

Guidelines for Effective Bridging in Global Software Engineering

Allen E. Milewski
Monmouth University, USA
amilewsk@monmouth.edu

Marilyn Tremaine
Rutgers University, USA
tremaine@caip.rutgers.edu

Richard Egan
New Jersey Institute of
Technology, USA
egan@adm.njit.edu

Suling Zhang
Kean University, USA
suling.zhang@gmail.com

Felix Köbler
Technische Universität
München, DE
koeblerf@in.tum.de

Patrick O'Sullivan
IBM Corporation, Ireland
patosullivan@ie.ibm.com

Abstract

Globally-distributed software engineering involves one or more of geographic, temporal or cultural distances, which empirical studies find have deleterious effects on the efficiency of the software engineering process. There have been some successful examples where one "bridge" location has facilitated collaboration and coordination across the other locations. Managers might want to use this bridging as a tactic for future projects, even when future collaborations may be composed of very different participants and in different locations and contexts than current successfully bridged teams. However, group behavior is complicated and establishing an effective bridge is neither a simple nor a straightforward step. We propose a set of guidelines, based on empirical findings, to help managers understand what to expect from the bridging tactic. These include cultural, organizational, individual and temporal factors as well as insights into the costs and benefits of bridging.

1. Introduction

The development of software has become an increasingly global operation over the last fifteen years with the software industry being one of the earliest adopters of offshoring where globally-distributed software teams are commonplace. Global software development poses something of a paradox. On the one hand, there are many anecdotes to suggest that globally distributed teams can be highly productive [25]. On the other hand, the empirical literature has

also identified global teams that perform suboptimally. Herbsleb, et al., [19] for example, have demonstrated that there can be significant decreases in the efficiency of a global software project compared to a co-located one, and, as in other studies, decreased communication and coordination activities are a key cause. Many reasons have been proposed for this decrease [11], but they can be generally categorized as relating to three kinds of "distance": (i) geographic distance (ii) temporal distance and (iii) cultural distance [10].

Increased geographic distance reduces informal and face-to-face interactions along with their high rates of information transfer value and enhanced trust [21] [24]. Geographic distance also creates redundant support staffs and larger organization size, which in turn can result in more conflict [18]. Finally, the lack of a sense of social presence of a team member reduces the pressure to respond to an information request so that a request from a remote individual is less likely to get handled quickly [37].

Increased temporal distance between organizations results from placement into different time zones, and decreases or even eliminates the number of overlapping hours in a typical work day. Lack of temporal overlap strains real-time, synchronous communication and decreases the likelihood of obtaining needed information in a timely manner. In addition, members know less about the reachability and temporal habits of distant team members making finding an appropriate information source more problematic [18]. Several developers have proposed that time zone differences might actually have an advantage by affording "follow the sun" development, but this practice requires very detailed specifications and careful task packaging which has been difficult to achieve [43].

Finally, increased cultural distance can result from national, ethnic or even organizational differences and results in disparities in team members' strategies, behaviors and assumptions about the work at hand and how to work with others [10]. It has been posited that cultural diversity has the advantage of increasing a team's problem solving potential, but it can also result in difficulties in team communication.

These distances, although known to increase communication and coordination difficulties, are inherent in globally distributed software development. One approach for managing this problem is an attempt to decrease these distances, not by putting all employees closer together, but rather by building shorter paths between non-co-located workgroups. This has been done in several ways. To lessen the cultural distances, individuals are exchanged between workgroups so that some members from one culture are always working with members from another culture. An example of this approach is the "75/25 rule of thumb" described by Carmel and Agarwal [13]. This strategy reduces cultural distances between parts of an organization by arranging for seventy-five per cent of the personnel to work in their home country and twenty-five per cent to relocate from that offshoring country to the customer site. Because twenty-five percent of the offshore team members are collocated with the customer, they interact closely and, presumably, overcome cultural differences with face-to-face encounters. In addition, they can work more effectively with the developers in their home country despite geographic and temporal distances.

Another approach has been to reduce the temporal distance by locating workgroups in the same time zone as for example, software development that takes place between Brazil and the United States [11][12]. This practice of "nearshoring," i.e., the trend to work with partners outside of, but close to ones own home country [1][11][25], is an example that benefits from heterogeneous but less expensive labor while still keeping geographic and temporal distances fairly small.

Still another approach is to lessen the temporal and geographic distance by establishing "bridge" sites, that is, workgroup locations in countries whose overlap in working hours permits real-time communications between the more distant sites. An example would be to set up a control center for managing software development that is located in a European nation in which its time zone both overlaps workers in North America and China [23][31]. Bridge country arrangements have allowed distributed projects and offshoring arrangements to occur successfully when they might not have otherwise [31]. However, in an

earlier study which interviewed an Irish bridging team [31], we found serious difficulties with interruptions, perceptions of unequal workloads and wide variations in technical skills that led to the development of the management recommendations in this paper.

All of these approaches, in essence, build a bridge to solve the distance problem. For this paper, we focus on the temporal bridge which is by its very nature also a geographical bridge. Figure 1 presents a diagrammatic example of how such a bridge might be configured. The black dots are team members. The circles around the dots denote a collocated team and the lines shown are the lines of communication between team members. Note that the diagram is hypothetical. The bridge could be located anywhere depending on the time zones needing to be bridged and the nature of the project's need for real-time communication.

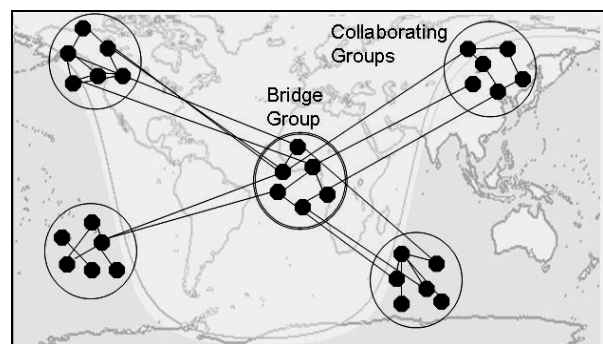


Figure 1: An hypothetical example of a distributed team configuration that bridges time zones.

It would seem that setting up an intermediary communication center would only tend to add additional complexity to communication between the various workgroups rather than serve as an aid to improving communication and coordination [46]. However, the problems with culture, time zones and geographic distance may make these bridges a viable management strategy. This paper addresses the establishment of these bridges and their viability using social network theory as a theoretical basis for this examination. Although based only on prior literature, the examination suggests that these bridges might be a workable strategy for improving communication and coordination in software. We have not addressed the issue of the costs vs. the benefits of setting up a bridge. Although it is known that real-time communication coupled with asynchronous communication is essential for carrying out complex projects [33], it is also known that increasing the complexity of the communication structure also degrades a team's performance,

especially when work involves unambiguous outcomes [45]. We characterize software development as a task that is both complex and ill-defined suggesting that bridges are likely to be highly viable for this type of work. However, we note that more research is needed to find the approximate point where the tradeoff lies between choosing to establish or not establish a bridging site.

We begin the paper by describing an example temporal bridge that we have worked with, both visiting, interviewing and surveying its members [31]. We take this as a representative bridge that could be established anywhere in Europe or the Middle East to connect North America with India and China and thereby bridge these time zone differences. We then discuss the elements of social network theory and why they might apply to these bridging situations. Drawing on the research conducted on social networks, we then present guidelines for the establishment of a bridge as a viable management strategy. The paper closes with a discussion of the viability of bridges as a global software development management strategy.

While anecdotes indicate that bridges have been successful in facilitating global software development, there are still many unknown factors in how they work. The purpose of this paper is to explore the concept of bridges in distributed software development and to propose a very initial set of guidelines for their use. In some cases, these guidelines derive directly from empirical findings about global software teams. In other cases, they are proposed based either on more theoretical considerations or on analogies with other, not always similar, organizations and teams. Nonetheless, the goal is to summarize what is known and to encourage further study, all in the hopes of providing managers with a better footing with which to organize their software teams.

2. A bridging example in software engineering

Milewski et al. [31] have reported on a successful global collaboration between software engineers involved in the development and testing of a large software project within a Fortune 500 company. The collaboration included members from the U.S., Ireland, India and China. The U.S. provided both a corporate home base and planning for the project; China and India were responsible for parts of testing, and Ireland provided key testing facilities and also planned parts of verification testing for the project. Ireland also possessed a temporal overlap in standard business hours with all of the project locations. Figure 2, which

is adapted from [31], shows typical working days for each of the five locations, all on the same GMT timeline. It is clear that the opportunities for real-time interactions between some of the locations (e.g., the U.S. and India) are severely limited. Our interviews revealed significant difficulties when these locations attempted to communicate directly with one another. Partly because of its temporal overlap, the Dublin location gradually developed significant responsibility for coordinating and communicating information between sites. These bridging activities were studied by face-to-face and telephone interviews with twenty workers distributed across all locations. In addition, a larger, survey-based study of the organization explored management issues of delegation to remote teams and cultural differences in temporal perceptions.

Workers at the Dublin location were found to spend a significant portion of their time instant-messaging, emailing and teleconferencing with team members at the other locations as these teams successively began and ended their workday. The Dublin team members experienced a high level of task interruption especially via instant messaging. As soon as they logged on in the morning, they were inundated with a barrage of messages from remote workers who had been waiting for them to become available. Interactions leveled off after an initial flurry of exchanges although they seldom disappeared altogether and often spiked again with the beginning of another location's work day.

Our investigation of Ireland as a bridge in software development confirms and extends earlier reports (e.g. [23]) regarding the bridging strategy. We found that Irish workers were well aware of their position as a bridge between locations in the East and the U.S. They understood the unique advantages of their geographic / temporal location as indicated by comments during the interview process. In parallel, workers at the other locations also appeared to understand Dublin's special position. Irish workers were highly aware of the responsibility their position involved. Moreover, they were aware of the tasks and special skills it required – skills such as time management and cultural awareness. While we found that this bridging arrangement imposed stress on the bridge workers in terms of both long workdays and interruptions, the globally distributed project was considered a success. Team members in all locations used the bridge for a large flow of real-time, synchronous communications.. Communication was also faster than it would have been without the bridge since it reduced waiting for other locations to start their day. Finally, because the bridging organization could target information to other groups that needed it most, information redundancy

and overload may have been lessened. The bridge, thus, facilitated the effective use of multiple and much

less costly employees from multiple countries.

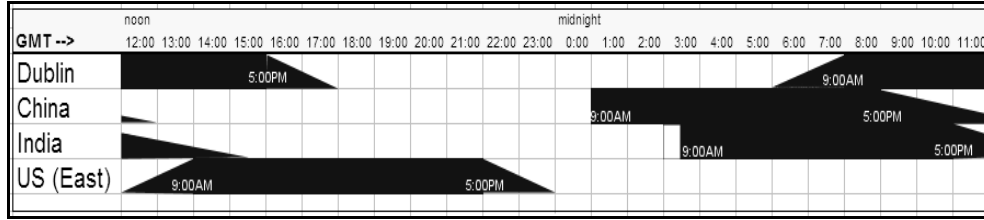


Figure 2: Typical working days for four locations studied in [31]

3. The science of bridges

Social network theory looks at how individuals make connections with each other via a variety of communication channels in order to manage their work and personal life. Studies of these communication connections have noted that different people play key roles in the social networks defined by the communication patterns found within the networks they participate in. In addition, it has been found that these roles arise because of the need to fill gaps or manage communication. The development of these different roles in social networks has been well studied for decades and the findings are accepted as relatively robust. Although the members of a social network are typically thought to be individuals, we have made an assumption in the application of social network theory to explaining bridges that the nodes in a network can also be portions of a distributed team. With this assumption, we have then assumed that the bridge portion of the distributed team represents the key communication management roles found in networks, for example, those of information broker, gatekeeper and boundary spanner. We review these roles and the theory that is associated with them in the next set of paragraphs.

All of the topics below have in common the notion that certain teams or organization behave in such a way as to mediate communications between other members who would not normally be able to share the information. For example, “Boundary Spanners” are organizational members that operate near the periphery of one group and interact with members in other groups [27]. It has been shown that an organization’s performance level and ability to adapt to change is dependent on the boundary spanners’ ability to gather and interpret information [27]. Moreover, high-performing organizations tend to rely more on

boundary spanners when uncertainty about the work task and environment is high [44]. In the area of development of large software systems, Krasner, Curtis and Iscoe [14] found a rich system of boundary spanners to be essential to project success. Boundary spanners in this environment did not simply convey information, but were found to actively translate information from a form used by one team into a form that could be used by another team. In some cases, this translation was between customer and engineers, but often it was between technical groups with different responsibilities. Boundary spanning took place for a wide variety of topics including: (i) software design, (ii) diagnostic/test (iii) new relevant technologies, (iv) product features, (v) reuse. In nearly all cases, these boundary spanning roles were entirely informal, and those taking on the role required good communication skills, a readiness to engage in frequent interaction and a willingness to keep communications open between rival groups. In short, boundary spanning is an active role requiring specific abilities to be successful. A bridging team would inherently be composed of boundary spanners. Note that the role of being a boundary spanner does not belie other technical skills in performing work. Boundary spanners arise because of their social sensitivity to a group’s needs. Quite often, boundary spanners are the most highly skilled members of a team with their deep task knowledge helping to interpret and convey crucial information across team boundaries [6].

Batallas and Yassine [5] have made similar observations about a role in the product development arena that they termed “Information Leader.” By virtue of their position in the organization, these team members became responsible for communication between other parts of the organization and, as a result, can be either facilitators or information bottlenecks. One key determinant of the success of an Information Leader was the ability to handle large amounts of information. These authors note that the job of coordination is extremely time-consuming. Since the

Information Leader role is often an informal designation, these people found themselves with a double workload, having to perform their regular assignments in addition to the job of coordination. Leaders of a bridging team would naturally have similar problems such that a company that uses bridging teams would need to recognize the importance of the communication role as a viable work assignment.

Social network approaches to understanding group communications have also dealt extensively with bridge-like arrangements. According to these approaches, members of groups, or groups within larger organizations, are considered “nodes” that are “tied” to one another by one or more kinds of interdependencies. Ties can include friendship, values or, for our purposes, communications. The complex patterns of these ties constitute group structure and social network analysis focuses on the ways in which this structure influences how the groups and their members function.

One common measure utilized in social network analysis is “betweenness” which is one of several measures of how central a node is within a network. Betweenness indicates to what degree a node lies on the shortest path between every other pair of nodes such that a member with high betweenness is one that other members usually communicate with in order to exchange information with others [15]. In short, members with high betweenness are the ones that bridge subgroups and groups in an organization. Any bridging organization would need to show high betweenness scores to validate its successful operation.

One of the important insights of the social network perspective is that group member’s behaviors and outcomes are heavily influenced by the structural positions they hold in the social network. Specifically, those members with a high degree of betweenness are often considered more important, have more esteem and power and often get more promotions [7]. These benefits are usually classified as part of members’ social capital, and social capital accrues for bridge members in two ways. First, informational benefits accrue because individuals with high betweenness have access to more non-redundant information than do those with lower betweenness. The volume of information is greater because these individuals reach more people indirectly [17]. Second, control benefits accrue because those with high betweenness are more often in a position to facilitate the interests of some members and not those of others [7]. A key example of this social capital is Structural Holes theory [9][7]. According to this theory, social networks that contain structural holes that make ties between nodes difficult

often experience the emergence of “brokers” (sometimes called “gatekeepers”). Brokers, because of their position, are more effective in reaching their own goals by framing information and setting expectations in self-centered ways [9]. That is, brokers have a competitive advantage compared with their peers and tend to utilize it actively by deciding which information to pass across the bridge and which to block [8]. Empirical evidence for this form of structural holes theory has accumulated using a variety of measures such as career advancement [39].

Despite this support for the broker concept, there has recently been substantial evidence suggesting that structural holes can result in other outcomes, which depend on several factors. For example, Xiao and Tsui [47] report that structural holes appearing in organizations in more collectivist national cultures, such as China, result less often in the emergence of brokers, and more often in the emergence of “integrators” whose information-passing behaviors tend to serve the success of the organization they are in, rather than serving self-interests. That same study has found similar trends in “high-commitment” organizations which are organizations that “implement a system of work practices that aims at eliciting employees’ commitment to the organization” [47]. Similar organizational effects have been reported elsewhere [3]. Both self serving broker behavior and more group-cohesive behavior depend on whether the members’ organization is collectivist or more individualist-oriented. Podolny and Baron [35] show that the contingencies set up by an organization in terms of career mobility and advancement also determine the behaviors of those in a bridging position. Siegel and Hambrick [41], for example, have found that managers in organizations with more pay equity exhibit more collaboration behaviors which helps organizations with uncertain markets and high product complexity perform better. This suggests that this collectivism can be embedded in corporate culture to encourage integrators in bridges. Finally, several studies find that the nature of bridging depends on the individuals doing the bridging. Burt et al., [8] report a prevalence of brokering associated with individuals who have many entrepreneurial personality traits, and, Mehra [28] finds that individuals’ personality and the type of network interact. Specifically, individuals who tend to adjust their own behaviors to the goals of their organization tend less often to engage in brokering strategies. Clearly, bridging teams can either create more problems or be a great help to an organization. Much of this depends on the assignment of the right people to these teams, corporate culture, reward

systems, and continued management oversight to ensure that the latter cooperative behavior is prevalent and that power-seeking gatekeeping behavior is absent.

4. Management guidelines drawn from social network theory

Globally-distributed software development involves one or more of geographic, temporal or cultural distances, and the empirical literature strongly suggests that these distances can have negative effects on productivity. As a result, the establishment of an organizational bridge may be an attractive tactic for managers seeking to improve productivity. However, group behavior is complicated and establishing an effective bridge is neither simple or straightforward. Although bridging may not be a panacea for all global projects, prior research suggests several factors that can influence the functioning and success of a bridge. The guidelines listed below describe important areas of consideration for managers interested in creating bridges. We neither consider this list exhaustive nor do all recommendations apply to all bridges; for example, there may be no need to build a team that handles cultural issues because a bridge may be between highly similar cultures. In addition, there is not enough extant research to suggest which of these recommendations is more important than another. In particular, much research has been done on the role of boundary spanners but not within the context of a team set up to bridge time zones.

4.1. Use a bridge when there is a high need for real-time interaction

Global software collaboration is, by its very nature, a situation where structural holes exist between groups that are geographically, temporally and/or culturally distant from one another. The establishment of a bridge is one of several tactics that can be attempted [13]. At a broad level of analysis, the establishment of a bridge can have positive effects. Both Milewski et al. [31] and Holmstrom, et al. [23] have studied bridge type arrangements and found that they can facilitate the success of globally distributed projects. In particular, the establishment of a bridge organization can assist the flow of distant team information that is necessary for development and testing of software.

However, the degree to which a structural hole in an organization is disruptive depends in part on whether group members have alternative, non-social, means for obtaining necessary information. For example, most

software development environments establish a set of knowledge repositories in which are kept many of the projects' significant decisions, plans, work assignments and work status. These repositories are typically available to all project team members. To the extent that team members can find, in a repository, everything they need to know in order to do their jobs, bridges become an unnecessary information channel. Non-social sources are often preferred for factual, predictable and highly-specified information as well as more formal information that typically occurs at the beginning and end of a project.(see [30]). But even for an organization committed to repositing project information, it is difficult to do so for some kinds of information. Social sources are often preferred for more contextual, dynamic, "diagnostic" information such as that exchanged when uncertainty is high [30].

This suggests that the value of bridging in global development may be highest for projects involving prototyping, new products or novel techniques and tools. There may be less need for bridging, for example, in legacy and maintenance-oriented projects.

That being said, managers should not underestimate the need for real-time interactions, even in projects that may not initially seem high in uncertainty. Verification testing might appear to be of low uncertainty, but examination of the testing coordinated by an Irish bridge [31] suggests that a large amount of real-time communication was required, often to solve configuration issues that prevented test cases from even being attempted. In addition, real-time communication was often used to help remote sites understand the documentation and test plans when language differences arose. There is a rich literature suggesting that real-time, synchronous communication is often a critical need in distributed teams [4][18][20][38].

4.2. Build bridge teams that are compatible with the cultures they are serving

While bridge arrangements can result in productive organizations and can ameliorate some of the problems inherent in globally distributed teams, managers need to be sensitive to potential differences between both national and organizational cultures. In some countries, such as the U.S., bridge arrangements evoke a broker mentality where team members are more likely to favor self-interests [9]. However, in other countries, such as China, self-interests are less often so open and bridging members favor cohesiveness and act to facilitate the organization goals as a whole [47]. In addition to these differences between national cultures, some studies have found similar differences in bridging motivations

between different organizations within the same culture. In “high-commitment,” collectivist and cohesive organizations, bridging members favor cohesive motivations [47] while in organizations that reward entrepreneurialism, brokering is favored [35].

Both of these bridging motivations can result in a productive communication channel, but in global software development being done by highly heterogeneous countries and organizations, the mix of motivations can be critical. Most important is the compatibility of the bridging organization’s motivations and the expectations of other organization members. For example, Xiao and Tsui [47] have listed two difficulties when broker-oriented bridges interact with others who may be more cohesive or collectivist-oriented. First, brokers may find it difficult to carry out entrepreneurial, self-interested behavior because the rest of the organization is likely to have strong sanctions against behaviors that are not selfless and in pursuit of the common interests. Rather than permit brokering, the others will become uncooperative. Second, even when broker-type behaviors can be carried out, the brokers are unlikely to be rewarded by a gain in social capital from them. At the least, those from more collectivist cultures and more cohesion-oriented organizations tend not to attribute value to anything but collectivist behaviors. Indeed, there may be negative consequences because of sanctions against self-oriented behaviors. For global software development, either case argues for careful consideration of the organization’s cultural composition and the potential interactions between members.

In summary, management of bridges in global development requires careful attention to motivations tied to the organizational and national culture of team members and then aligning members’ goals and rewards. This can be carried out by choosing appropriate bridge countries, by adjusting rewards and/or by instituting organizational cultures that help to align members’ goals.

4.3. Choose bridge team members that match the bridging function

Not only are the constituent national culture and organizational context critical to how bridging works, but so are the characteristics of individual team members in the bridge position. Managers planning global work that relies on a bridge organization must consider these characteristics in team composition. First, some individuals are more comfortable than others performing the bridge function [8]. Bridging

requires a substantial amount of real-time social interaction and frequent interruption [5][26][29]. There are individual differences in the strategies people use to manage interruption [29] so that some people are likely to handle the interruptions better than others. Second, it is likely that success at bridging in a global context also requires cultural sensitivity and the ability to coexist with others’ differing values. Holmstrom [23] found that Irish software outsourcers performing a successful bridging function were highly skilled at dealing with the diversity of differing cultural practices. Similarly, Milewski et al. [31] speculated that the success of a different sample of technical bridge members in Ireland may be associated with a generally low score among the Irish in uncertainty avoidance [22] which is associated with being more tolerant of opinions different from what they are used to [40]. A third factor to consider regarding individual bridging behaviors is expertise. Holmstrom [23] has noted that, even more than geographic location, the key factor in successful bridging is the depth of expertise and experience of bridging members. Not only are expertise and experience critical because bridges are at the hub of information sourcing, but also because of the added workload of bridging as discussed below. The final factor regarding individual differences in bridging behavior is that, just as with cultures, individuals differ in their motivations for bridging. Some personality types favor brokering activities while others tend toward cohesive behaviors [8][28]. It is likely that a mismatch of individual motivations with that of the individuals’ organization can result in the same kinds of unproductive behaviors as described above..

In summary, managers need to be aware of members’ individual characteristics when building a bridge organization and carefully match them to the contextual and functional requirements.

4.4. Protect bridges because they can be fragile

Because of the quickening pace of the software development industry in recent years, it is sometimes assumed that organizational issues are relatively stable compared with the software products being produced. This may not be the case when establishing global bridges. The social network literature has been consistent in demonstrating that bridging relationships are relatively short-lived. Burt [7], for example, has shown that nine out of ten bridging relationships among managers decay within a year of their establishment. Other studies have shown similar transience [3] [42].

In the case of broker-oriented bridges, this rapid decay may be related to the fact that the motivations for

maintaining a bridge is lessened after the broker reaps its benefits in terms increased power and promotion [42] and that those benefits may develop quickly. But, bridges appear to be short-lived even in more cohesive and collaborative networks as the result of a tendency for these networks to “close up” structural holes [42]. Specifically, there is a tendency for the team members that are connected by a bridge to attempt to go around the bridge and communicate directly. For example, in their study of temporal bridges, Milewski et al. [31] reported several attempts by team members to avoid the bridge. One example was a preference among Asian workers to seek information from other teams in Asia, rather than from the more geographically and culturally distant Irish bridge. There were multiple reasons for this. First, it was sometimes simply quicker to seek information from others in similar time zones rather than to wait up to an entire day for an answer from the, albeit, more expert members in Ireland. Note that this need for instantaneous real-time communication simply substantiates the need for a temporal bridge albeit even closer than that which was established. Second, team members reported that cultural similarity also made it easier to ask for help, possibly both in terms of language and in terms of keeping face. This example suggests staffing of a bridge that bridges not only temporally but also culturally. A second example was a preference by Chinese and Indians to interact directly with developers in the U.S. The U.S. was the company headquarters and working with U.S. team members was prized as having higher status and may have attracted more self-promotion behaviors. In both cases, these remote workers were acting in ways to circumvent the bridge-mediated communication, despite the extra effort involved.

Managers working within bridging contexts need to be aware of the dynamics of bridging and monitor the effectiveness of established communication channels. If the value of the bridge is significant, as it may be when groups are widely distributed, it can be protected by managerial emphasis on the established communication channels.

4.5. Continually assess the costs of a bridge

While the establishment of a bridge can permit global development that couldn’t otherwise occur, there is a substantial cost on all the collaborators, but especially on the bridge members themselves. The social network literature has argued consistently that bridge relationships are typically costlier than other kinds of ties [7] [42]. The key reason for this is that bridges bring together a heterogeneous mix of

personalities, practices and assumptions. It is easier for team members to establish and maintain relationships with others that are similar [7] and bridging, especially across global distances, reduces similarities.

In addition to the work associated with establishing and maintaining social ties, bridge members are typically required to do extra job-related tasks. Based on [5], these can include:

- Receive/distribute information between team members
- Acquire/send information to external contacts
- Identify those that might benefit from some specific information
- Control relationships between teams
- Ease (or complicate) information exchange, possibly by simplifying or translating
- Risk being an information bottleneck
- Retain information for later use and distribution

These tasks may be required in addition to whatever other deliverable-oriented tasks have been assigned to the group. These additional tasks may be hidden responsibilities in the sense that the time required to do them is not always formally accounted for [31]. Milewski et al. [31] show that as a result, bridge workers may experience a high level of stress extra overhead of several types. First, because of the high level of interruption by remote workers seeking information, bridge workers may find it difficult to organize their own time in order to do their own assigned tasks. A natural solution to this first problem is to increase one’s working hours to be able to meet all responsibilities. Increased working hours is common in a bridging situation also because it expands the temporal overlap available for real-time communications with team members. This extra work and extra hours can have significant impact on the workers relationship with their family.

Managers establishing bridging arrangements should be aware of their extra demands and find ways to ameliorate them. For example, extra working hours can be acceptable, but only if workers see management awareness and support, and only if appropriate infrastructure, such as broadband networking, can support work-at-home arrangements. An additional alternative might be to adjust the number of deliverable-related tasks in order to give bridge workers adequate time to perform the bridge function successfully.

5. Summary and Conclusions

We have argued in this paper that bridging can be a viable solution to the difficult problem of managing global software development teams. Our argument is not based on finding about global software team bridges since so few of them have been studied, but instead on an extrapolation of social network theory and its literature to bridging. We also note that most of the bridges we have found in our research and in the literature are not ones that were developed intentionally as part of organization strategy but units that have grown out of organizational need or of the team positioning themselves in this role. Our analysis suggests that it might be appropriate for an organization to examine existing bridge teams in terms of their effectiveness and also to consider pursuing a bridging strategy as a way to facilitate distributed development. We suggest analyzing the locations of current and future development resources, to select bridge locations based on their temporal/geographic and cultural overlap, and then to develop an appropriate workforce in these locations. However, it has not been shown that bridges can be engineered in so proactive a fashion. First, nearly all the research on organizational bridges have been done in situations where structural holes have formed dynamically and naturally; a management chain or group structure is established and only later it is discovered that communication paths are not completely interconnected. Global collaboration is somewhat unique in that structural holes result from a geographic/temporal or cultural necessity. This may make the functioning of this type of bridge somewhat different than others.

To the extent that social network structures have been found to be critical for how organizations function, it is possible that more of a “self-organizing” approach will be most effective in the establishment of formal organizational structures. First, it has been demonstrated that a careful analysis of existing and often informal social ties in a software development organization can be useful in establishing more formal organizational structures [32]. Second, the classic “Irish bridge” example [31][23], is one that has gradually evolved over several years and several different roles as Ireland graduated from being viewed as offshore itself and then progressed to a site in which it took on the offshore management role [23]. In the course of this evolution, its understanding of the organization developed well before it began its role as a bridge. In line with these findings, it has been suggested [5] that managers designate collaboration roles based on careful analysis of existing group

structure. In short, there may need to be a preparation period for “bossing the bridge before you come to it.”

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