

Your Time Zone or Mine?

A Study of Globally Time Zone-Shifted Collaboration

John C. Tang, Chen Zhao, Xiang Cao, Kori Inkpen

Microsoft Research

1065 La Avenida

No. 49, Zhichun Road, Haidian

1 Microsoft Way

Mountain View, CA, 94041 USA

Beijing 100190, China

Redmond, WA 98052 USA

{johntang, chzha, xiangc, kori}@microsoft.com

ABSTRACT

We conducted interviews with sixteen members of teams that worked across global time zone differences. Despite time zone differences of about eight hours, collaborators still found time to synchronously meet. The interviews identified the diverse strategies teams used to find time windows to interact, which often included times outside of the normal workday and connecting from home to participate. Recent trends in increased work connectivity from home and blurred boundaries between work and home enabled more scheduling flexibility. While email use was understandably prevalent, there was also general interest in video, although obstacles remain for widespread usage. We propose several design implications for supporting this growing population of workers that need to span global time zone differences.

Author Keywords

Time-shifted collaboration, global work, distributed teams, global time zones, empirical study.

ACM Classification Keywords

H.4.3. [Information systems applications]: Communication applications---*Computer conferencing, teleconferencing, and videoconferencing.*

General Terms

Human Factors, Design

STUDYING GLOBALLY DISTRIBUTED TEAMS

The spread of globally distributed work, especially into the developing regions of Asia, has created teams that need to work across time zone differences on the order of eight hours or more. This severe time zone offset beyond the typical workday makes it difficult to coordinate active collaborations across sites using conventional mechanisms such as synchronous meetings and unplanned calls. These

coordination challenges erode the promised benefits of offshoring work or follow-the-sun strategies for distributing work around the world.

Yet, increasing demands of the global economy continue to fuel the dispersion of work around the world. While earlier global efforts, such as manufacturing, only needed limited handoffs of information between sites, the increasing diversity of global work includes software development, research, and design, which require more interactive collaboration across sites. Global enterprises are seeking to provide products and services that reflect both the international reach of the Internet and the local customs and traditions of each market. Furthermore, companies want to take advantage of expertise and talent pools wherever they may be located in the world to contribute to their competitive advantage and connection to local markets.

While CSCW has explored the distribution of work across time (synchronous vs. asynchronous) and space (co-located vs. remote), we need more research to understand the effects of global time zone separation on collaboration to better support this emerging work configuration. Especially in light of new video and social networking tools that have recently come into common use, we wanted to understand how global teams are using these technologies and what areas remain for developing tools to better support their work. To address that need, we interviewed sixteen people who work in teams that collaborate across time zone differences of around eight hours or more. The participants represented work sites in Asia, Europe, and America (shown in Figure 1), and a diverse range of work in a variety of different companies and institutions. The interviews identified best practices (or coping strategies) in dealing with the time zone differences as well as needs for better support of globally distributed collaboration.

PRIOR RESEARCH

Most prior work on global teams has focused on software development teams [3, 9, 6, 1]. Software development was quick to embrace globally distributed teams, due to its digital, “virtual” work product that was easily transported around the world. Some companies even orchestrated follow-the-sun work strategies that enabled continuous development during three workday shifts spread across the globe. The availability of economical but highly qualified

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

CSCW 2011, March 19–23, 2011, Hangzhou, China.

Copyright 2011 ACM 978-1-4503-0556-3/11/03...\$10.00..

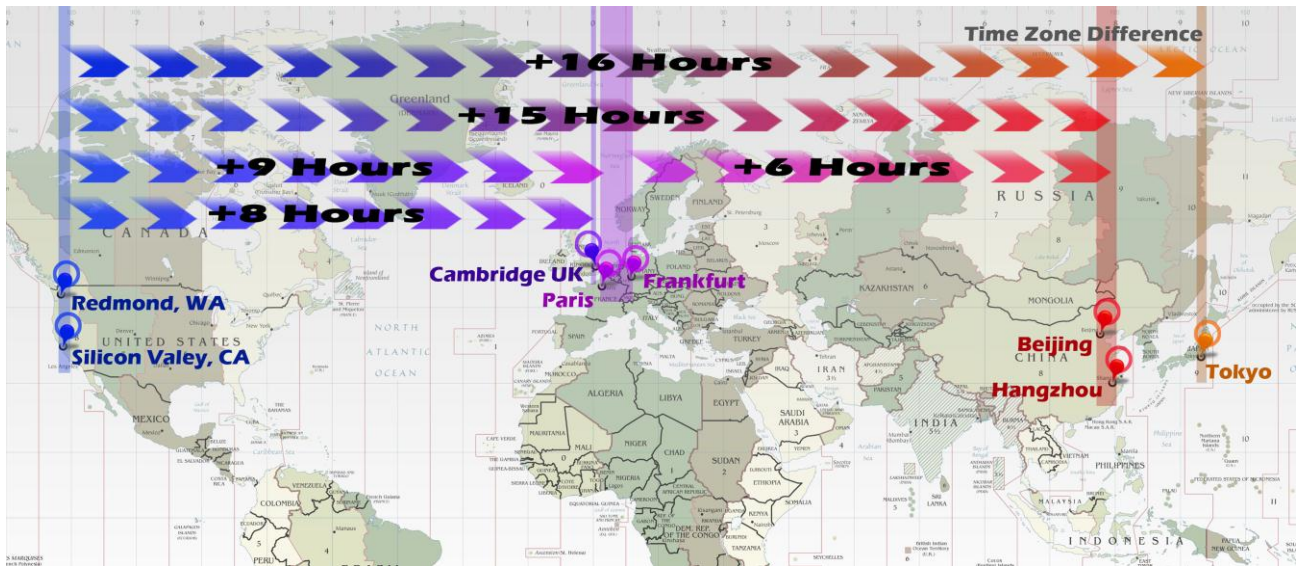


Figure 1. The time zone differences across sites in the US, Europe, and China, with which the participants worked.

talent pools in developing regions have made it economically attractive to explore offshoring other kinds of work to those sites.

Besides geographic distance, there are a number of other factors that can vary among globally distributed teams. Connaughton and Shuffler [4] review prior research that identified multinational and multicultural factors that differ among the sites in global teams. Communication style, dealing with conflicts, and the interpretation of time add to the differences in distance that global teams must navigate.

Olson & Olson [13] identified a few key dimensions of how distance affects collaboration, and they noted time zone differences as a “...difficulty not predicted to be overcome with technology”. Time zone differences can be especially problematic in the eight hour offsets common in globally distributed teams. Thus, our research focused on issues around time zone differences, while keeping in mind the context of other factors (e.g., cultural, organizational) that come into play in globally distributed teams.

Sarker & Sahay [1] conducted an in-depth empirical study of student teams evenly split between the US and Norway working on a 14-week project. They collaborated using WebCT (an e-learning system that included asynchronous threaded discussion, synchronous text chats, group calendar, and file sharing). They noted that power asymmetries usually forced “weaker” groups to synchronize their temporal rhythms to the stronger ones, and that routinely inconveniencing the weaker group led to resentment and dysfunction. They also documented fine-grained time problems (awareness of local holidays, different dates for changing to Daylight Savings Time, needing to always translate time zones when scheduling).

Espinosa & Carmel [6] contrasted the symmetry of distance separation with the asymmetry of time zone separation.

Global time zone shifts mean that an overlap time at the beginning of the day at one site but at the end of the day at the other site asymmetrically affects each site’s workday planning. They proposed a model, based on coordination theory, that categorized the coordination costs in globally dispersed teams into four main components: communication, delay, clarification, and rework. While delay is largely defined by the amount of time zone difference, our study examines how the communication costs can be reduced by recent trends expanding the global reach of communication accessibility, which can in turn reduce the cost of clarification and rework iterations.

Espinosa et al., [7] conducted a lab study on the effect of amount of time zone separation, and found that the team’s speed of working was best in the non-overlapping condition, and second best in fully overlapping, but was worse with 2/3rd or 1/3rd workday overlap. They surmised that this inefficiency is due to thrashing in switching between synchronous and asynchronous interaction modes. However, team accuracy was best with fully overlapping workdays and steadily declined with decreasing workday overlap. Their study, even on a rather simple map recreation task, raised the question of how task accuracy and speed trade-off in time zone shifted work.

O’Leary & Cummings [11] proposed a time zone index for measuring the impact of time zones on team productivity. However, in the interest of developing a universal metric, they treated time zones as uniformly defining the workday for a time zone, rather than the individual temporal work practices of the people, which emerged in our studies of global teams.

Espinosa & Pickering [8] pointed out the need to account for people’s actual work schedules, rather than just their geographic time zone differences. They also concluded that

reducing coordination costs or increasing coordination effectiveness was not correlated with any specific coordination mechanism. Rather, it depended on finding the right mix of mechanisms that suited collaborators' preferences and task needs. Our work elaborates on that observation to provide richer details of the factors teams should consider in crafting a collaboration and coordination process that works for them.

More recently, Cao et al. [2] focused on collaboration across time zones in the domain of family communication. Globally dispersed families are often motivated to stay connected, which has been enabled by the popularity of consumer-grade desktop video conferencing tools. Family members tended to know each other's rhythms and time windows to call without having to explicitly schedule. Seeing each other via video was a dominant aspect of family communication, as parents, grandparents, and children wanted to stay connected over global separation.

O'Leary & Mortensen [12] reported on a quasi-experimental study on the effect of team imbalance on geographically dispersed teams. Teams worked on a project for one month in 6:0 (wholly co-located), 5:1, 4:2, and 3:3 configurations. Surprisingly, they found that teams with an isolate (5:1, all co-located except for one) performed better (according to effectiveness measures of identification with the team, transactive memory, amount of conflict, and amount of coordination problems) than evenly balanced teams or even wholly co-located teams. Having one isolate tended to create a novelty effect and prompted the entire team to be more organized and more proactive about planning ahead without creating a potential territorial threat to the team. The worst configurations were imbalanced teams, where there was a minority at a site, giving rise to an in-group "us vs. them" mentality, instability, and less identification with the whole team. Their work documented some of the surprising advantages of isolate team members that also arose in our current study.

INTERVIEWING MEMBERS OF GLOBAL TEAMS

To explore current work practices in globally distributed teams, we conducted semi-structured interviews with sixteen participants (ten men, six women). In contrast to the student or experimentally contrived teams used in many of the previous studies, we wanted to learn from the experiences of individuals in real teams that had worked together over time. We sought a diversity of knowledge work domains, beyond just software development, in our interview participants. We also wanted to get an updated look at the variety of tools used to support their collaboration, in light of recent developments in video and social networking tools.

Participants were independently recruited through professional connections at four work sites (in Asia, Europe, and two US cities) at Microsoft (a global, computer software corporation). A snowball methodology was used to identify remote colleagues of participants that we could

also interview. This approach enabled us to interview colleagues at more than one site for four teams.

These sixteen participants represented eleven different teams across nine different companies and institutions. Figure 1 shows the main work sites involved in these eleven teams, which included three cities in Asia, three cities in Europe and two regions in the US West Coast. Figure 1 also indicates the time zone differences between the pairs of cities mainly involved in the collaborations in our study.

All interviews were conducted by one of the co-authors of this paper; eleven interviews were conducted by a pair working together. Except for one interview conducted over desktop video conferencing (due to scheduling constraints), interviews were conducted face-to-face, usually at the work site of the participant. Interviews lasted approximately one hour and participants were given a small gratuity for their time. All interviews were audio-recorded and reviewed for analysis. Observations from the interviews were first open-coded for recurring themes, then analyzed by comparing specific instances of those themes across the participants.

Besides collecting demographic information and the nature of their global collaboration, the interviews asked about their current practice and strategies for dealing with globally time zone-shifted collaboration. We probed specifically about what tools they used to support their work, and what tools they wish they could have. We asked them to rate their effectiveness of their global team (on a scale where 1=ineffective and 7=highly effective), and to describe how they accomplished their work and what challenges they encountered. Participants were invited to freely comment on their global collaboration experiences.

Team Backgrounds

Table 1 shows the demographics of the sixteen interview participants and the diversity of types of work and job roles among them. While several of the participants had a manager job role, all of them had individual contributor responsibilities. The participants represented eleven teams that came from nine different institutions (only three teams were from Microsoft). Throughout this paper, team labels (T7) and participant labels (T7-US-2) from Table 1 will be used to refer to teams and their members.

Most of our participants were involved in teams that collaborated across just two sites, although the international patent lawyer (T8-UK) and product support manager (T11-UK) worked with clients scattered over a variety of locations in the US. Four teams (T1, T2, T6, T7) were involved in product development, three teams were active in conducting research (T3, T5, T9), two teams provided services for clients (T8, T11), and the remaining teams were involved in coordinating an international forum (T4) and providing design consulting services within the company (T10). Four teams primarily focused on working across company boundaries (T4, T8, T9, T11), and four other teams (T1, T6, T7, T10) included work that crossed

Team	Team Name	Participant	Work Site	Gender	Age	Job Role	Rating (1-7)
T1	Software development	T1-China	Beijing, China	M	20-30	R&D Engineer	6
T2	User experience development	T2-China	Hangzhou, China	M	20-30	UX Engineer	5
		T2-US	Santa Clara, CA US	M	31-40	UX Director	4
T3	HCI research	T3-China	Beijing, China	F	41-50	Research Manager	6
		T3-US	San Jose, CA US	F	31-40	Senior Manager	7
T4	International forum	T4-China	Beijing, China	F	20-30	Program Manager	5-6
T5	Academic research	T5-China	Beijing, China	M	41-50	Professor	5
		T5-US	Seattle, WA US	M	20-30	Graduate Student	7
T6	Software storage development	T6-China	Beijing, China	M	31-40	Program Manager	5-6
T7	Hardware development	T7-UK	Cambridge, UK	M	41-50	Software Architect	3-4
		T7-US-1	Redmond, WA US	M	41-50	Quality Manager	5-6
		T7-US-2	Redmond, WA US	F	41-50	Program Manager	3-5
T8	International patent law	T8-UK	Cambridge, UK	F	31-40	Patent Attorney	5-6
T9	Research consulting	T9-US	Palo Alto, CA US	F	41-50	Research Manager	5-6
T10	Design consulting	T10-US	Palo Alto, CA US	M	31-40	User Researcher	5
T11	International product support	T11-UK	Cambridge, UK	M	21-30	Support Manager	4-5

Table 1. Demographics of interview participants, including their rating of the effectiveness of their team (7=highly effective)

organizational boundaries within a company (e.g., research/product, corporate resource/product group).

FINDINGS

Almost all the participants we interviewed considered their team's global collaboration to be largely effective. As shown in Table 1, participants generally rated their global team in the 5-6 range (where 7=highly effective). Team T7 had a participant at both sites that included a rating as low as 3. In general, the results presented in this paper reflect on experiences of people who consider their globally distributed team to be working effectively.

We present our findings in terms of two main categories: How globally distributed teams still relied largely on synchronous meetings (and the variety of strategies they employed to enable synchronous interaction across the global time zone differences) and the ways they used the current range of tools to support their global collaboration. We also document stories that our interviews evoked of prior experiences with globally time shifted collaboration that failed and the reasons for those failures.

Reliance on Synchronous Meetings

All teams used synchronous meetings to facilitate their work. Ten out of eleven teams (all except T11) used at least weekly meetings in their global collaboration. Several even found ways to create opportunities for ad hoc, unscheduled synchronous interaction.

Synchronous meetings are a naturally effective way to coordinate and communicate within a team, avoiding the coordination costs, delays, and potential for confusion of asynchronous communication. It is telling that such severely time-shifted teams went through considerable effort to find times for synchronous interaction. The

following sections detail the strategies used to create time windows for synchronous interaction, the factors that are important for negotiating those time windows, and a particular strategy of leveraging working with an individual isolate in the remote time zone.

The interview participants demonstrated a diverse range of strategies for creating time windows for interaction. Given the time zone difference of eight hours or more, it was impossible to schedule meetings that fell within the "typical" workday at both sites. While each team found meeting times that worked for them, these times were quite different across the teams.

Finding Times to Meet

While an apparently obvious way to minimize the inconvenience between sites is to schedule meetings that are slightly early or late in the workday for each site, the experiences of the hardware development team (T7) illustrated why scheduling in the "edges" of the day may not work for people. They used to schedule their meetings at 9 am Pacific US (which was early for their work culture) / 5 pm Cambridge UK time. However, at the edges of the workday, this time conflicted with a number of other routines such as childcare pickup/dropoff, public transit schedules, or commute traffic patterns. Instead, the team found that meeting times at 8 am Pacific / 4 pm UK or 10 am Pacific / 6 pm UK worked better, where one site or the other would attend the meeting remotely from home. This timing preserved their workday start or end routines (which were often prescribed by circumstances beyond their control), actually lessening the scheduling inconvenience.

By contrast, T10-US complained about needing to come in to the office for a weekly 8 am meeting with his colleagues

near Frankfurt Germany. This scheduling required driving (rather than taking the train) during a congested commute time, resulting in “feeling grouchy” every week. However, given the need to use high fidelity video conferencing equipment located in the office, they were not able to find a different time that would work better. These examples illustrated how other routines around the edges of the workday may make time windows that are more offset from the typical workday actually more convenient.

One tactic that team T7 also employed to spread the time offset inconvenience between the two sites was to alternate meeting times so that the meeting occurred in the typical workday at the office for one site or the other. The team alternated between the 8 am Pacific / 4 pm UK and 10 am Pacific / 6 pm UK times each week. Thus, each site shared the experience of participating from the office and connecting from home on alternating weeks.

This example also illustrated the impact of growing work connectivity from home [5] and other mobile locations on enabling cross-time zone interaction. Team members were comfortable participating in meetings from home since the technology for desktop video conferencing, window sharing, and even accessing corporate resources was available from home. This increasingly pervasive capability of work connectivity from home enables much more flexibility in the kinds of collaboration that can be engaged in from home, thus opening more opportunities for finding time windows that can work with time zone-shifted sites.

The growing trend of blurring work and home boundaries [10] also enabled this increased flexibility in creating time windows for global interaction. Prior assumptions about “9 to 5” workdays are no longer as commonplace in today’s information worker population. Years of promoting flex time and changing social and cultural conditions make flexible work times outside the typical 9 to 5 boundaries possible, if not preferred. Prior research on work rhythms of distributed teams found that any individual’s work schedule may not conform to the assumption of a 9 to 5 workday, and remote collaborators may not be aware of unexpected time windows available to interact with them [1].

For example, participant T7-US-2 explained that her role as a single mother lent toward more flexible scheduling that worked well for global collaboration:

I’m the one that does most of the communication and I am kind of perfect for this type of job just because of my life situation. Being a single mom with a young child I can’t be at work for a 10 or 12 hour day. It is really convenient for me actually if I can be here [in the office] for a core 5 or 6 and then work before my daughter gets up and after she goes to bed.

Her more flexible work schedule enabled more involvement in her child’s daytime activities. Furthermore, being able to interact with remote workers during those off-hours time

periods actually transformed solitary work time to be more social and collaboratively productive.

A concomitant implication of scheduling meetings where participants regularly participate by connecting from home is that the meeting environment also spanned across work and home boundaries. Several of the interviews referred to the impact of having people call in from home: kids interrupting, being in a state at home (either early or late in the day) where they did not want to be seen on video, using only text chat because their collaborator was at home at night watching TV with his wife, being sensitive to keeping someone up too late. While benefiting from the added flexibility of blurred lines between home and work, global collaboration also added to the increased demands in managing work activities that take place in the home.

Creating Time Windows for Interaction

Another strategy for creating more opportunities for synchronous interaction is for one site to shift their work day to better align with the time zone at the remote site. Participant T4-China of the international forum team explained that staying at work until 9 or 10 pm in China enabled more time zone overlap with her colleagues in Paris, affording unscheduled phone calls to work through issues as they arose. This late work schedule was not unusual for the work culture of young, single employees such as T4-China; she would probably still work late into the evening regardless of needing to interact with globally remote colleagues.

The user experience development team (T2) illustrated some variations on this strategy, depending on the different seasons of employees’ lives. T2-US worked at a regional office in California for an international e-commerce company headquartered in Hangzhou, China. Employees at the California regional site were expected to shift their workday to create more overlap time with their colleagues in Hangzhou. As someone with a family, T2-US preferred to start the workday later in the morning, go home for dinner, and get back online from home around 9:30-10:00pm at night to collaborate with Hangzhou colleagues that were fifteen hours ahead of him. But other young, single colleagues at the California regional office would prefer to work continuously until about 8 or 9 pm to overlap with their Hangzhou colleagues before leaving the office for the rest of the evening.

Shifting the workday afforded unscheduled, impromptu interaction that reduced the communication delays that could otherwise add a whole day or more in coordinating work between global sites. This strategy retained natural opportunities for communication without requiring advance planning and scheduling that can become burdensome and limiting over time. However, since the ability to shift the workday depended on many factors specific to each individual, people (even at the same site) made different choices that affected their availability. This diversity weakened the notion of a typical workday when people

were available, and required more negotiation to discover mutually agreeable scheduling opportunities for the team.

It is also interesting to note that many of the participants who shifted their work day did so without complaining that it was an unnatural disruption in their life schedule. Of course, our interview participants were a self-selected sample of people committed to make global collaboration work. At the same time, the emergence of new work practices that take advantage of flexible work time and the blurring of work and personal boundaries plus mobile connectivity to the workplace also naturally affords more interaction time across global time zones. There is a segment of the work population for which creating windows of time to interact with other global time zones may not be considered a burdening inconvenience.

Taken together, recent trends in mobile technologies that enable conducting work from locations outside the office (especially from home) and temporal flexibility in working during what was traditionally considered personal time can combine to greatly enhance opportunities to synchronously interact with globally time zone shifted colleagues. While not everyone exhibited this kind of flexibility in connectivity and time, it featured prominently from members in five teams (T2, T3, T4, T5, T7) out of eleven in our interviews. The variety of practices exhibited by the teams illustrated several different ways in which teams found a tailored solution that worked for them.

Negotiating Interaction Time Windows

Given this increased flexibility of when to schedule synchronous meetings, global teams needed to negotiate when to conduct these meetings. The teams in our study exhibited a diverse range of when they scheduled their recurring synchronous meetings. A number of factors were mentioned that contributed to negotiating when to have these meetings:

- Number of people involved at each site—typically more people gave a site more center of gravity, and if there was only one person at a site, they often had more flexibility
- Status of site—participants at the company headquarters site or in the client role tended to have more influence
- Status of people at the site—having people with special expertise, seniority, or access to important local information influenced the negotiation
- Cultural deference—participants from some cultures were more deferential, especially if there were differences in status involved
- Flexibility—many factors (professional and personal) affected the scheduling flexibility of the participants

Negotiating a mutually agreeable solution for meetings was crucial for long term viability of the group. A couple participants (T2-US, T3-US) showed surprising patterns where they ended up working later at night even though they were the more senior participant. Prior research [1]

documented the negative long-term effects of one site dominating the scheduling of working together. However, we did observe a mismatch in team T7 where participants at one site thought that they were always accommodating the scheduling of and traveling to the other site, whereas those at the other site did not see it that way and did not recognize the efforts expended to work across global time zones.

Much of the prior work had a bias towards studying US companies that became international, which meant that the US sites tended to have status of being the headquarters site. By contrast, our teams included companies that were headquartered in China or Europe, which might have contributed to observing more diverse patterns for negotiating time windows for interaction.

Leveraging Time Zone Isolates

Four of our interviews (T2-US, T3-US, T5-China, T11-UK) involved a team configuration where they were an isolated team member at a site. Prior work by Venolia et al. [15] noted the prevalence of the “hub-and-satellite” geographic distributions, where a sole “satellite” worked remotely from a “hub” team. Their work focused on the special needs of teams with an isolated member at one site, leading to tools tailored to support this imbalanced team configuration.

In our study, coordinating with only one person at a time zone shifted site afforded leveraging the flexibility of the time zone isolate. Having to coordinate with only one temporally remote member afforded more flexibility for finding time windows for interaction and creating more overlap time. This flexibility was observed in meetings that occurred in the early morning (6 am) or late in the evening (10 pm) when those times worked for an individual at a remote time zone.

For example, team T7 had meetings twice a week that alternated between either 8 am US / 4 pm UK or 10 am US / 6 pm UK. While this time was negotiated to avoid the “edge” of the workday (preserving people’s workday start and finish routines), these meeting times still hovered near the traditional workday. By contrast, the user experience development team (T2) meetings involved a time zone isolate in the US and a team of people in China. They tended to have calls at 10 pm in the evening US time, after T2-US’s family went to bed and he became available for work at night.

Other teams (T4, T7, T8) designated a “site delegate” as a single point of contact at a site to coordinate with other sites (as recommended by Espinosa & Pickering [8]). Focusing on one designated person at a site simplified the coordination complexity and opened up more scheduling flexibility. This delegate also became a socially embedded advocate within the site for the time-difference problem across sites. T7-UK explained how he felt as a delegate for the UK team working with a US site: “Because I know the work habits and other times. I actually care about these guys having to stay later or whatever... where I don’t think the [US site] guys do”.

While group meetings tended to hover near the workday, one-on-one meetings might extend further into off hours in the day. Somewhat like the ambassador model where one person is the designated representative for a country as a collective, these groups used a “temporal ambassador” to manage the cross-site interactions on behalf of a time zone shifted remote work site.

With our limited sample, we cannot say how widespread is this practice of leveraging time zone isolates in global teams, but it is notable that eight of our eleven teams involved either an individual team member at a site or a temporal ambassador. While leveraging temporal isolates may be a coping mechanism to make dealing with a time zone-shifted site more manageable, research by O’Leary and Mortensen [12] actually found that groups that include an isolated site member are more effective.

Tools to Support Time-Shifted Collaboration

While the teams used a variety of tools to support their cross-site collaboration, there was a heavy reliance on email, a range of reactions to using video, and a number of other tools used to support their collaboration (although not much mention of social networking and other modern collaboration tools).

Reliance on Email

Not surprisingly, all teams used email in support of their global collaboration. As a popular, asynchronous communication tool that is deeply embedded in users’ current work practices, it makes sense that email was heavily used to exchange information and coordinate work across time zones. However, we were surprised at the extent of reliance on email, in light of the wave of more recent collaboration tools (e.g., wikis, social networking) that could be useful in this setting. The interviews identified several reasons why email was uniquely suited for collaboration across global time zones.

While the pervasive nature of email is widely appreciated, it becomes especially valuable in the many cross-boundary settings that we observed in global collaboration. In particular, extensively collaborating from home or other mobile settings (to extend flexibility in finding time windows to interact) meant that any tools with obstacles for crossing corporate firewall boundaries or only working on company-issued computing devices had substantial disadvantages. Besides employees working from home (which many companies have solutions for supporting), several of the teams we interviewed involved working across company boundaries (e.g., T8-UK’s patent law work for client companies and T11-UK’s product support with customers). Exploiting email’s ability for reaching anywhere the Internet can connect supports collaboration among all the possible locations and work settings that global collaborators needed to work from.

Furthermore, as a written text communication media, email afforded the greatest opportunity to clarify explicit communication. This was especially valuable when

working across language differences. Email avoided problems with understanding spoken accents, which came up in T4-China’s collaboration with colleagues in Paris where both sites were using a second language (English) to conduct business. Plus as an asynchronous media, email gave time “to plan your next move” and edit it to be as clear as possible before sending. While email may take longer to compose and edit, cross-time zone collaborations often afforded spans of time when the other site was off work to compose email without losing opportunities for interaction.

Using Video Tools (with Obstacles)

Of the eleven teams, six (T1, T5, T6, T7, T9, T10) used video regularly. Most of the teams with multiple people at each site (T6, T7, T9, T10) used video in a conference room setting. The three Microsoft teams (T1, T6, T7) had a tool and corporate IT infrastructure that integrated text IM, VoIP telephone, desktop video conferencing, and computer screen sharing together. Those features could be used wherever the user’s company-issued laptop connected to the Internet (i.e., did not require additional firewall tunneling). Furthermore, T5-China had mastered using a consumer-grade desktop video conferencing program that enabled international video and audio calls from anywhere he worked (including taxi rides to his Beijing office). Extending the reach of video tools to wherever the user could connect to the Internet greatly increased the opportunity to use them regardless of the user’s location.

Furthermore, several participants expressed interest in using video if it were more convenient and reliable. T4-China mentioned that she would like to use video to communicate with her colleagues in Paris, but it required IT support to set up, and her meetings with Paris were typically so late in the day that IT support was not available on site at that time. Five participants (T2-China, T3-US, T4-China, T8-UK, T11-UK) explicitly mentioned that they would like to use video more often if it was more reliable or readily available. Part of the problem is that desktop video conferencing can be thwarted if only one colleague does not have the video equipment (e.g., webcam) or compatible program needed.

There was a range of opinions on the value of video among the sixteen participants. While five (T5-China, T6-China, T7-UK, T9-US, T10-US) were strong advocates for video and three more (T3-US, T7-US-2, T11-UK) commented that they liked video, two (T5-US, T1-China) said that they did not see any need for video and one (T3-China) did not want video. Advocates for video liked the richer, non-verbal cues that provided a more comprehensive sense of the communication and went through some amount of effort to use video. The design consulting team (T10) felt that the visual nature of design work relied on video to work effectively, and they even outfitted a special room with multiple cameras and dedicated video equipment for their meetings. T9-US went to a special video conference room for her weekly meeting, even though it meant leaving the resources of her office behind and had to wrestle with getting the video equipment to work.

Comments from participants who did not see a need for video reflected that the perceived effort needed to get video to work weighed on their opinion. In one case, T5-US, who did not personally see a need for video, still used it to communicate with T5-China, who was a strong advocate for video, reflecting the negotiation around which collaboration tools are used. T3-China, on the other hand, actually disliked the experience of video conferencing, saying that it was “not natural” to see her colleague’s face in a window on the computer screen.

Including meeting participants that connected from home added complications to the use of video. Many video conferencing solutions require special network connections and equipment that are not readily available at home. Plus, many do not allow or gracefully manage multi-point connections, which frequently arose when meetings occurred at times where several people would prefer to connect from their home rather than commute in to a video conferencing room at the office. T9-US described an elaborate (if not brittle) arrangement of using a video conference room system to connect the Palo Alto, CA and Tokyo, Japan sites and adding a consumer video conferencing system to independently connect a colleague working from home (due to the early meeting time). While this arrangement created a sub-optimal video conferencing experience, it was the only way to connect another site from home into a video conference using existing tools.

Furthermore, connecting into the home through video raised some privacy concerns, as mentioned earlier. Meeting at home very early or late in the day could encounter situations where the participant would not like to be seen over video. Interruptions from kids or pets at home can also be awkward to deal with in work meetings. Even though T5-China is a strong advocate for using video, he chose to use text chat IM only when collaborating with a US colleague late at night because he knew that colleague was interacting from his couch at home while watching TV with his wife. Global collaborations highlighted additional challenges to using video to support their work.

Using Other Tools

Of the other commonly used tools mentioned, most were in support of synchronous communication: IM, phone, and computer screen sharing. Several participants also mentioned using shared file repositories to enable the team shared access to documents and files as they got updated.

There were few mentions of using more recent collaboration tools such as wikis or social networking. One participant explained that using such tools would require too much of a change of current work practice (an area where email carries a distinct advantage compared to almost any other tool). In two teams (T9 and T10) wikis were used as a way to share information, and T9-US mentioned that they used the wiki for expedient real-time sharing during the course of a synchronous meeting (i.e., updated the wiki and asked all sites to refresh their browser

to see the updates). This solution was one of the easier ways to cross the corporate boundaries involved in that team.

Only a few interviews mentioned blogs as relevant to their team’s work, although T1-China mentioned an interesting practice where they would actively monitor the team’s blog and shared repository to notice new additions that might indicate activities that their US colleagues were involved in but did not explicitly mention to them. This practice took advantage of an implicitly shared resource that helped the China team gain some context of their US colleagues.

While we explicitly asked about participants’ use of social media, no one stated that they used them for work purposes. A few participants mentioned that they did indeed have social media connections with work teammates. However, they described their usage of social media as providing more context or personal information about their colleagues. Although participants commented positively on the increased awareness and personal feel this could provide, one commented that they did not like seeing social networking updates on the personal issues a colleague was experiencing while falling behind on a work deliverable.

T7-UK elaborated on how overlaying social knowledge in facebook with work can create awkward dynamics:

Yes and when I say distracting, what I mean is when you are working together as colleagues you function on one capacity and your personal opinions and stuff don’t matter so much. But if you are sharing information about your personal life then suddenly, for instance, political differences or ideological differences, those tend to be more of an issue. So then you might find yourself somebody you were perfectly happy to work with before, because of ideological differences it’s not as pleasant working with them.

Unsustainable Global Collaborations

While our interviews reflected the opinions of people who seemed committed to make global collaboration work, they also evoked stories of previous global collaborations that were not sustainable and the reasons they did not work. These examples illustrate pitfalls to avoid when organizing global collaborations.

T7-US-2 described a global team that she worked on previously involving sites in the US and China. In that team, the vendors and manufacturers were in China, but there were no decision makers located there. That meant that a team member in the US had to be on-call 24 hours a day to address any issues that arose during the Chinese workday. She recalled dealing with 2 am calls from China, and ultimately left that position. She mentioned that they had also since changed the team to provide for a local decision-making authority in China.

Similarly, T4-China described a previous position that involved working with the financial markets in the US. That job required that employees rotate into a two-month shift where they were on-call 24/7, which required them to come

into the office within a half hour of a call. This response was required by the time urgent nature of financial market work and the need to access large amounts of sensitive information that was only available in the office. This issue was one of the main reasons she left that position.

T2-US described an earlier position working with a site in China. The job routinely required working through the US dinnertime to provide more time overlap with the team in China and frequent travel to China. This schedule was unsustainable with his family life, and he changed to his current position that still involved working with China but at a more manageable work rhythm.

T3-US related a prior experience involving teams at various sites around the world (she was working in China at the time). When setting up recurring meeting times, certain sites refused to consider meeting times outside their normal work hours, nor rotating the meeting time to share the scheduling inconvenience among the sites over time. She was so upset by this inflexibility that she stopped participating in that activity.

DESIGN IMPLICATIONS

In reviewing the observations from our interviews of globally distributed teams, we identified several design implications to better support working across global time zone differences.

- Remove firewall access constraints for collaboration tools: Firewall constraints often prevented or rendered inconvenient the usage of collaboration tools (video, data access) from home. Since many cross-time zone interactions involve participants connecting from home, due to the off-hours scheduling of meetings, this issue particularly affects globally distributed collaboration.
- Integrated tools: Several participants mentioned the desire to integrate the tools needed to collaborate together. Several teams had to manage tools for video conferencing, phone, IM, email, scheduling, computer window sharing, shared file repositories, etc. totally separately. Yet, the use of those tools had to be coordinated together, often in the context of a synchronous, cross-time zone meeting.
- Pervasive diffusion of video capability: Despite years of widespread availability of video conferencing capability (equipment and software), there are still obstacles to routinely using video. Usability and reliability of video conferencing remain as obstacles to use, especially outside the typical workday when technical support resources may not be readily available. The need for easily usable multipoint video interfaces is also especially important when frequently needing to include participants connecting from home or other sites (due to scheduling and availability constraints).
- Increased calendaring support: A rather simple design implication for shared on-line calendars is to allow more subtle and fine-grained support for finding time windows

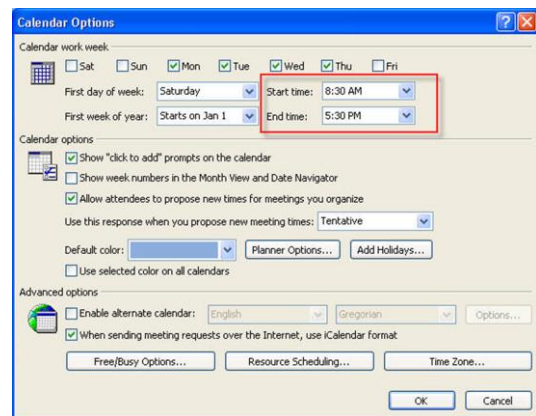


Figure 2. Current interface for setting workday options in calendar.

to interact with time zone-shifted collaborators. Many modern calendaring systems allow users to designate their default workday region, as shown in Figure 2. However, this interface presumes a traditional, contiguous workday, whereas current work practices (and our interviews) show that people may be available for work at different times throughout the day. This flexibility is especially important when negotiating times to meet synchronously with globally time zone-shifted colleagues. Thus, calendar systems need to have an updated notion of the user's workday, and perhaps provide more states to designate time spans when meeting times with the user are available, unavailable, or allowable. Furthermore, they could support a more negotiated process for finding convenient meeting times across global time zones.

- Visualizing the other site's coordinating effort: An issue that arose in our interviews is that some sites seemed unaware of the effort that the remote site was going through to coordinate schedules. This misperception can distort the negotiation process of finding time windows for interaction. If a site is unaware of the remote site's coordinating efforts, they may be less accommodating in their scheduling negotiations.
- Supporting temporal isolates: Many of the teams we interviewed leveraged temporal isolates, either as an isolated participant at a site or as a temporal ambassador for the site. We speculate that this pattern may be prevalent among time zone-shifted teams, and such temporal isolates may benefit from tools tailored to their roles as individuals at a remote site.

While some of these design implications are shared with supporting collaboration in general, studying the accentuated challenges of globally time zone-shifted collaboration emphasized these needs in improving support for collaboration.

CONCLUSION

Our interviews of participants in globally time-shifted collaborations documented the variety of strategies and

technologies used to work across global time zone differences. Despite the large time zone differences, all the teams continued to **rely on synchronous meetings** to complete their work. The teams showed a wide range of **flexibility in negotiating time windows** to interact across global time zone difference. This flexibility was facilitated by a combination of recent trends in technology (being able to connect to work from home) and social practice (blurring boundaries between work and home time). **Leveraging a time zone isolate** further increased the flexibility in finding times to interact across sites. Our study documented the diverse ways globally distributed collaborations **tailored their collaboration processes** to work with the specific set of individuals and constraints. Teams need better tool support (especially calendaring) to discover and take full advantage of opportunities to tailor their collaboration process and negotiate mutually agreeable times to flexibility interact.

Regarding technologies to support global collaboration, we still found a **heavy reliance on the use of email** to manage their collaboration. The asynchronous, text-based nature of email not only worked well given the time zone difference but was also preferred for helping work across language differences. While there was general **interest in using video**, it was still plagued by problems of availability and reliability, especially with people connecting from home where network bandwidth and technical support was limited. Connecting multiple sites, especially when including several people calling in from home, is still a challenge for many video conferencing tools.

Our study examined globally distributed collaboration at a relatively early stage of its development. As the global economy continues to develop, we expect that working across global time zones will become more common and more people will encounter the issues we identified. We expect that our proposed design implications will start an iterative process of identifying and meeting the needs of collaborators who need to work across global time zone differences. In particular, while our study found a persistent reliance on synchronous meetings despite limited overlap time, more research is needed to explore new technologies and social practices to enable effective alternatives to synchronous meetings for global collaboration.

ACKNOWLEDGEMENTS

We thank the anonymous participants and their institutions for their time in sharing their cross-time zone collaboration experiences with us. We also thank our intern Jiawei Gu for creating the time zone map figure.

REFERENCES

1. Begole, James “Bo”, John Tang, Randall Smith, & Nicole Yankelovich. Work rhythms: Analyzing visualizations of awareness histories of distributed groups. *Proc. CSCW 2002*, ACM Press, (2002), 334-343.

2. Cao, Xiang, Abigail Sellen, A.J. Brush, David Kirk, Darren Edge, & Xianghua Ding. Understanding family communication across time zones. *Proc. CSCW 2010*, ACM Press, (2010), 155-158.
3. Carmel, Erran. *Global Software Teams* Upper Saddle River, NJ: Prentice Hall, 1999.
4. Connaughton, S. L., & Shuffler, M. Multinational multicultural distributed teams: A review and future agenda. *Small Group Research* 38, 3, (2007), 387-412.
5. DeSanctis, Gerardine. Attitudes toward telecommuting: Implications for work-at-home programs. *Information and Management* 7, 3, (1984), 133-139
6. Espinosa, J. A. & 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, (2004), 249-266.
7. Espinosa, J. A., E. Carmel, & N. Nan. Do Gradations of Time Zone Separation Make a Difference in Performance? A First Laboratory Study. *International Conference on Global Software Engineering*, IEEE, August 2007.
8. Espinosa, J. A. & C. Pickering. The Effect of Time Separation on Coordination Processes and Outcomes: A Case Study. *39th Hawaii International Conference on System Sciences*, IEEE, January 2006.
9. Herbsleb, J.D., A. Mockus, T.A. Finholt, & R.E. Grinter. An empirical study of global software development: Distance and speed. *International Conference on Software Engineering*, (2001), 81-90.
10. Nippert-Eng, Christena. *Home and Work: Negotiating Boundaries through Everyday Life*. Chicago: University of Chicago Press, 2006.
11. O'Leary, M. & J. N. Cummings. The spatial, temporal, and configurational characteristics of geographic dispersion in teams. *MIS Quarterly*, 31, (2007) 433-452.
12. O'Leary, M. B. & M. Mortensen. Go (Con)figure: Subgroups, Imbalance, and Isolates in Geographically Dispersed Teams. *Organization Science*, 21, 1, (2010), 115 - 131.
13. Olson, Gary M. & Judith S. Olson. Distance Matters. *Human Computer Interaction*, 15, 2, (2000). 139-179.
14. Sarker, S & S. Sahay. Implications of space and time for distributed work: An interpretive study of US–Norwegian systems development teams. *European Journal of Information Systems*, 13, (2004), 3–20.
15. Venolia, Gina, John Tang, Ruy Cervantes, Sara Bly, George Robertson, Bongshin Lee, & Kori Inkpen, Embodied Social Proxy: Mediating Interpersonal Connection in Hub-and-Satellite Teams, *Proc. CHI 2010*, ACM Press, (2010), 1049-1058.