It is likely that people would become more effective using a CMCS with practice (Hollingshead, McGrath, & O'Connor, 1993). Frequent users of discussion forums on the Internet and online services develop ways to convey more meaning in their messages as a means of replacing paraverbal and nonverbal cues. The use of symbols called "emoticons" is one example (McGrath & Hollingshead, 1994). One only needs to spend some time reading the messages posted on some of the more controversial online forums to determine that quite detailed and emotional discussions are possible. Asynchronous media such as email, electronic bulletin boards, and the MeetingWeb™ system used in this study are more conducive to carefully constructed dialogue than synchronous conferencing systems such as GroupSystems V and videoconference systems. This is supported by the data in Table 6, which shows the correlations between self-reported User WWW/computer experience variables and the three relational variables. Only two correlations are significant at the .05 level. WWW use was positively correlated with Perceptions of Group Interaction Process and Cohesion. This means that relational links were stronger in groups whose members reported more frequent use of the WWW than other groups. Being more familiar with the WWW may allow frequent users to concentrate on their interaction with other group members rather than on the system itself.

CREATING VIRTUAL TEAMS : GUIDELINES FOR ORGANIZATIONS ON THE BLEEDING EDGE

While face-to-face teams reported greater satisfaction with the group interaction process, the exchange of information was no more effective than that in virtual teams. In other words, there was no statistically significant difference between the effectiveness of communication (as measured by information exchange), but the traditional teams have more positive perceptions of the interactivity and the results. Therefore, since virtual teams are becoming a necessary tool, organizations must strive to bolster the satisfaction level of CMCS. If this were done, there

Figure 2: Illustrative screen from one virtual team.



would be no significant drawback to the use of virtual teams, which can be made more acceptable and satisfying in several ways.

While a large amount of research about technology-supported work groups has been conducted and published, there are relatively few axioms that can be identified, due to the complexity of this technological-social realm. Deep understanding of the social and psychological aspects is probably more elusive. It may also be more difficult to codify the social and psychological aspects than the technological factors employed in creating and managing CMCS. Nevertheless, an attempt to identify some of the general principles that can be used by organizations seeking to capture the advantages of these emerging technologies is warranted.

Jay (1976) suggested a set of guidelines for organizing and conducting a meeting that offer useful insights for the CMCS designer. He started by insisting on defining the objective of the meeting, and defined ways to assess each agenda item. He noted that proper preparation is required to ensure the group's success, including the identification of appropriate participants, the distribution of all appropriate documents beforehand, and establishment of the role of the leader. Among his guidelines for conducting a meeting were "draw out the silent," "protect the weak," and "encourage the clash of ideas."

The decision to implement CMCS is often based on necessity stemming from geographic separation of group members. Ideally, however, the unique characteristics of CMCS when compared to face-to-face and other communication modes should dictate when they are used. Zack (1993) showed that the highly

Table 6: Correlation of relational variables with WWW use of team members.

	Outcomes	Process	Cohesion
WWW use	.4587	**.5667**	**.6023**

Bold values are significant at .05 level.

interactive nature of face-to-face meetings makes this mode "appropriate for building a shared interpretive context among group members, while [CMCS], being less interactive, is more appropriate for communicating *within* an established context" (p. 207), such as ongoing discourse consisting primarily of "adjacency pairs." Ongoing groups have an established culture and set of routines, and may have a greater commitment to achieving effective communications. Further, Zack suggested that while "social presence" (a sense of belonging) is diminished in CMCS, it is the lack of interactivity that primarily constrains computer-mediated communication.

Another factor to consider when creating effective virtual teams is the psychological profile and personality characteristics of the specific team members. In order to be successful in this environment, participants must possess patience, persistence, and perseverance along with a certain degree of tolerance, flexibility, and understanding. The traditional methods of control and influence that we are socialized to utilize as children may not be effective in computer-mediated environments. Users of CMCS must exercise leadership and influence with little means of social control, and some members may become "lost in cyberspace" and may "drop out" of virtual teams in the void of familiar communications patterns. Care must be exercised to develop and foster familiarity and proficiency with these new tools and techniques of social interaction. This represents an entirely new paradigm of communication that must be learned, much like the rules and methods of face-to-face communications that must be learned by all children.

The most important goal of CMCS is to foster interaction, inclusion, and participation (McGrath, 1991), which are all related to the feeling of "being there," or social presence. Social presence defines the extent to which a communication medium allows participants to experience each other as being psychologically close or present (Fulk & Boyd, 1991). Face-to-face communication, for example, is characterized by social cues such as nonverbal and paraverbal communications channels and continuous feedback (Rogers, 1986). The success of computer-mediated communication systems lies in part on their ability to provide the participants with socioemotional content sharing. Clearly, videoconferencing offers a greater opportunity for sharing these social cues than text-based communications modes, yet the latter do not entirely lack such cues (Rice & Love, 1987; Walther & Burgoon, 1992). Designers of CMCS should work explicitly to incorporate innovative methods and channels for sharing various cues between participants. For example, users might be trained in the use of "emoticons" (also known as "smileys") to increase the media richness of their communications. Numerous linguistic conveniences in computer messages are evident in the culture of CMCS users, such as "BTW" for "by the way" and "IMHO" for "in my humble opinion," can also create a more familiar or informal sense for the communications

exchange, which can serve to increase social presence. Whereas many first-time users of CMCS such as email might write formal messages that read like a business letter, the messages of high-volume users usually evolve into a far more familiar tone with personal comments that serve to create a greater sense of actually speaking with someone.

Kraut, Fish, Root, and Chalfonte (1993) suggested that whereas formal communication is characterized by preset agendas between arranged participants scheduled in advance with "impoverished content," informal communication often occurs spontaneously with no arranged agenda between random participants with richer content. Further, they showed that informal encounters create a common context and perspective that support planning and coordination of group work. Without informal exchanges, "collaboration is less likely to start and less productive if it does occur" (Kraut et al., p. 313). Participants in purely computer-mediated systems who have never met and exchanged informal conversation have exhibited a strong desire to do so when given the opportunity. Whenever the environment affords the opportunity, it would behoove CMCS developers to facilitate informal face-to-face contact early in the project life cycle.

Managers who wish to introduce these technologies into the workplace should capitalize on the beneficial differences inherent in computer-mediated communications and mitigate the negative differences. New communication technologies such as the MeetingWeb™ allow organizations to create virtual teams as needs arise without regard for the geographical location of the team members. Many of the technologies are still evolving and unique issues arise as new organizational structures are implemented. As a result, each scenario is likely to provide novel problems, and modern managers must be flexible to restructure their socio-technical system as such problems are encountered. This requires that managers become familiar with the strengths and limitations of the relevant technologies. This study highlighted some of the characteristics of a Web-based conferencing system. The relevance of this type of system will grow as corporate "intranets" become a widespread platform for intraorganizational communications.

FUTURE RESEARCH

The findings of the present study suggest several avenues for future research. First, this study might be replicated with experienced users to determine whether significantly higher levels of computer familiarity and web use might contribute to any interesting differences between face-to-face and virtual teams. Second, not all teams are strictly virtual or strictly face-to-face. Examination of various combinations of amalgamated teams (with both types of interaction for all members or with only some members using one or the other medium exclusively) might be illustrative.

Third, the group's ability to perform the three group functions described by the TIP theory can be investigated (McGrath, 1991). For example, this may involve a detailed analysis of the group interactions to track what activities are performed by the groups and how well they are accomplished. The development of relational links may be tracked over time to determine whether relationship developing activities are as effective in CMCS groups as in face-to-face groups and

whether CMCS groups can achieve the same level of relational links as face-to-face groups.

Another avenue of research is to examine which media virtual team members select for specific tasks and whether they choose appropriate media based on media richness or social presence. A related question is how a virtual group's performance is affected by the use of different combinations of communication media. Another topic of interest is the effect of cultural factors on virtual team processes and outcomes. A comprehensive contingency framework might be developed to incorporate many of these relationships between and among system and environmental factors, which could serve as a guide to CMCS researchers and practitioners alike.

Another factor that may affect how users accept CMCS is organizational subcultures. Research has suggested that membership in a particular subculture may be more useful for predicting a user's satisfaction with an information system than other variables such as demographic measures (Kendall, Buffington, & Kendall, 1987). The implications of subcultures for the use of CMCS is unknown although it might be reasonable to assume that, as with satisfaction with other information systems, satisfaction with CMCS may be affected by subculture membership. However, with virtual teams an additional factor that must be considered is that team members may not even be members of the same organization or may be members of independent divisions of the same organization. Thus, the organizational cultures of the team members may be very different. The effect this may have on a team's performance and satisfaction remains an interesting and largely unanswered question. [Received: May 21, 1996. Accepted: July 14, 1997.]

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APPENDIX: SURVEY INSTRUMENT (FOR VIRTUAL TEAMS)

Group Cohesiveness

1. Do you feel that you were really a part of this team?
   - ❑ Really a part of my work team
   - ❑ Included in most ways
   - ❑ Included in some ways, but not in others
   - ❑ Didn't feel I really belonged too much
   - ❑ Didn't feel I belonged at all

2. If you had a chance to do the same kind of work again, how would you feel about moving to another team versus staying in the same team?
   - ❑ Would want very much to stay in the same team
   - ❑ Would rather stay in the same team than move to another team
   - ❑ Would make no difference to me
   - ❑ Would rather move to another team than stay in the same team
   - ❑ Would want very much to move to another team

How does this group compare with other teams on each of the following points?

	Very Much Better	**Better Than Most**	**About The Same**	**Worse Than Most**	**Very Much Worse**
The way people:					
3. got along together	❑	❑	❑	❑	❑
4. worked together	❑	❑	❑	❑	❑
5. helped each other	❑	❑	❑	❑	❑

Perceptions of process

To a very little extent			To some extent			To a very great extent
1	2	3	4	5	6	7

6. Were team members committed to the goals and objectives of the team (during this project)?

1	2	3	4	5	6	7

7. To what extent was trust exhibited within the team (during this project)?

1	2	3	4	5	6	7

8. Did members have a strong sense of belonging to the team (during this project)?

1	2	3	4	5	6	7

9. Did team members recognize and respect individual differences and contributions (during this project)?

1	2	3	4	5	6	7

10. Were team members open and frank in expressing their ideas and feelings (during this project)?

1	2	3	4	5	6	7

Satisfaction with Outcomes

Strongly Disagree			Undecided			Strongly Agree
1	2	3	4	5	6	7

11. Overall, I was personally satisfied with the team decision process.

1	2	3	4	5	6	7

12. This team produced effective and valuable results during this project.

1	2	3	4	5	6	7

13. I agree with the final decision of the team.

1	2	3	4	5	6	7

14. Overall, the quality of this meeting team's interaction was high.

1	2	3	4	5	6	7

Yourself

15. Describe (rate) your *general* skill level with computers:

0	1	2	3	4	5
None ("illiterate")	Very Low ("newbie")	Low (novice)	Medium (intermediate)	High (advanced)	Very High (expert)

16. Describe (rate) your skill level with using the *World Wide Web*:

0	1	2	3	4	5
None ("illiterate")	Very Low ("newbie")	Low (novice)	Medium (intermediate)	High (advanced)	Very High (expert)

17. How often do you use the WWW?

0	1	2	3	4	5
Never	Rarely	Occasionally or Monthly	Regularly or Weekly	Frequently (Almost Daily)	"Constantly" or Daily

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