7

Spatial and Temporal Boundaries in Global Teams

Distinguishing Where You Work from When You Work

Jonathon N. Cummings[1], J. Alberto Espinosa[2], and Cynthia K. Pickering[3]
1 Fuqua School of Business, Duke University
jonathon.cummings@duke.edu
2 Kogod School of Business, American University
alberto@american.edu
3 Information Services and Technology Group, Intel Corporation
cynthia.k.pickering@intel.com

Abstract. While spatial boundaries include the geographic differences among team members (different cities), temporal boundaries include the workday differences among team members (different time zones). In global teams members have to deal with both spatial and temporal boundaries since their co-workers are often located in cities within and across time zones. For global team members with high spatial boundaries and low temporal boundaries (those in different cities in the same time zone), synchronous communication technologies such as the telephone and instant messenger provide a means for real-time interaction. However, for global team members with high spatial boundaries and high temporal boundaries (those in different cities in different time zones), asynchronous communication technologies, such as e-mail and web software, provide a way to interact intermittently. Using social network data from 625 team members (representing 5986 pairs) across 137 global teams in a multi-national semiconductor firm, we explore the impact of spatial and temporal boundaries on coordination delay. We also illustrate how member awareness can reduce coordination delay, thus increasing the likelihood of better global team performance.

1 Introduction

A wide range of terms—including distant, proximate, dispersed, collocated, and virtual—evoke the spatial boundaries inherent in distributed work. Global software development, information technology offshoring, and just-in-time manufacturing are a few of the business practices that rely on employees in different geographic locations. Spatial boundaries, defined as geographic differences where people are located, are fundamental to the study of distributed work [1]. Prior research has linked an increase in relatively low spatial boundaries (different hallway vs. different floor vs. different building) to a reduction in work outcomes such as task communication [2], collaboration likelihood [3], and teamwork quality [4]. As work continues to become more globally distributed across different cities and countries, spatial boundaries will undoubtedly overlap with temporal boundaries [5]. Temporal boundaries, conceptualized as the amount of non-overlapping work time (8am to 5pm Pacific Standard Time vs. 8am to 5pm Greenwich Mean Time), have the potential to be as disruptive as spatial boundaries. Unfortunately, empirical research has not kept up with theorizing about temporal boundaries in distributed work [6-9].

To illustrate the distinction between spatial boundaries and temporal boundaries, consider a product development team with members split between sites in Northern and Southern California. Though members on the team reside in different geographic locations, they share the same hours in a workday. Thus, if members encounter an urgent problem or need to coordinate their work in real-time, they have access to synchronous communication technologies (the telephone or instant messenger) throughout the workday. Now consider a separate product development team with members split between sites in Northern California and India. Because of the 13.5-hour time difference between sites, members will likely experience a one-day delay in solving their problems and coordinating their work through asynchronous communication technologies (e-mail or web software). In both product development teams, the members encounter high spatial boundaries. However, in the first team, the temporal boundaries are low, while in the second team, they are high. The purpose of this paper is to explore the differential impact of spatial and temporal boundaries on coordination delay and global team performance.

1.1 A Boundary-based Model of Coordination Delay

Coordination has long been considered an important aspect of joint work since people have to manage task dependencies and integrate their work towards a common goal [10-12]. For members working on a project across different sites, coordination is even more critical as it can take longer to resolve issues, clarify communication, and rework tasks [13]. These time lags in coordination, or coordination delay, are costly to organizations due to the additional hours of time spent by project members [14]. Practitioners and academics alike have been optimistic that various communication technologies will be able to help team members overcome distance to coordinate effectively [15-17]. Although there are documented examples of software development teams that successfully “follow-the-sun” and product development teams that do an excellent job of designing in the West (the US, Europe) and producing in the East (India, China), it is unclear if these are exceptions or the norm. Furthermore, the coordination delay issues that global team members face have not been linked to different combinations of spatial and temporal boundaries, and there has not been empirical evidence regarding which communication technologies are best suited for managing these boundaries.

Spatial boundaries, such as being located in a different city from other team members, impact the likelihood of face-to-face contact, spontaneous communication, and shared social settings [18]. It follows that coordination delay should increase with spatial boundaries when informal and unplanned interactions are required [19]. Temporal boundaries, such as being located in a different time zone from other team members, impact the likelihood of synchronous communication, real-time problem solving, and workflow availability [8]. That is, the resulting communication across high temporal boundaries will be largely asynchronous, leading to longer response and issue resolution times. Thus, coordination delay should increase with temporal boundaries since there are fewer overlapping hours within which to work [7]. Global team members who work across spatial and temporal boundaries face even greater consequences for coordination delay. Not only do team members have to work harder to create opportunities for informal interaction, but they also have to be more aware of the work hours of other members. Therefore, we propose that:

Hypothesis 1a: *Holding constant temporal boundaries, an increase in spatial boundaries (same city vs. different city with overlapping workday) will be associated with an increase in coordination delay for pairs of global team members*.

Hypothesis 1b: *Holding constant spatial boundaries, an increase in temporal boundaries (same workday vs. different workday in different cities) will be associated with an increase in coordination delay for pairs of global team members*.

Hypothesis 1c: *An increase in spatial boundaries will be more strongly associated with an increase in coordination delay when there is also an increase in temporal boundaries for pairs of global team members (same city with overlapping workday vs. different city with overlapping workday vs. different city with non-overlapping workday)*.

Communication technologies allow team members to communicate at a distant through the use of audio, video, text, graphics, and other features. Researchers have categorized communication technologies according to whether they are used synchronously or asynchronously, as well as whether they are used in the same place or in different places [20, 21]. For example, telephone communication is synchronous and is often used when two people are in different places, while e-mail communication is asynchronous and is often used when two people are in different places. In teams separated by high spatial boundaries, face-to-face communication is not a regular option, given that members are not in the same place. Therefore, members are less likely to bump into one another in the hallway, see each other in the lunchroom, or encounter one another in meetings throughout a workday. As a result, they will have less mutual knowledge about team members in other locations, including contextual information such as work schedules, time commitments, and other task constraints [22]. Opportunities for informal communication, which give team members a chance to update one another on progress and develop mutual knowledge, are more difficult to create. Similarly, synchronous communication, such as talking on the phone, is less likely to occur naturally when team members are spread across spatial boundaries given the need to be available at the same time. Developing common practices for dispersed coordination is difficult, and requires aligning the effort of all parties involved [23]. When team members are in different geographic locations, but have time overlap in their workday, both informal communication and synchronous communication should reduce the likelihood of coordination delay. We hypothesize that:

Hypothesis 2a: *An increase in informal communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have low temporal boundaries (overlapping workday).*

Hypothesis 2b: *An increase in synchronous communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have low temporal boundaries (overlapping workday).*

For team members separated by high spatial boundaries and high temporal boundaries, informal communication and synchronous communication are even less likely to happen by chance. One way for members to mitigate this challenge is through active awareness of when others are working (in order to make an early morning or a late-night phone call for example). Through transactive memory, members can build awareness of who is doing what, and try to forecast when interaction is necessary [24, 25]. Team members with greater awareness of other members should be in a better position to connect when needed [26]. An alternative to interaction outside of the typical work day is through asynchronous communication such as email. Research suggests that managers prefer email for a wide range of activities, and it can be used to share information, coordinate work, and create a shared identity for the group [27, 28]. Other technologies, such as WebEx and Groove, allow team members to share a desktop, on which they can save files, leave messages, and interact asynchronously (or synchronously if both people are available at the same time). Given the advantages of member awareness and asynchronous communication, we expect the following:

Hypothesis 3a: *An increase in awareness of when other members are working will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have high temporal boundaries (non-overlapping workday).*

Hypothesis 3b: *An increase in asynchronous communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have high temporal boundaries (non-overlapping workday).*

Finally, we argue that the overall performance of global teams, such as completing work on time, working well within budget, and meeting final product requirements [29], is impacted by the coordination delay among pairs of members. When workflow coordination does not proceed smoothly among members who depend on one another for knowledge and expertise [30], we anticipate that performance will suffer. It follows that:

Hypothesis 4: *An increase in coordination delay for pairs of members will be associated with a decrease in global team performance*.

We test the above hypotheses using survey data from 625 members of 137 global teams in a Fortune 500 corporation. Our boundary-based model of coordination delay is displayed in Figure 1. It summarizes the linkages between spatial and temporal boundaries, coordination delay, and performance. We identify potential moderators of spatial boundaries and coordination delay (informal communication and synchronous communication), as well as temporal boundaries and coordination delay (member awareness and asynchronous communication).

1.2 Analysis Strategy

Given the co-occurrence of spatial boundaries and temporal boundaries in the case of team members spread across the world, we highlight our strategy for analyzing where and when people work. In hypotheses focused solely on spatial boundaries, we hold temporal boundaries constant by examining N=2911 pairs of team members who are in the same time zone (and thus have an overlapping workday). In hypotheses that address temporal boundaries and the difference between an overlapping workday and a non-overlapping workday, we hold spatial boundaries constant by only looking at N=3746 pairs of team members who are in different cities. Finally, for the combination of spatial boundaries and temporal boundaries, we create a 3-pt scale that captures N=5986 pairs of members who are in (1) the same city with overlapping workday, (2) different cities with overlapping workday, and (3) different cities with non-overlapping workday. In our dataset, a traditional statistical interaction is not appropriate because there are no pairs of members in the same city with a non-overlapping workday.

Hierarchical Linear Modeling (HLM) is used to analyze the pairs of team members. HLM takes into account the non-independence of observations, and adjusts the degrees of freedom to account for pairs of members nested within teams (see [31] or [32] for additional discussion about the use of multi-level models). For the analysis of member pairs, coordination delay is the dependent variable, and spatial boundaries (H1a), temporal boundaries (H1b), and spatial and temporal boundaries (H1c) are the independent variables. The moderating variables (following the approach recommended by [33]) include informal communication (H2a), synchronous communication (H2b), member awareness (H3a), and asynchronous communication (H3b). Ordinary Least Squares (OLS) regression is used to analyze the association between coordination delay and team-level performance (H4).

2 Method

2.1 Sample

Participants from a large, semiconductor manufacturing firm were solicited to participate in a study of team effectiveness. Roughly 4,000 randomly sampled managers from several large business units in the company were asked to provide the name of a project they led in the prior 6 months along with the project start/end date and project description. Of these managers, 380 provided project information. Then, the same project managers were asked to complete an online survey that included asking them to add the names of other people on the project, how much communication they had with each person on the project, and how well the project performed. The online survey was dynamic, so once the project manager added people, they were automatically sent an email message inviting them to participate and complete the survey.

Of the managers providing project information, 300 of them provided the names of other people on the project. From the projects, a total of 2,318 names were generated, and 1,311 of them completed the survey, for a response rate of 57%. Out of the completed responses, we distinguish between the 1,039 responses from project managers or project members (the “core” members), and the 272 responses from project advisors, outside experts, stakeholders, or others affiliates (the “non-core” members). For purposes of our analyses, we only examine data from the core members. We reduce the sample further by only including data from 625 respondents (representing 5,986 pairs of core members) who were on a project with at least one other core member who responded. This ensures that we have at least two assessments of team performance by core members.

Respondents in the sample worked in 54 locations across 23 countries (Belgium, Brazil, Canada, China, Costa Rica, Denmark, France, Germany, India, Ireland, Israel, Japan, Malaysia, Mexico, The Philippines, Poland, Russia, Singapore, South Korea, Taiwan, The United Kingdom and the United States). Over half of the respondents were from engineering or IT, and worked on hardware or software projects. The typical project length was over a year and a half. Around 70% of the respondents were male, and the average age was 38 years old. Respondents had, on average, over ten years of industry experience and about five years of experience in the company. We developed survey questions through pilot testing with employees in the company.

2.2 Variables

- *Spatial boundaries*. Survey respondents were asked whether each team member was located in the same room, same hallway, different hallway, different floor, different building, different city, or different country. In cases where data were missing—some respondents did not know where other members were located—we used company database records to determine the location. Because pairs of members in different buildings are always in the same time zone, we used city as the cut-off for spatial boundaries (0=same city, 1=different city), since members in different cities could be in different time zones.

- *Temporal boundaries*. Almost 90% of the sample reported working between 9-11 hours a day, arriving 7-9am local time and departing 5-7pm local time. Therefore, we based the measure of temporal boundaries on the time zone difference between cities where members worked (0 = during a 9 hour workday, there was at least 1 hour of overlap, 1 = during a 9 hour workday, there were no hours of overlap). For example, there are only four time zones in the continental United States, so all pairs of project members there have an overlapping workday. However, for pairs of project members working in the United States and India, the time zone difference is at least 10.5, so they have a non-overlapping workday.
- *Spatial and temporal boundaries*. The extent to which two members are separated by spatial boundaries and temporal boundaries (1=same city with overlapping workday, 2=different city with overlapping workday, 3=different city with non-overlapping workday). As mentioned above, this variable was used because there were not any members located in the same city with a non-overlapping workday.
- *Core size*. The number of core members on the project (project manager and project members).
- *Time shifting*. For the roughly 10% of team members reporting workday hours outside of 7am to 7pm, we created a dummy variable to account for possible shifting of their work time (0=no time shifting, 1=time shifting).
- *Years known*. For each core member, the respondent reported the number of years knowing the other person (1: < than 1 year; 2: 1 to 3 years; 3: 3 to 5 years; 4: 5 to 10 years; 5: more than 10 years).
- *Member interdependence*. Average of a 3-item scale measuring the extent to which team members depended on one another (tasks this person performed were related to tasks I performed, this person depended on me for information or materials needed to complete their work, I could not accomplish my tasks without information or materials from this person; 1: not at all; 3: sometimes; 5: very much). Cronbach's α=0.90
- *Coordination delay*. Average of a 3-item scale measuring the extent to which there were delays in coordination (typically it took a long time to get a response from this person, our communications required frequent clarification, we often had to rework tasks beyond what I would normally expect; 1: disagree; 3: neutral; 5: agree). Cronbach's α=0.79
- *Synchronous communication*. Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person via… (a) Voice Communication (telephone or voice conference). Note that though we collected data on Synchronous Text Communication (instant messenger), we exclude it from our analyses because it was used infrequently.

- *Asynchronous communication*. Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person via… (a) Asynchronous Text Communication (e-mail)."
- *Informal communication*. Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person by phone, electronically, or face-to-face . . . through informal or unplanned encounters."
- *Member awareness*. Core members were asked on a 5-pt scale (1: disagree; 3: neutral; 5: agree) to indicate their awareness of other members with the item "I always knew when and where to find this person."
- *Team performance*. Average of a 3-item scale that asked "Overall, to what extent do you disagree or agree with the following . . . we completed the work on schedule/on-time, we completed the work well within budget, the final product met requirements (1: disagree; 3: neutral; 5: agree)." Cronbach's α=0.81, and Intra-Class Correlation (ICC)=0.19, $p < .01$, indicating that responses within teams were more similar than those between teams, suggesting the team level of analysis is appropriate for this variable.

3 Results

The following two control variables were significantly negatively correlated with coordination delay: years known ($r = -0.14$, $p < .001$) and member interdependence ($r = -0.21$, $p < .001$), and remain significant throughout the HLM models (which are available from the authors). In support of hypothesis 1a, when pairs of members were in the same time zone, there was greater coordination delay for those in different cities compared with those in the same city ($B = 0.11$, $p < .01$). In support of hypothesis 1b, when pairs of members were in different cities, there was greater coordination delay for those with non-overlapping workdays compared with those who had overlapping workdays ($B = 0.12$, $p < .01$). In support of hypothesis 1c, when pairs of members were in different cities and had non-overlapping workdays, there was greater coordination delay than those with an overlapping workday in the same city and those with an overlapping workday in a different city ($B = 0.11$, $p < .01$).

We did not find support for hypotheses 2a or 2b. Informal communication ($p = .66$) and synchronous communication ($p = .38$) did not negatively moderate the relationship between spatial boundaries and coordination delay. In addition, we did not find support for hypotheses 3a or 3b. Member awareness ($B = -0.28$, $p < .01$) and asynchronous communication ($B = -0.23$, $p < .01$) were negatively associated with coordination delay, thought they did not negatively moderate the relationship between temporal boundaries and coordination delay. Rather, there was a positive interaction effect for member awareness ($B = 0.05$, $p < .01$) and asynchronous communication (Email: $B = 0.07$, $p < .01$). This indicates that pairs of members with non-overlapping workdays derived significantly fewer benefits than pairs of members with overlapping workdays who had greater member awareness and asynchronous communication.

Finally, we found support for hypothesis 4. In an OLS model available from the authors, coordination delay was negatively associated with performance at the team level of analysis ($B = -0.31$, $p < .05$). Even after controlling for the same variables used in the HLM models, we did not find a direct relationship between spatial or temporal boundaries and team performance.

4 Discussion

We contribute to the literature on distributed work by conceptually and empirically distinguishing between the impact of spatial boundaries and temporal boundaries on coordination delay in global teams. While years known and member interdependence are generally helpful for reducing coordination delay, there does not appear to be a silver bullet for pairs of members separated by spatial and temporal boundaries. Although we control for the amount of dependence one member has on another member, one possible explanation for lack of interaction effects is that pairs of global team members are engaging in non-communication activities to coordinate their work, such as pre-established schedules, division of labor, and work routines [34]. We also have not examined other factors that prior research has identified as being important for distributed work, such as changes in technology use over time [35-36], conflict among team members [37], general levels of trust [38], and other forms of diversity in global teams [39].

We believe that focusing on pairs of members in global teams can provide insight that aggregating to the team level does not allow. Though members work together as part of a team, much of the work is done alone or with another member. Rarely does an entire global team work on the same task at the same time. Therefore, by disaggregating the team into pairs of members, we are able to better understand what factors predict coordination delay within the team. By further demonstrating that coordination delay is linked to overall team performance, we were able to develop a full model of global team effectiveness that incorporates inputs (spatial and temporal boundaries), processes (coordination delay), and outputs (team performance) [40, 41]. It is important to highlight that spatial and temporal boundaries do not directly affect team performance, but rather they do so indirectly through processes such as coordination delay.

4.1 Limitations and Future Directions

In exploring global teams in a single organization, we limit the generalizability of our results to large, multi-national organizations that have operations in many parts of the world. Smaller companies, or firms with only a few geographic locations, may face other issues not described in this study. We also realize that spatial boundaries could be conceptualized as the number of miles between team members, and temporal boundaries could be conceptualized as the number of time zones between team members. However, in our dataset, the number of miles and number of time zones within pairs of members were correlated r = .95, making a comparison of this alternative conceptualization of boundaries infeasible. We encourage other researchers to look for ways to further tease apart the impact of spatial boundaries and temporal boundaries, for example, by examining teams with members in North America and South America so that the spatial boundaries are greater yet the temporal boundaries are still restricted. In our sample, most team members where either in the same country (separated North-South) or were in different countries (separated East-West).

We also find the issue of time shifting very interesting, even though in our study only about 10% of respondents reported working outside of a typical workday (and it was not associated with coordination delay). In-depth qualitative analyses and field interviews may shed more light on the advantages and disadvantages of working during the middle of the night, or shifting the workday to better overlap with team members in other geographic locations. There may also be cultural differences in how team members in different countries control their use of time, for example, members in the US and India may differ in norms of what is acceptable communication outside of typical business hours. There is also the issue of transportation time, since in Europe it takes much less time to travel from one country to another than it does to travel from the US to a country in Europe. In some parts of the world, members can be in different cities, but have more opportunities to hold face-to-face meetings and discussions at critical points in the global team lifecycle (for example, at the beginning and middle of a project).

Along with exploring differences in spatial and temporal boundaries and how time shifting affects global team effectiveness, there are a number of other avenues for exploring "virtuality." Following the lead of Griffith et al [42] and Kirkman and Mathieu [43], we need to learn more about the extent to which team members are supported in their use of communication technology, as well as how members are supported when they are apart from other members. For example, project managers who travel a lot may have access to different levels of technology (broadband Internet access vs. dial-up Internet access). Similarly, the technical support for communication tools may be greater in some regions of the world than others, depending on the number of employees at a particular site or the resources available to employees. There are certainly an increasing number of technologies available to help team members communicate across space and time, though it may take awhile for them to achieve the critical mass of e-mail and the telephone.

4.2 Managerial and Technological Implications

There are many ways to manage a global team. Our results suggest that the use of communication technology with team members who are spread across spatial and temporal boundaries provides limited help with the problem of coordination delay (with the exception of email). Other aspects of the working relationship, such as how long members have known one another and how aware they are of when and where others are working, can be beneficial for reducing coordination delay. While member awareness can be encouraged, team members who have just met on the team for the first time will need additional support for building relationships.

Interestingly, the more members depend on one another, the less likely there is to be coordination delay, which suggests that team members with greater interdependencies can become more effective at working out problems. However, even with an increase in all of the above factors, the impact of spatial and temporal boundaries on coordination delay *does not disappear*. The findings from the interaction effect of member awareness and asynchronous communication on temporal boundaries also suggest an unintended consequence: pairs of members with fewer temporal boundaries benefit from awareness and asynchronous communication significantly more than pairs of members with greater temporal boundaries. To reduce coordination delay, managers might consider including members on global teams who have at least some overlap in their workday (for example, for team members in the US and India, having members in Europe who can help coordinate workflow).

While many technological tools are available to team members, they each require an investment of time and effort to learn the features, in addition to making sure other members are also using the tools. Certainly e-mail and the telephone are preferred in many situations, but we believe the next generation of tools will help teams coordinate their work without relying so heavily on communication. Training team members to better partition work, plan for dependencies in the task, and synchronize the hand-off of individual pieces will facilitate work when members do not have overlapping workdays, but need to be involved in the project together. Technology that helps with task organization, rather than simply communication, should enable global teams affected by spatial and temporal boundaries to overcome coordination delays. Explicitly embedding information about when and where people are working on a global team is a step in the right direction.

References

1. P. Hinds and S. Kiesler, *Distributed Work* (MIT Press, Cambridge, MA, 2002).
2. T. Allen, *Managing the Flow of Technology* (MIT Press, Cambridge, MA, 1977).
3. R. Kraut, C. Egido, and J. Galegher, Patterns of Contact and Communication in Scientific Research Collaboration, in: *Intellectual Teamwork: Social and Technological Bases of Cooperative Work*, edited by J. Galegher, R. Kraut, and C. Egido (Lawrence Erlbaum, Hillsdale, NJ, 1990), pp. 149-171.
4. M. Hoegl, and L. Proserpio, Team Member Proximity and Teamwork in Innovative Projects, *Research Policy* 33, 1153-1165 (2004).
5. A. Espinosa, J. Cummings, J. Wilson, and B. Pearce, Team Boundary Issues Across Multiple Global Firms, *Journal of Management Information Systems* 19(4), 159-192 (2003).

6. M. Watson-Manheim, K. Crowston, and K. Chudoba, Discontinuities and Continuities: A New Way to Understand Virtual work, *Information, Technology and People* 15(3), 191-209 (2002).
7. M. O'Leary and J. Cummings, The Spatial, Temporal, and Configurational Characteristics of Geographic Dispersion in Teams, *MIS Quarterly*, in press (2007).
8. J. A. Espinosa and E. Carmel, The Impact of Time Separation on Coordination in Global Software Teams: A Conceptual Foundation, *Journal of Software Process: Practice and Improvement* 8(4), 249-266 (2004).
9. C. Saunders, C. Van Slyke, and D. Vogel, My Time or Yours? Managing Time Visions in Global Virtual Teams, *Academy of Management Executive* 18(1), 19-31 (2004).
10. T. Malone, and K. Crowston, The Interdisciplinary Study of Coordination, *ACM Computing Surveys* 26(1), 87-119 (1994).
11. J. Thompson, *Organizations in Action* (McGraw-Hill, New York, 1967).
12. A. Van de Ven, A. Delbecq, and R. Koenig, Determinants of Coordination Modes Within Organizations, *American Sociological Review* 41, 322-338 (1976).
13. J. Herbsleb, A. Mockus, T. Finholt, and R. Grinter, Distance, Dependencies, and Delay in a Global Collaboration, paper presented at the Computer-Supported Cooperative Work (CSCW) December 1-6, 2000, Philadelphia, PA 2000.
14. F. Brooks, *The Mythical Man-month* (Addison-Wesley, Reading, MA, 1995).
15. C. Gibson and S. Cohen, Ed., *Virtual Teams that Work: Creating Conditions for Virtual Team Effectiveness* (Jossey-Bass, San Francisco, 2003), pp.
16. J. Lipnack and J. Stamps, *Virtual Teams: Reaching Across Space, Time, and Organizations with Technology* (John Wiley and Sons, New York, 1997).
17. E. Carmel, *Global Software Teams: Collaborating Across Borders and Time Zones* (Prentice Hall, Englewood Cliffs, NJ, 1999).
18. S. Kiesler and J. Cummings, What Do We Know About Proximity and Distance in Work Groups?, in: *Distributed Work*, edited by P. Hinds, and Kiesler, S. (MIT Press, Cambridge, MA, 2002), pp. 57-80.
19. R. Kraut and L. Streeter, Coordination in Software Development, *Communications of the ACM* 38(3), 69-81 (1995).
20. C. Bullen and J. Bennett, Groupware in Practice: An Interpretation of Work Experiences, in: *Readings in Groupware and Computer-Supported Cooperative Work*, edited by R. Baecker (Morgan Kaufmann, San Mateo, CA, 1993), pp. 69-84.
21. J. McGrath and A. Hollingshead, *Groups Interacting with Technology: Ideas, Evidence, Issues, and an Agenda* (Sage, Thousand Oaks, CA, 1994).
22. C. Cramton, The Mutual Knowledge Problem and Its Consequences in Dispersed Collaboration, *Organization Science* 12(3), 346-371 (2001).
23. W. Orlikowski, Knowing in Practice: Enacting a Collective Capability in Distributed Organizing, *Organization Science* 13(3), 249-273 (2002).
24. K. Lewis, Measuring Transactive Memory Systems in the Field: Scale Development and Validation, *Journal of Applied Psychology* 88, 587-604 (2003).
25. D. Liang, R Moreland, and L. Argote, Group versus Individual Training and Group Performance: The Mediating Role of Transactive Memory, *Personality and Social Psychology Bulletin* 21, 384-393 (1995).

26. P. Dourish and S. Bly, Portholes: Supporting Awareness in a Distributed Work Group, paper presented at the Computer Supported Cooperative Work, Monterey, CA 1992.
27. M. Ahuja and K. Carley, Network Structures in Virtual Organizations, *Organization Science* 10(6), 741-757 (1999).
28. T. Finholt and L. Sproull, Electronic Groups at Work, *Organizational Science* 1, 41-64 (1990).
29. D. Ancona and D. Caldwell, Demography and Design: Predictors of New Product Team Performance, *Organization Science* 3(3), 321-341 (1992).
30. S. Faraj and L. Sproull, Coordinating Expertise in Software Development Teams, *Management Science* 46(12), 1554-1568 (2000).
31. J. Singer and J. Willett, *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence* (Oxford University Press, New York, 2003).
32. A. Bryk, and S. Raudenbush, *Hierarchical Linear Models* (Sage Publications, Newbury Park, CA, 1992).
33. R. M. Baron and D.A. Kenny, The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations, *Journal of Personality and Social Psychology* 51, 1173-1182 (1986).
34. J. March and H. Simon, *Organizations* (Wiley, New York, 1958).
35. A. Majchrzak, R. Rice, A. Malhotra, N. King, and S. Ba, Technology Adaptation: The Case of a Computer-supported Inter-organizational Virtual Team, *MIS Quarterly* 24(4), 569-600 (2000).
36. M. Maznevski and K. Chudoba, Bridging Space Over Time: Global Virtual Team Dynamics and Effectiveness, *Organization Science* 11(5), 473-492 (2000).
37. P. Hinds and D. Bailey, Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams, *Organization Science* 14(6), 615-632 (2003).
38. S. Jarvenpaa and D. Leidner, Communication and Trust in Global Virtual Teams, *Organization Science* 10(6), 791-815 (1999).
39. J. Cummings, Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization, *Management Science* 50(3), 352-364 (2004).
40. R. Hackman, The Design of Work Teams, in: *Handbook of Organizational Behavior*, edited by J. Lorsch (Prentice-Hall, Englewood Cliffs, NJ, 1987).
41. J. McGrath, *Groups* (Prentice Hall, Englewood Cliffs, NJ, 1984).
42. T. L. Griffith, J. E. Sawyer, and M.A. Neale, Virtualness and Knowledge in Teams: Managing the Love Triangle of Organizations, Individuals, and Information Technology, *MIS Quarterly* 27(2), 265-287 (2003).
43. B. Kirkman and J. Mathieu, The Dimensions and Antecedents of Team Virtuality, *Journal of Management* 31(5), 700-718 (2005).

About the Authors

Jonathon Cummings is an Associate Professor at Duke University's Fuqua School of Business. His current research focuses on social networks and teams in organizations, and the role of knowledge sharing in work distributed across different geographic locations.

Alberto Espinosa is an Assistant Professor of Information Technology and UPS Scholar at the Kogod School of Business at American University in Washington DC. His current research focuses on understanding how technical teams bridge geographic boundaries to coordinate their work and achieve high levels of performance.

Cynthia Pickering is an Intel Principal Engineer with the IT Innovation and Research group. She is director of the IT Collaboration Research Lab, called Collaboratory, based in Chandler Arizona. The Collaboratory has a primary focus on global team collaboration: comprehending people, process, and technology interdependencies. Cindy's research combines needs assessment, new concept development, emerging usage models definition, and enabling architecture and technologies exploration.