

Virtual Teams: A Review of Current Literature and Directions for Future Research¹

Anne Powell

Southern Illinois University Edwardsville

Gabriele Piccoli

Cornell University

Blake Ives

University of Houston

Abstract

Information technology is providing the infrastructure necessary to support the development of new organizational forms. Virtual teams represent one such organizational form, one that could revolutionize the workplace and provide organizations with unprecedented levels of flexibility and responsiveness. As the technological infrastructure necessary to support virtual teams is now readily available, further research on the range of issues surrounding virtual teams is required if we are to learn how to manage them effectively. While the findings of team research in the traditional environment may provide useful pointers, the idiosyncratic structural and contextual issues surrounding virtual teams call for specific research attention.

This article provides a review of previously published work and reports on the findings from early virtual team research in an effort to take stock of the current state of the art. The review is organized around the input – process – output model and categorizes the literature into issues pertaining to inputs, socio-emotional processes, task processes, and outputs. Building on this review we critically evaluate virtual team research and develop research questions that can guide future inquiry in this fertile area of inquiry.

ACM Categories: H.4.3, H.5.3, K.4.3

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Introduction

Global competition, reengineered product life cycles, mass customization, and the increased need to respond quickly to customers' needs are just some of the more pronounced trends currently driving organizational change (Grenier & Metes, 1995; Miles & Snow, 1986; Miles & Snow, 1992). Increasingly, successful organizations are those organized in a dynamic network form that, using Information Technology (IT) as a primary enabler, can more quickly adapt to ever-changing competitive landscapes and customer requirements (Davidow and Malone, 1992; Jarvenpaa & Ives, 1994).

One of the building blocks of these successful organizations is the *Virtual Team*. Technological support for virtual teams and collaboration in distributed environments is now viable and widespread (Constant et al., 1996). As a consequence, a growing number of organizations are implementing them or plan to implement them in the near future (Lipnack & Stamps, 1997; McDonough et al., 2001) and their use is expected to continue to grow (Carmel & Agarwal,

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2001; McDonough et al., 2001). While virtual teams offer a wide range of potential benefits to organizations (Townsend et al., 1998), implementations will be at risk if organizations fail to adequately address the many challenges present in the virtual context (Iacono & Weisband, 1997; Victor & Stephens, 1994).

The increasing popularity of virtual teams has spurred a parallel growth in research examining various aspects of virtual team adoption and use. To identify relevant work, a computer search using ABI/INFORM was conducted searching on the terms "virtual team", "computer supported collaborative work", and "computer mediated communication" between 1991 and February 2002. In addition, resources on virtual teams located on the ISWORLD web site were utilized. Finally, we examined a recent review (Fjermested & Hiltz, 1998-1999) of the extensive literature on group support systems (GSS) in order to identify whether any GSS research involved the use of teams that could be classified as "virtual teams."² All articles identified were read to determine if the unit of analysis in the study met our definition of virtual team (see next section). Altogether, forty-three papers were identified as meeting the criteria for inclusion and were analyzed in this literature review

Recent research has studied virtual team inputs, socio-emotional processes, task processes, and outcomes. Much of this literature focuses on comparisons of virtual teams and traditional teams.³ While traditional teams research offers valuable theoretical background and a starting point for virtual team research, virtual teams with their unique managerial, technical, and social challenges call for additional, specialized research. In the last 10 years, a significant amount of research on virtual teams has been conducted, but no major review of this body of knowledge has been published to date. The goal of this article is to provide a comprehensive overview of the existing literature, identifying the major areas of focus and the findings. Building on the literature review, we then identify gaps in current research and provide suggestions for future research.

The article is organized as follows: The next section provides relevant definitions. The following section organizes previously published work and its findings into issues pertaining to inputs, socio-emotional processes, task processes, and outputs. The article concludes with the development of research questions

² The two latter resources provided us with references to relevant research predating 1991.

³ For the purposes of this article, we will refer to teams in traditional environments as traditional teams. Traditional teams are comprised of members who work together in the same location and have relatively easy access to face-to-face communication on which they rely as their primary mode of communication (McDonough et al., 2001). Other terms that have been used as synonyms include face-to-face teams, co-located teams, and collocated teams.

that hold significant potential to advance our understanding of virtual team design, processes, and effectiveness.

Virtual Teams

Traditionally, both the terms "team" and "group" have been used to describe small collections of people at work. While the two terms are often used interchangeably in traditional and virtual team research (Cohen & Baily, 1997; Langfred, 1998; Sundstrom et al., 1990), this duality in terminology has increasingly been questioned (Fisher et al., 1997; Katzenbach & Smith, 1993). Several authors suggest that the term "team" should be reserved for those groups that display high levels of interdependency and integration among members. We accept this distinction and use the term "team" in its stricter sense adopting a widely accepted definition: "A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationship across organizational boundaries." (Cohen & Baily, 1997, p. 241). This definition is general enough to capture traditional as well as virtual teams while precisely identifying the defining features of a team: its unity of purpose, its identity as a social structure, and its members' shared responsibility for outcomes.

The adoption of this definition limits the scope of our work. As a consequence, we do not review research that focuses on computer-supported collaborative workgroups that meet for one or two sessions of very limited duration, or where no shared responsibility for outcomes is identified.

We define virtual teams as groups of geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational tasks (Alavi & Yoo, 1997; DeSanctis & Poole, 1997; Jarvenpaa & Leidner, 1999). While they can be ongoing, virtual teams are often assembled on an "as needed basis" to cooperate on specific deliverables, or to fulfill specific customer needs (Chase, 1999; Lipnack & Stamps, 1997). Distinctive features of virtual teams include their preponderant – and at times exclusive – reliance on IT to communicate with each other, their flexible composition, and their ability, if necessary, to traverse traditional organizational boundaries and time constraints. Virtual teams are often assembled in response to specific needs and are often short lived (Chase, 1999). This is not a defining characteristic of the virtual team but rather a byproduct of the specialized function they often serve.

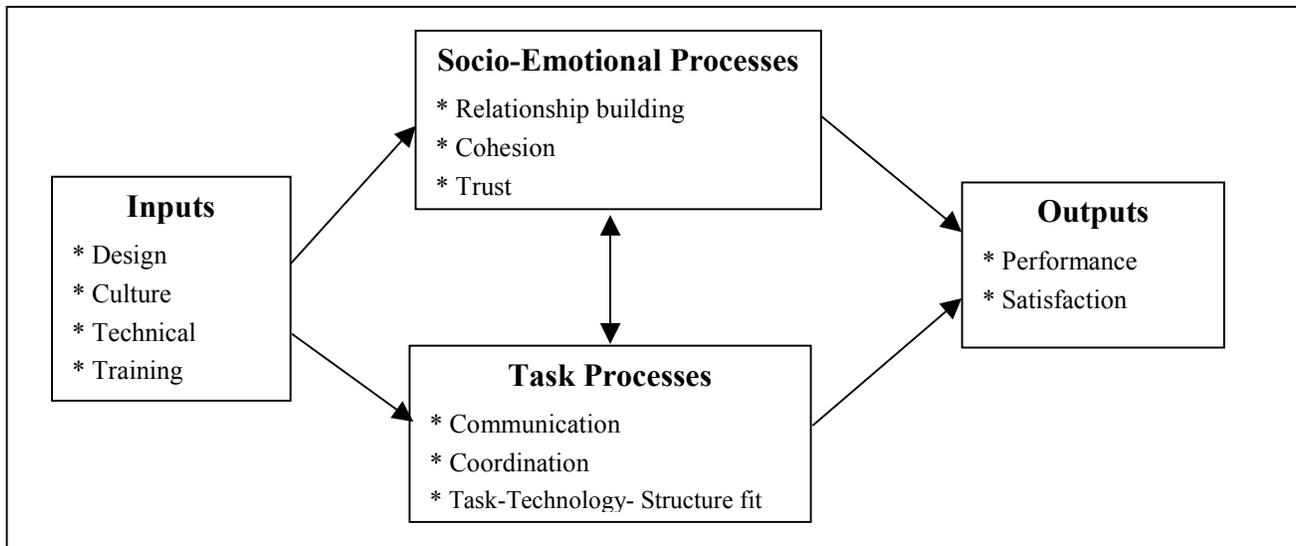


Figure 1. Focus of early virtual team research

A particular type of virtual team that has received significant research attention is the global virtual team (e.g., Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001), distinguished because it draws members that work and live in different countries and are culturally diverse.

Virtual Team Literature: Issues

Appendix A presents references to the forty-three articles and information on several dimensions, including the variables studied, the duration and size of the team, the theoretical grounding for the investigation, and a brief summary of results. Consistent with previous virtual teams work, the review is organized around a life cycle model (Saunders, 2000) which includes four general categories of variables: inputs, socio-emotional processes, task processes, and outputs. Figure 1 presents the major issues that early virtual team work has identified in each of these categories.

Inputs

Inputs represent the design and composition characteristics of the virtual team and the endowment of resources, skills, and abilities with which the team begins its work. Inputs that have been investigated by previous research can be grouped under the labels of design, culture, technical expertise, and training.

Design. The design of the virtual team and the structuring of its interactions, particularly early on in the team's life, have been found to impact the development of a shared language and shared understanding by team members. Various designs include different levels of face-to-face (FtF) interaction,

planning of activities and the use of communication media, and the articulation of goals, structures, norms, and values.

Traditional teams have generally been found to outperform their virtual counterparts with respect to the ability to orderly and efficiently exchange information and engage in effective planning (DeMeyer, 1991; Galegher & Kraut, 1994). Thus, previous research has studied interventions designed to structure virtual team interaction to limit this difficulty. Evidence suggests that team-building exercises (Kaiser et al., 2000), the establishing of shared norms (Sarker et al., 2001; Suchan & Hayzak, 2001), and the specification of a clear team structure (Kaiser et al., 2000) contribute to virtual team success. When feasible, using periodic FtF meetings during project planning, while limiting the use of electronic communication to coordinate tasks (i.e., scheduling, sharing results, and sharing materials and documentation) appears crucial to the development of the team and to its successful interaction (DeMeyer, 1991). Discussion and team interaction in virtual environments can be lengthy and confusing, leading to poorer comprehension and understanding when compared to traditional FtF interaction (Bordia, 1997). As a consequence, some authors see periodic FtF meetings among virtual team members as necessary to successful team development (Saunders, 2000). Early FtF meetings during the team's launch phase have been found to improve the team's project definition (Ramesh & Dennis, 2002), to foster socialization, trust, and respect among team members (Maznevski & Chudoba, 2001; Robey et al., 2000; Suchan & Hayzak, 2001), and to enhance the effectiveness of subsequent electronic

communication (Krumpel, 2000; Majchrzak et al., 2000a).

Designs that foster knowledge sharing, whether by FtF meetings or electronic communication, benefit the team by ensuring that a common understanding and language is established. Once a shared language is instituted, the members of the virtual team appear to be able to complete ambiguous tasks relying on electronic communication (Majchrzak et al., 2000a). Conversely, when the team is unable to establish a shared knowledge base – achieved when all members possess the same information *and* also know that teammates possess the same information – numerous communication problems ensue including failure to communicate, unevenly distributed information, difficulty understanding the importance of information to various team members, and difficulty interpreting the meaning of silence or non-reply by others (Crampton, 2001). When FtF meetings are not feasible, a shared language and shared mental models may be built by relying on a common database providing all information pertinent to the team assignment (Suchan & Hayzak, 2001).

Designing team interaction that requires the setting of goals and strategies leads to the achievement of shared mental models. Setting intermediate as well as final goals and clearly articulating them has been shown to improve performance (Kaiser et al., 2000; Kayworth & Leidner, 2000). Setting the team's strategy and agenda for task completion and formulating a media strategy also contributes to improved performance (Malhotra et al., 2001; Suchan & Hayzak, 2001).

Cultural differences. A number of virtual team studies have examined the role of cultural differences among team members. Cultural differences appear to lead to coordination difficulties (Johansson et al., 1999; Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001; Robey et al., 2000), and create obstacles to effective communication (Kayworth & Leidner, 2000; Sarker & Sahay, 2002; van Ryssen & Godar, 2000). Cultural and language differences are common in global virtual teams. But subtler differences among team members from different regions of the same country may be enough to negatively impact a virtual team (Robey et al., 2000). The negative effect of cultural differences may be mitigated by an effort to actively understand and accept the differences (Robey et al., 2000; Sarker & Sahay, 2002), although McDonough et al., (2001) found project management challenges such as setting goals, budgets, schedules, resources, and identifying needs were more related to distance between members rather than to cultural differences.

Technical expertise. Not surprisingly, virtual team researchers that have investigated the impact of

members' technical expertise have found evidence of its effect on team performance and individual satisfaction. Specifically, a lack of technical expertise and the inability to cope with technical problems has a negative effect on individual satisfaction with the team experience and performance (Kayworth & Leidner, 2000; van Ryssen & Godar, 2000). There is also evidence that virtual team members are affected more by the newness of the technology being used than by the newness of the team structure itself (Hollingshead et al., 1993). Conversely when team members are able to deal with technical uncertainty and technology related challenges, high trust develops (Jarvenpaa & Leidner, 1999). Recent work has shown that members' technology experience mediates the process by which external norms are internalized and adapted by team members (Sarker et al., 2001).

Training. Virtual teams research to date has focused on the relationship between team members' training and team performance. Early results suggest that consistent training among all team members improves team performance (Kaiser et al., 2000; van Ryssen & Godar, 2000), while virtual teams characterized by diverse technology skills may experience conflict when members are unable to resolve differences and compromise on the use of a specific skill during task completion (e.g. choosing to work with Oracle versus Access or using an object-oriented approach versus a structured analysis approach) (Sarker & Sahay, 2002). Early and uniform training has also been found to foster cohesiveness, trust, team work, commitment to team goals, individual satisfaction, and higher perceived decision quality (Tan et al., 2000; Warkentin & Beranek, 1999). A similar approach, the establishment of a formal mentoring program, has been examined in order to foster relational development and aid new members to feel connected to team members (Suchan & Hayzak, 2001).

Socio-Emotional Processes

The practitioner press points to relationship building, cohesion, and trust as fundamental processes that foster team effectiveness, while suggesting that virtual teams face significant difficulty in achieving them (Alexander, 2000; Kezsbom, 2000; Lipnack & Stamps, 2000; Solomon, 2001). Research on socio-emotional development in virtual teams has focused on relationship building in general, and more specifically on team cohesion and trust. Relationship building includes interaction processes designed to increase feelings of inclusiveness or belonging to the team that are hypothesized to foster cohesion and trust. Early work has established a positive link between socio-emotional process and outcomes of the virtual team project, while also confirming that virtual teams face unique difficulties in meeting socio-emotional needs of

virtual team members (Chidambaram, 1996; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2001; Sarker et al., 2001).

Relationship building. Virtual teams tend to have more of a task-focus and less of a social-focus than traditional teams although, over time, virtual teams appear to lessen their task-focus (Chidambaram & Bostrom, 1993; Walther, 1995; Walther & Burgoon, 1992). When compared to traditional team members, virtual team members generally report weaker relational links to teammates (Burke & Chidambaram, 1996; McDonough et al., 2001; Warkentin et al., 1997). These results are attributed to the significant reliance of virtual teams on electronic communication and the difficulties associated with such communication modes (Sproull & Kiesler, 1986). As a consequence, FtF communication among virtual team members early in the project has been found to foster the ability to form closer interpersonal relationships between members (Maznevski & Chudoba, 2001; Robey et al., 2000). If it is feasible for team members to physically meet, these early meetings should focus on relationship building because these early experiences strengthen the socio-emotional development of the team (Robey et al., 2000) and foster later success by improving performance and enhancing learning (Kaiser et al., 2000). The degree to which a virtual team engages in early socialization appears to be affected by members' cultural inclinations. In a student team experiment, for example, van Ryssen & Godar (2000) found Belgian students wanted to socialize early on, but American students preferred to wait until the end, "if time permitted" (p. 57).

When FtF meetings are not feasible, other avenues to foster relationship building can be found. A focus on exchanging social communication represents one such avenue. Virtual teams that send more social communication achieve higher trust (Jarvenpaa & Leidner, 1999) and better social and emotional relationships (Robey et al., 2000). For example, female-only virtual teams have been found to send more social information to one another and to be more satisfied with the team experience than their male-only or mixed-gender counterparts (Savicki et al., 1996). Social conversations between members that emphasize commonalities between members of different cultures (i.e. "I am a proud Norwegian-American...." from an American team member and "I've [visited] the US twice...." from a Norwegian team member) also tend to improved social bonds and relationship building (Sarker & Sahay, 2002). Finally, effective leaders have also been found to be able to stimulate relationship building by facilitating socialization among virtual team members by scheduling regular chat sessions with all team members present and using humor to lighten moods

(Kayworth & Leidner, 2000; Kayworth & Leidner 2001-2002).

Cohesion. Cohesion is an important aspect of the virtual team. It has been associated with better performance (Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2001) and greater satisfaction (Chidambaram, 1996). Several studies have focused on cohesion by comparing virtual teams with traditional teams, but results have been mixed. Warkentin et al. (1997) found collaborative technologies hindered the development of cohesion in virtual teams and that, therefore, traditional teams had higher levels of team cohesiveness. However, other studies have found that while virtual teams begin with lower cohesion, over time, virtual team members exchange enough social information to develop strong cohesion (Chidambaram, 1996; Chidambaram & Bostrom, 1993; Chidambaram et al., 1990-1991; Walther, 1995). Lind (1999) compared perceptions of cohesion between men and women in both virtual teams and traditional teams. Both women in virtual teams and men in traditional teams perceived greater team cohesiveness than men in virtual teams.

Trust. Trust development in virtual teams also presents significant challenges because it is difficult to assess teammates' trustworthiness without ever having met them (McDonough et al., 2001). Moreover, as the life of many virtual teams is relatively limited, trust must quickly develop (Jarvenpaa & Leidner, 1999). Yet, trust development is deemed crucial for the successful completion of virtual team projects (Sarker et al., 2001).

Early work on trust in the virtual environment has found that short-lived teams are in fact able to develop high trust but they do so by following a swift trust model rather than the traditional model of trust development (Jarvenpaa et al., 1998; Jarvenpaa & Leidner, 1999). The swift trust paradigm suggest that, when they don't have enough time to slowly build trust, team members assume that others are trustworthy and begin working as if trust were already in place while seeking confirming or disconfirming evidence throughout the duration of the project (Meyerson, et al., 1996). Virtual teams that exhibit high trusting behaviors experience significant social communication as well as predictable communication patterns, substantial feedback, positive leadership, enthusiasm, and the ability to cope with technical uncertainty (Jarvenpaa & Leidner, 1999). This early research identified perceived integrity of other team members as particularly important in the development of trust early in a team's life and perceptions of other members' benevolence as a trait that supported the maintenance of trust over time (Jarvenpaa et al., 1998). High trust teams may also develop as a result of early FtF meetings with the intent of developing a strong foundation of trust

between members (Suchan & Hayzak, 2001), or thanks to communication training (Warkentin & Beranek, 1999).

Task Processes

Task processes are the processes that occur as team members work together to accomplish a task or goal. Major issues identified in the task processes category included communication, coordination, and task-technology-structure fit.

Communication. At the core of any virtual team process is communication. Numerous articles in the practitioner press discuss the importance of communication focusing on the need to create a team of excellent communicators, on the selection of the right technology for most effective communication (Alexander, 2000; Chase, 1999; Dune, 2000; Solomon, 2001), and on the communication difficulties engendered by the virtual environment (Johansson et al., 1999; Lurey & Raisinghani, 2001). As noted by Hulnick: "if technology is the foundation of the virtual business relationship, communication is the cement" (2000, p. 33).

Traditional team research emphasizes that successful co-located teams are able to communicate effectively and share information crucial to project completion in a timely manner (Allen, 1977; Ancona & Caldwell, 1992; Bordia, 1997; Brown & Eisenhardt, 1995). The virtual environment presents considerable challenges to effective communication including time delays in sending feedback, lack of a common frame of reference for all members, differences in salience and interpretation of written text, and assurance of participation from remote team members (Crampton, 2001; Mark, 2001). Moreover, nonverbal communication, an important component of team communication, is usually missing in virtual teams (Sproull & Kiesler, 1991). Because of its central role in virtual teams, communication has been the focus of substantial research. This work has found that traditional teams tend to communicate more effectively than their virtual counterparts (Burke & Chidambaram, 1996; Galegher & Kraut, 1994; McDonough et al., 2001). Because of the distributed nature of their work unit, virtual team members have to rely heavily on information and communication technologies (Saunders, 2000). But technology tends to restrict the communication process because electronic media are intrinsically leaner than face-to-face communication and convey a limited set of communication cues (Sproull & Kiesler, 1986). Thus, teams operating in the virtual environment face greater obstacles to orderly and efficient information exchange than their counterparts in the traditional context, a difficulty that is compounded when the virtual team is global in nature (Hightower et al., 1997; McDonough et al. (2001). But technical challenges are not the only cause of

communication difficulties in virtual teams. The lack of mutual knowledge at the onset of the project and the lack of a shared language among team members tend to hamper communication (Crampton, 2001; Qureshi & Vogel, 2001). Information exchange is also complicated when some team members are co-located while others are dispersed. Dispersed members often assume that co-located team members are talking and sharing information that is not communicated to them and private exchanges has been identified as the cause of friction between team members (Crampton, 2001; Sarker & Sahay, 2002). In addition, ineffective leadership (Kayworth & Leidner, 2001-2002) and cultural differences (Kayworth & Leidner, 2000; Sarker & Sahay, 2002) have also been found to negatively impact communication effectiveness.

The above difficulties notwithstanding, for virtual teams to achieve their objectives and successfully complete their task, information must be effectively exchanged. Thus, virtual team research to date has focused on mitigating communication difficulties and fostering an information-sharing culture. One company with very effective virtual teams recognized communication as the key to success and created an explicit reward system designed to foster a culture of extensive information sharing (Suchan & Hayzak, 2001). In another organization, it was noted that for knowledge production to occur, team members needed to do more than just share information. All perspectives of an issue needed to be raised and debated for the team to be effective (Krumpel, 2000). Early results suggest that the frequency and predictability of communication, and the extent to which feedback is provided on a regular basis, improves communication effectiveness leading to higher trust and improving team performance (Jarvenpaa et al., 1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001). Conversely, unpredictable communication patterns have been found to undermine the coordination and success of virtual teams (Johansson et al., 1999). Unpredictable communication was mostly associated with team members leaving for an extended period of time and failing to communicate their absence beforehand to other members (Crampton, 2001; Sarker & Sahay, 2002; van Ryssen & Godar, 2000). With respect to the extent of communication, virtual teams have been found to communicate more frequently than traditional teams (Eveland & Bikson, 1988; Galegher & Kraut, 1994) and members of female-only virtual teams communicated more than members of male-only or mixed-gender virtual teams (Savicki et al., 1996). In mutually reinforcing fashion, more effective communication was also found to improve cultural understanding (Robey et al., 2000; van Ryssen & Godar, 2000).

Coordination. Coordination represents the degree of functional articulation and unity of effort between

different organizational parts and the extent to which the work activities of team members are logically consistent and coherent (Cheng, 1983). Coordination has been linked to virtual team performance (Johansson et al., 1999; Maznevski & Chudoba, 2001), but early work has also highlighted the significant difficulties that virtual teams face as they attempt to coordinate across time zones, cultural divides and divergent mental models (Galegher & Kraut, 1994; Kayworth & Leidner, 2000; Sarker & Sahay, 2002; Warkentin et al., 1997). Sarker et al. (2001) found collaboration norms need to develop for the team to be able to consistently and coherently meld team members' contributions.

Given the significant challenges to effective coordination in the virtual environment, recent research has begun to investigate interventions and approaches designed to improve virtual team coordination. Periodic FtF meetings have been used with promising results by one organization to coordinate activities and drive a project forward (Maznevski & Chudoba, 2001). When FtF meetings are not feasible, the development of a coordination protocol as well as communication training interventions have been shown to foster improved coordination and collaboration (Malhotra et al., 2001; Tan et al., 2000; Warkentin & Beranek, 1999). Efforts to minimize cultural barriers have also been shown to improve coordination of team members (Robey et al., 2000).

While most research in this area has been unable to break away from the traditional team model, Ramesh & Dennis (2002) impute the significant coordination difficulties experienced by virtual teams to their design and argue for a fresh approach. They suggest an object-oriented model to virtual team design that requires the standardization of the team's inputs, processes, and/or outputs. Such compartmentalized structure, they argue, should minimize the need for extensive members' coordination and help the team overcome some of the limitations engendered by the virtual environment.

Task-Technology-Structure Fit. With the significant attention devoted to the role of FtF meetings in virtual teams, it is important to evaluate the possible fit between various technologies available to virtual teams and the tasks they are called upon to execute. Previous research that has investigated such questions has hypothesized that the choice of technology depends on individual preferences, individual experience with the technology and its ease of use, the need for documentation, and the urgency of the task (Hollingshead et al., 1993; Robey et al., 2000). For example, recent work has found FtF meetings or phone calls to be best suited for ambiguous tasks, managing conflicts, managing external resources, brainstorming, and for setting strategic direction.

Conversely, electronic communication is best used for more structured tasks such as routine analysis (i.e., comparing competing concepts, examining design tradeoffs) or monitoring project status (Majchrzak et al., 2000a). However, virtual teams that have no access to synchronous meetings are found to be able to overcome these limitations and to adapt the technology to accomplish ambiguous tasks after having successfully developed a shared language (Hollingshead et al., 1993).

Irrespective of their access to various technologies, effective virtual teams appear to be able to adapt the technology and match it to the communication requirements of the task at hand (Maznevski & Chudoba, 2001). Members of teams that rely on a variety of different technologies to accomplish tasks are also more satisfied and perform better (Kayworth & Leidner, 2000).

Several studies have examined virtual teams over time to investigate whether virtual team members adapt to the different team structure. Similar to traditional teams, virtual teams have been found to experience distinct stages of team development (Sarker et al., 2001). Although their members need time to adapt to the technology and new team form, they have often been found to be able to do so satisfactorily (Chidambaram et al., 1990-1991; Chidambaram, 1996; Maznevski & Chudoba, 2001; Sharda et al., 1988). Changes made by virtual team members include adaptations to the technology, organization/social environment, and/or team structures (Majchrzak et al., 2000b; Qureshi & Vogel, 2001). Effective virtual teams are able to adapt their communication to fit the team's structure (Maznevski & Chudoba, 2001). Majchrzak et al., (2000b) also found that virtual team members initially changed the structure of how and what they communicated to match the technology used, but eventually the technology structure was also adapted as needed. Qureshi & Vogel (2001) address technological, work, and social adaptation issues that can affect virtual teams and the challenges faced by organizations as they adapt to a virtual team environment.

Outputs

The virtual team research on outputs, or outcomes, has focused on the performance (i.e., effectiveness) of the team. Some papers have examined more specific aspects of performance such as decision quality, number of ideas generated, and/or time it took team members to reach a decision. Besides the ultimate performance of the virtual team, satisfaction with the virtual team experience has also been examined.

Performance. Several papers have compared the performance of traditional teams and virtual teams with mixed results. While one study reported greater

effectiveness for virtual teams (Sharda et al., 1988) and others found that virtual teams could not outperform traditional teams (McDonough et al., 2001; Warkentin et al., 1997), the majority of the early work has detected no difference between the two types of teams (Burke & Aytes, 1998; Burke & Chidambaram, 1996; Galegher & Kraut, 1994; Lind, 1999);

Similar to the more generic "performance" measure, most researchers have found no significant differences between traditional teams and virtual teams when examining decision quality (Archer, 1990; Chidambaram & Bostrom, 1993) and the number of ideas generated by decision making teams (Archer, 1990; Lind, 1999; Sharda et al., 1988), although in their study, Chidambaram & Bostrom (1993) did find virtual teams generated more ideas than traditional teams. Not surprisingly, given the constraints of working virtually, virtual teams have been found to take longer to reach a decision (Archer, 1990; Galegher & Kraut, 1994; Sharda et al., 1988).

Several studies have summarized what contributed to the successful performance of a virtual team. These have included training (Kaiser et al., 2000; Tan et al., 2000), strategy/goal setting (Kaiser et al., 2000; Malhotra et al., 2001); developing shared language (Majchrzak et al., 2000a), team building (Kaiser et al., 2000), team cohesiveness (Maznevski & Chudoba, 2001), communication (Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001; Suchan & Hayzak, 2001), coordination and commitment of the team (Maznevski & Chudoba, 2001), the appropriate task-technology fit (Malhotra et al., 2001; Maznevski & Chudoba, 2001), and competitive and collaborative conflict behaviors (Montoya-Weiss et al., 1999). The latter study also found that avoidance and compromise conflict behaviors had a negative impact on virtual team performance.

Satisfaction. Satisfaction has been almost exclusively examined with student virtual teams. Again, mixed results emerge from the comparison of traditional and virtual teams with some work detecting no difference in satisfaction between the two types of teams (Archer, 1990) while others found traditional team members were more satisfied with their experience than counterparts in the virtual environment (Warkentin et al., 1997). A few studies have investigated satisfaction over time. One study found that traditional team members started out more satisfied, but virtual team members' satisfaction levels rose throughout the year until they surpassed the satisfaction level of traditional team members (Eveland & Bikson, 1988). Women appear to be more satisfied than men with the virtual team experience (Lind, 1999; Savicki et al., 1996) and women in virtual teams are more satisfied with their experience than women in traditional teams (Lind, 1999). The antecedents to cohesion also appear to

change over time in virtual teams (Chidambaram, 1996). Satisfied virtual team members were more likely to have been given training (Tan et al., 2000) and used more communication methods (Kayworth & Leidner, 2000) than unsatisfied team members.

Issues Summary

Appendix B provides a summary of variables and issues investigated by the articles reviewed in this paper; here we summarize the major issues studied.

Previous work that has studied virtual team inputs has focused on team and process design interventions, the effect of cultural differences, of technical expertise, and of training interventions. The results of this line of research are generally positive and suggest that attention to the launch stage (Saunders, 2000) of virtual team projects can help to mitigate some of the challenges of virtual work and foster virtual team effectiveness. The research in this area has studied both organizational virtual teams in the field and student teams in experimental settings. Research on virtual team design and cultural differences has been cast in both an organizational and experimental context, while most work focusing on technical expertise and training has primarily used student teams.

Previous work that has studied socio-emotional processes in virtual teams has found a positive relationship between socio-emotional issues and outcomes of the virtual team. While cohesion, trust, and relationship building appear to be essential for the satisfaction of team members and subsequent better performance of the virtual team, current research has also confirmed the increased difficulty of meeting socio-emotional needs of virtual team members (Chidambaram, 1996; Lurey & Raisinghani, 2001; Maznevski & Chudoba, 2001; Sarker et al., 2001). While trust and relationship building have been examined in organizational settings and through quasi-experiments using student teams working on a real-world problem, cohesion has been studied almost exclusively through the use of student team experiments (Maznevski & Chudoba, 2001 offers one notable exception).

Task processes and their effect on virtual teams has been studied extensively in both organizational settings and with experiments using student teams. Current virtual team research has identified several communication problems that affect virtual teams, as well as identifying potential keys to alleviating typical communication and coordination problems.

More attention has been focused recently on the performance of virtual teams in an organizational setting. Much of this work has shown that various inputs, socio-emotional processes, and task processes

discussed earlier have a direct impact on performance. Most of the work looking at satisfaction of team members has still been done with student teams and it has concentrated on *who* is most satisfied (virtual team versus traditional team, women versus men) and very little has been done on *what* makes team members satisfied or changes their degree of satisfaction with the virtual team experience.

As shown in Appendix A, a number of theoretical perspectives have been employed to guide previous virtual team research. This theoretical pluralism is not surprising since no unifying theory of virtual teams currently exists. Rather, researchers interested in different constructs (e.g., technology adoption and use, trust, leadership, communication, design, effectiveness) in the context of virtual teams' processes and management, have relied on theories that addressed their specific research questions.

Also notable in Appendix A are the many studies that do not clearly identify a specific theoretical perspective as guiding the research. Whether it is possible, or even desirable, to develop a unifying theory of virtual teams is debatable. But it is important to emphasize that future work should not be a-theoretical. Given the novelty of virtual teams as an area of academic inquiry, it is important that results from different studies be comparable and cumulative – a result ensured by the adoption of good theories, and disciplined inquiry that builds on them. Note that we don't mean to suggest that new theory development should not occur. Indeed, the idiosyncrasies of the virtual environment call for such development. But we urge authors to make their theorizing explicit so that others can build upon it.

Future Research Directions

We are still in the early stages of investigation of virtual teams and significant work remains to be done to understand these new organizational forms. The literature to date has surfaced and framed many of the issues and challenges associated with effective teamwork in the virtual environment. A substantial portion of this literature, finding its roots in the computer mediated communication tradition, has focused on the implication of virtual teams' inability to meet face-to-face, and their reliance on electronic communication media. But, new perspectives are beginning to emerge.

In this section of our review, we evaluate the body of knowledge on virtual teams in an effort to highlight areas of research that hold significant promise and those that appear to have been overlooked. We draw on this analysis to shed light on important areas that, to date, have remained under researched, and we provide research questions to guide future work. The analysis is organized around the four issues framework

we introduced earlier: inputs, socio-emotional processes, task processes, and outputs.⁴

Inputs

Early virtual team research has paid significant attention to the design of virtual teams interaction, with particular attention to the role of FtF interaction at different stages of the team's life. Considerably less attention has been devoted to the design of the work unit itself. This finding is somewhat surprising since managers charged with the task of effectively using virtual teams could have significant input in their design, making research in this area particularly crucial.

Our analysis of the research to date shows that the virtual teams studied in controlled settings have been relatively small, with nearly 90% of published articles using student teams limiting team size to less than eight individuals (an average of four members). Only three studies in this tradition have used team sizes greater than eight people (Johansson et al., 1999; Sarker & Sahay, 2002; Sarker et al., 2001). Conversely, virtual teams studied in situ have been relatively large, with all of published articles examining teams of more than eight members (an average of 12-13 members), with only two exceptions (Lurey & Raisinghani, 2001; Ramesh & Dennis, 2002). While the results of controlled experiments using students may often be generalized to organizational settings, our findings indicate that there is a disconnect between controlled setting and field based research. Unless this inconsistency is resolved, the synergies of complementary research methodologies cannot be reaped. More importantly, no study to date has explicitly examined virtual team size as a variable controlled during the team design phase. Traditional team research indicates that team size and composition, and their fit with the team's task, has significant impact on team effectiveness (Steiner, 1972).

With respect to the type of team, research to date has mostly focused on new product, business development, and customer service teams. But, the nature of the team project and its interaction with other team design variables has not been addressed by previous research. Several questions remain unanswered. What projects are virtual teams best suited to work on? What is the appropriate size and skills composition for virtual teams approaching different project types?

⁴ Note, however, that these four issues are not disjointed, but represent four elements of virtual teamwork. Thus, they affect one another and several of our research questions encompass more than one element.

With respect to the duration of the project and the life of the virtual team as a work unit, we observed a similar disconnect between student based and field based research. Short-term virtual teams – those whose life is limited to less than six months – were almost exclusively student teams and met on average for 4-5 weeks. The only short-term, field-based virtual team research was one of the three studies examined by Ramesh & Dennis (2002). Conversely, the investigation of long-term virtual teams relied exclusively on field-based investigations. Because virtual teams are not bound by geographic constraints, significant virtual team research has focused on global virtual teams drawing geographically dispersed and culturally diverse members. Interestingly, as shown in Table 1, long-term non-global virtual teams have been investigated exclusively through field-based investigations in natural settings and little research has focused on global, long-term virtual teams. Once again, we believe that to gain a complete understanding of

virtual teams, different methodologies and approaches should be used in complementary fashion. More work is needed to investigate short-term virtual teams in organizations in order to determine how they differ from long-term virtual teams. Some possible future research questions include: do task and socio-emotional processes develop differently in different types of virtual teams? If so, how? Are antecedents for team effectiveness different for long-term virtual teams versus short-term virtual teams? Are antecedents for team effectiveness different depending on the type of task the virtual team is accomplishing? That virtual team design has so far been treated as an afterthought by virtual team researchers becomes apparent when examining the structural characteristics of virtual teams studied to date. Almost without exception previous research has focused on self-directed teams (for a notable exception see Kayworth & Leidner, 2001-2002) with little attention to the role of managers and managerial structures.

	Short term (all short term studies used student subjects <i>except</i> Ramesh & Dennis, 2002)	Long term (all long term studies were field based)
Non-global	Archer, 1990 Berdahl and Craig, 1996 Burke & Aytes, 1998 Burke & Chidambaram, 1996 Chidambaram, 1996 Chidambaram & Bostrom, 1993 Chidambaram et al., 1990 Galegher & Kraut, 1994 Hollingshead et al., 1993 Savicki et al., 1996 Sharda et al. 1988 Tan et al., 2000 Walther, 1995 Walther & Burgoon, 1992 Warkentin & Beranek, 1999 Warkentin et al., 1997	Eveland & Bikson, 1988 Krumpel, 2000 Majchrzak et al., 2000a Majchrzak et al., 2000b Malhotra et al., 2001 Mark, 2001 Robey et al., 2000 Suchan & Hayzak, 2001
Global	Crampton, 2001 Jarvenpaa et al., 1998 Jarvenpaa & Leidner, 1999 Johansson et al., 1999 Kaiser et al., 2000 Kayworth & Leidner, 2000 Kayworth & Leidner, 2001-2002 Lind, 1999 Montoya-Weiss et al., 2001 Ramesh & Dennis, 2002 (1 team) Sarker & Sahay, 2002 Sarker et al., 2001 van Ryssen & Godar, 2000	Ahuja & Carley, 1999 Galvin & Ahuja, 2001 Maznevski & Chudoba, 2000 McDonough et al., 2001 Ramesh & Dennis, 2002 (2 teams)

Table 1. Previous research organized by geographic scope and duration

This lack of attention to virtual team structures is all the more surprising given the substantial research on team structure in the traditional environment and can probably be ascribed to the relative novelty of virtual team research. This novelty notwithstanding, we believe that investigation of team structure in the virtual environment holds significant promise for research and practice because it represents perhaps the most controllable and influential aspect of virtual team design.

Virtual teams have the ability to diverge from formal structures and traditional reporting requirements. As a consequence, they may be granted high degrees of autonomy and may not have to follow formalized rules and procedures (DeSanctis & Poole, 1997). While most empirical research has focused on teams that retain control over the task and can independently organize their work, team effectiveness in virtual environments may be hindered by excessive autonomy coupled with exclusive reliance on electronic communication and lack of FtF interaction. Under these circumstances, managerial control mechanisms typically employed in traditional teams (Kirsch, 1997; Ouchi, 1979) may be instrumental in limiting confusion and coordination problems while providing guidance to the team and ensuring accomplishment of team goals. The current literature provides no guidance in answering the following questions: Are autonomy and self-direction the team structures best suited for virtual teams? Under what circumstances (e.g., team size, type of project, duration and team composition) does autonomy hinder team effectiveness in the virtual environment? Do traditional managerial control mechanisms remain applicable in the virtual environment? If so, what are the most appropriate managerial controls (formal versus informal)? Can informal control mechanisms be used when teams rarely meet FtF and are short-lived? Can a set of behaviors that promote effectiveness of a wide range of virtual teams be identified? How can these behaviors be effectively enforced in virtual teams? In traditional teams, a portfolio of control mechanisms is often used (Kirsch, 1997). Since virtual teams often draw members from different cultures, a mixed approach to control in the virtual environment, including various forms of control and different requirements for different members, may prove most appropriate. Such mixed approaches provide fertile grounds for future research.

Early research on technical expertise and virtual team members' training has shown the importance of these two inputs to the virtual team experience. Yet, this early work provides little guidance as to the technical expertise needed to be a proficient virtual team member and what constitutes effective training in the virtual environment. Many observers advocate early FtF meetings or team building exercises during the

launch phase of the team's life, but little if any information is offered with respect to what constitutes appropriate training. Should these meetings focus on effective communication skills in the virtual environment, such as written and asynchronous communication skills, or should training focus on available technologies and their appropriate use? Should team-building meetings simply focus on creating a shared identity for the team? Early research seems to show that any type of training benefits the team. But, facing time and resource constraints, organizations may be forced to prioritize training topics and goals. Under these circumstances it is essential to understand, what type of training offers the greatest return on the time invested.

Finally, who should be a member of a virtual team? If a manager has several people to choose from, how does he or she decide which employee to place on the virtual team? Very little work has been done on any personal characteristics of team members. Gender has been examined with results showing that females tend to enjoy being on virtual teams more than men, perhaps because of the influence they perceive themselves as having, their perceptions of greater inclusiveness, or the flexibility it provides them in meeting the conflicting challenges of family and work (Berdahl & Craig, 1996; Lind, 1999; Savicki et al., 1996). Future research needs to examine more closely what personal characteristics characterize the members of high performing virtual team and what traits or qualities managers should look for in employees when selecting virtual team members.

Socio-emotional processes

High levels of communication early in the life of virtual teams foster mutual trust among teammates and team cohesiveness. High levels of trust and cohesiveness then further reduce barriers to communication and are instrumental in promoting a virtuous cycle of cooperation. Early findings in virtual team research indicate that early communication and interaction have lasting effects on trust in the virtual environment (Jarvenpaa & Leidner, 1999). As virtual teams often experience "swift trust" (Meyerson, et al., 1996), early interactions are particularly crucial to the development and maintenance of trust. Future research should identify which, if any, socialization activities foster trust in different types of virtual teams. What can a manager or team leader do to foster swift trust? Is swift trust observed or even needed in long-term virtual teams?

One barrier found to hinder effectiveness of traditional teams and their development is diversity. Deeper level diversity involves team members' values, characteristics, and attitudes. People tend to like others whose attitudes and values appear congruent with their own, and dislike those with whom they

disagree (Griffitt, 1974). Attitudinally similar teams have been found to have higher cohesion than dissimilar teams (Terborg et al., 1976). Surface-level diversity (demographic diversity) effects weaken over time while deep-level diversity (attitudinal differences) effects are strengthened (Harrison et al., 1998). Research has found, however, that when faced with diverse teams, individuals' perceptions can be altered through manipulations. By doing so, team effectiveness and development can be enhanced. Giving traditional teams specific behavioral instructions to increase self-disclosure and increase information about fellow team members increased team cohesion, favorable attitudes, and frequencies of work-oriented interpersonal communications (Bednar & Battersby, 1976; Hoogstraten & Vorst, 1978). Similarly, providing specific goals and feedback from management significantly improved product quality, team cohesion, and goal commitment (Koch, 1979). Future research on cohesion in virtual teams should determine how diversity is treated in virtual teams. In the leaner environment of virtual teams, where some diversity may not be known, will diversity affect virtual teams in the same way it does traditional teams? Can cohesion be manipulated successfully in a virtual team in a manner similar to that employed with a traditional team? Can team leaders minimize deep-level diversity to improve cohesion?

Virtual teams offer the opportunity to overcome surface-level diversity since much, if not all, of the interaction among teammates takes place through electronic communication. But, because of their dispersed nature and inherent membership diversity, commonality among teammates may be much more difficult to identify (DeSanctis & Poole, 1997). Virtual teams are generally cross-functional and cross-organizational and their members often serve on multiple diverse teams (e.g., traditional teams, virtual teams, mixed teams drawing local as well as remote members) and are characterized by fluid membership. These structural characteristics compound the relationship building difficulties that early virtual team research has uncovered and create significant obstacles to members' social identification with the team. But overcoming these difficulties is of paramount importance, not only to achieve its performance objectives, but also to limit the potentially negative effects on individual well-being and satisfaction (Victor & Stephens, 1994). Future research should further our understanding of social identity in virtual teams. Do virtual team members identify with their team as a social entity or do they remain tangential to it? What are the characteristics and behaviors of virtual teams that have been able to achieve significant levels of social identification? Are virtual team members able to perform satisfactorily even when they do not identify with the team? What types of managerial intervention

foster increased social identity? Are there identifiable processes of adaptation that enable virtual teams to overcome the limitations of the virtual environment?

Task processes

Task processes, primarily as they pertain to communication in the virtual environment, have been among the most widely researched of the issues surrounding virtual teams. This is not surprising as communication is perhaps the most salient of virtual team processes and information systems research has a well established tradition in the study of electronic communication. Related to communication is the issue of coordination of effort by dispersed and often culturally diverse team members. Virtual teams studied to date have been characterized by little formalization in the way of managerial structures or working procedures. Rather, research has for the most part studied how these self-directed teams have attempted to overcome coordination difficulties. More importantly, virtual team research to date has not questioned the applicability of traditional team process views to the virtual environment. The literature has approached the communication and coordination challenges faced by virtual teams seemingly assuming that, even while drawing geographically and time-dispersed members, they will operate according to traditional models including members "working together" and collaborating either synchronously or asynchronously. But, as the reengineering movement has shown, new technologies often provide the opportunity to relax old assumptions regarding how work is, or should be, performed. Information systems researchers, with their understanding of new technology, organizational structures and social systems, and their experience studying the introduction and adaptation of new technologies, are well positioned to explore novel approaches to virtual team operation and management. An example of such fresh thinking is provided by the notion of object-oriented virtual teams (Ramesh & Dennis, 2002). Its proponents posit that a virtual team will achieve better coordination and higher performance if, instead of the customary way of working together, virtual team members are decoupled, decreasing the need to synchronize efforts and decreasing the amount of communication needed to perform their tasks. This work provides a start, but it also generates a substantial number of questions that await answers. Is it feasible to deconstruct virtual team projects so as to enable the object-oriented model? Does the decoupling process successfully reduce coordination challenges? What type of tasks and projects are most amenable to such deconstruction? What available technology can be used to enable the decoupling process without sacrificing the essence of teamwork?

Virtual team research has also yet to fully engage the notion of time dispersion and the role of time in virtual team processes. Virtual teams are generally asynchronous teams that have limited ability to engage in real-time collaboration. As such, they differ significantly from traditional teams for which synchronous interaction is the primary means of collaboration where traditional notions of chronological time are not challenged. Thus, simply extending traditional team theories to the virtual environment limits the scope of these investigations and fails to capture one of the fundamental dimensions of virtual work. A number of time dependent issues affect virtual teams (Sarker & Sahay, 2002): Teammates separated in time experience different physiological and social activity schedules (e.g., when an Australian team member is getting ready to go home for the day, European teammates are just waking up). As a consequence work performed by time dispersed teammates generally cannot proceed in parallel but needs to be re-sequenced to incorporate, and take advantage of, time lags. Inexperienced virtual team members with limited familiarity with this type of work environment may experience anxiety or trust decline due to negative interpretations of silence or delays associated with time dispersion (Piccoli & Ives, 2002). These idiosyncrasies of the virtual environment create fertile ground for future research that explicitly addresses the role of time in its investigations. What interventions can be used to limit the negative effect of time dispersion? Is training and sensitizing of virtual team members sufficient to overcome the limitations associated with time dispersion? As Sarker & Sahay (2002) note, when a virtual team is able to "reclaim" time, by organizing the work around time differences rather than focusing on traditional work processes and "the way a team is supposed to work," a virtual team is able to leverage time differences and develop a social structure that incorporates time dispersion – rather than attempt to limit its effect. What team norms facilitate the reclaiming of time? What adaptive processes and structural work arrangements are best suited to incorporate time differences into the team's social structure?

An area that is just beginning to be explored is that of virtual team leadership. The leadership literature that compares traditional and virtual teams indicates that the former experience more effective leadership than the latter (Burke & Aytes, 1998; Eveland & Bikson, 1988). Yet, early evidence suggests that an effective leader in a virtual team has to lead in ways that differ from established practices designed for the traditional environment. An effective leader of a virtual team needs to be more flexible and willing to let others take the lead when necessary (Eveland & Bikson, 1988; Jarvenpaa et al., 1998; Jarvenpaa & Leidner, 1999; Kayworth & Leidner 2000). Moreover, the ability of the

leader to be a very effective communicator using electronic media is essential because he or she must be able to facilitate communication among teammates, create clear structures, foster role clarity, and improve socio-emotional relationships with limited access to FtF meetings (Kayworth & Leidner, 2001-2002).

Following a familiar pattern, recent virtual teamwork has attempted to extend our knowledge of leadership in co-located teams to the new environment. Little attempt has been made to explore novel approaches that stem from an understanding of the idiosyncrasies of the virtual environment. But interesting insight can be drawn from parallel work on network organizations management (Snow et al., 1992). This work suggests that once a network of firms has been established, responsibility for that network's support and maintenance should shift to ad hoc managers. These individuals, named caretakers, are responsible for engaging in nurturing and disciplinary behavior (i.e. maintenance), for sharing scheduling information (i.e. coordination) and information about the network's inner workings (i.e. norms). While this perspective is a macroscopic one, the insight in the role of the caretaker in network organizations can be extended to the team level of analysis. The caretaker should ensure that mission critical information is shared in a timely fashion, that each virtual team member's efforts are aligned with those of teammates, that there is role clarity and no duplication of effort, and that each teammate's contribution advances the team toward its goals. Arguably, without the appointment, or spontaneous emergence, of a caretaker, virtual teams may find it very difficult to efficiently share information, plan a concerted course of action and resolve conflict while enhancing mutual relationships. Early work on leadership (Kayworth & Leidner, 2001-2002) and individual roles in the virtual environment (Vogel, et al., 2001), suggests that virtual teams benefit from the presence of these caretakers whose sole contribution to the team is to support regular, detailed, and prompt communication, as well as identifying individual role relationship and responsibilities. The notion of caretakers has significant potential, but our understanding of this role is still very limited. Management may formally appoint the caretaker, it could be appointed by the team, or a member may spontaneously emerges and assume the role. Future research should examine the following questions: Under what circumstances a caretaker is instrumental in reducing process losses? What are the traits of successful caretakers? What portfolio of technologies do successful caretakers employ, and under what contingencies do they employ them? Does the role of the caretaker change based on the type of virtual team being assembled? Do the potential benefits of caretaker intervention differ depending on the timing of the intervention? Do early interventions contribute to

improve virtual team trust? Can the caretaker contribute to create and enforce early norms that lead to effective interaction – enabling to depart the team after a time?

Conflict resolution is another area of task processes that requires more research in the future. Certain types of conflict (avoidance, compromise) have significant, negative effects on virtual team performance although process structures implemented in virtual teams should negate the effect of the conflict on performance. Competitive and collaborative conflict behaviors are positively associated with performance of virtual teams (Montoya-Weiss et al., 1999). While the amount of conflict may not differ between virtual and traditional teams, traditional teams seem to be better able to manage conflict, particularly in the early stages of the team's life (Chidambaram & Bostrom, 1993; Chidambaram et al., 1990-1991). Future research in this area is needed to investigate the extent to which different tasks are more prone to engender conflict. What can a team leader or caretaker do to manage conflict in virtual teams? Besides the use of process structures, are there other strategies that can be implemented to increase positive conflict while decreasing negative conflict?

Outputs

Virtual teams hold significant promise for organizations that implement them because they enable unprecedented levels of flexibility and responsiveness. But, for the enthusiasm surrounding the use of virtual teams to be warranted, this new organizational form must prove to be effective in advancing organizations' goals. Thus, effective virtual teams must be able to produce high quality outputs (i.e. products and services), reward team members in terms of gratification and satisfaction with the working experience, and contribute to individuals' learning and ability to engage in future projects (Jarvenpaa & Ives, 1994).

Virtual team research to date has focused on various performance measures and has typically "benchmarked" virtual team performance based on comparisons to traditional teams. Because virtual teams differ structurally from traditional teams we believe future research should focus much more on understanding when virtual teams are appropriate and then focus on maximizing their performance, moving beyond comparison to traditional teams.

Past research has also focused on individual satisfaction with the team experience. This construct is important since there is a general carry-over effect from previous experiences that influence individuals' willingness to collaborate and contribute to future team projects (Hackman, 1989). Employees who are unsatisfied with early virtual team experiences may be

more likely to withdraw, refuse to participate, and, in general, not perform well in the new environment (Hackman, 1992). But we believe that there is significant value in expanding the focus to psychosocial outcomes (Pinto, Pinto, and Prescott, 1993) – a construct that includes individuals' well being and their assessment as to whether the virtual team experience has been a worthwhile and productive one, as well as satisfaction. We believe that this broader focus is important in light of the attention that theorists have recently drawn to the "dark side" of the new virtual organizational form (Victor & Stephen, 1994).

An important output of team processes that has been examined in traditional teams but has yet to be investigated in virtual teams is that of team viability. Team viability represents the extent to which the team is able to continue working productively as an integral work unit. There is evidence that the geographically and time dispersed nature of virtual teams often causes stress and anxiety that hamper the team's ability to function effectively for more than short periods of time (Piccoli & Ives, 2002; Sarker & Sahay, 2002). The current literature provides no guidance in answering the following questions: What are the determinants of team viability in the virtual environment? What socio-emotional and task processes foster team viability? What is the process by which these antecedents of team viability operate?

The idiosyncrasies of the virtual environment may also call for the development of new measures of viability. Virtual teams are often short lived and are often disbanded upon project completion, with team members departing and often reassembling in other, newly formed, virtual teams (Townsend, et al., 1998). Because of this dynamic membership and the limited life span of many virtual teams, it is crucial that dispersed knowledge workers develop the unique knowledge, skills and ability (KSA) to immediately and efficiently contribute to their team's success. The set of KSAs necessary to contribute to virtual teams appears to be, at least partially, different from the ones that most employees have developed over time working in traditional teams (Furst et al., 1999; Townsend et al., 1998). Further, not everyone may feel at ease or quickly adapt to the "free-floating demands of the hyperflexible workplace" (Victor & Stephens, 1994, p.481). Since team members "must be trained and acclimated to the virtual team environment" (Townsend et al., 1998 p. 26), we propose the notion of virtual team member viability – defined as the individual's KSA development and ability to perform effectively in virtual teams in the future. In organizations that adopt a team model, the teams themselves often become the "training grounds for the acquisition of new skills and knowledge areas" (Cianni & Wnuck, 1997 p. 106). Thus, significant skills acquisition takes place "in action" and the team is used as a tool for members'

own development (Cianni & Wnuck, 1997 p. 106). This may be particularly true for virtual teams, due to their novelty. Thus, an important output of the virtual team experience, and an important measure of effectiveness, is its ability to tangibly contribute to the ongoing on-the-job training and acclimatization process of their members. Significant future work is needed to understand the determinants of virtual team member viability and the process by which it can be fostered.

Conclusions

Our aim in this article has been to further clarify what we know, and what we don't know about virtual teams. After covering the necessary definitions, we present a comprehensive list of issues that have been examined by virtual team research to date. We have categorized the literature so as to provide easy reference and analysis of previous findings. We have then examined the literature review to identify promising under examined areas. In an effort to stimulate such future work, we have presented a set of research questions, organized around inputs, socio-emotional processes, task processes, and outputs. We believe that addressing these questions has the potential to rapidly fill the void in our understanding of virtual teams and help moving forward both research and practice.

Virtual teams represent a new form of organization that offers unprecedented levels of flexibility and responsiveness and has the potential to revolutionize the workplace. Virtual teams however, cannot be implemented on faith and they do not represent an organizational panacea. Extensive research is needed to understand the design characteristics of successful virtual teams. Our work, we believe, provides a further step in this direction.

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About the Authors

Anne Powell is an assistant professor of Computer Management and Information Systems at Southern Illinois University Edwardsville. She received her Ph.D. in MIS from Indiana University. Her current research interests include organizational and individual impacts of virtual work and user acceptance of information technologies. She has published articles in several conferences as well as the Journal of End User Computing.

Gabriele Piccoli is on the faculty of the School of Hotel Administration at Cornell University. His research interests relate to the business application of network and Internet technologies in support of internal activities, such as training and teamwork, and external activities, such as customer service. His research has appeared in MIS Quarterly, Communications of the ACM, as well as other academic and applied journals.

Blake Ives is the Charles T. Bauer Chair of Business Leadership and Director of the ISRC at the College of Business, University of Houston. A Fellow and Past President of the Association for Information Systems, Ives has been a member of the ACM for 25 years. In 2002 he was designated Educator of the Year by the EDSIG of the Association of Information Technology Professionals.

Appendix A: Studies Included in the Review

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type ⁴	Journal
Ahuja & Carley	99	task, network structure, hierarchy, centralization, fit, performance	VTs can be hierarchical and centralized from a communication standpoint. Fit between task and structure not associated with objective performance, but is associated with satisfaction.	Network & Organization Form Theories	Ongoing Organization employees and academics	66	1,2,3	Organization Science
Archer	90	Decision quality, # alternatives, time to reach decision, satisfaction	VT* took longer to reach decision, but had equal quality and satisfaction *VT: virtual team	Results provided support for AST	8 week Grad students	4-5	4	Behaviour & Information Technology
Berdahl & Craig	96	participation, influence, gender	Participation more centralized in VTs. In VTs, males in majority-female teams had more influence, males in majority-male teams had less influence than females.	Proportional, Social Role, Expectation States	7 week UG students	3-4	4	Journal of Computer Supported Collaborative Work
Burke & Aytes	98	cohesiveness, equality of participation, leadership, coordination, performance	No difference between VT and TT* in cohesiveness, performance, and equality of participation. Leadership better in TT, VT better at coordination at first *TT: traditional team		4 week UG students	3-4	4	HICCS
Burke & Chidambaram	96	social presence, communication effectiveness, ease-of-use, performance	TT reported greater social presence, communication effectiveness, and ease-of-use. No difference in performance between VT and TT.	Social Presence & Media Richness	4 week UG students	4	2,4	HICCS
Chidambaram	96	work processes, cohesiveness, satisfaction	Over time, VT members will exchange enough information to develop relational ties. Over time, attitudes improve as does satisfaction with outcomes.	SIP, Punctuated Equilibrium Model	4 week UG students	5	4	MIS Quarterly

⁴The task type classification follows an established categorization scheme (McGrath, 1984).

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Chidambaram & Bostrom	93	conflict mgt, cohesiveness, # alternatives, decision quality	No difference between teams' decision quality, VT more equal participation, task focus, more alternatives generated. TT better at first in conflict mgt, cohesiveness; by midpoint, VT had surpassed TT.	SIP, AST	4 week UG Students	5	4	Journal of Organization Computing
Chidambaram et al.	90-91	conflict resolution, cohesiveness	Conflict resolution and cohesiveness both initially better in TT, by time 4, VT better at both VT more likely to think of idea as "ours"	AST	4 week UG students	5	4	JMIS
Crampton	01	mutual knowledge, communication problems	5 types of communication problems identified from failure of creating mutual knowledge in VT.	Communication Theories	7 week Grad students	6	2,4	Organization Science
Eveland & Bikson	88	leadership, structure, satisfaction, communication	TT greater leadership stability, VT leadership fluctuated more. VT created unique structure, VT satisfaction continually increased, TT satisfaction remained same, VT communicated more		1 year Org workers & retirees	20 6-10 in sub-groups	4,6	ACM Transactions on OIS
Galegher & Kraut	94	planning, social conversations, revising/writing, coordination difficulty, total communication, perceived communication quality, perceived fairness, perceived project quality, proj. performance	TT more effective planning, revising/writing, perceived fairness, communication quality. VT had more total communication. No difference in project performance. VT required more time, spent more time communicating. VT had more coordination difficulty, fewer social conversations.	Contingency Theory Discuss several others	4 week Grad students	3	3,4	Information Systems Research

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Galvin & Ahuja	01	communication, member status, info exchange, info content	Newcomers to team engage in greater info seeking, established members engage in more info providing. Established members engage more in seeking norms & values info – new members more likely to seek out this type of info from “private” source.		Ongoing Org employees & academics	Not given	3,6,8	Our Virtual World chapter
Hollingshead, McGrath, & O'Connor	93	task type, task performance, cumulative experience, changes	No difference between VT and TT for generating and decision making tasks, TT better for negotiation and intellectual tasks early on. Relationship between task and technology performance more dependent on experience with technology and team membership rather than task type.	Task-media fit Task circumplex model	9 week UG students	4-5	2,3,4,6	Small Group Research
Jarvenpaa et al.	98	benevolence, integrity, ability, team building, trust, propensity to trust others	Integrity early on important to development of trust, benevolence over time. Tem building increased knowledge about team members, but did not directly increase trust.	Results support theory of swift trust	8 week Grad students	4-5	2,4	JMIS
Jarvenpaa & Leidner	99	swift trust	VTs with high trust also had: social communication, enthusiasm, predictable communication, substantial & timely feedback, ability to cope with tech uncertainty, initiative, social to task focus, positive leadership, phlegmatic response to crises. Swift trust likely a result of communication.	Swift trust	6 week Grad students	4-5	2,4	Organization Science

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Johansson et al.	99	communication, coordination	Communication and coordination were biggest issues in VT. Obstacles to coordination: power, doing it own way (power issues), communication predictability, culture		5 week UG and Grad students	22	1,2,4,6,8	IEEE Transactions on Professional Communication
Kaiser et al.	00	performance	To improve performance in VT: intermediate goals as well as final goals, similar training for all, clear structure, team maintenance activities/team building.		3 week UG and Grad students	6	4	Business Communication Quarterly
Kayworth & Leidner	00	communication, culture, technology, leadership, relational links, satisfaction, success	VTs using more communication methods more satisfied and more successful. Cultural differences intensify communication and coordination problems. Effective leadership needed, richer communication facilitates socialization.		6 week UG and Grad students	5-7	2,4	European Mgt. Journal
Kayworth & Leidner	01-02	leader role, role clarity, leadership effectiveness, culture, communication effectiveness	Effective leadership associated with communication effectiveness, communication satisfaction, role clarity, better relational skills, ability to foster relational aspects, structure	Leadership Theories	5 week UG and Grad students	5-7	2,4	JMIS
Krumpel	00	group knowledge production, communication content	Group knowledge production possible in VT. Groups engaged in knowledge production would do better with a leader.	Structuration Theory	Ongoing Working Group of subcommittee 'e' for IEEE	51	2,4,6,8	IEEE Transactions on Professional Communication

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Lind	99	gender, cohesion, conflict, quality of work, inclusiveness	Women more satisfied, felt more included and greater team cohesiveness with the VT experience than men. No difference in quality of work between VT and TT.		5-6 week Students	4	4	IEEE Transactions on Professional Communication
Lurey & Raisinghani	01	job characteristics, selection procedures, team relations, team processes, leadership, effectiveness, education, rewards, executive leadership, tools & technologies, communication	Team processes and member relations had strongest relationship to performance and satisfaction. Selection procedures and executive leadership style moderately related to performance and satisfaction		Length varied Organization employees	Varied (3-15 in 12 separate teams)	Varied	Information and Management
Majchrzak et al.	00a	technology use, success, task type, conflict, shared language/knowledge	FtF or phone used for ambiguous tasks, managing conflicts, brainstorming, clarifying goals, etc. VT used for routine tasks of analysis, project status. FtF meetings early on created a shared language between members – this enabled ambiguous tasks to be completed later by VT.	Media Richness, Social Presence, Task Circumplex	10 month Organization employees	8	1,2,4,6	Information Resources Mgt Journal
Majchrzak et al.	00b	adaptation, technology, structure, knowledge sharing, decision making	Using collaborative technology creates several misalignments with pre-existing structure and environment. VTs need to adapt all 3 structures – technology, org environment, and work group structures.	AST	10 month Organization employees	8	1,2,4,6	MIS Quarterly

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Malhotra et al.	00	shared understanding, knowledge sharing	3 mgt practices contribute to success of VT: strategy-setting, technology use should facilitate shared knowledge and collaborative use, restructuring work without changing core needs.		10 month Organization employees	8	2,4	MIS Quarterly
Mark	01	socialization, technology, participation, team culture, integrating team members	Key challenges of VT of participation, team culture, and integrating remote work discussed		Over 6 months Organization employees	8-15	1,3,4	Our Virtual World chapter
Maznevski & Chudoba	01	processes, performance, communication, cohesion, culture, technology use, decision quality, commitment	Effective VTs have high commitment, high cohesiveness, effective processes, satisfaction with decisions, continuous communication, task-technology fit. Cultural differences affected coordination. Regular FtF meetings provided necessary coordination.	AST	Long-term Organization employees	8,9, & 12	3,4,5,6,8	Organization Science
McDonough et al.	01	behavioral challenges, project mgt challenges, performance	Behavioral challenges greatest in GVT, then VT, then TT. Project mgt challenges least in TT. Performance greatest in TT, then VT, then GVT. Greater project mgt challenges are associated with lower performance for all 3 types of teams. Project mgt challenges more a function of distance between members than cultural differences.		Ongoing Organization employees	Did not report	Varied	Journal of Product Innovation Management

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Montoya-Weiss et al.	01	process structure, conflict, performance	Avoidance, compromise conflict have negative relationship with performance. Process structure weakens negative effect on performance for avoidance, compromise conflict. Competition, collaboration conflict have positive relationship with performance.	Conflict Theories	3 week UG students	5	2,4	Academy of Management Journal
Qureshi & Vogel	01	adaptation (technology, work, social), structure, specialization, coordination, task, learning	Provide framework of adaptation and organization challenges in VTs. Review of current research on adaptation.	Structuration Theory	Not applicable (NA)	NA	NA	Group Decision and Negotiation
Ramesh & Dennis	02	coordination, work processes	VTs may operate better as object-oriented teams – decoupling team members through use of well defined processes, inputs, and/or outputs rather than trying to tightly couple members may improve coordination in VTs.	Media Richness, Media Synchronicity	3 month, 11 month, 2 years Organization employees	3 6 10-56	Poten- tially all	HICCS
Robey et al.	00	learning, mgt, performance, communication, technology use, FtF meetings	Communication improves cultural understanding which improves coordination. FtF meetings needed to gain respect, trust, interpersonal relations. Choice of technology based on many factors. Learning can be effectively accomplished in VT.	Learning Theories	3+ years Organization employees	11-13	Poten- tially all	IEEE Transactions on Professional Communication

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Sarker & Sahay	02	time, space, culture, technical expertise, communication, coordination, socialization	Strategies for dealing with challenges involved with VTs.		14 week students	8-10	Potentially all	HICCS
Sarker et al.	01	technology, norms, social practices, team development stages, frames of reference, collaboration	Communication, collaboration, social norms all adapt and change in different stages of team development.	Adapted Grounded Theory Communication Theories Structuration	14 week students	8-10	Potentially all	Database
Savicki et al.	96	gender, task, communication, team development	Female-only VTs are more satisfied, send more words, have better team development, and self-disclose more than male-only or mixed-gender VTs.		4 week UG students	4-6	3,4	Computers in Human Behavior
Sharda et al.	88	effectiveness, decision time, confidence, # alternatives	VT greater effectiveness and took longer to make decision. No difference between VT and TT on confidence, # alternatives generated.		8 week UG students	3	4	Management Science
Suchan & Hayzak	01	communication, attitudes, technology use	Communication most important factor for success, seen as strategic activity to be considered daily. Mentoring program enabled socialization of members. Leaders used FTF meetings to help develop trust. Culture and reward system supported information-sharing.		Ongoing Organization employees	31	1,2,3,4, 8	IEEE Transactions on Professional Communication

Appendix A: Studies Included in the Review, continued

Authors	Year	Issues/ Variables Examined	Results	Theory	Time Frame and Subjects	Team Size	Task Type	Journal
Tan et al.	00	cohesiveness, collaboration, perceived decision quality, perceived decision satisfaction	VTs receiving dialogue training had higher cohesiveness, collaboration, perceived decision quality, perceived decision satisfaction. Differences remained over time.	Dialogue Theory	4 week experiment UG students	5	4	IEEE Transactions on Professional Communication
Van Rysson & Godar	00	culture, technology, communication effectiveness	Cultural differences created problems for UG students in areas of socialization, communication, coordination. Training needed both in how to communicate and how to use technology.		3 month UG students	4	3,4	Journal of International Management
Waither	95	relational communication	VTs became less task-oriented and less formal over time. VTs perceived greater immediacy / affection / inclusion, communication of attitude likeliness than did TT.	SIP	5 week UG students	3	4	Organization Science
Waither & Burgoon	92	relational communication	VTs increased in several relationship dimensions to more positive levels – approaching or surpassing TT levels	SIP SPT	5 week UG students	3	4	Relational Communication
Warkentin & Beranek	99	communication training, interaction process, trust, commitment to team goals	By mid-point of VT life, teams with communication training had higher trust, commitment to team goals, openness of expression, better interaction processes	Discuss many	6 week Grad students	3-4	3	Information System Journal
Warkentin et al.	97	performance, relational links, info exchange	TT had higher relational links, performance. No differences on effectiveness of info exchange.	TIP	3 week UG students	3	3	Decision Sciences

Appendix B: Summary of Major Issues Investigated

Authors	Subject*	Inputs				Socio-emotional Processes			Task Processes			Outputs	
		Structure	Culture	Technology	Training	Cohesiveness	Trust	Relationship Building	Communication	Coordination	Task-Technology-Structure Fit	Performance	Satisfaction
Ahuja & Carley (99)	O	X						X				X	
Archer (90)	S											X	X
Berdahl & Craig (96)	S							X					
Burke & Aytes (98)	S					X		X	X			X	
Burke & Chidambaram (96)	S			X				X	X			X	
Chidambaram & Bostrom (93)	S					X		X				X	
Chidambaram (96)	S					X			X				X
Chidambaram et al. (90-91)	S			X		X				X			
Crampton (01)	S								X				
Eveland & Bikson (88)	O	X						X	X				X
Galegher & Kraut (94)	S	X							X	X		X	
Galvin & Ahuja (01)	O	X							X				

Appendix B: Summary of Major Issues Investigated, continued

Authors	Subject*	Inputs				Socio-emotional Processes			Task Processes			Outputs	
		Structure	Culture	Technology	Training	Cohesiveness	Trust	Relationship Building	Communication	Coordination	Task-Technology-Structure Fit	Performance	Satisfaction
Hollingshead et al. (93)	S			X							X		
Jarvenpaa & Leidner (99)	S			X			X	X					
Jarvenpaa et al. (98)	S	X					X						
Johansson et al. (99)	S		X					X	X				
Kaiser et al. (00)	S	X			X							X	
Kayworth & Leidner (00)	S	X	X	X				X	X	X	X	X	X
Kayworth & Leidner (01-02)	S	X	X					X	X				
Krumpel (00)	O	X											
Lind (99)	S					X		X		X	X	X	X
Lurey & Raisinghani (01)	O							X	X	X			
Majchrzak et al. (00a)	O	X										X	
Majchrzak et al. (00b)	O	X								X			

Appendix B: Summary of Major Issues Investigated, continued

Authors	Subject*	Inputs				Socio-emotional Processes			Task Processes			Outputs		
		Structure	Culture	Technology	Training	Cohesiveness	Trust	Relationship Building	Communication	Coordination	Task-Technology-Structure Fit	Performance	Satisfaction	
Malhotra et al. (01)	O	X								X			X	
Mark (01)	O		X	X				X						
Maznevski & Chudoba (01)	O	X	X			X			X	X	X		X	
McDonough et al. (01)	O		X					X		X			X	
Montoya-Weiss et al. (01)	S	X											X	
Qureshi & Vogel (01)	N/A	X								X			X	
Ramesh & Dennis (02)	O	X							X	X				
Robey et al. (00)	O	X	X						X	X	X		X	
Sarker & Sahay (02)	S		X		X					X	X			
Sarker et al. (01)	S	X		X				X		X	X			
Savicki et al. (96)	S									X				X
Sharda et al. (88)	S												X	

Appendix B: Summary of Major Issues Investigated, continued

Authors	Subject*	Inputs				Socio-emotional Processes			Task Processes			Outputs	
		Structure	Culture	Technology	Training	Cohesiveness	Trust	Relationship Building	Communication	Coordination	Task-Technology-Structure Fit	Performance	Satisfaction
Suchan & Hayzak (01)	O	X	X		X		X		X			X	
Tan et al. (00)	S				X	X				X		X	X
Van Ryssen & Godar (00)	S		X	X	X				X			X	
Walther & Burgoon (92)	S						X						
Walther (95)	S						X						
Warkentin & Beranek (99)	S				X		X			X			
Warkentin et al. (97)	S					X		X	X	X	X	X	X

* S = Students; O = Organization