Synchronizing Pace in Asynchronous Global Virtual Project Teams

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Abstract

In this study, we explore the nature of team interaction and the role of temporal coordination in asynchronously communicating global virtual project teams (GVPTs). Drawing on Time, Interaction, and Performance (TIP) theory [34], we consider how and why virtual team behavior is temporally patterned in complex ways. We report on the results of an experiment consisting of 35 virtual project teams comprised of 175 members residing in the U.S. and Japan. Through content and cluster analysis, we identify distinct patterns of interaction and examine how these patterns are associated with differential levels of GVPT performance. We also explore the role of temporal coordination mechanisms as a means to synchronize temporal patterns in GVPTs. Our results suggest that successful enactment of temporal coordination mechanisms is associated with higher performance. However, we found that temporal coordination per se is not the driver of performance; rather, it is the influence of coordination on interaction behaviors that affects performance.

1. Introduction

New organizational forms tend to arise in response to social and technological advances [20]. Recent technological advances are enabling new ways of structuring, processing, and distributing work [5]. In particular, new technologies are providing the means for dispersed (different place), asynchronous (different time), or virtual, work. Since much of the work in organizations requires collaboration with others, the focus of this study is on global virtual teams, an important new organizational form [25]. A global virtual team is a group of geographically dispersed individuals who are assembled via technology to accomplish an organizational task [49][26]. We are specifically interested in global virtual project teams (GVPTs), defined as time-limited, non-repetitive groups charged with producing a one-time output [9]. In general, there has been very little empirical research concerning how to effectively manage and coordinate dispersed teams. Research in the information systems area has extensively examined the effects of computer-mediated systems on “same-time/same-place” group work (c.f., [18]). However, there has been a paucity of research on “different-time/different-place teams” supported by asynchronous technology (cf., [18][7][21] for reviews). A review by Maznevski and Chudoba [31] found only two studies [26][27] that examined internationally dispersed teams. Thus, despite the fact that asynchronous technology is more commonly used than synchronous and that a larger portion of future teamwork will be fully dispersed [29], little is know about the dynamics or effectiveness of asynchronous global virtual teams.

Most studies of teams, virtual or otherwise, emphasize the importance of communication to accomplish team requirements [12][27]. However, for GVPTs, significant time and space boundaries affect the context in which communication takes place and thus communication itself[50]. According to McGrath [34][35], a significant problem facing dispersed teams is coordinating the temporal patterns of team behavior. Specifically, the traditional social cues and mechanisms that facilitate human interaction and decision-making are absent or altered by technology. The lack of reference points for coordinating the flow of work by time, place, or talk sequence can lead to disjointed interactions [40]. For GVPTs facing time constraints, temporally patterning workflows takes on heightened importance.

The purpose of this study is to examine the nature of team interaction in asynchronously communicating global virtual project teams (GVPTs). We also explore the role of temporal coordination mechanisms as a means to synchronize temporal patterns in GVPTs. In this study, temporal coordination mechanisms are defined as an interaction process structure that may intervene to direct the pattern, timing, and content of interaction incidents in a team [40][34][35]. We report on the results of an experiment consisting of 35 virtual project teams with members residing in different
geographic locations in the U.S. and Japan. The teams communicated solely via Lotus Notes®, a widely used groupware system that enables geographically distributed team members to share messages and engage in asynchronous, threaded discussions [51].

In the following section we develop our conceptual background. Then, we describe the methodology of our experimental design and analytic approach. Since temporal coordination affects team outcomes by influencing the way teams work, our primary focus is on the team interaction process. In this vein, we content analyze the discussions of the 35 teams and use cluster analysis to identify distinct patterns of team interaction. We then examine the relationship of the different team interaction patterns to team performance outcomes. We conclude with a discussion of our findings and implications for research and practice.

2. Conceptual background

The advent of advanced information and communication technologies provide organizations a mechanism for leveraging local expertise at the global level. Thus, GVPTs have the potential to increase the productive capacity of an organization’s human resources through more flexible allocation of effort. Like face-to-face (or synchronous) computer-mediated groups, the effectiveness of asynchronously communicating teams reflects the degrees to which outputs meet quality standards and work processes enhance the capability of the team to perform to these standards [21][48]. Before turning our attention to the temporal issues and how temporal coordination mechanisms affect team interaction, we first briefly discuss the nature of team interaction.

2.1 The nature of team interaction

McGrath [34][36] argues that teams perform three simultaneous functions as they work: the production function (i.e., performance of the task), team well-being function (i.e., relationships among team members), and member-support function (i.e., relationships with others). While the team interaction process itself can be conceptualized in different ways, it broadly includes all communicative, decisional, and interpersonal behaviors in support of the three team functions and underlying activities [41][11][7].

Communicative processes refer to the efforts made by team members to convey information and make sense of the task. Conveyance efforts center on the sharing of information, perspectives, and opinions by individual team members. Here, members are not actively engaged in disagreements or qualifications of each other’s contributions [10][44]. Conversely, decisional processes involve team members critically examining others’ contributions with the goal of converging to a common understanding such that a decision can be reached or problem solved. Convergence efforts will likely involve criticisms, disagreements and qualifications of members’ ideas and positions [10][44]. Decisional processes also include team process management efforts, i.e., the establishment of operating procedures and how the team will proceed. Both communicative (conveyance) and decisional (convergence, team process management) processes directly support the performance of the task, i.e., production function [34][17][10].

Interpersonal processes involve managing relations among team members as well as relations between individual members and the team. The development of relational ties is associated with the member support and team well-being functions. Interpersonal processes often involve social/relational interactions not germane to the focal performance task, e.g., joking, personal or interpersonal discussions [37][34][55]. Researchers have associated social/relational team behaviors with many positive outcomes including satisfaction and better quality team decisions [52][53][8].

2.2 Temporal patterning

Successful team outcomes depend largely on the nature of a team’s interaction processes; i.e., the “intertwining threads of activity that evolve simultaneously and interlock in different patterns over time” [46, p. 328]. Temporal patterning is concerned with the rhythms by which teams synchronize or coordinate their activities. The temporal aspects of the flow of work influence communicative, decisional, and interpersonal process behaviors. Synchronous (e.g., face-to-face) interaction is an orderly process wherein verbal, paraverbal, and nonverbal cues help regulate the flow of conversation, facilitate turn-taking, provide immediate feedback, and convey subtle meanings [34]. This inherent structuring of interaction is violated in an asynchronous communication environment since the conveyance of cues is hindered, feedback is delayed, and there are often interruptions or long pauses in communication. For example, in an asynchronous groupware discussion, the norm is for many topics to be active at the same time with team members making contributions at different times (possibly on different topics) [40]. This can increase information overload and may reduce the synergy of the team if there is no linkage among the responses. In addition, long time lapses between communication events can lead to
discontinuous and seemingly disjointed discussions [40]. The orderliness of team interactions (communicative, decisional, and interpersonal behaviors) is altered [54][55].

All this suggests that asynchronously communicating GVPTs must find workable substitutes for temporally coordinating their interactions and flows of information. Whereas synchronous teams have the luxury of allowing temporal patterns to emerge spontaneously, theory suggests that working in a virtual environment requires explicit attention to issues of temporal coordination [21]. A recent study by Maznevski and Chudoba [31] found that effective virtual teams were distinguished by a strong, repeating temporal pattern. In their study, basic temporal patterns were agreed upon and set during periodic 2-day face-to-face coordination meetings. These meetings played an important role in structuring the overall team process, influencing interactions (both synchronous and asynchronous) between coordination meetings. However, since initial or intermediate face-to-face meetings for GVPTs are often not possible, either due to time or travel budget constraints, the fundamental question of how to achieve temporal coordination remains.

Three generic temporal patterning problems are inherent in any group activity: temporal ambiguity, conflicting temporal interests and requirements, and scarcity of temporal resources [33]. Typical organizational approaches to these temporal patterning problems can be characterized as scheduling (deadlines), synchronization (aligning the pace of effort within and between members), and allocation of resources (specifying time spent on specific tasks) [34]. We refer to these patterning approaches as temporal coordination mechanisms imposed to manage team interaction processes. Ocker et al. [40] suggested two approaches to temporal coordination in virtual project teams: (1) provide mechanisms for organizing group communication, and (2) provide a sequenced or structured process for work and problem-solving activities. In addition, any communication technology employed by a virtual team may have embedded structural features that may facilitate temporal coordination. For example, the inherent structure of Lotus Notes’® passively facilitates document creation, indexing and searching, database generation and management, and messaging -- all to/from a common repository of contributions [51].

For time-limited GVPTs, effectively managing the team interaction process is of paramount importance. Past research suggests that temporal coordination mechanisms can influence the nature of team interaction and thus team outcomes [23]. For example, process structuring via scheduling, synchronization, and time allocation should reduce the uncertainty and chaos associated with a team task. As a result, a temporal coordination mechanism may reduce the time devoted by the team to process management issues and make communicative processes (the conveyance of ideas) more efficient. This, in turn, should allow GVPTs more time to devote to decisional processes involving critical evaluation and convergence activities. In this vein, Ocker, et al. [40] found that providing a process structure stimulated greater levels of participation among members, which led to the surfacing [conveyance] and discussion of more divergent perspectives [convergence] in the team interaction process. This suggests that GVPTs should perform better when their communicative (conveyance) and decisional (convergence and process management) processes are temporally coordinated.

Temporal coordination mechanisms may also help create relational links among team members so that interpersonal barriers to asynchronous communication can be overcome. This can be accomplished by providing structured opportunities for socialization and relational exchange. Past research has found that interaction in a computer-mediated environment is impersonal, task-oriented, less friendly, and more business like (e.g., [4]). There is evidence that this creates a less satisfying experience for team members and slows the development of social/relational ties among members [8]. As evidence, Maznevski and Chudoba [31] found that interim face-to-face coordination meetings facilitated beneficial social ties among virtual team members, which ultimately enriched team performance. This suggests that GVPTs should perform better when their interpersonal (social/relational) processes are temporally coordinated.

Overall, we expect that temporally coordinating interactions and workflow for GVPTs should help overcome the communication challenges and constraints imposed by the technology. We expect that temporal coordination will benefit GVPT performance by influencing team interaction patterns. In the next section, we describe our methodology for discovering effective team interaction patterns for GVPTs and examining the role of temporal coordination mechanisms in inducing these successful behaviors.

3. Methodology

In total, 175 Master’s level students participated as members of 35 five-person virtual project teams. Thirty-four, full-time, MBA students were drawn from a large international university in Japan. Ninety-eight, full-time, MBA students were drawn from two large US midwestern universities. Forty-three, part-time,
Masters students were from a large US southeastern university. The exercise was conducted over a fifteen-day period, with nine days devoted to team collaboration.

The experimental task was adapted from a widely used marketing simulation developed by Boyd, Walker & Larréché [6]. The adapted case involves a fictitious global company that is attempting to bring a greater degree of coordination and global perspective to its South and Latin American marketing effort in Argentina and Mexico. Participants were asked to act as a member of a global project team assigned to this effort and were provided with a brief (3-page) summary of the case. Participants were asked to: (1) recommend the degree of local adaptation for product specifications, consumer marketing, and trade marketing in both Argentina and Mexico, and (2) to explain the team’s rationale for its decision.

3.1 Procedure and technology

Participants were instructed to complete the task individually (Deliverable 1) and in their respective teams (Deliverable 2). Individual completion of the task provided an opportunity to consider the details of the case and formulate one's own opinion prior to the virtual team meeting. The team decision required reconciliation of different views and consensus on a quantitative solution and a qualitative rationale to support the team decision.

Participants in each of the 35 teams communicated solely through specially designed and access controlled Lotus Notes® discussion forums. Notes® allows for the creation of threaded, yet asynchronous, discussions. Accessible via a Web browser, the team forums were designed with ease-of-use in mind and differed according to the experimental conditions (described below). Participants were prohibited from accessing team forums other than their own. One additional Notes® database was designed and served as a central repository to post individual and team decisions (Deliverables 1 and 2). The Notes® databases were automatically opened and closed by the research team according to a pre-defined schedule.

3.2 Experimental conditions

Temporal Coordination Mechanism. The temporal coordination mechanisms included schedule deadlines, coordinated pace of effort within and between members, and specification of time spent on specific tasks [40][34]. As such, the temporal coordination mechanism provided a structure for process management. Leaner communication contexts do not have the same capacity to convey social cues (e.g., backgrounds and experience) known to contribute to social interaction [27]. Thus, for the temporally coordinated teams, the first step (Step 1) instructed participants to complete a “personal profile” form in the team forum and introduce themselves to the team. In addition, participants were instructed to note any time constraints that s/he would have during the course of the team collaboration. This step simulated an initial socialization, relationship-building event that is typical of face-to-face groups.

Second, for each team in the temporal coordination condition, the individual decisions (Deliverable 1) of each team member were automatically posted (i.e., electronically copied) into the team forum. This made conveyance of initial positions automatic. The team was instructed to review and consider the positions of other team members. After review, each member was instructed to post a "revised" position to the forum (Step 2) -- this did not imply, however, that individual positions must changed. Participants were instructed to complete steps 1 and 2 by a specified time and date (by 10 am EST Day 3).

Third, one team member was randomly assigned to serve as the team coordinator. The coordinators were pre-determined and represented all four universities as evenly as possible. In Step 3, the team coordinator was instructed to review all of the "Revised Individual Position" postings and look for similarities and/or differences. This step was intended to initiate the convergence process in the temporally coordinated teams. After review, the team coordinator was instructed to summarize the current thinking of the team and post this to the team forum. This summary would serve as the starting point for subsequent team discussion. This task, step 3, had an associated deadline for completion (by 10 am EST Day 5).

Fourth, after the team coordinator posted the summary, each team member was instructed to review it and proceed with discussion (Step 4). Once the team reached consensus, the team coordinator or another member should offer to draft a rationale for the team decision. The team could then review, discuss and revise the rationale, as needed or desired. The teams were given a deadline for completion of the team decision, with the coordinator was instructed to post the team decision and rationale (Deliverable 2) to the deliverables database (by 10 am EST Day 9).

No Temporal Coordination Mechanism. The eighteen teams working under this condition received no temporal coordination instructions regarding how to proceed with their team activities. The interface for these team forums contained instructions that simply reiterated the team task and final deadline.
4. Analyses and results

In order to explore the nature of team interaction in GVPTs and how temporal coordination mechanisms influence team interaction, each of the 35 discussion forums was content-coded for analysis. Specifically, each team’s Notes® discussion forum was coded to determine the overall proportion of the team’s time devoted to the communicative (conveyance), decisional (convergence, process management), and interpersonal (social/relational) behaviors described earlier.

Coding a transcript of an audio- or videotaped synchronous meeting, with an ordered conversational flow, might involve coding individual statements or short periods of interaction [44]. However, in an asynchronous discussion, the flow of conversation is altered due to time-disjointed postings and multiple discussion threads going on at any one time. In addition, since GVPT members work at different times and access the virtual environment more or less frequently, for the sake of efficiency, they often compose messages that simultaneously involve multiple purposes (communicative, decisional, and/or interpersonal) [32]. Thus, in this study, the unit of coding is necessarily each posting, or “communication incident”, within each respective GVPT.

Across the 35 GVPTs, a total of 812 communication incidents were analyzed. An independent coder was instructed to read each posting and ascertain the proportion (0 to 100%) of the posting devoted to each of the four behaviors. Specifically, if the behavior was not present in the communication incident, it was assigned a score of 0%; conversely, if it was the sole purpose of the posting, it was assigned a score of 100%. If two or more interaction behaviors were simultaneously present, the relative contribution of each to the overall communication incident was assessed. (The coding instructions, examples of coded postings, and reliability analyses are available from the authors, upon request).

The proportion of time each GVPT devoted to the four interaction behaviors was determined by averaging the coded values across all postings within each respective team. The scores on these four variables, i.e., interaction behaviors, serve as the input to subsequent cluster analysis to classify GVPTs according to the pattern of their interaction processes.

4.1 Cluster analysis

The primary purpose of cluster analysis is to classify objects based on the characteristics they possess [15][39]. The resulting clusters should exhibit high within-cluster homogeneity and high between-cluster heterogeneity. Cluster analysis has been used in a variety of contexts such as market segmentation [14] and performance evaluations of firms based on various characteristics such as firms’ strategies and values [30]. Given our interest in exploring how the patterns of interaction in GVPTs relate to team performance and how temporal coordination influences interaction processes, cluster analysis provides an appropriate classification technique. Our analytic objective is to group GVPTs so that we can identify teams with similar interaction patterns in terms of the proportion of time spent on conveyance, convergence, process management, and social/relational behaviors.

Our analysis follows the process recommended by Milligan and Cooper [39] and Hair et al. [22]. The clustering variables were the proportions of time devoted to conveyance, convergence, process management, and social/relational behaviors. Since our objective is to classify GVPTs based on the similarities in the nature of interaction behaviors, we used a Euclidean distance measure as a measure of similarity [22]. Since distance measures are quite sensitive to differing magnitudes among the clustering variables, we also standardized the variables. The next step involved the selection of clustering method. Based on a review of major clustering methods [22], we chose a hybrid method that uses the centroids obtained from a hierarchical method to start a non-hierarchical (K-means) algorithm. The centroids of each cluster were obtained first using a hierarchical cluster analysis using Ward’s method [39][22]. These centroids were used as the initial seed points for the non-hierarchical cluster analysis. Analysis of the agglomeration schedule generated from Ward’s method suggested a 5-cluster solution. Table 1 contains the clustering variable profile for the 5-cluster solution. Table 2 shows that all the clustering variables differ in a statistically significant way across all five groups.

Figure 1 presents a graphical profile of the 5-cluster solution, illustrating the average proportions of time the GVPTs in each cluster devoted to conveyance, convergence, social/relational, and process management behaviors. As expected, since the clustering variables represent proportions, high scores on one are associated with lower scores on others. For example, the communication incidents of the GVPTs assigned to cluster 1 were largely devoted to convergence and thus less time was spent on conveyance, social/relational, and process management behaviors. Table 3 presents the results of pairwise comparisons of the differences between the 5 clusters.
Table 1. Clustering Variable Profiles

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Conveyance</th>
<th>Convergence</th>
<th>Social / Relation</th>
<th>Process Management</th>
<th>Cluster Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.07</td>
<td>.74</td>
<td>.08</td>
<td>.12</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>.22</td>
<td>.23</td>
<td>.16</td>
<td>.39</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>.01</td>
<td>.62</td>
<td>.24</td>
<td>.13</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>.11</td>
<td>.43</td>
<td>.17</td>
<td>.29</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>.16</td>
<td>.36</td>
<td>.30</td>
<td>.19</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Significance Testing of Differences Between Cluster Centroids

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cluster Mean Square</th>
<th>df</th>
<th>Error Mean Square</th>
<th>df</th>
<th>F Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance</td>
<td>5.149</td>
<td>4</td>
<td>.447</td>
<td>30</td>
<td>11.526</td>
<td>.000</td>
</tr>
<tr>
<td>Convergence</td>
<td>7.166</td>
<td>4</td>
<td>.178</td>
<td>30</td>
<td>40.302</td>
<td>.000</td>
</tr>
<tr>
<td>Social/Relational</td>
<td>5.479</td>
<td>4</td>
<td>.403</td>
<td>30</td>
<td>13.601</td>
<td>.000</td>
</tr>
<tr>
<td>Project Mgmt</td>
<td>6.069</td>
<td>4</td>
<td>.324</td>
<td>30</td>
<td>18.728</td>
<td>.000</td>
</tr>
</tbody>
</table>

Figure 1. Graphical Profile

Table 3. Cluster Mean Differences on Interaction Behaviors

<table>
<thead>
<tr>
<th>Interaction Behavior</th>
<th>Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Conveyance</td>
<td>[1,2]***</td>
</tr>
<tr>
<td>Convergence</td>
<td>[1,2]***</td>
</tr>
<tr>
<td>Social/Relational</td>
<td>[1,2]***</td>
</tr>
<tr>
<td>Process Mgmt</td>
<td>[1,2]***</td>
</tr>
</tbody>
</table>

1. The number in brackets indicates which cluster pairs are significantly different.
2. *** Significance at 99% confidence; ** significance at 95% confidence; * significance at 90% confidence.
Figure 1 and Table 3 highlight a number of key patterns. Clusters 1 and 3 show similar patterns with regard to the nature of their interaction processes. Relative to all other clusters, the GVPTs in clusters 1 and 3 spent a significantly greater amount of time on convergence-oriented interaction, and the least amount of time on conveyance and process management. The key difference between cluster 1 and 3 lies in social/relational behaviors. The GVPTs in cluster 3 spent less time on convergence than those in cluster 1, but significantly more time on social/relational interactions. Cluster 2 differed significantly from all other clusters with regard to the proportion of interactions focused on process management and convergence. Cluster 2 spent the most time on process management, but the least time on convergence. The GVPTs in cluster 2 spent a significantly greater proportion of time on conveyance-oriented interactions than clusters 1, 3, and 4. Finally, clusters 4 and 5 show a somewhat similar pattern. Specifically, both clusters spent significantly less time on convergence than clusters 1 and 3, but significantly more than cluster 2.

### 4.2 Interaction patterns and performance

Now that we have identified distinct patterns of interaction in GVPTs, we can examine the relationship between the nature of team interaction and team performance outcomes. We also explore if and how temporal coordination mechanisms are related to the nature of interaction and team performance. We define performance as the quality of the team rationale used to support the team decision. We used three indices to derive an overall measure of decision quality: range, organization, and depth [13][38]). Range is defined as the degree to which the team’s decision rationale covers a maximum range of relevant issues. Organization is the degree to which the team’s decision rationale is well-structured. Depth is the degree to which the team’s decision rationale explores issues deeply. Four expert raters independently assessed the quality of each team rationale. Each rationale was scored on the three indices on a scale from 1 (very low) to 5 (very high). Inter-rater reliability for each dependent variable was acceptable (.84 for range, .86 for organization, and .96 for depth) [24]. For each quality index, the responses of the four raters were averaged and, for each team, a composite performance score was determined by multiplying the three indices.

Using the composite performance score, we tested the pairwise performance differences across clusters. Our results in Table 4 indicate that GVPT teams in Clusters 1 and 3 have significantly greater levels of performance than teams in clusters 4 and 5. As described above, the GVPTs in clusters 1 and 3 spent a significantly greater proportion of time on convergence-oriented interactions, compared to the GVPTs in clusters 4 and 5. For time-limited GVPTs, our results suggest that decisional behaviors related to convergence are the key driver of performance. It may be that for time-limited project teams, time not spent on critical discussion may detract from the overall performance. Also, the cluster composition reported in Table 4 suggests that the temporal coordination mechanism tends to be associated with higher GVPT performance. Although there are exceptions (which we discuss next), a majority of the teams that received the instructions (11 out of 17) are associated with the two highest performing clusters 1 and 3. Conversely, a majority of the teams that did not receive temporal coordination instructions (13 out of 18) are associated with the two lowest performing clusters 4 and 5. These results suggest that the temporal coordination mechanisms positively influenced the overall nature of team interaction in such a way that team performance benefited.

<table>
<thead>
<tr>
<th>Cluster Composition</th>
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<tbody>
<tr>
<td>GVPT Mean Performance Score</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>55.83 29.40 56.57 18.75 10.60</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Pairwise Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1,4]*** ns [3,4]** [4,1]*** [5,1]***</td>
</tr>
<tr>
<td>[1,5]*** [3,5]** [4,3]** [5,3]**</td>
</tr>
</tbody>
</table>

### Table 4. Performance Differences and Cluster Composition

<table>
<thead>
<tr>
<th>Cluster</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVPT Mean Performance Score</td>
<td>55.83</td>
<td>29.40</td>
<td>56.57</td>
<td>18.75</td>
<td>10.60</td>
</tr>
<tr>
<td>Pairwise Differences</td>
<td>[1,4]***</td>
<td>ns</td>
<td>[3,4]**</td>
<td>[4,1]***</td>
<td>[5,1]***</td>
</tr>
<tr>
<td>Cluster Composition</td>
<td>[1,5]***</td>
<td>[3,5]**</td>
<td>[4,3]**</td>
<td>[5,3]**</td>
<td></td>
</tr>
<tr>
<td>5 teams w/TC</td>
<td>2 teams w/TC</td>
<td>6 teams w/TC</td>
<td>4 teams w/TC</td>
<td>0 teams w/TC</td>
<td></td>
</tr>
<tr>
<td>1 team w/o</td>
<td>3 teams w/o</td>
<td>1 team w/o</td>
<td>8 teams w/o</td>
<td>5 teams w/o</td>
<td></td>
</tr>
</tbody>
</table>

1. The number in brackets indicates which cluster pairs are significantly different.
2. *** Significance at 99% confidence; ** significance at 95% confidence; * significance at 90% confidence.
3. Cluster composition indicates the number of teams within each cluster receiving the temporal coordination (TC) manipulation and the number without (w/o) instructions.
4.3 Temporal flow of interactions

The cluster solution indicates 5 distinct patterns of interactions in terms of overall proportion of time spent on the four interaction processes. Asynchronous technology relaxes constraints on the who/where/when of participation, but at the same time, this can lead to a less orderly, more chaotic, and less predictable flow of work [34]. Thus, the pace of work over time becomes an important dimension to manage particularly for teams working under time pressures. To assess the pace of work and to develop deeper insights into why the 5 cluster patterns had differential effects on GVPT performance, we looked more closely at the temporal flow of team interactions over time. Our discussion focuses on the temporal flow of interactions across the nine days for the GVPTs in the highest and lowest performing clusters. (Illustrations of these temporal patterns are available from the authors, upon request).

Clusters 1 and 3. Convergence dominated daily interactions, albeit slightly differently for each cluster, for the GVPTs in clusters 1 and 3 across the nine days of team interaction. Eleven of the thirteen teams in clusters 1 and 2 received the temporal coordination instructions. To interpret the effect of the manipulation, we examined whether or not these teams had, in fact, followed the instructions. We reviewed the complete set of postings for each team and conclude that all of the 11 GVPT teams in clusters 1 and 3 that received the instructions did indeed follow the four steps.

For the 11 GVPTs with the temporal coordination instructions, the individual rationales and decisions were automatically copied into the respective team forums. Team members were instructed to review these, consider the positions of their teammates, and post “revised” individual positions no later than 10 am EST on Day 3. While some new perspectives and opinions were evidenced, limited conveyance was needed during the first few days of the team’s work. In fact, convergence-oriented interactions began immediately as members began to explore and discuss information and alternative positions. Simultaneously, there is little early evidence of social/relational behaviors – this may be attributable to that fact that the members of these 11 GVPTs completed a “personal profile”, allowing for initial member introductions. By no later than 10 am EST on Day 5, the team coordinators in these 11 GVPTs had reviewed the revised positions and had posted a summary position that reflected the current thinking of the team. As instructed, the teams used this posting as a focal point for subsequent discussion, again convergence-oriented. Analysis revealed that from Day 5 forward, while much interaction was devoted to convergence, there was increasing attention on process management. Even for these 11 GVPTs, during this work period, several process management issues needed to be addressed, i.e., choose a member to draft a rationale based on the discussion, which the members then had to review and edit. Thus, while the teams were primarily focused on critical discussion, they also had to coordinate their efforts to complete the task on time.

The remaining two teams in clusters 1 and 2 (team #31 in cluster 1, team #20 in cluster 2) that did not receive the temporal coordination instructions exhibited characteristics similar to the 11 teams that did. A review of the interaction patterns for team #31 and team #20 revealed that they too followed temporal workflow and interaction processes that achieved the overall objectives of the temporal coordination instructions. While these two teams did devote more time to process management than the other 11 teams, it was used to define an early work strategy and then again later in support of task completion.

Clusters 4 and 5. Comparing the nine-day temporal patterns for clusters 4 and 5 to the clusters 1 and 3 indicates a very different temporal workflow pattern that may have led to the significant differences in cluster performance. Of the 17 teams assigned to clusters 4 and 5, only four (in cluster 4) received the temporal coordination instructions. We reviewed the complete set of postings for these four teams and found that they had indeed not faithfully followed the 4-step process as laid out. Thus, by not taking advantage of a defined work strategy early, these teams enacted an overall chaotic work process that likely contributed to inadequate performance.

With regard to the overall proportion of time devoted to process management, the teams in cluster 4 exhibited significantly more process management behaviors compared to teams in clusters 1 and 3. Simultaneously, while the GVPTs in cluster 5 spent less time on process management than those in cluster 4, this extra time was taken up with social/relational interactions rather than with the critical conveyance or convergence interactions necessary to complete the task effectively. While the teams in cluster 3 likewise spent time on social/relational interactions, the overall time devoted to convergence was not negatively affected since cluster 3 teams did not have to spend much time on conveyance or process management. For clusters 4 and 5, there was an interesting inverse relationship between conveyance and convergence over the 9 days of interaction. However, unlike the GVPTs in clusters 1 and 3 where convergence dominated daily interactions, teams in clusters 4 and 5 devoted some proportion of daily interactions to all four behaviors, suggesting a more chaotic workflow.
Based on the above discussion of the temporal workflows, we conclude that temporal coordination mechanisms, as enacted through the process structure instructions, do influence GVPT interactions and can lead to differential performance.

5. Conclusions and directions

A plethora of past research has compared face-to-face and computer-mediated groups (c.f. [18][7][54][55]). Yet, Fjermestad & Hiltz [18] report a paucity of research to date on different-time/different-place teams communicating through asynchronous technology. Our study represents a step toward extending research into the asynchronous virtual project team context.

In this study, we explored the nature of team interaction and the role of temporal coordination in asynchronously communicating GVPTs. We identified distinct patterns of interaction by cluster analyzing the discussion content of 35 global virtual project teams. We found that distinct patterns of interaction were associated with differential levels of GVPT performance. Thus, our study provides empirical evidence to support previously untested elements of the Time, Interaction, and Performance (TIP) theory [34], a theory based on the premise that work and human behavior is temporally patterned in complex ways. Our results suggest that successful enactment of temporal coordination mechanisms was more often than not associated with higher performance. However, we found that temporal coordination per se is not the driver of performance; rather, it is the influence of coordination on interaction behaviors.

For teams that successfully enacted our temporal coordination mechanism, we found that it enabled a temporally efficient flow of work by reducing the time needed to convey ideas and manage the process. This increased the time required for critical discussion, which in turn, is essential to performance. Thus, we contend that certain characteristics of temporal coordination can be used to facilitate effective GVPTs. The temporal coordination mechanism employed in this study is not necessarily ideal or optimal. Future research is needed to examine the effects of alternative coordination mechanisms and how to match an appropriate mechanism to the task. With today’s increasing use of globally dispersed teams, we believe that understanding the effects of temporal coordination on interaction and performance is important as it has implications for how to better manage virtual teams.

Future research should explore the external validity of this study since we used student subjects as participants and a case study as the decision context. As research on virtual teams continues, field research with organizational work groups will expand our understanding of the effects of the organizational environment on virtual teams.

There is a great need for future research to explore additional variables of interest concerning the workings of virtual teams. For example, research should consider different task types and forms of virtual teams. Our focus was on time-limited virtual project teams engaged in a decision-making task. Future research is needed to explore the effects of temporal coordination on alternative outcome measures.

In conclusion, the rise of the virtual organization, in response to increasing global competition and advances in technology, has simultaneously led to increased deployment of global virtual teams. However, the task of electronically connecting dispersed organizational sites is far simpler than the task of coordinating and facilitating collaborative communication between members. Technology will not alone transform virtual teams into cooperative teams of collaborators. We must continue to explore how to make virtual teams work effectively when the central medium of the team’s process is technology.

6. Selected references


