Abstract

This paper describes an interview study investigating the collaborative information-seeking and -sharing practices of a global software testing team. A site located in Europe was used as a temporal bridge to help in managing time zone differences between the US, China and India. All sites utilized this bridge for critical, synchronous information seeking. Interviews suggest that Bridging can be a taxing job and that the success of the bridging arrangement depended upon an intricate balance of temporal, infrastructure and cultural factors.

1 Introduction

Information seeking and sharing are communication activities that are critical for successful software engineering, design, development and testing. Engineers spend from forty per cent to seventy-five per cent of their work time engaged in communication activities [12] [24] [29]. Some proportion of the information needed by software engineers can be successfully provided through asynchronous, non-social interactive activities such as document searching and reading relevant project documentation. However, using synchronous communication in socially interactive information seeking nearly always is a critical aspect of a project, and this occurs for several reasons [2] [21][27][11]. First, there appears to be a simple preference for face-to-face information sharing. Forty years of research on information-seeking among engineers (e.g. [2]) has demonstrated a general preference for social sources in many engineering contexts. Second, some of the kinds of questions that arise during the software development process more readily lend themselves to social sources. These questions may be those that are more spontaneous or require personal judgment [21]. They may be facts that are difficult to explain in written documentation or those that require feedback [29] or are items that simply have not yet been documented. As engineering projects evolve and information about them changes in focus and clarity, so do preferences between synchronous/social and asynchronous/non-social information sources [30] [7].

In addition to the direct information value of sources, there are other less direct reasons for using synchronous, social information sources. For example, Hertzum et al., [13] have argued that the information seeker’s perception of the source in terms of trust and reliability are key
factors, and social sources can, in some situations induce a greater sense of trust. Finally, social presence (e.g., the act of making another individual or individual’s aware of one’s activities or simply, one’s being part of the social / work milieu) is a potent factor in source preferences. Asking questions can be a powerful way to maintain social presence [28].

In summary, both synchronous, social and asynchronous, non-social information sources are utilized extensively in engineering projects and there are many factors determining dynamic preferences. Several writers have described engineers’ information-seeking activities in terms of a “least-effort” principle, in which they prefer sources where information is most easily accessible, available and therefore where the cost in terms of time, distance, effort, and other resources is minimal [13][8].

Global software development provides additional problems in information seeking. Communication activities such as information-seeking and –sharing can be highly complicated and of high “cost” in a global environment. Herbsleb, et al., [10] for example, have demonstrated that there can be significant decreases in the efficiency of a software project when the project members are remote from one another compared with being colocated. For example, software modification requests take significantly longer to resolve in multi-site projects. Several reasons have been proposed for this decrease. First, as found by Herbsleb, et al. [10], distributed projects require more people to be involved because each site now has additional management structures to navigate adding to communication time. More people also means more conflicts and more time spent on resolving them. In addition, the subtle communication that is typical in colocated, highly focused teams is missing generating misunderstandings and possibly more conflict. In distributed teams, fewer people have the deep understanding of the overall system that is acquired through “countless informal interactions” making easy problems hard and hard problems, nearly unsolvable. Thus, there is a need for more information in a situation where finding the information is more difficult.

A second set of reasons for the measurable decrease in efficiency for a distributed team is the difficulty of finding the appropriate people from which to get needed information as well as a reduced likelihood of getting information in a timely manner. Because organizations are distant, their worktime overlaps are less [6]. In addition, members know less about the reachability and habits of distant team members making finding an appropriate information source more problematic. Also, the history of a local group often identifies a source of expertise but this information is lost to remote team member. Finally, the lack of presence of a team member reduces the social pressure to respond to an information request so that requests from individuals who are not likely to stop by one’s office and query about the progress of a request are likely to get handled less hurriedly than local requests.

As globally distributed software development has become more common and as the positive outcomes multiply (e.g. diversity, emerging markets, costs, globalization), software companies have experimented with a variety of tactics to make global software development work better (e.g. [24]). One of these tactics is the “bridge”. The bridge is an organizational arrangement that attempts to connect portions of an organization across a dimension of concern. Carmel and Agarwal [3], for example, describe a bridging tactic that is often used to reduce cultural distances between parts of an organization. The “75/25 rule of thumb” arranges for seventy-five per cent of the personnel to work offshore in their home country and twenty-five per cent to relocate from that offshoring country to the customer site. Those at the customer site can interact closely with the customer because they are collocated, and efficiently with the developers because they share a culture. Another kind of bridge in software development is an organizational arrangement intended to ameliorate the effects of differing time zones. A typical example of a temporal bridge is Ireland [4][14]. One of Ireland’s key advantages in the global software market is its geographic and thus, temporal position. Ireland, as an outsource location from the United States works well because of the attributes they share in common with the U.S. culture which include cultural compatibility, flexibility, communication protocols as well as the similar processes of coordination, cooperation, conflict resolution and work integration. In addition, because Ireland initially was a major offshore site for US-based companies, the individuals matriculating under
this role understand the difficulties and needs of offshoring and thus, are more equipped to play the role of a bridge between the US and India and China, the new low-cost off shore havens [14]. Thus, sites in Ireland now serve as temporal and managerial bridges between eastern sites and the U.S. In this role of bridge, they serve as the information broker between the parent company and the eastern offshore sites. The questions asked in the study presented in this paper are: How effective is the bridge in serving in this role? And, are there ways in which this role can be improved?

The study presented in this paper is an exploratory study, that is, a general question is posed but not necessarily conclusively answered. The purpose of the work is by use of qualitative data gathering and interpretation techniques, to begin to generate possible hypotheses as to what types of relationships might exist in the global software project studied that will tell us more about what works and what does not work in information seeking using a bridge as a key information management mechanism.

The paper is organized as follows. First we describe the qualitative data collection method used. This is followed by a long section on interpretation of the data collected. It closes with a set of recommendations on how the Irish bridge can potentially be more effective, that is the hypotheses generated from the data collected.

2 Method

A set of semi-structured interviews were conducted on 13 global software team members belonging to a US-based company that used Ireland as a bridge to off shore development work in India and China. The interviews were done primarily for the purpose of providing backup corroborating evidence to a survey that had been distributed to the team members. The purpose of the interviews were not to explore information seeking behavior but rather to determine the relationship between cultural perceptions, leadership styles, team separation, trust, communication, member satisfaction and member motivation. However, a review of the interview data suggested that information seeking behavior played a key role in cross location interactions and not in ways that would have been anticipated.

Seven of the global team members were located in Ireland, 1 in India, 3 in China and 2 in the U.S. For the Irish participants, interviews were conducted face-to-face at the Irish site by one researcher, while another experimenter participated via telephone. For all other participants, interviews were conducted via telephone. A set of open-ended organizing questions was prepared beforehand to orient the interview. However, participants were encouraged to raise their own issues and describe their experiences even if not asked specifically. Each interview took approximately 30 minutes.

With the exception of the Chinese members, interviews were done by two researchers; one directly asked questions while the other took written notes. In addition, all interviews were audio-recorded. Each recording was subsequently reviewed, coded and analyzed by four or more researchers. A procedure of iterative “explanation-building” analysis was used whereby each researcher listened to an interview recording, took notes and formed a list of hypotheses about critical factors in global information-seeking behaviors in this context. Following this, a set of hypothesis breaking and supporting information was generated, that is, what information, if found in additional interviews would nullify the hypothesis and what would support it. Next, the recording of a different interview was listened to, with special attention paid to confirming, or rejecting the initially listed hypotheses. As a result of this second interview, the hypothesis list was revised and a third interview was analyzed. This process continued until all the recordings were analyzed. Each researcher analyzed the interviews in a different order to generate these hypotheses. Finally, all the researchers met and interactively compared and integrated the hypothesis lists into a single list. Note that the hypotheses were not necessarily about information seeking but rather that their prevalence indicated this to be an area of potential issues.

3 Interview Results

In the interview analysis, several factors were discovered that appeared critical to information-seeking and to the success of the bridge as an information broker. Several troublesome issues as-
associated with these factors emerged as well. The factors can be categorized into three main types: temporal factors, infrastructure factors and cultural factors.

3.1 Temporal Factors

Temporal factors are a critical issue in global collaboration. Indeed, the results of a separate survey administered to the global teams suggests that one of the key problems in collaboration is the “small amount of overlap between times” members are all at work. Not surprisingly, our interviews suggested that members sometimes spend valuable time waiting for important information from other sites.

“If it went past five o’clock and... you needed something important to be answered, then you would have to wait for that person” [M4, 18:20]

Figure 1 shows, on a GMT timeline, the common working hours of the four locales involved in this project, including their standard eight-hour days. As can be seen, there are considerable gaps in temporal overlap across sites. As expected and planned, China and India do not overlap temporally with the United States making Ireland the temporal bridge that both overlaps with the U.S. and these countries. However, the overlap is in the east to west direction so that information requests needing to be resolved by the last country on the chain, the U.S. puts the resolution of any query to China and India to the next day

Figure 1. Common working hours

One strategy commonly used to offset the short overlap between sites was to increase one’s working hours. This was an especially frequent behavior at the bridge site and several of our interviewees commented on the long days required, but it was reported at the other sites as well since India and China do not overlap considerably with Ireland. One team member from China said that he adjusted his schedule significantly so that he could be involved in meeting with other sites. Indeed, his family was starting to complain about the overtime and it was disrupting his sleep. Another Chinese team member suggested that because the Chinese site was the newest, it was natural that they should expect to take much of the brunt of the small temporal overlap by working overtime. For some members, only small adjustments were required. For example, a member from the US said that in her project they met at 7:00 AM because it was the most convenient time for everyone, but for her it just meant starting her day a little earlier. Ireland was coming in at 1:00 PM but India was coming in at 7:00PM. She did not see any problem with this. Other members, however, commented about struggling to communicate in meetings held at times quite distant from their own “peak” times.

Irish members of the global development teams are well aware of their position as the temporal bridge between the east and the parent company in the United States.

“We’re ... more of a proxy between the development team and the China team.... It doesn’t work out time-wise, so he works with us and we’re sort of working with the US development team. We’re in the middle”. [M1 25:07 ]

However, there are side effects of being in this bridge position, most notably (1) the stress of long workdays and (2) the problems with interruptions.

Team members in Ireland find themselves burning the candle at both ends, that is, they arrive early to work for meetings with India and
China and then stay late for meetings with the U.S. There has been a move to working at home precisely because of these long days which pull workers away from their families.

Team members in Ireland also find themselves the target of interruptions for five of their eight hour day. A large body of research has shown that users’ performances on a wide variety of ongoing tasks are often seriously disrupted by interruptions [1] [5] [22]. Interruptions are common in any technical organization, in part because the work of individual team members is highly interdependent. Perlow [25], in a nine-month field study of work in a software engineering team found that interruptions caused members of an engineering staff to continually work overtime and also miss many deadlines. An experimental manipulation that forced a “quiet time” during which interruptions were not allowed improved reported performance by sixty-five percent. The interruption problem in this environment, according to Perlow, resulted from an organizational crisis mentality that encouraged a collective use of everyone’s time as well as a reward system based on individual heroics of staying late. Several of the interviewees commented on the problem with interruptions from other sites.

“...you... come in with a plan on what you’re going to work on that day but as soon as you log on you’re pinged by developers in India...and by the time lunchtime comes and they’re login off then you’ve got the US coming on. And so sometimes you feel.. well its not what you’ve planned”. [M2, 12:13].

“You don’t get enough time in the day ... to solve issue’s...You might get three or four Sometimes from people from a different time-zone and they don’t realize how busy you are because they can’t see you”. [M4, 18:18]

3.2 Infrastructure Factors

A second factor that affected information sharing was the local infrastructure. Tenopir and King [28] have argued that the only significant difference in information seeking among engineers across the globe is based on differing levels of access to the required technology. Our interviews revealed no direct evidence that indicated that there were differences in the technology infrastructure at different sites - this is not surprising since the workplace context was supplied by a large and sophisticated global corporation. However, the interviews uncovered indirect effects of community infrastructure that affected information access. Specifically, the ability to work at home greatly enhanced the ability to work globally because it expanded the available contact time. Team members in Ireland installed broadband internet in their homes and began requesting “at home” days as a direct result of working with Americans and finding that their long days were supported by being at home...

This situation has evolved in Ireland over the past few years and is now similar to the work practices in the US. This situation is not, however, mirrored at other sites where, in order to have access to the technology needed to contact remote team members, employees need to stay in the office. Indeed the member from India expressed the hope of acquiring the same flexibility as some of their colleagues elsewhere.

“We’ve seen the benefits. We all have a day or two where we work at home.... we can take our work home. I’m not just leaving my work....Its one way to be able to do my job. As for the India team, I don’t know that they have the same setup. They are working extra hours. They are staying online late in the day and then they have to leave. I don’t think they have the same infrastructure as we have. When they’re online they’re actually in the office and they just work in the office straight-through...and then they have to go home”. [M2, 19:03]

[Of China]”...They seem to work really long hours ...Like twelve hours.. they could definitely be working that”. [M1, 14:43]

3.3 Cultural Factors

A third factor potentially affecting information seeking and sharing in global teams is national culture. There is evidence to suggest cultural differences in information seeking behaviors in environments other than software engineering, e.g., [16][17][18]. Generally, these are consistent with the cultural dimensions delineated by [15] and [9]. Milewski [22] has found evidence for similar cultural differences in the information seeking pref-
ferences of software engineers. Specifically, while the strongest determinant of whether social or non-social information sources were preferred was the nature of the question being asked, Milewski found that source preferences of software engineers also depended on the collectivism rating of their culture.

Indeed, our interviews showed several ways in which information seeking behaviors in global teams were influenced by the national culture of its members. Differences in information-seeking behaviors can be classified according to several distinct factors that are based on national culture. Some of these culturally-dependent behaviors are highly compatible with the use of a bridge country like Ireland, while others are less compatible with this practice.

The first behavior is choice of source based on cultural similarity. Primary information sources in the Chinese culture were found to be chosen for their cultural similarity rather than expertise or knowledge. For example, Chinese team members indicated that they were likely to first ask for help from either Korea or Japan rather than searching out team members in either the U.S. or Ireland. It is not clear whether this tendency results from a perceived similarity of national cultures or other secondary factors, such as a desire not to appear to be asking “stupid” questions of the team members perceived to be truly in charge. Regardless, this choice of information seeking usually delayed work by one to two days and avoided the intent of the bridge.

"It's easier to communicate with the Taiwanese, Japanese and Korean colleagues. I feel we are all Asian. The culture difference between us is not very big. We can easily accept the grammar and the tone each other use. ... with Asian colleagues, we can comfortably ask direct questions in a casual way. Don’t need to be very polite. But with the American colleagues, I would begin the email with some polite things like ‘sorry to bother you. I don’t know why, just feel I have to act that way”. [M4]

The second factor that was observed to influence information seeking behaviors in our global teams concerns culturally-determined norms for behavior that relate to perceptions and image, i.e., the culturally defined attributes of what constitutes a good, competent team member. Seeking information by asking questions can, in some cultures, be perceived negatively. The information seeker might be perceived as being less knowledgeable or less resourceful. There were examples of this for both Indian and Chinese teams, as reported by Irish software engineers. Team members were reluctant to ask questions about accepted practices even when the consequences could mean a serious delay. Asking was viewed as a lessening of face. When team members in one country fail to ask questions when necessary, this decreases the effectiveness of the bridge country. In the case of Chinese team members, it often resulted in a delay of an entire day in obtaining information. On one occasion, when the Chinese team was lagging behind in a certain area the manager decided to fly two experts to help them – without discussing it with the team itself.

"Chinese people are very proud and the fact that … we didn’t sort of discuss this with the team first of all and the manager of that team, they were ‘oh no. we don’t need any help, we're fine . That was a cultural thing we should have looked into”.

[M1, 4:55]

On the other hand, some Indian participants engaged in a very high level of question-asking that was sometimes viewed as excessive by the management teams. The reasons for this are not absolutely clear from the interviews. It may be that the initially lower level of experience and expertise in this team resulted in greater information needs. Alternatively, the high level of question-asking might be related to self-promotion. A high level of question-asking can be a vehicle for gaining “face-time” with others [27] and potentially increasing one’s level of respect. One senior engineer in Ireland describes the beginning of her day, when she would log into the text messaging system and discover several team members from India already “camping-out” … waiting to ask her a question. As discussed above, this practice can easily fill the few hours that the bridge country has overlapping with other countries and make that work less efficient.

"as soon as we log on... or even have the chance to check your email ahead of the day, you’ve got people pinging you about issues and they’re waiting for you to arrive. Sometimes ...we're in the middle”. [M2, 12:15]
That we observed this high level of question-asking only from some sites suggests the possibility of culture differences, but certainly the degree of remoteness makes a difference as well. Several of our interviews clearly suggested the importance of self-promotion in motivating other activities: working very hard to gain a remote manager’s recognition or maintaining presence with other team members.

The importance of competitiveness and self-promotion as an image-management technique cannot be underestimated across all aspects of global teams, although it was played out differently depending on the national culture and context. Team members in Asia exhibited, for example, what may have been a similar motivation by occasionally by-passing the Irish team members to ask questions directly of the members in the U.S. As noted later, working with U.S. members was often prized as having higher status and may have attracted more self-promoting questions. Competitiveness and positioning among the globally distributed teams is a factor that can’t be ignored.

“In the past, I had an India team and there was... quite strong competition...I felt the team wanted to make decisions but weren’t quite ready. They felt they wanted to prove themselves to be on par with the people in Dublin. There was certainly competition”. [M3, 6:18]

“That they would have liked to be ahead of where they were. They felt that they would like to be stronger and play a stronger role”. [M3, 11:46]

The final aspect of national cultural norms and image relevant to information-seeking has to do with work ethic and overtime. While all locations worked long hours, Chinese team members appeared to work longer hours and to consider it part of the norm more than did any of the other locations studied. When questioned about their other team members, the Chinese members expressed a greater willingness to disrupt their own family life in order to finish tasks in the work environment. This possibly has to do with their level of Future Orientation, as expressed on surveys [15]. That is, since the Chinese culture focuses more on achieving future goals these team members may be more willing to put up with current inconvenience as long as it contributes to their goals. Willingness to work overtime in a global context has enormous advantages. Not only is it possible to accomplish more, but the ability to communicate and seek information from members at other sites increases.

Another factor relevant to national culture and bridging has to do with the norms associated with the bridging country. In the context of culturally-defined norms, it is interesting to note that one norm commonly attributed to Irish workers is low uncertainty-avoidance [15]. According to Hofstede, those with low uncertainty avoidance are more tolerant of opinions different from what they are used to and are driven by as few rules as possible. They are more comfortable in spontaneous, multi-faceted situations with higher ambiguity. It would seem that the work involved in being a bridge fits that description quite well. Bridging is likely to involve more improvisational problem solving than more fully planned work. This cultural aspect is compatible with bridging behavior. Indeed, while Ireland has been relatively homogeneous culturally until the last decade, that is now changing rapidly, and its recent cultural globalization may also facilitate its position as a bridge.

3.4 Conclusions and Improvement Strategies

We have formed a number of conclusions about global information seeking from our analysis. First, it is clear that temporal bridging is an organizational technique that is actively utilized to facilitate global development processes. Team members both in the bridge location as well as other locations appeared to understand its position and use. Team members in all locations attempted to use it for critical, synchronous information-seeking and it is clear that having a bridge makes global development more viable then it otherwise would be.

For a team member within the bridging location, there are certain drawbacks. Specifically, frequent interruptions can make prolonged concentration difficult. This was somewhat surprising for a technical environment rich in collaborative tools. It suggests that even with methods for asynchronously sharing information, there is still an enormous need for synchronous information-seeking and –sharing. A natural approach to dilut-
ing the effects of interruptions is to increase the length of the work day and hence the amount of overlap time possible for integration. However, this approach can be taxing if not supported by other factors such as a technical and management infrastructure that allows work-at-home arrangements. For team members outside the bridging location, bridging provides the opportunity for increased information seeking from knowledgeable sources as well as the opportunity for self-promotion. The success of the bridging arrangement thus, to depends on an interaction of these temporal and infrastructure factors together with an awareness of cultural differences in information seeking.

The use of Ireland as a temporal bridge is a successful strategy that enables the company studied to utilize talented workforce from multiple countries on a single project. Given the amount of daily information seeking engaged in, success in this project would seem difficult to achieve without the use of a bridge. Several interviewees described past difficulties working on global projects that did not use a bridge, and it would be useful to compare the experience of those interviewees who have worked on this Ireland-bridging project with the experience of those who haven’t. Indeed, our interviews have suggested a number of strategies that can be utilized to make temporal bridging work even better.

The first of these has to do with minimizing interruptions. Basically team members should be encouraged and trained to manage their interruptions. Doing this will require that the organizational mindset not encourage collective use of individual times [22]. Consideration of interruptions in the design of collaborative tools can also reduce their effects. For example, interruptions whose response can be delayed or even negotiated are demonstrably less disruptive than those that require an immediate response [20]. Moreover, the inclusion of rich information that clarifies the significance of and response requirements for an interruption also give the team member being interrupted the flexibility to integrate interruptions with his/her own work [22].

Related to these interruptions, another potential improvement is to organize work assignments in such a way as to clearly separate the communication functions of being a bridge from the actual project work. Some of Ireland’s difficulty with their bridge role arose from the requirement to serve both functions which were often at odds in terms of time available. It is unlikely that these functions could be assigned to different personnel, but institutionally recognizing the two functions may reduce frustration.

A second potential area of improvement is to find ways to “share the pain” of time zone differences. This could be done by moving the shared time window on a regular basis to favor each of the sites in turn. Infrastructure issues in the residential aspect of some sites may deter this. There are ways to solve the infrastructure issues, such as providing bandwidth at employee residences or arranging for employee housing close to the wired office. These solutions seem well beyond the typical corporate scope, but solving them may be critical to the success of global work.

Finally, training can facilitate the bridging situation in several ways. First, the need for such extended information seeking and sharing activities comes from the relative lack of technical and organizational experience at some of the non-bridge sites. Focused technical training at these sites could reduce the sheer quantity of information requests and could lower the frenzy of working at the bridge site. However, there will always remain a need for fast-paced, synchronous information, and thus, global work necessitates the bridging function. An improvement could result from continued training in cultural differences and cultural awareness, but with special focus on the information-seeking preferences of different cultures.

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