Leadership Roles and Communication Issues in Partially Distributed Emergency Response Software Development Teams: A Pilot Study

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Abstract

Emergencies often require inter-organizational and/or international coordination for effective planning and response. Therefore, planning and response teams are often configured as partially distributed teams. A partially distributed team (PDT) is a virtual team, in which some sub-groups are collocated, yet the subgroups are dispersed from each other, and communication between them is primarily by electronic media. We describe a project investigating different configurations of group and sub-group distribution and leadership in global PDTs engaged in tasks related to emergency response; in this paper we focus on results related to the leadership configuration (each of two subgroups in a team chose a local leader) and communication issues. Analysis of pilot data has helped us to articulate key leadership roles and suggests that significant in-group/out-group divides occurred. Implications for practitioners and future research plans are discussed.

1. Introduction

Large scale emergencies, such as the 1995 Kobe earthquake or the more recent hurricane Katrina, have demonstrated that emergency preparedness and response may require inter-organizational and/or international coordination, and that such coordination is frequently lacking. When disaster response or planning teams are dispersed, they often work as "virtual teams." We define a virtual team (VT) as "a team of interdependent members working on a common task who use electronic media as a primary means of communication; at least some of whom are dispersed in geographic and/or temporal dimensions."

VTs are often complex and multi-dimensional in configuration [15]. One common configuration is the partially distributed team (PDT). A PDT is "a hybrid, such that a given sub-group of members is physically collocated and collaborates primarily via face-to-face interaction; however, multiple sub-groups within the team are geographically dispersed."[10] As multiple organizations or nations collaborate in emergency preparation and response, they often do so in partially distributed teams. Yet, behavioral dynamics over time in PDTs, as affected by such factors as team and leadership configuration, have largely been ignored [3].

An emergency need not be "large scale" or long-lasting to cause problems of leadership and coordination among partially distributed teams. Hundreds of motorists were stranded in bitter cold for about 24 hours in February 2007, after severe weather and a string of vehicle crashes rendered impassible long stretches of major interstates in eastern Pennsylvania [18]. There were many different agencies that should have been involved. However, there were no plans for who should be "in charge" in such a situation, and no guidelines for how those assuming leadership roles for one of these subgroups should communicate and coordinate with leaders or members of different subgroups. Transportation Committee Chairman Joe Markosek said afterward he was "struck by the lack of communication among the various agencies," he said [18].

Thus, a major problem for PDTs charged with emergency planning and response is how to configure leadership, coordinate it, and distribute it. One way to study these issues is to be "in the field" during such emergencies, interviewing and observing. However, even if one happened to be on the highway during the aforementioned disaster, it is unlikely that such a researcher would be able to play a research role – he or she would be trapped in the situation, just like everybody else. In addition, each situation is "unique" and it is difficult to find generalizations from such case studies. Therefore, we are conducting field experiments to identify and investigate issues of coordination and leadership among subgroups in PDTs working on tasks related to emergency response – in our case, the design of a community-based emergency response information system. We hope that this

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work will generate observations and insights that can later be tested in "real" situations.

This paper discusses pilot studies conducted in preparation for a large-scale experiment that will investigate leadership and team configuration as they impact the performance and viability of global PDTs. After a literature review, the methods and findings of a pilot study are briefly described. The paper concludes with a discussion of implications and future work.

2. Issues for Partially Distributed Teams: A Literature Review and Conceptual Framework

This section summarizes concepts derived from a review of literature on virtual teams and leadership, including the idea of "faultlines" between subgroups, in-group dynamics, and leadership roles.

2.1. Faultlines

In PDTs, subgroups may be demographically diverse, with cultural (organizational or geographic), language or other variations associated with the different groupings. A faultline [11, 12] is a perceived border that divides members of a group on the basis of demographic attributes. The strength of a faultline is determined by the number of attributes that are aligned on it. The stronger the faultline between subgroups, the more perceived distinction between the subgroups.

Faultlines can have great impact on a team's processes and outcomes [12], which can be detrimental. For example, it has been shown that the stronger the faultline, the less effective the communication between sub-groups separated by the faultline [12]. In inter-organizational and/or global PDTs, one might expect faultlines of varying strength between subgroups.

2.2. In-Group/Out-Group Effects

According to Social Categorization Theory [20] and Social Identity Theory [19], a person's social identity is primarily derived from group membership. When people make favorable comparisons between their perceived groups and other groups for which they do not perceive affiliation, a positive social identity results. Demographic differences tend to promote different viewpoints that encourage people to strongly identify themselves as belonging to "us" rather than "them." The "us" becomes the "in-group" while "them" is the "out-group." One potential effect of such polarization is in-group bias, in which an in-group views an out-group negatively and does not give full consideration to out-group members' work contributions (e.g [13, 16]). Thus, as demographic contrasts increase in strength along a faultline between subgroups in a PDT, the perceived differences between subgroups may reinforce in in-group/out-group effects.

In a PDT, some subgroups will have members who are collocated and able to interact face-to-face. These team members are also likely share culture (organizational, work, and geographic), resources, etc. which may add to their perceptions of group membership. Also, shared identity is more likely to result from face-to-face interaction [9]. Research on PDTs suggests that different forms of distance (e.g. geographic, temporal, and cultural) strengthen a faultline, making PDTs particularly susceptible to in-group dynamics [10].

2.3. Leadership in PDTs

2.3.1. Leadership Configuration. The number and location of leaders can vary in PDTs. For example, leaders can be decentralized (one leader per subgroup), centralized (one leader per team), or hierarchical (a combination of decentralized and centralized). The location of leaders can affect team interaction and outcomes. The danger is that the location of the leader exaggerates in-group team dynamics and thus strengthens the distance faultline [1, 10, 15].

2.3.2. Leadership Roles. Leaders engage in activities that encompass affective, logistical, and task oriented processes [2]. Denison et al. [5] examined eight leadership roles. The Innovator encourages and promotes change; the Broker maintains contacts with the external environment and promotes the team; the Producer is task-oriented and encourages behavior that will successfully complete tasks; the Director sets goals, objectives, and expectations; the Coordinator engages in such behaviors as scheduling, coordinating, setting standards; the Monitor distributes and collects information and monitors performance; the Facilitator promotes expression of ideas and

facilitates compromise; and the Mentor pays attention to and supports individuals' needs.

Leader roles may not be restricted to one individual but instead distributed across multiple team members. Additionally, team members who exhibit leadership roles informally may constitute *emergent* leaders. Emergent leaders may be very important in PDTs, because there may be no officially-designated leader for the entire effort, or the designated leader(s) may not be available or competent to supervise the full range of tasks assigned to the team. In one empirical study, emergent VT leaders were found to assume the roles of Initiator (i.e., initiated communication between team members) and Integrator (i.e., integrated the work of team members to compile team deliverables) [21].

We synthesized the concepts of faultlines, in- and out-group dynamics, and leadership configuration to create a theoretical framework for our empirical studies of PDTs. Figure 1 diagrams the main components of the framework. More specifically, we propose that several contributors to perceived distance (geographic, temporal, cultural) affect the strength of faultlines between subgroups; these perceived distance factors combine and perhaps interact with leadership variables to influence group processes involving communication, team dynamics and the instantiation and evolution of roles in the team and subgroups. Not surprisingly the effectiveness of group process has important ramifications for PDT success.

2.4. A Conceptual Model

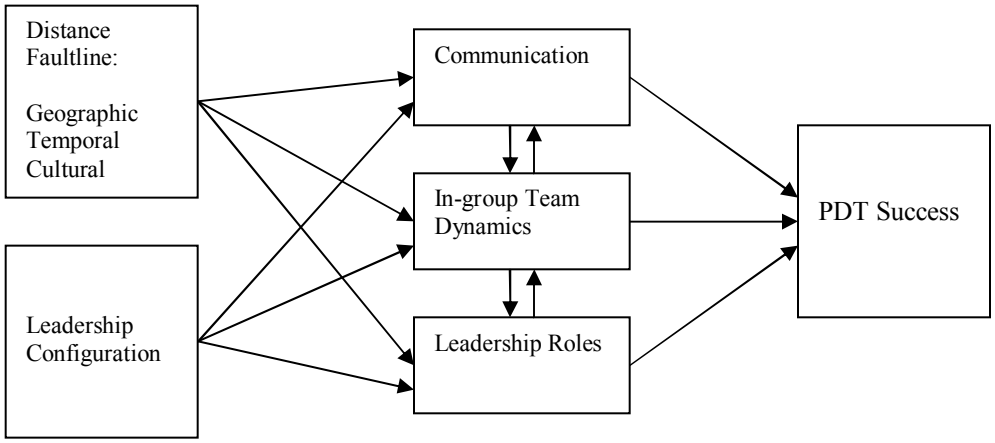

Figure 1. Conceptual Framework

3. A Pilot Study

Pilot studies are typically conducted to pre-test task instructions, experimental procedures, dependent measures, and so on, to make sure that they are valid before proceeding to full-scale experimentation. However, pilot studies of PDTs can also provide initial insights into the dynamics and problems of such teams, and that was one goal of the study reported here.

In the pilot study, each PDT consisted of two subgroups located in different places. Their task was to prepare a deliverable with functional requirements and high-level design for a regional "self-help" emergency preparedness system (Grassroots Regional Repository, or GRRR) for a specified Latin American country. The report was to include policies to manage and govern the system as well. The participants were students in courses related to this topic (e.g., systems analysis and design, emergency response information systems), for whom the four-week team project determined a significant part of their course grade.

Although the teams did not face a "real" emergency that needed a solution, the GRRR task is relevant to the problems of coordinating a variety of subgroups from different organizations to produce an emergency response information system that addresses a specified need. This type of emergency response system is increasingly prevalent [17]. For example, Currion, Desilva, and Van de Walle [4] describe Sahana, a system built from free and open source software to

respond to the Asian tsunami; this system was created in a few weeks by students and other volunteers working in the Sri Lankan IT industry.

3.1. Study Design

Leadership configuration was constant across teams in a decentralized form. One leader was selected by each subgroup; no leader was identified for the overall team. Note that this is a frequent situation when ad hoc teams comprised of distributed subgroups are brought together to work on a short term task such as creating an information system to support an emergency situation – although existing organizational units may have formal or informal leaders, the ad hoc team as a whole may not. What kinds of roles and behavior do subgroup leaders exhibit that result in more or less effective coordination in each situation? This was one of the questions our pilot study sought to answer.

3.2 Participants

A total of 177 undergraduate and graduate students from five universities were formed into subgroups of three to four students each from the same class (one subgroup had only two). The students were from universities in Spain, South Korea, China, and the United States. Subgroups were formed into teams comprised of two subgroups. With the exception of two teams, subgroups making up a team were from different universities. Each team was given a number and denoted as a "Green Team." The subgroups were designated as either a "Blue Subgroup" or "Yellow Subgroup" within a given Green Team.

3.3 Collaborative Tool

To support team electronic communication and collaboration, a wiki-based environment was built from open source software components. (As noted above, such adaptation of open source software is very likely to be the type of software adopted by PDTs to support their communication and work.) Basic features included a threaded discussion board, file sharing repository, shared document creation and editing, and a project calendar. Each Green Team had its own wiki, accessible to its members only. The subgroups comprising a team also had a private space that was not accessible by their partnering subgroups. Students were encouraged but not required to use the wiki tool for project communications.

3.4. Procedures and Data Collection

Prior to the pilot, participants completed a background survey. Teams collaborated on the project over a four-week time period. In the first week, participants introduced themselves in the Green Team discussion space and selected leaders within their subgroups. Each subgroup leader announced his/her appointment in the team-wide (Green Team) discussion space. Each subgroup completed a briefing containing background information on the geographic region, and subgroups shared briefings with their partner subgroups. The remaining three weeks was spent preparing the overall team report.

The participants were instructed to maintain logs of all project-based communications, both electronic and face-to-face. Communication logs were submitted to the researchers at the end of each week. Students also completed weekly personal reflections regarding their experiences working in the PDT.

A post-project survey was administered after the project was finished. Students also completed peer evaluations assessing the efforts of their subgroup members.

4. Observations and Discussion

The participants completed post-project surveys that included scales that were analyzed to evaluate self-reported communication media, as well as perceptions of leader and group effectiveness.

Using qualitative analysis methods, we also investigated participants' personal reflections. We applied an open coding scheme in this analysis [8]: One researcher developed initial coding categories based upon the literature, including leadership roles as described in the literature as well as expected issues (e.g. communication, in-group/out-group, and temporal issues). As subcategories and additional coding categories were uncovered in the analysis of the personal reflections, the coding schema was expanded to include them.

Other than instructions to select subgroup leaders and submit the final report as a team, participants were not instructed on a process to follow in accomplishing their tasks. Nonetheless most teams chose a "divide and conquer" approach wherein tasks were divided between subgroups and later compiled to create a single document.

The personal reflections revealed that leaders engaged in both managerial and task-related activities. Therefore, we examined how the teams worked on the project as a team, and, specifically, what the leaders did. We also examined the data for evidence related to the subgroup faultlines (temporal, cultural, and language differences), in-group dynamics, and other factors related to PDT success.

4.1. Communication

The post survey included 14 items to measure how frequently different communication channels were used *within* a subgroup. The same set of 14 items was also used to measure use of media for communicaiton *between* subgroups. 14 media types were rated from "never" (1) to "to a great extent" (10): wiki; instant messaging; email; text messaging; FaceBook; phone; Internet phone; face-to-face meetings; FAX; video conferencing; teleconference calls; course management system; external forums or bulleting boards; or "other."

The 111 respondents who completed these survey items reported that they used the wiki more frequently for between subgroup communication than within subgroup (X^2=15.08, p<0.02). We suspect that the subgroup members may have perceived more options for interacting with each other than they had for communicating with their partner subgroup, and thus may not have needed the wiki as much for their within-subgroup communication. Remember that subgroup members were able to meet face-to-face (in class) with subgroup members, and had access to standard course management software with other communication options.

A nonparametric one-way ANOVA (Kruskal-Wallis test; chosen because of lack of residual normality), was performed for media options used both within and between subgroups. This analysis revealed that in both cases there were significant differences in reported usage frequency of the different options (within subgroup: X^2=738.58, p<.0001; between subgroups: X^2= 911.58, p<.0001).

To explore which media were used more frequently than others, we also performed ANOVAs with Tukey's tests on reported frequencies for within and between subgroup communications. Model adequacy for ANOVA tests require that the residuals (error terms) are normally distributed with constant variance. However, the F test and related procedures (e.g. Tukey's test) are robust to violations of the normality assumptions, although deviations from normality can "cause both the true significant level and the power to differ slightly from the advertised values, with the power generally being lower" [14] The general robustness of these statistical procedures make them good candidates for preliminary analysis of pilot data. Results indicated that media use differed significantly for between-subgroup interaction (F=178.29, p<.0001, df=13) and for within-subgroup communication y (F=99.5, p<.0001, df=13).

Tables 1 and 2 summarize the results of the Tukey's test for the media use between and within subgroups, including the mean for each type of communication and the Tukey grouping. Means with the same Tukey grouping letter are not significantly different. Means with different Tukey groupings are significantly different at the .05 level of significance.

Table 1. Within Subgroups Media Use

Media	Mean	Tukey Grouping
Email	5.2423	A
Wiki	5.1171	A
Face-to-Face	4.8468	A
Instant Messaging	3.1802	B
Phone (mobile or land-line)	2.9369	B
Course Management System	2.5586	B
Text messaging	1.6847	C
Other	1.4685	C
Internet phone (e.g., Skype)	1.4595	C
Teleconferencing	1.3694	C
FaceBook	1.3514	C
External forums or bulletin boards	1.1622	C
Videoconferencing	1.1441	C
FAX	1.0991	C

This analysis indicated that, for within subgroup communication, there were no significant differences between the reported usage frequency of email, wiki, or face-to-face media. However, these media types were reported to have been used significantly more frequently than other media. Text messaging, "other", internet phone, teleconferencing, FaceBook, external forums, videoconferencing, and fax comprised a group of least-used media.

A different pattern of media use emerged for communications between subgroups (Table 2).

Table 2: Between Subgroup Media Use

Medium	Mean	Tukey's Grouping
Wiki	5.8919	A
Email	4.4595	B
Instant Messaging	1.9099	C
Phone (mobile or landline)	1.5225	D C
Course Management System	1.4144	D C
Text messaging	1.2432	D
Other	1.2072	D
Face-to-face	1.1892	D
Internet phone (e.g., Skype)	1.1532	D
External forums or bulletin boards	1.1171	D
Teleconferencing	1.0811	D
FaceBook	1.0811	D
Videocnferencing	1.0360	D
FAX	1.0180	D

In contrast to within-group communication, the wiki was used significantly more than any other medium for communications between subgroups. Next frequent was email, but only the wiki and email were used with any regularity. This is not surprising as some media (e.g. face-to-face, course management systems) were impossible to use across subgroups.

These results suggest that if multiple means of communication are provided, members will prefer, or have available to use, some subset of them. However, preferences for communicating within subgroups and between subgroups may differ in the ways suggested here.

The communication preferences have implications for emergency planning and response teams — frequently formed as PDTs — suggesting that multiple communication options are required. However, in emergency planning and response, a history of communication may be important to maintain for retrospective analysis and because membership may be fluid so that new members may benefit from access to such archives. Thus, it is important that the subgroups and the whole team discuss and agree upon the media they plan to use and their planned procedures for sharing and recording the results of communications that may not leave a record for others to find out what is happening. For example, phone and instant messaging communications are not automatically archived but, just as face-to-face meetings usually have "meeting minutes" to share information with members who were not present or may forget what was discussed and decided, a procedure for recording and making available the contents and context of the communications should be instituted. For instance, procedures to keep communication logs can be enacted. If the system had the functionality to store and search such logs, the entire team could benefit.

Qualitative analysis of participants' personal reflections provided us with more insight and depth of understanding of the issues of communication the participants faced. For example, international teams experienced some communication difficulties due to temporal, cultural, and language differences. The response delays and limitations for communication options caused by time zone differences were frustrating for some:

> *"It is a little bit hard to communicate on line because each group cannot get answers from the other group within promised time. In truth, because the time lag between Korea and U.S. is almost 12 hours, it is also hard to contact them by phone or messenger."*

Even when communication was seen as going well, members believed that the time difference was an obstacle. An American student wrote,

> *"At this point communication between us and Madrid has been pretty good. We exchanged MS Messenger screen names and will be having a virtual meeting shortly. I have realized that working on distributed teams is no easy task with the differences in time."*

It is possible that the second student was less disturbed by the time difference because the time shift between the US and Spain allows for some overlap in work hours and thus enables some synchronous communication, while the larger time shift between the US and Korea makes it less possible to conduct synchronous interaction.

Temporal distance can present a barrier that is more disruptive than physical distance alone [1]. During emergency response it is likely that subgroups will be staffed round-the-clock or "on call." Even then, within and between subgroups there will be challenges of interaction between individuals not on the same schedule. During normal operations, including during planning, temporal distance can be particularly difficult.

In this pilot, all subjects had at least some facility with the English language. However, fluency varied for the non-US participants. It

seems that a working knowledge of English was sufficient to avoid major language problems. Project papers were to be written in English and some US members wrote that they had to make grammar and spelling corrections to their non-English speaking teammates' work. However, it did not appear to be a significant problem. One US subgroup leader noted that his subgroup found a way to minimize the language barrier issues:

> *"Even the language barrier hasn't proven to be too much of an issue. I have noticed that it makes communication easier if we use a bit more proper English. It's complex enough without adding slang, etc. into the mix.*

Cultural differences were more problematic. A Korean student explained his difficulty with the communication tool:

> *"The interface is quite difficult for non-American users. The language isn't a problem. However, the wiki system hasn't spread outside the west and many Korean users have been confused by how it works."*

Work habit differences between countries were also seen as issues: Spanish students were in the habit of logging into the system once a week which was far less often than their US counterparts. One member of a US subgroup wrote:

> *"We have had some communication issues with Spain. Their once-a-week check-in creates confusion about what they are covering, how far along their draft is, etc."*

4.2. Leadership Roles

4.2.1. Brokers. Leaders often acted as spokespeople for their subgroups. In this they were project brokers, working with partner subgroup leaders, as well as with the researchers and professors on behalf of the subgroup. When a subgroup failed to respond with work, the other subgroup leader went to the instructor:

> *"I checked with our instructor and he has verified that we can turn the project in without the Yellow Team's part."*

One member, however, saw her subgroup leader's efforts to be spokesperson for the group as draconian:

> *"It's hard to say, but I do not know much about the other subgroup of our team. We don't have contact and don't stay in touch. I tried, but our leader stopped me as she is supposed to be the one communicating with the 'other side.' I don't quite agree with her views, but I respect her wishes."*

However another member from the same subgroup had a rather different perspective:

> *"It's been amazing working with the team members. The response from the other team is also [amazing]. Our team leader is able to coordinate with the rest. …"*

4.2.2. Coordinators – Monitors – Producers. Leaders also coordinated team members by assigning and scheduling tasks both within and between their subgroups. They monitored progress, and took on the role of producer, by taking corrective action to facilitate successful task completion.

> *"Throughout the project, A (other group member) and I had some issues with clarifying the assignment to N. … At some point I decided to give her a role in compiling and completing the document. All she did was copy and post. … I told her that she needs to use headings and subheadings to guide the reader. … I suggested putting them into columns."*

4.2.3. Integrators. In most cases reported, the designated team leaders did not delegate the tasks of collecting and integrating the various parts of the document, choosing instead to reserve that responsibility for themselves.

> *"Today I hope to be able to combine the team's work and make a rough draft of our final paper and start the editing."*

4.2.4. Emergent Leadership. Leaders frequently emerged to serve the function of overall team leader (i.e., Green Team leader). In most cases, this role was filled by one of the designated subgroup leaders. However, one overall team leader came from the ranks of non-leaders. In another team, overall team leadership was shared:

> *"…J and I definitely kept pushing for schedules, working on material, and communicating. …I acted as a GT leader when I communicated with the other subgroup…. J helped coordinate work and schedules.*

In the case above — and likely in many other PDTs — leadership was shared through a distribution of leader roles among members. (The member who was reflecting had enacted the

Broker role, while J had enacted the Coordinator role.)

4.3 Perceptions of Leadership Performance

Overall, participants were satisfied with the performance of their subgroup leaders. A semantic differential scale item in the post-project survey asked participants to rate the performance of their subgroup leaders on a scale of poor (1) to outstanding (10). One hundred and three respondents answered this question, with a mean of 7.88 and a standard deviation of 2.18.

We were interested in ascertaining whether perceptions of subgroup leadership affected perceptions of subgroup performance. More concretely, did subgroups with high-performing leaders perform more highly on these dimensions of subgroup performance: efficiency; quality; creativity; adherence to schedule; coordination of member efforts; and communication between members? Six semantic differential scales asked respondents to rate the performance of their subgroup on these dimensions, compared to other teams they had worked on, from low (1) to high (7).

Table 3 shows the results of a nonparametric one-way ANOVA (Kruskal-Wallis test) comparing perceived leader performance and the studied dimensions of subgroup performance:

Table 3: Perceptions of Leader Performance vs. Subgroup Performance

Subgroup Performance Dimension	Chi-Square	P
Efficiency	29.7994	.0005**
Quality	24.5142	.0036**
Creativity	25.9677	.0021**
Adherence to Schedule	5.6842	.7711
Coordination of member efforts	21.8558	.0093**
Communication between members	15.4495	.0793

** significant at the .01 level of significance

The data suggest that subgroup members who reported higher performing leaders also perceived better efficiency, quality, creativity, and coordination of their subgroup's efforts. There was not a significant effect for perceptions of leadership performance and subgroup adherence to a schedule or between leader performance and member communication. Training of leadership of PDTs may help. Future research should incorporate this so as to study the effects of training on leadership performance as well as subgroup and team performance.

4.4. In-group/Out-group Effects

Most subgroups maintained separate identities and the leaders coordinated the effort between them to divide the work. Thus, the subgroups continued to function independently of one another. By dividing the Green Team task into two sets of activities, each to be accomplished by one of the two subgroups, the subgroups maintained their "us" versus "them" mindset. A member of one subgroup noted the extent of the polarization in work:

> *"… even if we are working for the same project, each subgroup's members have a tendency to focus on only each subgroup's assigned part."*

The relationship between subgroups was frequently strained. A lack of awareness of what the other subgroup was doing seemed to be the biggest issue, as highlighted by one team member:

> *"But that feeling of oneness or team spirit has never been felt since I do not know what is happening with the other groups. … I strongly feel that I do not belong to the main team, the Green Team. The connecting factor is missing."*

Subgroup leaders who assigned the other subgroup their tasks were often motivated by distrust that the other subgroup would be able, or willing to satisfactorily complete the assignment, as noted by one subgroup leader:

> *"This week we decided on how the work should be divided on the project and we will assign the other distant team the first two parts of the project. We did this because we felt it would be easier for us to complete the work quickly at the end of the project cycle if they failed to do so on time."*

Some members were dissatisfied that the other subgroup unilaterally assigned them work to do:

> *"We're not clear on the tasks distributed by the Yellow subgroup, and not sure why they are picking and just assigning it rather than discussing it."*

5. Summary and Implications

The structure used in this study, consisting of subgroups with a specific function and identified subgroup leader, is characteristic of many PDTs that collaborate on software for emergency planning and response, as well as for other types of software or tasks. As expected, the PDT structure led to considerable in-group/out-group divides, especially when time zone differences made synchronous communication difficult.

In only a very few cases were subgroups able to overcome the "us" versus "them" in-group team dynamics emanating from the distance faultline separating them. These subgroups were able to create a shared *team identity* (rather than separate subgroup identities) — a new, inclusive distinctiveness shared by both subgroups. The challenge we face as researchers is to identify processes and structures that foster this shared identity. We are starting to explore this through analyses and manipulations of leadership.

In this pilot, we found evidence that leaders adopted a variety of roles including that of broker, coordinator, monitor, producer, and integrator [5, 21]. Leadership was sometimes shared, but often one subgroup member emerged as an overall team leader. Noticeably absent were leadership roles associated with mentoring team members, facilitating compromise and directing subgroups to reach across the distance divide to team together. The division of labor and leadership configuration employed seemed to promote in-group/out-group effects as the teams divided the task and maintained subgroup autonomy.

Global teams such as the ones we studied could probably benefit from orientation exercises that would surface differences in temporal expectations and specify a means for coordination between subgroups. Furthermore, education concerning in-group team dynamics and team building training designed to bridge the distance faultline between subgroups are needed.

6. Limitations and Future Research

Relying on university students to serve as research participants may limit generalizability. It is possible that variation in the commitment of team members or the limited leadership experience of some designated leaders has influenced results. In addition, the content coding of the personal reflections of the participants was conducted by a single coder. Future studies should establish reliability of the categories used and inter-coder agreement rates. We also plan to expand retrospective case analysis of especially successful or unsuccessful teams.

The results of this study provide some support for our theoretical model, but much more data will be necessary in order to test and refine it. We plan to conduct a large-scale experiment with PDTs engaged in software design for emergency preparedness and response; the teams will vary in terms of the distance or "faultlines" among subgroups (e.g., by varying geographical distance, time zone, and culture). These variables will be crossed with three different leadership configurations, currently being piloted. Each of these configurations is likely to occur "naturally" in PDT situations:

1. Designated decentralized: Each subgroup has one subgroup leader, chosen by the subgroup members; an overall team leader is not chosen.
2. Designated centralized: Each team has one overall leader, subgroup leaders are not chosen.
3. Hierarchical: Each subgroup has one leader, chosen by the respective subgroup members; each team also has an overall leader.

These manipulations will allow us to assess what kinds of leadership configurations are most likely to be effective under different types of distance faultline conditions.

In recognition of inherent difficulties in working in PDTs and the likelihood that student participants will have had minimal experience working in distributed work teams, the planned large-scale experiment will include a week of orientation and training prior to the experimental task. The first week will be used to form teams, to train the students and instructors on the media used (a wiki), to clarify expectations and process, and to coach for effective partially distributed team functioning. This training and orientation may enable the study results to more closely mirror what might be found in a field study.

Reviews of studies of the use of computers to support teams by Fjermestad and Hiltz [6, 7] and others have noted that the reported "success" rate is much higher in actual use than for controlled experiments, which usually have a short time span and use students for whom the task is not central to their work. We suspect that the same is true for PDTs. In addition, there will always be questions about the generalizability of the results from studies of university students to "real life" settings. Therefore, during the latter

stages of the project, we also plan to conduct one or more field studies of multi-national, multi-organizational PDTs engaging in creating and supporting software for emergency preparedness and response, and invite potential collaborators to contact us.

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