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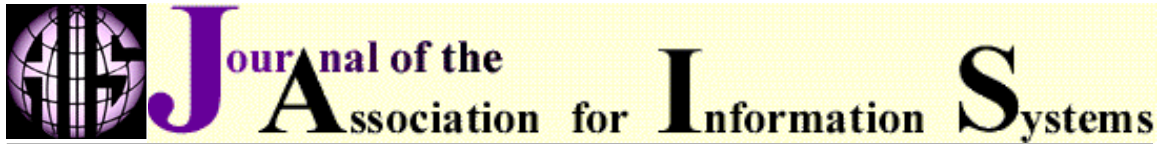
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Understanding Virtual Team Development: An Interpretive Study

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ABSTRACT

In this paper, we develop an understanding of how virtual teams develop over time by inductively studying communication transactions of 12 United States-Canadian student virtual teams involved in ISD. Our analysis is based upon two influential streams of social science research: (1) interaction analysis, which aided in the examination of the micro-processes of communication among members of a virtual team, and (2) structuration theory, which provided a meta-framework to help link the micro-level communication patterns with the more macro-structures representing the environmental context as well as the characteristics of teams over time. Based on our interpretation of the communication patterns in the virtual teams, we propose a theoretical model to describe how virtual teams develop over the life of a project, and also attempt to clarify how the concepts of communication, virtual team development, and collaboration are related.

Key words: Virtual teams, virtual team development, group development, collaboration, technology-mediated communication, interpretive methodology, virtual participant observation, interaction analysis, structuration theory

I. INTRODUCTION

Virtual teams are becoming an integral part of organizational life (Igbaria et al. 2001; Jarvenpaa and Leidner 1999; Saunders 2000). These teams may be viewed as temporary work groups con-

sisting of geographically dispersed members who primarily interact using different information and communication technologies (ICTs) such as e-mail, groupware, video, and computer-based conferencing systems to produce a deliverable that is evaluated as a team outcome (Furst et al. 1999; Lipnack and Stamps 1997). In the context of information systems development (ISD), recent trends such as globalization, shortage of qualified ISD professionals at different locations in which major companies may operate, the availability of excellent quality ISD talent at low costs in different parts of the globe, the hyper-competitive environment wherein businesses are under increasing pressure to develop more cost-effective strategies for software development, and advances in telecommunications have increasingly led to the creation and utilization of virtual teams (e.g., Carmel 1999; Jablin and Sias 2000). However, despite the burgeoning demand of virtual teams, the complex processes relating to how these teams develop over time in particular social contexts are inadequately understood (Briggs et al. 1998; Sarker et al. 2001). Adopting a social perspective to understand the evolutionary process of virtual teams is useful in interrogating what creates (or does not create) the synergy that is likely to lead to superior outcomes in these organizational forms. Such an understanding can help identify specific tactics that tend to be effective in building and maintaining this synergy.

The aim of this paper is to develop an empirically informed understanding of how virtual teams develop over time. This aim is consistent with the views of Jarvenpaa and Leidner (1999), who, among others, have argued for the need to adopt a *developmental view* to understand virtual teams. Prior research on colocated groups provides us with a useful starting point to define virtual team development. According to Mennecke et al. (1992, p. 526), group development refers to "the degree of maturity and cohesion that a group achieves over time as members interact, learn about one another, and structure relationships and roles within the team." This definition emphasizes the interaction between the structural aspects of a group (for example, cohesion) and the interactional aspects at the micro-level (for example, members learning from each other). Unfortunately, as Gersick (1988, p. 9) observes, the existing group development models in the literature do not consider the role of the group's environment or identify the triggers for transition between stages that are critical to understanding and managing group development. Further, most models focus either on the micro or on the macro aspects of group development, leading to a limited understanding of the process.

Owing to issues of the temporal, spatial, and cultural separation along with the intensive mediation of ICTs, virtual teams have their unique complexities. These complexities have implications on a wide range of issues relating to trust relationships, knowledge management, identity, and network building, communication, socialization, and collaboration skills, and team member satisfaction (Jackson 1999; Jarvenpaa and Leidner 1999; Knoll and Jarvenpaa 1998; Warkentin et al. 1999). Given the specific issues associated with virtual teams, it appears reasonable to suggest that virtual teams differ from colocated teams in many fundamental ways. A consideration of the potential differences between colocated and distributed teams in conjunction with the apparent limitations in much of the existing body of knowledge on group development points to the need for fresh theoretical approaches to conceptualize and thereafter empirically examine virtual team development.

Our aim is to develop such a theoretical understanding by taking a perspective inspired by social science. Three sets of issues are key to this understanding. The first concerns the *micro-level* team processes of how team members communicate with each other to complete the required task at hand, and also to build up mutual social understanding. The second concerns the *macro-level structures*, related to, for example, the dependency, control, and intimacy in the team as well as specific characteristics pertaining to the environmental context (Gersick 1988). The third critical element, often ignored, concerns the interactions among various micro and macro issues (Conrad and Haynes 2000; Lea et al. 1995). A focus *exclusively* on one of the two levels (micro or macro) creates a

dualism since attention is limited either on the cognitive aspect of beliefs, perceptions, and actions of individuals, or on the structural features and routines of the team (Gersick 1988; Pentland 1992). In virtual teams, such a dualism (i.e., focus on either the micro or the macro) leads to *an incomplete understanding of team development* since the identification of mechanisms that link micro-level actions (e.g., individual member's communication) to structural characteristics (e.g., nature of team's goals) is ignored. One of the consequences of this limited understanding of team development is an *unclear conceptualization of the notion of collaboration*, a crucial element in virtual teamwork. An implicit assumption made is that communication can be equated to collaboration among distributed members in virtual teams. This leads to a deterministic stance wherein it is believed that by introducing more efficient ICTs, collaboration can be enhanced. We argue against such deterministic reasoning and emphasize the need to study virtual teamwork as a phenomenon involving emergent socio-technical interactions (Markus and Robey 1988).

Pentland (1992) suggests that researchers adopt a situational approach that takes *situations* rather than individuals or structures as the most appropriate level of analysis. This approach is referred to as *methodological situationalism* (Knorr-Cetina 1981). Consistent with Pentland's suggestion, in our study, we were interested in situations concerning how members communicate in different *virtual team situations*, and how these communicative actions¹ relate to team *structure* over time. The underlying assumption is that "actions of members are always shaped to some extent by the situation they find themselves in," and it is important to "discern what is distinctively organizational about their performances" (Pentland 1992, p. 529). Situated approaches are in line with existing context-based IS research which seeks to describe mutual interrelationships between the context and process of IS design and use in organizations (Walsham 1993). A situated approach, we thus argue, allows for a more coherent understanding of communication, collaboration, team development, and how they mutually relate to each other. Based on this perspective, we attempt to address the following two interrelated questions:

- *How can micro-level communicative actions be related to the changing nature of macro-level structural properties associated with virtual teams over the course of a project?*
- *What does collaboration mean, and how is it related to communication and team-development?*

We address these research questions through an intensive empirical analysis of 12 information systems development (ISD) virtual team situations, which results in an inductively developed theoretical model that links the micro level of communication with the macro level of team structure. This changing mutual linkage between the micro and macro levels over time is what we conceptualize as *virtual team development*, within which *collaboration* is labeled as one of the phases in the development process.

The rest of the paper is organized as follows. In the following section, we outline the theoretical approach. The methodological approach is described in the third section. The fourth section includes

¹The term *communicative action* is often associated with the work of Habermas (1984) of the critical social theory tradition (which focuses, among other issues, on communication distortions). However, in this study, we use this term in a general sense to represent the action (e.g., impression management, calling upon higher authority, etc.) implied in a communication transaction.

the case discussion and model development. Finally, the contributions as well as some of the limitations of the research are presented.

II. STUDY OF VIRTUAL TEAM DEVELOPMENT: THEORETICAL APPROACH

Our research is an inductively grounded interpretive case study (Walsham 1995) wherein we draw upon social theory to sensitize us to issues of importance, and examine this empirical data through a theoretically informed lens. The metaphor of theory as language (Van Maanen 1989) allows us to interactively communicate between our conceptual understandings and data. At the micro-level, we adopt an interactionist perspective that has been described as breathing new life into the study of communication in computer-based settings (Myers 1987, p. 251). This analysis is primarily informed by concepts drawn from the interaction/conversation analysis tradition (Goffman 1959, 1967, 1983; Heritage 1984; Jordan and Henderson 1994; Putnam and Fairhurst 2000; Silverman 2000, 2001). In addition, structuration theory (Giddens 1976, 1979, 1984) helps to analyze the recursive linkages between the micro-level communicative actions with the macro-context of virtual team structures. We now discuss the theoretical underpinnings of these two levels of analysis in some detail.

MICRO LEVEL OF COMMUNICATIVE ACTION

We use the term *communicative action* to represent the action (e.g., impression management, calling upon higher authority, apologizing, etc.) implied in a communication transaction (say, an e-mail message) occurring between virtual team members. Interaction analysis helps us analyze the patterns of communicative action that are seen to emerge as an “achievement amongst possibilities” rather than as something given or preplanned (Pentland 1992, p. 530). A “strip” of communication (Agar 1986) cannot be understood without knowing what provoked it and the associated response. These patterns of communication, referred to as *interaction orders* (Goffman 1983), are associated with a set of interactional rights and obligations that are linked to the micro level of personal identity and to the large-scale macro institutions such as family and religion (Jordan and Henderson 1994).

Since the “world’s business gets done in talk and in conversation” (Denzin and Lincoln 2000, p. 640), analysis of communication becomes fundamental to understanding organizational work. This is especially crucial in virtual teamwork where nearly all work is conducted through computer-mediated communication. Drawing upon the literature on interaction/conversation analysis, we conceptualize context as both a project as well as a product of participants’ actions; in other words, context is built, invoked, and managed through interactions (Correll 1995). Virtual team members come together with very minimal prior history of working together, and *evolve* the context in the process of engaging in and making sense of their virtual interactions.

We see the strategies of *turn-taking* and *dealing with conversational problems* identified by interaction/conversation analysts as relevant for understanding micro-interactions among virtual team members. **Turn-taking** allows members to participate in an interactional exchange system (Jordan and Henderson 1994), to define or negotiate the situation and to respond to conversation (Goffman 1959; Scheff 1968). To take turns in interaction, members have to be *virtually present* (extending the notion of co-presence) which, in virtual teams, implies that members must share consciousness of

each other's presence, synchronously or asynchronously, through a combination of textual, auditory, and visual contact (Couch 1989). Turn-taking in virtual teams can be characterized by both simultaneity and timelessness (Castells 1996) where actors can communicate simultaneously (say, in a chat program) or postpone the act of replying for later to persistent text (say, in an e-mail, or in an on-line discussion forum), thereby creating a "disordered temporal collage of jumbled tenses" (Hine 2000, p. 85). Virtual team communication thus reflects Castells' description of a culture that is "at the same time of the eternal and of the ephemeral" (1996, p. 463).

Turn-taking in virtual teams is influenced by the *contents* of messages, *artifacts and documents* being exchanged, and the *technologies* in use. *Contents* of messages carry a distinctive symbolism that can be referential or evocative (Couch 1996). *Referential symbols* may be seen to include "requests, invitations, instructions, orders, and/or commands" (Putnam and Fairhurst 2000, p. 90) that aim to coordinate activities. For example, scheduling a videoconference requires the use of referential symbols within a directive, in response to which the other team members need to take a "turn" to confirm their presence in the session. *Evocative symbols* reflect socio-emotional content (see Rice and Love 1987) such as shared jokes that allow members to emote in unison and develop social solidarity through an interactional exchange (Couch 1996).

Turn-taking is also facilitated through the *exchange of documents and artifacts* since actors are expected to acknowledge receipt or respond with comments (Jordan and Henderson 1994). The process of jointly constructing, revising, and completing a document (such as a requirements document in a systems development project) provides resources for participants to monitor the degree of agreement among geographically distributed members. In virtual teams, the manner in which artifacts and documents are transmitted, to whom they are sent, how they are accessed, and the clarity with which they can be interpreted by members are of special interest. *Technologies* play a key role in defining who takes a turn and when. For example, the medium (e.g., e-mail, on-line discussion forum) on which a communication transaction occurs partially determines whether a few individuals or all members of the group are enrolled into processes of explanation and issue resolution.

Dealing with trouble has always been a focus of anthropologists in developing insights regarding the unspoken rules by which activities are organized in particular social spheres. A "trouble" can occur when a team member is perceived as contradicting, discrediting, or doubting an agreed upon norm of interaction. For example, trouble may arise because a member does not respond to an e-mail within an agreed upon time period. Analysis of troubles leads to an understanding of the new kinds of opportunities that are opened (or closed off) as a result, and how actors engage in its avoidance and repair (Silverman 2001). *Disclaimers* and *alignments* are strategies often used to deal with trouble in conversations (Putnam and Fairhurst 2000). *Disclaimers* serve as feedback strategies to help prevent conversational breakdowns, expressed through statements such as "I am not an expert on this issue." *Alignments* refer to corrections used by members in potential breakdown situations. For example, a misunderstanding arising in the team from a statement could lead to explanations or clarifications by the communicator (or by other team members) regarding the original intent behind the communication transaction (Putnam and Fairhurst 2000). Under cooperative conditions, trouble may be easily preempted or repaired, while in uncooperative settings, even a minor instance of trouble may spiral into an irretrievable breakdown that is beyond repair, leading to closure of other opportunities for interaction.

In summary, the tradition of interaction analysis provides us with a set of concepts that enables us, from strips of text that we refer to as communication transactions, to develop interpretations about communicative actions. Next, we discuss the macro-level concept of *participant structure*.

MACRO LEVEL OF PARTICIPANT STRUCTURES

Participant structures in virtual teams (i.e., team structures) contain two key dimensions related to *participation* and *structure*. Structure refers to the domain of orderly and repetitive relationships among members and between members and technologies within the context of a project. Participation specifies the domain of virtual teamwork through communication. Taken together, the concept of participant structure reflects the *structural constraints* for communicative actions that team members create as well as enact in communicating (i.e., *participating in teamwork*) with other members.

Drawing from the literature on colocated groups (e.g., Bettenhausen 1991; Mennecke et al. 1992), we identify two broad aspects of structure as relevant for virtual team analysis: **production** and **social structure**. Production structure relates to the rules and resources that groups draw upon to perform their tasks, and consists of two dimensions: (1) *task focus*, which defines the extent to which virtual team members are engaging with substantive project related issues, and (2) *task ability*, which reflects the expertise of members to achieve project objectives, including both the *technical* and *behavioral* skills (Jablin and Sias 2000). Social structure reflects the rules and resources that structure social interactions, and is conceptualized using four interrelated dimensions:

- (1) *Virtual presence*, which refers to the manner in which team members share consciousness of each other's presence through the use of ICTs (Couch 1989; Walther 1992), and indicates the asynchronous or synchronous availability of members on the electronic medium.
- (2) *Social responsiveness*, which highlights the degree of reciprocity in communication (Couch 1989, 1986). Such responsiveness can be *unidirectional* (communication from only one side) or *bilateral* (when actors communicate *with respect to* or *past* the other), or *mutual* (when actors communicate *with* the other, and are willing to surrender a degree of autonomy to the other).
- (3) *Shared goals*, which reflect the degree to which team members agree on the project aims with other team members (McGrath et al. 1993). Formation of shared goals is a pre-requisite for future-oriented cooperative action (Couch 1986, 1989), especially in conditions of high task-interdependence (Knoll and Jarvenpaa 1998).
- (4) *Identity*, which is created and experienced through the "negotiation and co-construction" over "meanings and manners" among team members interacting in a specific context (Wynn and Katz 1997). A *congruent identity* reflects the sense of oneness among members irrespective of their own personal biographies or geographical locations (Couch 1989). Such an identity, in the view of Cheney and Christensen (2000, p. 246), allows team members to "perceive themselves as part of a whole, autonomous, and anthropomorphic entity."

LINKING THE MICRO WITH THE MACRO DOMAIN OF VIRTUAL TEAM DEVELOPMENT

According to Baszanger and Dodier (1997), social science analysis seeks to connect observed facts with specific features of the backdrop in which these facts occur. They describe this process of generalization from in situ studies as one of *totalization* carried out by integrating different observation sequences into a global referential framework. Structuration (Giddens 1976, 1979, 1984; Orli-

kowski and Robey 1991; see also DeSanctis and Poole 1994²) provides an excellent avenue for such integration, since the theory describes the manner in which regular micro-level interaction patterns occurring within the realm of human action become established as standard practices in social systems and are reified over time as macro structures (and in turn enable or constrain human action including interactions). Orlikowski and Yates (1994) emphasize this idea when they describe communication (i.e., interactions) as “an essential element in the ongoing process through which social structures are produced, reproduced, and changed” (p. 541).

In structuration theory, this recursive process of production, reproduction, and change is mediated through the modalities of norms, meaning, and power (Giddens 1984), and the concepts allow us to incorporate aspects of the environmental context in our study. Our initial conceptual model representing the ideas discussed above is depicted in Figure 1.

In this particular study, the observation sequences were the interpretations of communicative action at the micro-level as members of 12 virtual teams exchanged electronic messages during the course of their project work. These interpretations were totalized in a conceptual framework in terms of participant structure. The linkage between the micro and macro levels over time is conceptualized as **virtual team development**. Within this conceptualization, each phase³ of development is seen as an *idealized set of distinct patterns* (in team members’ communication, the virtual team’s structure, and the modalities of structuration) at different points of time that are associated with the virtual teams studied.

III. EMPIRICAL APPROACH

In this section, we provide a brief outline of the study setting, data collection process, data analysis, and our presentation strategy for the case studies.

THE STUDY SETTING

In our study, the virtual teams were composed of students from two universities working collectively to analyze a business information systems problem, converting it into a systems design, and then developing a working prototype. The participants were students enrolled in Information Systems courses at two large North American universities, one based in Canada (UA) and the other in the United States (UB).⁴ Each virtual team consisted of four or five UA students matched with four or five UB students (i.e., each team had a total of eight to ten students), where participants at the *same* university were referred to as local members, and participants at the *other* university were referred to as remote members. Team members from the two locations jointly carried out a 14-week-long project. A total of 12 teams participated in this study, five in the Fall of 1997 and seven in the Spring of 1998. Each virtual team was given the task to jointly define, design, and develop an infor-

²DeSanctis and Poole proposed the adaptive structuration theory (AST) drawing on Giddens’ structuration theory.

³We use the terms *phase* and *stage* interchangeably in this paper.

⁴In UA, the focus of the course was on decision support systems and in UB it was on database systems.

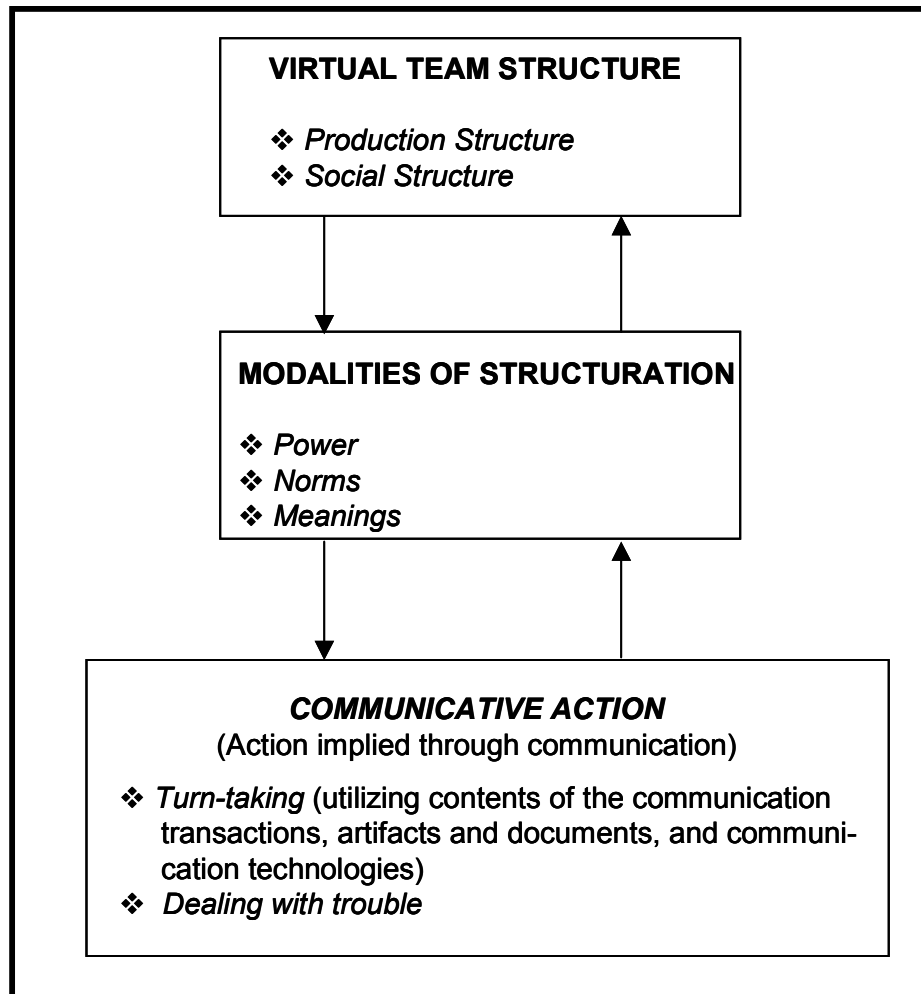


Figure 1. Theoretical Framework for the Study

mation system for an organization. The UA members of each team acted as business systems analysts, responsible for going into an organization and identifying a problem situation that needed resolution using a computer-based information system. They were to then create a rich narrative of the problem in the form of an information requirement document (IRD) and transmit it to their counterpart UB team members (the systems analysts/designers). In addition, UA members were required to provide a preliminary design of the user interfaces preferred by the organizational clients. The UB members of each team were responsible for using the IRD to create a detailed systems design (including an entity-relationship diagram) and then a working prototype of the database system. Finally, UA and UB team members made a joint presentation of their entire project, including the working prototype and potential implementation challenges. Table 1 lists the participants in this project, and Table 2 summarizes the project events with timelines.

Table 1. Project Participants

Main Participants	Brief Description
UA members	Members of virtual teams who were students at UA. Primarily involved in interacting with the clients and defining information and end-user interface requirements.
UB members	Members of virtual teams who were students at UB. Primarily involved in logical design and implementation of the system based on specifications created by UA members in their teams.
PA	Professor facilitating the virtual teams from the UA side.
PB	Professor facilitating the virtual teams from the UB side.
Companies (each team interacted with a different company)	Located in the same city as UA. UA members interacted with company representatives to define the systems requirements.

Table 2. Formal Project Structure

Steps in the Project	Timeline (in weeks)	Event Descriptions
<i>Step I:</i> Formation of the team and creation of work plans	Week 0 to week 4	<ul style="list-style-type: none"> • Event 1: Creation of the virtual team by PA and PB • Event 2: Selection of organization by UA members for which the virtual team would develop a system • Event 3: Introductory videoconference #1 • Event 4: Completion of project proposal by UA members
<i>Step II:</i> Defining the business problem	Week 5 to week 8	<ul style="list-style-type: none"> • Event 5: Completion of the information requirements document (IRD) by UA members • Event 6: Videoconference #2 to clarify the contents of IRD
<i>Step III:</i> System design, development and delivery	Week 9 to week 14	<ul style="list-style-type: none"> • Event 7: Completion of conceptual/logical design by UB members • Event 8: Completion of user interfaces by UA • Event 9: Prototype delivery by UB members and joint presentation in videoconference #3

The course faculty members in both universities played two distinct roles in the project: (1) as *professors*, they designed the project requirements and deadlines, acted as norm enforcers, facilitators, and advisors to each of the virtual teams participating in this study, and also assigned project and final grades to the teams and the individual team members, and (2) as *researchers*, they acted as participant observers⁵ and analyzed communication transactions occurring among the students in their conduct of virtual teamwork.

Methodologically, from a control standpoint central to a positivist research perspective, interference by the researchers in the interaction among team members, and the obvious reward (grade) power the researchers had over the participants, may appear to be problematic in terms of generating valid findings. However, within the interpretive tradition, specifically pertaining to ethnography and participant observation, the inescapable "interdependence between the observer and what is observed" is well recognized (Patton 1990), and data is viewed as *inherently* value-laden and subjective (Walsham 1993). In addition, the interpretive methodology literature acknowledges the fact that researchers are often viewed by subjects as possessing multiple competing identities and roles (Angrosino and Mays de Perez 2000; Wellin and Fine 2001), and also as having asymmetric power over them (Angrosino and Mays de Perez 2000). Asymmetries in power, especially when the researcher also has the role of an evaluator, may lead to research participants changing their behaviors: "[In the presence of a researcher] participants are motivated to 'show off.' On the other hand, the presence of the evaluator may create so much tension and anxiety that performances are below par" (Patton 1990, p. 473).

Contemporary interpretive researchers, however, argue that it is not necessary or acceptable to deny the interdependence or the consequences of interdependence (Angrosino and Mays de Perez 2000; Patton 1990). A researcher is no longer conceived as "a passive bystander who generates representational products" but as one who partly constitutes reality, and forges "generative, communicative relationships" (Gergen and Gergen 2000, p. 1039) such that data collection becomes a co-constructive "negotiated accomplishment" (Fontana and Frey 2000). Interdependence is not only seen as being unavoidable, but sometimes desirable, since the researchers' immersion and participation in the situation ensures a high degree of understanding of the phenomenon being studied (Patton 1990; Walsham 1995). Patton advises researchers to simultaneously maintain detachment and personal involvement to the extent possible, and reflexively take on the responsibility to understand the results of their interventions.

Throughout the research study, we have adopted a critically reflexive approach to understand the potential consequences of our interventions on communication patterns, and team development. Similar to real-life business projects, where, due to time pressures in virtual-team projects, managers try to structure projects tightly by including intermediate deadlines, defining norms of communication and performance, issuing directives, and providing advice, we also defined the structure of the project, set and enforced deadlines for various deliverables, designated Webboard as the official

⁵Given the apparent similarities between participant observation and action research (Baskerville 2001), we have carefully considered if our study should be categorized as an interpretive case, or should be labeled as an action research (AR) owing to the researchers' (intervening) role in the study. There are several reasons that convinced us that our study is not an instance of AR, the two most important ones being that (1) unlike AR studies, the intention behind the design of our study was not to "democratize" the research process through "the inclusion of local stakeholders as coresearchers" (Greenwood and Levin 1998, p. 3) and, (2) unlike AR studies, there wasn't a fundamental orientation in the research study to diagnose the social situations of the students participating in the virtual-team projects, and to facilitate "social change" through "collaborative change experiments" (Baskerville 2001, pp. 194-195).

medium of communication, designated dates for videoconferencing sessions, "appointed" UA as the business analysts and UB as the technologists, and provided directives and guidance to the teams as necessary. These interventions no doubt influenced the communication process (for example, by defining the preferred media of interaction, or by creating a sense of urgency by announcing a videoconferencing meeting). However, we contend that changes observed in the team processes and outcomes were not inconsistent with the influence that a manager's intervention might have in a real-world ISD project involving a virtual team and, therefore, should not be viewed as distorting the real process. Throughout the study, team members were also aware that the project coordinators, who were also evaluators, were lurking on the Webboard. Consistent with Patton's observations regarding the potential consequence of researchers' evaluative role (quoted above), we believe that we (as evaluators) may have prompted study participants to change their communication patterns. Again, such distortions would not necessarily invalidate the findings of our study, since, in real-world virtual teams (e.g., Pauleen 2001), facilitators or supervisors (including those with evaluative power) could indeed be virtually present on the electronic communication channels where all communicative actions of project team members are visible.

DATA COLLECTION

Two main types of data were collected from several sources at different points in time: (1) communication transactions of each virtual team and (2) each student's individual reflection of their experience at the end of the project. Table 3 summarizes our data collection efforts.

DATA ANALYSIS

Data analysis was conducted by the researchers who themselves worked as a geographically dispersed virtual team, and this further provided *theoretical sensitivity* (Strauss and Corbin 1990). The data analysis process spread over two years during which period the researchers met face-to-face three times. The interpretations evolved through the reading and rereading of the communication transcripts, and discussions of the individual team's cases among the researchers led to the development of the initial themes of the proposed model and to their subsequent refinement. At the next level, the case descriptions were analyzed to discern broader patterns across the teams, and this led to the formulation of the initial theoretical model. This model was further elaborated upon through discussions and reading of theory. Thus, to summarize, the data analysis approach involved an ongoing dialogue with existing literature and among the researchers concerning the data collected and the emerging interpretations (Alvesson and Skoldberg 2000).

The case discussion below is presented with a view to emphasizing the different dynamics and processes of the different virtual teams. We were confronted with the dilemma of whether to do justice to the individual teams through a detailed description of each case, or to focus on discerning the "overall patterns in the process" emerging through the cross-case analysis (Leonard-Barton 1990). Given our aim of theorizing about the nature of team development, we chose to provide examples from different teams to illustrate the broader theoretical model of virtual team development.⁶ We thus selectively draw upon examples to highlight various facets of the model, related to

⁶A preliminary version of the model was introduced in a previously published paper (Sarker et al. 2001).

Table 3. Data Collection Summary

Source of Data	Nature of Data Collected	Time/Frequency of Data Collection
Webboard	All messages and attachments posted	Throughout the life of the project
Electronic mail	<ul style="list-style-type: none"> • E-mails sent directly to coordinators, PA or PB • E-mails exchanged among team members 	<ul style="list-style-type: none"> • At different times • Compiled and submitted by each team at the end of the project
Videoconferencing	<ul style="list-style-type: none"> • Real-time observations by coordinators during the meeting • Videotapes of the meetings 	During the three videoconferencing sessions
Participant/direct observation by coordinators	Informal feedback from participants and direct observations	Throughout the life of the project
Final team reports on project	Substantive description of the problem, design, development and collaboration process	At the end of the project
Reflection documents	Summary of individual experiences in the project, and lessons learned	At the end of the project
Evaluations of other team members	Quantitative and qualitative feedback on team members' performances through e-mail to the coordinators	At the end of the project
On-line feedback (optional)	Comments on the virtual-team project itself	As and when completed by participants

the interpreted phase of the development process (see Figure 2). For each phase, we provide snapshots of key elements of *the structure of the team*, *recurring communicative actions*, and the *modalities* of the interaction. Tables 4, 5, and 6 summarize these three elements at the four phases of the development process respectively.

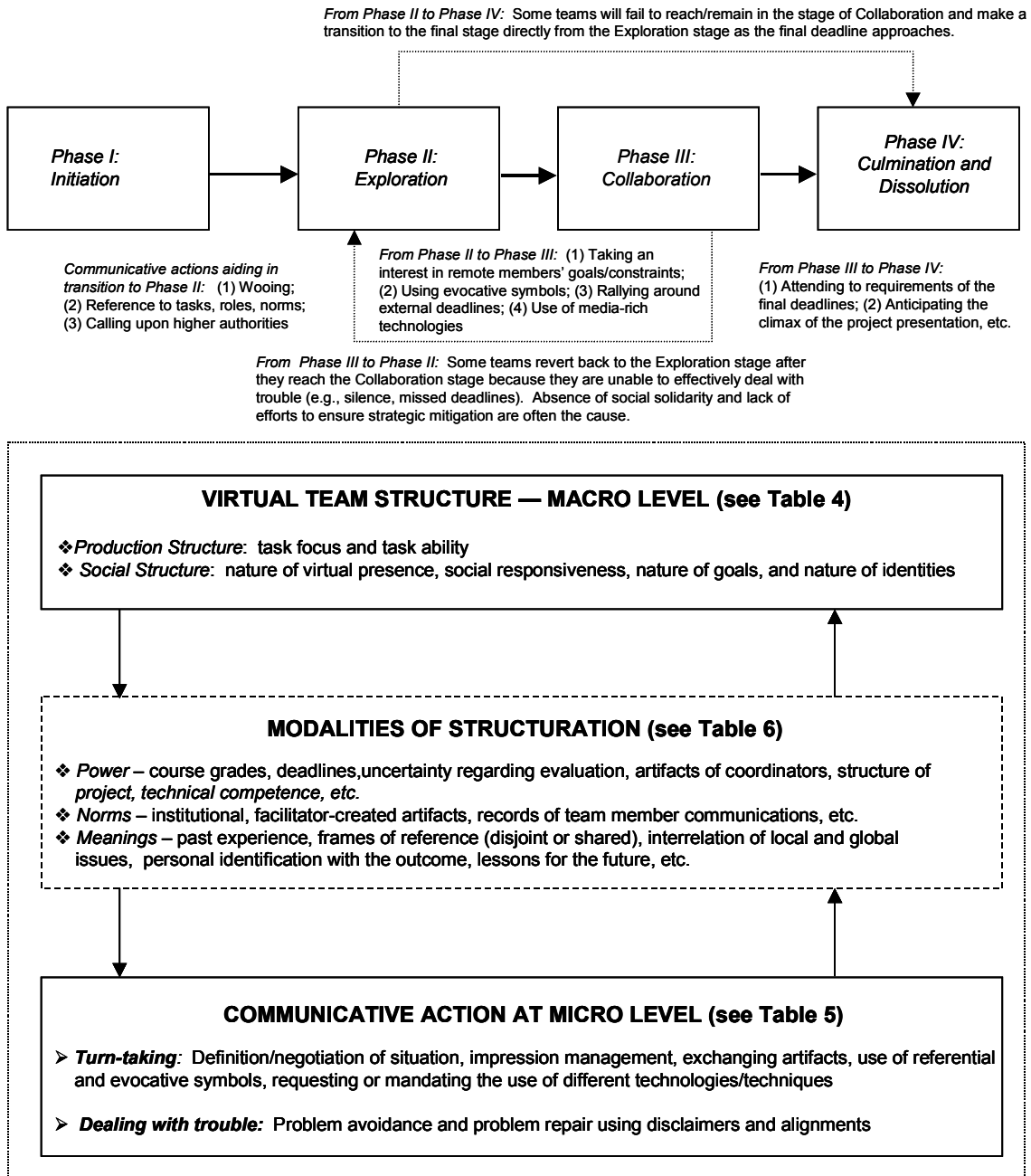


Figure 2. Team Development Stages Conceptualized in Terms of the Reciprocal Interaction between the Macro and the Micro

Table 4. Changing Structure in Virtual Teams

Phases →		Initiation	Exploration	Collaboration	Culmination
SOCIAL STRUCTURE	Virtual presence	Virtual presence <i>limited to initiating side</i> members in most cases.	Increased but <i>intermittent virtual presence of members from both sides</i> . No shared norms of virtual presence.	Most members <i>uniformly copresent virtually as per established/accepted norms</i> .	For effective teams (those making a transition from Stage 3), virtual presence remains uniformly high until project end, and sometimes persists after the project ends. In other teams, virtual presence is intermittent and abruptly disappears immediately after project presentation.
	Social responsiveness	<i>Unidirectional</i> (from the direction of initiating group, other side largely silent).	<i>Bidirectional</i> (both sides conversing <i>past</i> each other).	<i>Mutual</i> (both sides conversing <i>with</i> each other).	Effective teams remain mutual until the end of the project, and, often, beyond. Not so for the other unsuccessful teams.
	Nature of goals	Reflect <i>individual concerns</i> . Team members unsure about local goals and unaware of overall project goals.	Reflect the <i>local concerns</i> of satisfying members' local (course) requirements.	<i>Shared goal</i> (of building an acceptable IS for the client, and delivering an impressive presentation). Evidence of supporting remote members' specific goals.	For effective teams, successful joint presentation of the IS and good grades (i.e., joint success). For teams transitioning from second stage, there is no shared goal—focus is on getting a good grade (favorable individual evaluation) at any cost.
	Identities	Participants switch between <i>individual identities and identities linked with some local members</i> with shared bios (fragmentation).	<i>Differentiated identities</i> develop and solidify based on local affiliation.	<i>Team-level integrative identities</i> form that appear to transcend locations.	Team-level integrative identities persist in “effective” teams, while, in others, project or team-related identities disappear.

Table 4. Changing Structure in Virtual Teams (Continued)

Phases →		Initiation	Exploration	Collaboration	Culmination
PRODUCTION STRUCTURE	Task Focus	<i>Low focus</i> , formed primarily based on artifacts created by project coordinators, (i.e., Web-site information in the form of syllabus, etc.).	<i>Increasing focus</i> as communication occurs on the project requirements among team members (both sides) and with coordinators.	<i>High focus</i> reflected in substantive discussions, and precise responses made to specific questions (over an extended period).	<i>Peaking of task focus</i> in almost every team.
	Task Ability	<i>Low with respect to communication competence and task-related skills.</i> Ability based on prior coursework and experiences with IT.	<i>An improvement in ISD and communication skills</i> that are required for the project (e.g., Access, ER modeling, VBA, videoconference, altercentricism)	<i>Substantial</i> (i.e., high task ability) as team members gain experience and delegate responsibilities according to competence or interest.	In effective teams, high task ability clearly evident. In the less effective teams, task ability remains marginal—limited to making “grade-saving” development and presentation.

Table 5. Examples of Recurring Communicative Actions in the Process of Virtual Team Development

Phases →		Initiation	Exploration	Collaboration	Culmination
TURN-TAKING	Definition/ Negotiation of situation	Coordinators define project landscape, as members enact their local affiliations and self-centeredness.	Members tend to redefine project unilaterally and somewhat awkwardly according to their local frames.	Joint negotiations to clarify deadlines and technical parameters of the system. Alter-centricism evident in negotiation. Also very limited topic shifts.	Effective groups agree on details, such as format of videoconference. In other groups, a sense of chaos and frustration as details remain unclear, each side waits for the other to do something. Lot of excuses and blame assignment.
	Impression management	Members try to establish technical credibility, and also use symbols (icons) to project their images of being "cool" individuals.	Both sides attempt to portray an image of being professional and credible. Some teams use humor to express collegiality.	Competence expressed in practice as team members work through project issues, sometimes with humor and verve.	Teams attempt to impress coordinators and other teams with the successful completion of "complex" projects. For ineffective teams, individual team- members consciously manage the coordinators' impressions about them.
	Exchanging artifacts	None between members. Coordinators provide project details on Web site, and in some cases, examples of previous year reports.	Transmission of formal documents relating to proposal and requirements, without any ostensive purpose. No shared norm(s) on ICTs to be used.	Formal as well as informal documents and diagrams exchanged frequently, comfortably, and purposefully using different ICTs where norms for usage are shared.	Rapid exchange of documents to meet project deadlines. Chaos in some teams where norms of exchange unclear (e.g., a team struggled to transmit a large document.)
	Use of referential/ evocative symbols	Minimal use, other than proposals on project team names being done locally, and unilateral invitations to be virtually present.	Primary use of referential symbols, some evocative symbols with reference to sports and drinking. Negative evocative symbolism (e.g., sarcasm, berating in jest) also evident and appeared to have a negative influence in the teams.	Frequent use of evocative symbols seamlessly weaved with referential symbols. Helps the project evolve into a fun and productive work environment.	Use of evocative symbols help to establish an enduring social relationship, in some cases, even after the project. Referential symbols used extensively to coordinate project completion.

Table 5. Examples of Recurring Communicative Actions in the Process of Virtual Team Development (Continued)

Phases →		Initiation	Exploration	Collaboration	Culmination
DEALING WITH TROUBLE	<i>Problem avoidance</i>	Members use various strategies, including wooing, calling on external norms, appealing to coordinators to intervene.	Humor proposed to “break the ice” and establish an environment in which problems don’t occur. Those showing initiative and knowledge are publicly praised.	Explicit appreciation of the ideas and efforts of the others, and substantive disagreements resolved through polite but reasoned argumentation—“strategic mitigation.” Referential and evocative symbols intertwined.	Careful planning of project completion and presentation. Crisis management through intense exchange of referential symbols, sometimes intertwined with evocative symbols as members scramble to complete tasks.
	<i>Problem Repair</i>	Coordinators intervene to repair problems caused by non-response to messages (i.e., silence of remote members.).	Use of repair strategies of negative interpretations by thanking remote members for their patience, shifting attention to technological failures or their lack of knowledge of it, and blaming coordinators.	Intervention required by coordinators in isolated cases to defuse potentially negative situations. Apologies and humor used routinely by team members to sort out problems (if they arise).	Directed primarily towards coordinators to ensure favorable evaluation even if process outcome was poor.

Table 6. Modalities of Structuration in Virtual Teams—Examples

PHASES →	Initiation	Exploration	Collaboration	Culmination
POWER	<ul style="list-style-type: none"> • Institutional position of the coordinators • Project structure and evaluation criteria specified by the coordinators • Project related uncertainty • Knowledge of technology (or lack of) 	<ul style="list-style-type: none"> • Coordinators' institutional position to reward and punish • Roles implied in the project structure (manager) • Knowledge of technology and techniques (or lack of) 	<ul style="list-style-type: none"> • Awareness of complexity of achieving shared social goal • Coordinators' institutional position to reward and punish (subtle but present) • Mutuality enabling the abdication of formal power in the interest of expediency • Individual technical and behavioral skills 	<ul style="list-style-type: none"> • Evaluative criteria specified in the project document (syllabus) by the coordinators • Coordinators' institutional position to reward and punish more prominent • Individual technical skills especially become important source of power in the team
NORMS	<ul style="list-style-type: none"> • Few pre-existing views on effectively participating in virtual collaboration • Initial guidelines proposed (imposed) by coordinators • Individual members' own beliefs about the use of different IT based on prior experience • Norms of behavior in projects in university contexts 	<ul style="list-style-type: none"> • Norms of satisfying requirements of the local institution • Working rules of technology use, responsiveness, etc., proposed, negotiated, and/or appropriated • Expectations of professionalism and collegiality as proposed by project coordinators 	<ul style="list-style-type: none"> • Taken-for-granted shared rules (across location) of virtual presence maintenance, technology-use, turn-taking, etc. • Documented history of turns taken publicly available on the Webboard to verify or reinforce agreed upon guidelines • Expectations of professionalism and collegiality in a virtual team, as proposed by coordinators 	<ul style="list-style-type: none"> • Taken-for-granted of shared rules (across location) of virtual presence maintenance, technology-use, responsiveness, etc. • Some norms (e.g. timeliness, technology-use) stretched to (beyond) limit as members frantically try to achieve project deliverables • Project parameters and evaluative criteria described in syllabus become the main source of norms for structuring interaction and final artifacts

Table 6. Modalities of Structuration in Virtual Teams—Examples (Continued)

PHASES →	Initiation	Exploration	Collaboration	Culmination
MEANINGS	<ul style="list-style-type: none"> • Virtual team holds little meaning. Also, team membership not part of self-definition • Course and term project meanings based on discussion with past students at the same location • Meanings about the efficacy and novelty of different technologies (paging, e-mail, videoconferencing, etc.) and the project itself • Meanings held by coordinators based on their research embedded in artifacts (syllabus) 	<ul style="list-style-type: none"> • Emergent understanding of ISD concepts from the course • Emergent understanding of project requirements/structure • Natural identification with local (us) versus remote (them) 	<ul style="list-style-type: none"> • Shared frame of reference regarding project • Responsibility towards the client • Interrelatedness of the global requirements and local requirements of each side • The entire project team viewed as an anthropomorphic whole, and a sense of belonging to this whole • Positive affect regarding the project, framed as a unique and realistic experience 	<ul style="list-style-type: none"> • Joy or anger or relief based on experiences in the project • Emotional closeness, irritation or indifference with team members • Learning becomes "shared stocks of knowledge" for both the coordinators and students with respect to future virtual-team projects

CASE NARRATIVE

Initiation Phase

The project was initiated at both sites (UA and UB) with the coordinators (PA and PB) describing the project through their respective course syllabi and through on-line announcements. UA and UB parts of each team were self-formed, often based on whether members were from the same country of origin (e.g., China) or if they had worked together in a lab or in a project in a prior course. *Social structure* at this stage was primarily derived from members' prior shared experiences as a result of the same cultural, national, or professional backgrounds, and their beliefs regarding their coordinator's (i.e., professor's) expectations of the project. *Production structure* of the teams came from team members' status as IS majors, which implied certain skills and competencies, including a familiarity with technologies such as e-mail. However, team members' familiarity with newer technologies such as videoconferencing and Webboard was limited. For example, one member repeatedly referred to Webboard as "Web-Boat" in both oral and written communication.

Both production and social structures during this period can be characterized as marginal and largely undefined. Students felt overawed by the unknown nature of the project, their remote team members, and of the new ICTs they needed to use. The high weight of the project (40% of the grade in the course) gave extreme power to the coordinators, who unilaterally specified certain norms of communication and coordination for the teams, for example:

I can't over-emphasize the importance of communication in such collaborative work. An effective group is one which has clearly defined channels of communication. So, it is important for you to start defining these channels, and agreeing on the parameters for subsequent work. Please post all messages that relate specifically to your group work under this Topic.⁷

Such statements provided the initial set of rules and resources for communication, and these were later negotiated and appropriated by team members. The UA members tended to take the initiative in inviting their UB counterparts into the communication arena using different strategies such as *issuing greetings* ("saying hello") and *invitations* ("feel free to e-mail us any time") or *managing impression* by presenting themselves as dedicated professionals or as "cool" people. In some cases, norms were *proposed* regarding the use of alternative ICTs (like ICQ), which challenged the official project norm of using Webboard. Also, attempts were made to better *define (and negotiate)* the roles and relative power of the two sides in the project, for example, by asserting, "It seems as though our team is in the *management role* and your team is playing the role of *IS professionals*" (emphasis added).

While initial messages often reflected team members' focus on individual identities (e.g., "Hello from the lone female" or "If you want to know more about me check out my web-site at..."), subsequent messages reflected the members' differentiated group identities (based on location—UA or UB), and reinforced the fact that they had still not accepted themselves as one *geographically distributed* virtual team. The process of team naming reflected the fragmented identities, for example, a team named itself DFLKK, representing the initial letters of the local team members' names, completely oblivious of the existence of their team's UB members.

⁷A *topic* is an area designated for the team to exchange messages on the Webboard.

During initiation, UB members, in general, maintained silence in response to the UA messages. This UB silence could be seen to represent a typical technocentric systems developer attitude (e.g., Hirschheim and Klein 1989), as reflected in the comments of one team: “*send us the complete requirement specifications, and then we can get the show on the road here at UB.*” UB members’ silence, reflected in the lack of turn-taking, was interpreted negatively by UA members. They inferred that their UB counterparts were casual or perhaps uninterested in the project, and that UB members were deliberately trying to ignore or reject the UA members’ constructive proposals regarding norms of communication and performance.

In the absence of turn-taking by UB members, despite repeated Webboard messages and the first videoconference, norms could not be solidified through practice. The power relationships, although still largely not negotiated, were tilted in favor of UA because of their management status, their early presence on the Webboard, and the structural condition of them driving the first phase of the project of requirement analysis. These power asymmetries were reinforced through UA members’ use of *referential symbols*, for example, by providing deadlines for tasks. Little use of humor and other *evocative symbols* reflected a lack of social solidarity at this stage, contributing further to an image of team fragmentation. With the passage of time, UA members started utilizing a number of problem-avoidance strategies to counter the anticipated trouble arising from UB members’ nonparticipation. Such strategies included *wooing* (e.g., “we are interested in working with you”), and making *reference to norms of performance* (e.g., “it would be nice to start collaborating on a regular basis”) or to *tasks and roles* (“you are responsible for communication”). Sometimes the *higher authorities* (i.e., the professors) were called upon to intervene and break the silence by *mandating attendance* in videoconference meetings or to issue firm instructions *calling for prompt response* to remote members’ messages.

These communicative actions of UA members slowly started to evoke a response from UB members, thereby enabling teams to make a transition from initiation to the next phase, exploration. A snapshot of the structural process associated with this phase is summarized in the initiation column of Tables 4, 5, and 6.

Exploration Phase

Initially, UB members, in their role as systems developers, couldn’t quite comprehend the need for communication with UA members who had still not frozen their systems requirements. In response to the various strategies used by UA members, UB members reluctantly started to respond, crafting their initial communication transactions carefully in order to exercise “considerable control over the front” they presented (Correll 1995, p. 277). Some of the problem-repair strategies adopted by UB included *thanking* UA members for their early initiative, or *apologizing* for the earlier lack of turn-taking and attempting to create an alignment by providing an explanation. Sometimes an attempt was made to *shift the blame on technology for missing deadlines*, for example, in their inability to send an attachment, or *blaming the coordinators* for not clearly explaining project requirements. Communication transactions of this nature may be seen as an attempt toward creating an alignment or issuing a disclaimer regarding the lack of expertise in using a particular communication technology.

As turn-taking intensified, the role of the coordinators started to be redefined from one of *directive regulation/law enforcement* to one of *facilitation* (e.g., “Please see updated schedule for videoconferencing...”) and of *aiding in information processing* (e.g., explaining some subtle elements of project requirements). However, in teams where the communication was still seen to be unsatisfactory, the coordinators continued to play a primarily *directive* role.

As different members started sending messages, there was an *increased* (albeit still *intermittent*) level of *virtual presence*. There were still few accepted norms on the intensity, frequency, or length of presence on different media and on requirements of participation expected. Some UB members questioned the structures, for example, the presumed privileged position of UA acting as managers or the norms of communication proposed by UA. The local origins of norms of this stage contributed primarily to a bilateral form of negotiation, with members acting *with respect to* rather than *with each other*. Members were largely disinterested in the time or schedules of remote team members, and distinctions of the type of “our group” and “your group” were dominant. Communication patterns suggested that the *individual member-level identities and goals* of the first stage had been superseded by *location-based differentiated identities and goals* respectively. The “us-them” distinction was reflected and reinforced by bidirectional responsiveness with members not ready to surrender their own autonomy to remote members’ wishes or their specific objectives and constraints.

Thus, to summarize, the social structure of teams, while more developed compared to that in the initiation phase, primarily due to an increased level of virtual presence, still reflected a lack of social integration required for effective cooperation (Couch 1989). The sense of oneness among all team members was notably absent. The production structure of the teams was also more functionally developed than during the initiation phase, with members showing greater understanding of project goals and some degree of familiarity (although maybe not expertise, given the continuing problems in using Webboard features such as attachments) with the ICTs in use. This greater understanding about the project and technology contributed to improve both task ability and task focus. However, in the absence of mutuality in social responsiveness among team members, evidence of synergy among members in working together seamlessly was still rather thin.

Communication was largely sluggish and disorganized, with teams acting opportunistically with little concern for the other side or the entire team. However, at least 4 of the 12 teams appeared to be making serious attempts to transition to a more mature collaboration phase through the adoption of innovative turn-taking strategies. These included *demonstrating interest in the requirements of remote members* (“We were wondering if it would be possible for you to tell us what Professor [PB] has outlined as the requirements on your part of the project. ... Therefore we may tailor our information to meet your needs as well as ours...”) or *building social solidarity through the use of evocative symbols*⁸ (e.g., UB member: “have ya’ll been watching the Olympics...we’ll see ya on the ice rink;-)), and inclusion of other *humanistic details* in communication (Edwards et al. 1996, p. 164). Paying *close attention* to details and deadlines also acted as a powerful rallying force for team members to coordinate activities and develop a form of “swift trust” (Jarvenpaa et al. 1998; Jarvenpaa and Leidner 1999). Finally, the increased *use of media-rich technology* such as videoconferencing and/or on-line chats, which by virtue of properties of synchronicity and/or multiple channels of communication (audio and video) allowed members to develop intimacy and solve some problems through real-time discussion, also appeared to facilitate the transition to collaboration in some cases. A snapshot of the structural process associated with this phase is summarized in the exploration columns of Tables 4, 5, and 6.

⁸Interestingly, during this stage, we found that communication of evocative symbols with negative connotations by team members, even when done playfully, tended to fragment the team rapidly.

Collaboration Phase

After a period of jerky and awkward turn-taking in exploration, 7 out of 12 teams in our study made a transition to what we see as a truly collaborative mode of conducting work. This was expressed through an increased interest in local requirements of remote members, and more extensive use of evocative symbols to develop social solidarity. Changes in social structure started becoming evident with identity becoming *integrated at the team-level*, and social responsiveness more *mutual*. Increased mutuality helped in developing shared meanings and norms, and in diffusing the power from local locations as defined by initial project parameters to the other location as negotiated through communicative action. Some team members voluntarily surrendered their rights of making critical decisions about the project to their remote members on whom they could now rely, given the increased congruence in both the work and social spheres. For example:

UB member: *we changed the forms...hopefully that's OK with you guys.*

UA member 1: *Personally that is alright with me. I don't know if the rest of my group has seen this message but I think they would agree with me.*

UA member 2: *The format of the forms are ultimately up to you...If it works...I don't think that our group here has a problem with the layout.*

The mutuality in social responsiveness contributed to the clarification and stabilization of norms of timeliness (e.g., issues of dealing with time-zone differences) and frequency for turn-taking. There was increased sensitivity to the schedules of the remote members (e.g., an apologetic message sent to remote members regarding a scheduled videoconferencing meeting: "You have to wake up so early on a Saturday"). Such transactions indicated a growing sense of oneness as well as empathy in the social relationship. With a cohesive social structure co-constructed and enacted by both sides, and major project deadlines approaching, the frequency of turn-taking intensified and discussions took place on substantive issues with virtually no abrupt topic shifts (Putnam and Fairhurst 2000), reflecting a high task focus. As collaborative activity directed toward team-level goals intensified, potential for trouble tended to recede. However, teams without a strongly developed social solidarity or "social glue" showed greater potential of regressing rapidly to exploration with few mechanisms to recover from sticky situations (e.g., when norms of communication were severely violated without prior notice, or a local deadline was missed due to the perceived indifference of the remote members, or a critical document could not be opened on time). This pattern was observed in 2 out of the 12 teams. In the first case, the team reverted back to exploration and remained there almost until the end of the project. In the second case, the team continued to oscillate between exploration and collaboration, with even minor irritations causing a backward transition to exploration. Repair or avoidance of situations with potential for causing breakdowns was attempted through the *timely intervention* of the project coordinators, a *sincere apology tendered by the offending team members or subgroup* to enable realignment, through *the conscious use of evocative symbols*. Other strategies that helped ensure the stability of teams so as to enable them to continue operating in the collaborative mode included *appreciating and incorporating ideas* from remote team members, and handling *substantive disagreements* with remote team members with care and sensitivity. These communicative actions were directed toward "strategic mitigation" (Baym 1996), which, in the case of teams firmly grounded

in this stage, appeared to be exercised in a taken-for-granted manner by drawing on existing mutuality in the structure. The collaboration columns in Tables 4, 5, and 6 summarize this important phase.⁹

It is worth noting that *passage of time* is *only one* antecedent condition to the development of mutuality in social responsiveness (Walther 1992). Over one-third of the teams (i.e., 5 out of 12 teams) continued to operate in an exploratory mode throughout much of the assigned time to complete the project and made a transition directly to the final phase with the final *project deadlines* approaching. Another important pattern observed in the data was that teams that did not spend significant time in collaboration, in general, failed to effectively function and deliver excellent products (see Table 7).

Culmination and Dissolution Phase

This phase represented the physical closure of the project with team members presenting final project deliverables to the coordinators and clients, and the subsequent disbanding of the virtual teams. The sense of urgency due to the rapidly approaching deadline, as reflected in the increased frequency and intensity of turn-taking, was reflected in all of the teams. As noted earlier, 5 out of 12 teams made a direct transition from exploration to culmination and dissolution (perhaps less culmination and more dissolution), and we label such teams as *disorganized and desperate*. Even as the project was drawing to a close, 4 out of 12 teams exhibited very weak production and social structures, and reflected poor communication competence, lack of integrative identity and shared social goals, intermittent virtual presence, and a primary focus on local interests. For example, one team, despite being in the last phase of the project, was still engaged in defining the conceptual data model. While the frequency of turn-taking became frenetic, it was hardly effective, and even at this late stage, members of this team were unaware of the usefulness of certain ICTs, had few norms of communication and coordination, and seemed unfamiliar with each others' roles and responsibilities. Such teams expressed their sense of project closure *by expressing individual relief that the stressful experience of virtual teamwork was over or by assigning blame and presenting excuses*. Excuses as described in the reflection document ranged from remote team members' low commitment and poor quality, team member attrition, the unrealistic scope of the project, poor technical infrastructure, insufficient training in technologies, and poor health. Needless to say, teams within this category submitted poor products, and also made poorly coordinated final presentations. These teams were also noticeable for their abrupt and complete termination of turn-taking with their remote partners after the formal project deadline.

Another set of teams made a steady transition from collaboration to culmination and dissolution, which we label *steady and joyful*. In sharp contrast to the teams described above, these teams delivered superior products¹⁰ and conducted well-planned and coordinated presentations. Six of the

⁹We remind readers that the collaboration phase, like the other phases identified in this study, should be understood by considering the macro level, the micro level, and the modalities in the structural framework simultaneously (Figure 2).

¹⁰We recognize that, depending on the technical complexity of the system, the relative contribution of production and social structure to the project outcome (i.e., the quality of product delivered) may vary. There are also other unique factors associated with projects, such as the presence of a super-programmer, who may pull off an entire project without the need to develop mutuality or congruence among the remote team members. That notwithstanding, in our case, which involved projects of moderate complexity (requiring the use of skills

Table 7. An Interpretive Assessment of Theory Fit

Team #	Extent of fit with theorized <i>Initiation</i> patterns (with approximate duration)	Extent of fit with theorized <i>Exploration</i> patterns (with approximate duration)	Extent of fit with theorized <i>Collaboration</i> patterns (with approximate duration)	Extent of fit with theorized <i>Culmination</i> patterns (with approximate duration)	Evaluation of the Team (with additional comments)
# 1	High (1-2 weeks)	High (4 weeks, then about 4 weeks after over 2 weeks of Phase III)	High (over 2 weeks after which the team regressed back to Phase II)	High (over 1 week)	Poor (As expected theoretically due to limited time spent in Collaboration, i.e., Phase III)
# 2	High (2 weeks)	High (< 1 week)	High (10 weeks)	High (Over 1 week)	Excellent (As expected theoretically due to very substantial proportion of time in spent in Collaboration)
# 3	High (1-2 weeks)	High (< 1 week)	High (11 weeks)	High (< 1 week)	Excellent (as expected theoretically due to very substantial proportion of time in spent in Collaboration)
#4	Medium (1-2 weeks)	High (12 weeks)	N. A. (The team did not reach the collaborative phase)	Medium (< 1 week)	Poor (Completely dysfunctional process and very poor deliverables throughout the project; a product, albeit incomplete, delivered due to one individual's last moment heroic effort)
#5	High (1-2 weeks)	Medium (over 11 weeks, oscillating between Phases II and III, mostly matching patterns of Phase II)		Medium (1-2 weeks)	Satisfactory (Reasonable product; somewhat collaborative process)
#6	High (1 week)	High (6 weeks)	High (6 weeks)	Medium (1 week)	Satisfactory (Reasonable product, though collaboration occurred for a limited time. Conflict within locations observed)

that were more or less covered in class) but of large enough size so as to demand pooled resources of the team members, we found that most effective teams achieved their actual work in stage III.

Table 7. An Interpretive Assessment of Theory Fit (Continued)

Team #	Extent of fit with theorized <i>Initiation</i> patterns (with approximate duration)	Extent of fit with theorized <i>Exploration</i> patterns (with approximate duration)	Extent of fit with theorized <i>Collaboration</i> patterns (with approximate duration)	Extent of fit with theorized <i>Culmination</i> patterns (with approximate duration)	Evaluation of the Team (with additional comments)
#7	Medium (< 1 week)	High (12 weeks)	N. A. (The team did not reach the collaborative phase)	Medium (< 1 week)	Poor (As expected theoretically due to almost no time spent in Collaboration)
#8	Low (< 1 week)	High (13 weeks)	N. A. (The team did not reach the collaborative phase)	Medium (< 1 week)	Poor (As expected theoretically due to almost no time spent in Collaboration)
#9	N. A. (The team started in a bi-directional mode)	High (13 weeks)	N. A. (The team did not reach the collaborative phase)	High (1 week)	Poor (As expected theoretically due to almost no time spent in Collaboration)
#10	Medium (< 1 week)	Medium – some overlap with Phase III patterns (6 weeks)	Medium – some overlap with Phase II patterns (6 weeks)	Medium (< 1 week)	High Satisfactory (Perhaps insufficient time in Collaboration)
#11	High (2 weeks)	High (3 weeks)	High (8 weeks)	Medium (1 week)	Excellent (As expected theoretically due to very substantial proportion of time in spent in Collaboration)
#12	Medium (2 weeks)	Medium (6 weeks)	High (5 weeks)	High (1 week)	High Satisfactory (Perhaps insufficient time in Collaboration)

Notes:

Extent of fit between the patterns suggested by our theoretical model and the actual team-wise data was interpretively judged by the researchers as High, Medium, or Low for each phase (N. A. implies that the team did not reach that particular stage).

Teams were evaluated as Excellent, Satisfactory (on one occasion, High Satisfactory), and Poor based on Task Performance at the end of the project.

12 teams signed off with joy, but with little emotional attachment evident (e.g., "It was great working with you guys. I think we worked really well as a team. I hope you enjoy your vacation, take care."). Members of one of the very successful teams, however, not only expressed their joy but also emotional attachment, signifying the pain of parting company (e.g., "I guess it's my turn to say job well done and wish you all well...[crying smiley]...The one thing that most of us have learned in UB is that it's a small world, so maybe we'll run into each other one day. It will probably be stumbling out of the bar, so we really won't recognize each other, but our paths will cross nonetheless"). Personal information was also exchanged in anticipation of the possibility of a future rendezvous.

As the formal project came to an end, many of the participants, including the coordinators, reflected on the past 14 weeks of intense project work. This lessons as well as the experience itself was incorporated into the institutional frameworks as "stocks of knowledge" of the two participating universities in different degrees and in varying ways. For example, in UA the project became part of the curriculum, students talked about their experience to new students, and new students immediately associated the course with the project. Project participants also emphasized this virtual team experience to potential employers in their job interviews, when appropriate, and utilized lessons from this experience in their jobs involving computer-mediated work.

We again refer the reader to Figure 2 for the processual view of virtual team development integrating the micro and the macro, and to Tables 4, 5, and 6 for the summary of patterns observed in the four phases described above. A comparison of Figures 1 and 2 shows how our initial theoretical model (Figure 1) was extended to a substantive process model of virtual team development through an intensive examination of communication patterns in different teams.

In addition, Table 7 presents an evaluation of each team's performance, along with an interpretive assessment of the degree of fit between the characteristics of each individual team and the patterns suggested by our theory. Overall, it is clear that the theoretical model that was developed based on the overall patterns observed in the 12 teams reflects the individual team-level dynamics reasonably well. We thus submit that the proposed model provides a firm grounding for future scholars researching the phenomena of development (and collaboration) in other virtual team contexts.

IV. DISCUSSION

LIMITATIONS

Like all other studies, ours too has some potential limitations. An obvious one is that the theoretical model is derived from empirical observations of undergraduate students within the context of university courses, where conditions are no doubt different from those surrounding virtual teams in organizations. For example, a professor's power over students is arguably of a different nature than a manager's power over his or her subordinates, and the incentives or disincentives of grades that students receive are very different from what real-world team members will obtain in organizations. While acknowledging the differences in these conditions, there are a few points we would like to make in defense. First, students have been quite extensively used in IS research on virtual teams (e.g., Jarvenpaa and Leidner 1999; Kayworth and Leidner 1999; Warkentin et al. 1999), and the widespread acceptance of such data within the subcommunity of MIS scholars conducting research in this area legitimizes the use of student data (Stablein 1999). Second (more importantly), the teams in our study were working with real business organizations on problems for which managers wanted solutions. As such, there was an expectation that the teams' proposed solutions would be actively

considered for actual implementation. There was thus a fair amount of realism in the projects, such that team members experienced both a sense of pressure and also pride, and this helped to create a level of commitment and seriousness that is not typically associated with student projects. Finally, given the longitudinal and intense nature of the projects, most students participating in turn-taking and dealing with trouble were appropriated by the world of virtual teamwork, wherein they enacted their socially-constructed roles (Lee 1994) of interconnected and interdependent team members involved in ISD, rather than behaving as typical students interested in merely passing a course.¹¹

Another potential limitation stems from the dyadic nature of the virtual teams, implying that team members were distributed between two locations. While dyadic configurations are used quite routinely in the contemporary business world, particularly in ISD (e.g., Carmel 1999; Nicholson and Sahay 2001), many other configurations are conceivable, such as subgroups distributed over *multiple* (more than two) geographical locations, or members traveling across multiple locations for different stages of the project. The spatial and temporal setting of the actors and groups no doubt influence both the macro- and micro-level dynamics of the configurations. While our proposed model cannot be *directly* applied to all possible configurations, the fundamental inferences and principles emerging from our study would still be valid. For example, in a team of distributed individuals across many locations, the exploration stage may reflect less of an "us versus them" mindset, although (consistent with our theory) teams without mutual responsiveness, integrative identity, shared goals, steady virtual presence, and use of evocative symbols in communication would most likely not be very effective. Clearly, there exists ample opportunity to extend and refine our theoretical model and to articulate its implications for other configurations, and we invite future work in this direction.

Yet another potential limitation is our lack of focus on the differences in the individual characteristics of members such as their cognitive styles and personalities. This omission reflects the theoretical perspective adopted in this study that focuses on the interactions and the mutual linkage between the members' communicative actions and their social settings rather than their individual characteristics. It is worth noting, however, that individual differences are implicitly accounted for in the teams' communication patterns, given that they are intersubjectively shaped. Future research using other theoretical perspectives specifically concerned with the role of individual's traits would certainly further the knowledge on this topic, and we welcome such efforts to build on the findings presented in this paper.

CONTRIBUTIONS

We now discuss four key contributions that arise from the development of the process model for virtual team development in this study. ***First, it clarifies the notion of collaboration and its relationship with communication.*** In literature on ICT-mediated teams, while collaboration is a frequently used term, the distinction between communication and collaboration is often left unclear (e.g., Baker 2002). Often, it is assumed that increased communication is a desirable state which leads to a higher degree of collaboration and, thereby, to better team outcomes. This assumption leads organizational efforts to be focused on how to apply ICTs to enhance the level of communication (e.g., Lai 2001). In this deterministic view, communication and collaboration are treated

¹¹We believe that there is greater likelihood of such behavior in cross-sectional studies where the students are not immersed in the context.

synonymously, just as increased information sharing is equated with better learning. While information sharing may be a necessary condition for learning, it is not a sufficient one (Davenport and Prusak 1998). For learning to take place, the information also needs to be effectively assimilated, put to practice in day-to-day social conduct, and its consequences actively reflected upon. Similarly, *while communication is a necessary precondition for collaboration among distributed team members, it is not sufficient*. We have conceptualized collaboration as a multi-faceted phase in a team's development that can be understood only by simultaneously examining *team-structure*, its *communication patterns*, and the *modalities*. All three aspects have to be effective and compatible with each other for collaboration to occur. For example, if a team's structure reflects uniform virtual presence as per norms, mutual responsiveness, team-level identities and goals, high focus on task and ability, but the communication transactions reveal discomfort with transferring artifacts, almost no use of evocative symbols, and no strategic mitigation to address disagreements, the team cannot be seen as being in a truly collaborative mode. In fact, it is more than likely to revert back to the exploratory phase characterized by awkward turn-taking and fragmented location-based structure.

Second, the paper describes the process by which the state of collaboration may be attained (or not) in virtual teams, and provides evidence regarding the likely consequence of the team operating (or not) in this state for a substantial duration. Virtual teams do not start collaborating as soon as electronic connectivity is provided, irrespective of the richness or bandwidth of the enabling technologies. A lot of systematic effort is needed for the teams to develop through the initiation¹² and exploration phases¹³ to a point where their members can really collaborate with each other, with communicative actions, structural characteristics, and modalities of interaction all aligned in a synergistic manner. In the absence of appropriate communicative actions (including triggers) and a supportive macro structure, some teams may not be able to attain the collaborative state irrespective of the duration of the project. Further, our analysis revealed that *the final team outcome* (i.e., performance in terms of product quality and its presentation) *appears to be dependent on the length of time that a team spends in the collaborative phase*. The implication of this set of findings is that virtual teams, aided by their managers or facilitators, should strive to systematically but rapidly reach the collaborative phase using appropriate triggering mechanisms. Having reached the stage, the teams should remain vigilant regarding the possibility to breakdowns that could result in a transition back to the exploration phase.

Third, the paper provides some lessons for colocated teams as well. While our focus has been primarily on virtual teams, we emphasize the point that team development is not an issue in the virtual context alone. While development may proceed differently, or require different tactics in ICT-mediated virtual teams, the conceptual approach could very easily be applied to colocated teams, where communication often takes place through verbal and other nonverbal means (i.e., social cues). There could be different tactics for turn-taking and dealing with trouble in colocated teams because of the team members' physical proximity. However, the fact that strategies for turn-taking are required remains unchanged. While we have drawn on a limited set of concepts from the tradition of interaction analysis to study communicative action in virtual teams, we believe that additional

¹²It is worth noting that, depending on the *nature* of the project being undertaken, many teams may not experience the patterns associated with the initiation phase, but instead, may find themselves in exploration at the start of the project.

¹³As per process theorists' recommendations (Monge 1990; Gersick 1988), our model not only outlines the phases in the process, but also specifies the triggering mechanisms that facilitate the transition from one phase to another.

concepts (e.g., adjacency pairs) can be profitably drawn upon to study interaction patterns in colocated teams.

Aspects of production and social structure discussed as part of our model are also essential to colocated teams, even though the particular rules/resources as well as communicative actions that constitute and reflect aspects of structure may not be identical to those evident in virtual teams. For example, task ability will not be exclusively inferred based on what members imply (or claim) through communication regarding what they plan to accomplish (i.e., impression management), but instead, perhaps, by physically verifying what has been achieved and how. Similarly, social solidarity is not inferred from evocative symbols that are exchanged in text or on-line conversations, but on how members physically socialize with each other. In applying the model of virtual team development to colocated teams, two key differences have to be kept in mind: (1) the nature of frames guiding the interactions; and (2) the separation of time, space, and culture in virtual teams.

Initial frames: Virtual team members typically come from different backgrounds with limited shared history, and are assembled for a specific project and then disbanded once the project is completed. These conditions imply that members have few initial shared frames of reference to engage in coordinated social action. In contrast, in colocated teams, there may be a preexisting common ground in understanding because members share institutional as well as location-related assumptions (including a collective sense of norms, meanings, and power distributions). Having such a shared frame among a team's members introduces different dynamics in its development, and in many cases, makes the state of collaboration easier to achieve.

Separation of time and space: Another difference between virtual teams and colocated teams is the separation of members by time, space, and cultures (Sarker and Sahay 2002). For example, in our project, the two parts of each virtual team were separated by about 3,000 miles and a two-hour time difference, were situated in two distinct university settings (e.g., public versus private) with different student demographic profiles, and initially enacted different role orientations. Under such circumstances, it becomes extremely important to understand the role of time and space in the structuring of virtual team interactions, something that is far less important in the case of colocated teams. Virtual and colocated teams have different time and space conditions, thus leading to variations in the synchronicity, rhythms, and patterns of messaging among members. These variations have implications regarding the choices of channels used for communication, the structure and contents of the message, as well as the nature of artifacts with which team members may be comfortable. These differences could lead to varying turn-taking strategies with distinctive implications on team development. For instance, the asynchronous nature of communication inherent in virtual teams coupled with a lack of a shared frame of reference among members could make a team's development from the initial to the collaborative phase more complex.

The study also informs existing research on (colocated) group development. As Gersick (1988) observed, a large existing body of work portrays group development as a sequence of stages (conceptualized in terms of activities) where transition from one stage to another is seen as gradual, and "all groups are expected to follow the same historical path" (p. 32). These development models also do not mention specific mechanisms involved in transition between stages and ignore environmental influence on the development. Gersick's path-breaking work attempted to address many of the earlier shortcomings, and revealed that group development is not gradual (as proposed earlier), but occurs as a "punctuated equilibrium," wherein around the midpoint of projects, team members sense an alarm clock that acts as a trigger for transition. Gersick, however, left unanswered the question as to why the alarm results in progress (i.e., transition) in some groups and not in others.

Our study's findings are only partially consistent with those of Gersick. Like her, we also observed that teams do not follow a linear, gradual path of development, and identified a number of triggers that act as necessary although not sufficient conditions for transition. However, we did not observe a punctuated equilibrium at the project midpoint occurring in the teams. Instead, we found that some teams, often through strategic use of turn-taking and dealing with trouble, were able to progress in development, while others were stuck in an earlier (i.e., exploration) stage. While we do not provide a *deterministic* explanation as to why some teams progressed while others remained stuck in a less developed stage (or regressed back from a more developed stage), we do identify a number of potential triggers, mostly in the form of micro communicative actions within a macro context. In this sense, we feel that our work adds substantially to the existing body of knowledge in the area of group development, both in terms of the research approach and the specific findings. Of course, given that our study was conducted in a virtual context, further work is required to assess how applicable the approach and findings are for colocated groups.

The final implication pertains to the theoretical and methodological approach adopted in this study. Our approach is consistent with the general concern in social sciences of integrating social action (i.e., communication) with social structure in nondeterministic ways. Conrad and Haynes (2000, p. 57) elegantly summarize the role of structuration in this endeavor:

Symbolic acts are central to the constitution of organizational "reality"...Giddens's duality of structure provides a process-oriented framework for scholars to explore the emergence, reproduction, and transformation of meaning systems and communicative interaction. In short, structuration includes constructs that integrate the key terms of the doctrine of social action and those of the doctrine of social system. The resulting perspective serves as a corrective to deterministic tendencies while not ignoring social structure or reducing it to ideation.

Our underlying premise in conducting this study was that virtual team development could not be studied by focusing only on the micro-level team member interactions or the macro level structural characteristics. While a micro-level focus obscures the understanding of the macro properties related to a team's context as well as its production and social structures, a macro structural focus ignores communication processes that are fundamental to the functioning of the virtual team and to the creation of its context. The process model presented in this paper was developed based on the simultaneous consideration of the micro-level communicative action and the macro-level of team structure in 12 virtual teams (i.e., sets of situations) using an approach known as *methodological situationalism* (Knorr-Cetina 1981). We made ultra-detailed observation of what team members did and said in situ to build macro-sociological conceptions of virtual team development, identifying concepts from the established theoretical and methodological traditions (i.e., structuration and interactionism) and adapting them to the specific context of virtual teamwork.

This unique approach, we believe, can be usefully applied by IS researchers to study a variety of topics in the arena of computer-mediated work such as the bridging of time by distributed team members and the process of knowledge transfer across distributed knowledge localities.

V. CONCLUSION

As virtual teamwork becomes an integral aspect of contemporary organizational life, and as work arrangements become more complex owing to the variety of tasks, technologies, and cultures

involved, there is a strong need to develop novel approaches that can provide insights beyond those generated and validated using the traditional theoretical and methodological perspectives. Our paper takes a small step in this direction by utilizing concepts from the traditions of interaction analysis and structuration theory to investigate the process by which virtual teams develop over time. We believe that the adopted approach was largely instrumental in our being able to discern valuable insights not only regarding the development of virtual teams but also regarding the fundamental notion of collaboration.

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