Intense Collaboration In Globally Distributed Teams: Evolving Patterns Of Dependencies And Coordination

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ABSTRACT

As multi-national firms and major offshore outsourcing companies develop experience with global work, their globally distributed teams face the challenge of collaborating intensely without the common interaction advantages associated with collocated work. This chapter analyzes the sources of intense collaboration. It then introduces strategies that organizations have developed to *reduce* the intensity of collaboration (sequentializing work, using mediating artifacts, modularity), or to *enable* intense teamwork (real time contact, boundary spanners). Strategy properties and deployment opportunities and constraints are indicated in order to equip managers and researchers with a framework for handling or analyzing globally distributed teamwork.

Keywords: globally distributed teams, intense collaboration, coordination

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INTRODUCTION: THE PROBLEM WITH INTENSE COLLABORATION IN GLOBALLY DISTRIBUTED WORK ARRANGEMENTS

The objective of this chapter is to investigate how global organizations adapt to the requirements of intense collaboration in geographically distributed teams. In a business climate driven by innovation and competitive pressures, teams have become a familiar way of organizing work (Brown & Eisenhardt, 1997; Gibson & Zellmer-Bruhn, 2001; Nemiro, 2000). Moreover, increasingly, over the last decade, teams, their members, and work in teams are becoming distributed across national and cultural boundaries around the globe (King & Frost, 2002). While people from different cultures may not share a common definition and understanding of teamwork (Gibson & Zellmer-Bruhn, 2001), most people will agree that teamwork, whether collocated or distributed, requires intense[1] collaboration between team members. Examples of intense collaboration are a pair of dancers dancing the Tango; a team of surgeons, nurses, and anesthetists performing a complex operation; a team of users, software engineers, and programmers developing and implementing a computer-based information system; or, as in our case, co-authors working jointly across the Atlantic in developing this article.

[1] The concept of team or intense interdependence in collaboration was originally conceived in management literature by Van de Ven et. al. in 1976. However, in this paper, team or intense interdependency was one among many contingencies that were studied by the authors as determinants of coordination modes. The authors did not de-construct and further investigate the concept in detail. Since then, the concept of team or intense interdependence has become accepted in literature without any further examination. However, at this point we also need to recognize the difference in the use of the term "team" by Van de Ven et. al. (1976) and in other general management literature. While general management literature takes a team to be an organization structure that may include both coordinated solo-acts by individual members of the team as well as concurrent or joint acts by more then one team members, Van de Ven et. al.'s concept of team interdependence is defined primarily as joint or concurrent action by all members of the team at the same point in time.

Intense collaboration normally translates into coordination mechanisms requiring intense communication and information processing, mostly through direct face-to-face contact, meetings, and feedback communications (Faraj & Sproull, 2000; Galbraith, 1973; Roberts & Moore, 1993). Moreover, team-members need to maintain a high level of continuous awareness of each other to coordinate their work (Endsley & Jones, 2001; Weick & Roberts, 1993). The question then becomes how organizations are dealing with and adapting to the demands of intense collaboration in a globally distributed work environment.

Before we examine the concept of collaboration intensity in a team, we need to make explicit the notion of teamwork that is the basis for our analysis. We take teamwork to be more than one person working on a task to achieve a shared or agreed upon goal. The outcome of a task could either be an artifact or a work-object (a new car design), an action (sports teams), or the result of an action (car wrecking). Often there is an object of the task (a task-object or work-object) associated with the task. The work-object may be relatively concrete (e.g. an IKEA table to be assembled or a patient to be operated upon), an action (for example, carrying a table over a flight of stairs, or dancing the waltz), or abstract (an information-object, for example, a project plan, aircraft design, a theory, or a chapter/article for this book). Completing the task requires a set of activities to be performed on the task-object, either as solo-acts performed in isolation by individual team-members, or jointly by two or more team-members. It is how these activities and the team-members performing them interact with each other, that determines the level of intensity in the collaboration (Quinn & Dutton, Forthcoming; Wageman, 1995). Furthermore, In order to function as a well-coordinated team, the members of the team need to be constantly aware of each other, the activities being carried out, the current state of the artifact or the work-

object, and the context of the team work. This awareness is maintained through explicit or sub-conscious interactions such as communicative acts; observations; and anticipatory behavior based upon prior experience. The greater the need for these interactions, the greater is the intensity of collaboration.

We therefore define ***Collaboration Intensity*** (CI) of a team situation as the required level and frequency of interactions needed for the initiation and ongoing joint action and mutual awareness of: the members of the team; the flux of activities in teamwork; the evolving work-object; and the context of the collaborative situation. Interactions include both conscious and sub-conscious communication actions, observation, and, anticipatory behavior based upon prior experience, anticipation of moves, behaviors, and their consequences. High collaboration intensity requires high levels and frequency of such communicative, observatory, and anticipatory interactions.

These requirements of intense collaboration are fundamentally at odds with the defining characteristic of globally distributed teams: that is, work distribution. With the advance of globalization, distributed teams – also referred to as virtual (Mohrman, Klein, & Finegold, 2003), polycontextual (Engeström, Engeström, & Kärkkäinen, 1995), or dispersed (Cramton, 2001) teams – have become a common way of structuring multinational organizations (DeSanctis & Fulk (Eds), 1999; Gibson & Manuel, 2003; van Fenema, 2002), cross-company alliances (Gerwin, 2004), and offshore outsourcing relationships (Meadows, 1996; Smith, Mitra, & Narasimhan, 1996).

Within the broader concept of multi-national teams, globally distributed teams emphasize the widespread physical separation of team members that leads to an international working environment. As a consequence of geographical separation, the team members may come from

different nationalities or cultural backgrounds. This is not a necessity however. Multinational firms often send workers from the home or the headquarter country abroad to work at a distinct location while maintaining ties to the 'mother' country (Edström & Galbraith, 1977). These ex-pats would be members of a globally distributed yet culturally homogeneous team.

At this point we emphasize that we are electing to use the term "globally distributed teams" (GDT) rather than the term multi-national teams (MNT). The term "multi-national team" can be subject to a variety of interpretations. For example, is a collocated surgery team consisting of a Dutch nurse, an American anesthetist, a Chinese radiologist, and an Indian surgeon performing an operation on a member of the Saudi Royal family, working together, in the same operation theater in Riyadh, a multi-national team? Or is a team of all Indian software professionals from an Indian company such as Tata Consultancy Services, some located in New York, others in Amsterdam and Budapest, and the rest in Bangalore, a multi-national team?

To avoid such potential confusion we elect to use the term, *Globally Distributed Teams,* a term with a more limited meaning, A globally distributed team is a team whose members are distributed across large geographical, often global, distances (gray cells, Table 1). According to this definition the former team performing the surgical operation, while a MNT, is not a globally distributed team (it is a collocated team), whereas the second one, though not a MNT, is a globally distributed team. On the other hand, if the first team included a radiologist who was performing remote interpretation of X-rays or radiological images, say from New York, that would have been a Globally Distributed Team.

Table 1 ABOUT HERE

The challenges of geographical distribution and their consequences for teamwork have received ample attention since the early 1990s. For example, in studying geographical distribution, researchers have focused in particular on communication and information processing problems (Cramton, 2001), collaboration processes (Maznevski & Chudoba, 2000), use of technology (Majchrzak, Rice, King, Malhotra, & Ba, 2000), and trust between team members (Gibson & Manuel, 2003; Jarvenpaa, Knoll, & Leidner, 1998).

While these studies provide a rich base of knowledge about global distribution, they do not systematically recognize and address the consequences of global distributedness of work for intense collaboration. This makes it difficult for practitioners to understand, identify, and resolve the problems associated with distributed teamwork. **The objective of this chapter is to investigate how people deal with intense collaboration requirements in geographically distributed teams and work arrangements**. Based on current literature and our own research on multiple globally distributed projects (van Fenema, 2002; van Fenema & Kumar, 2000), we examine strategies for dealing with the challenges introduced by the shift from collocated to geographically distributed intense collaboration.

The chapter is organized as follows. After exploring the sources of collaboration intensity, we examine the impact of geographical distribution on collaboration intensity. Next, we describe two types of strategies being used by organizations for handling intense distributed collaboration. First, we identify the set of strategies aimed at *reducing* the intensity of interpersonal collaboration between sites. Next, we examine a set of strategies that leave intensity intact and

rather focus on *enabling* it. We then assess how managers, team leaders and members can select, combine and deploy these strategies. The chapter concludes with implications for practice and research.

UNPACKING INTENSE COLLABORATION: FOUR SOURCES

Teams represent an important structure for arranging complex activities. Researchers have developed different perspectives on how teams and intense collaboration work. From an organizational behavior point of view, teams represent a social organizational entity that facilitates interactive work accomplishment (Barker, 1993; Mohrman et al., 2003). In organization design and coordination theory, teams are considered as vehicles for supporting intense collaboration (Crowston, 1997; Thompson, 1967). Other researchers emphasize the uncertainty of team-based project work (Goodman, 1981). The intensity of team collaboration may therefore stem from multiple sources that need to be explicitly identified. We describe collaboration intensity as having its origins in four concepts (Figure 1): temporal simultaneity of work processes (Van de Ven, Delbecq, & Koenig Jr, 1976), stickiness of information in task situations (von Hippel, 1994), task uncertainty (Loch & Terwiesch, 1998), and tight coupling of tasks.

Figure 1 ABOUT HERE

A. Interdependencies and Temporal Arrangement of Activities

First, based upon Thompson's (1967) and Van de Ven et al.'s (1976) classic work on team or intense dependencies, we recognize that task-interdependencies and the temporal arrangement of

member activities is a key determinant of collaboration intensity in a team. Communication and information processing needs increase as activities overlap sequentially or occur simultaneously (Van de Ven et al., 1976). We recognize three levels of temporal relationships between the activities of team members working on a task-object (Figure 2).

Figure 2 ABOUT HERE

At the lowest level are relatively independent activities performed sequentially (or reciprocally) by team members. At any one instance in time, there is only one team member who is in control of and processing the work-object. Upon completion of his part of the task, team-member "A" hands off the work-object to member "B," the next person in the sequence of workflow. Depending upon the level of uncertainty and ambiguity in the task, the hand-off could either be clean (i.e., the work transfer is instantaneous), or sticky (work-transfer requires intense interaction at the time of the hand-off). For example, while a package drop-off by Sears or DHL delivery at a customer's door is a clean hand-off, getting a receipt-signature begins to introduce a small element of stickiness. On the other hand, delivery, set-up, installation, and minimal training on a computer-software package significantly increase the level of stickiness of the hand-off.

In case of a sticky hand-offs, when the succeeding team-member B receives the control of the work-object or task from the preceding team member A, both need to expand time and effort to arrive at a common and joint understanding of the state of the work-object and work-situation being passed from A to B. Common understanding is needed in order for B to be able to comprehend what actions are required of her/ him and to continue with the task. Thus when Paul

C. van Fenema from Rotterdam, through an e-mail and an attachment, hands-off the next version of the paper to Kuldeep Kumar in Key Largo, both need to talk on the phone to calibrate their meanings of the additions and modifications Paul made overnight, and to discuss Kuldeep's ideas about adding and revising concepts before Kuldeep can take over and continue work by himself on the revised version. In both clean and sticky hand-offs, except at the time of the hand-off, team members work separately and independently of each other on the work-object.

The third temporal level identified by Van de Ven et al. (1976) is team or intense interdependence where the team members simultaneously and concurrently work on the task-object. Van de Ven et al. (1976: 325) stress the temporal dimension in their definition of team interdependence:

> *"The situations where the work is undertaken jointly by unit personnel who diagnose, problem-solve and collaborate in order to complete the work. In team work flow there is no measurable temporal lapse in the flow of work between unit members as there is in the sequential and reciprocal cases; the work is acted upon jointly and simultaneously by unit personnel at the same point in time."*

A clean hand-off has minimal or zero requirements for interactions for maintaining awareness, except at point of transfer between the preceding and succeeding activities. An example could be professional relay racers who know and have adjusted to their partner's specific mode for passing on or receiving the baton. On the other hand a sticky hand-off requires high levels of frequent communicative or observational interactions for duration of the hand-off. Team or

intense dependency requires high levels of frequent communication, and continuous observation and anticipation interactions during the entire duration of the simultaneous activity in the team engagement.

B. Stickiness of information task situation

The stickiness of the sequential hand-offs or of simultaneous, concurrent work can sometimes be a consequence of the stickiness of information. There is continuous, ongoing exchange of information between the team members (von Hippel, 1994, 1998). The information being exchanged is either information about the work-object (for concrete, action, or abstract work-objects) or the work-object itself (as in the case of abstract work-objects). In either case, how easily, or with how much effort, this information is shared determines the interactions and the intensity of connection between the team participants. The greater the effort required in sharing this information, the greater the level of intensity.

Von Hippel (1994, 1998) defines stickiness of a given unit of information as the "incremental expenditure required to transfer that unit of information to a specified locus in a form usable by the given information seeker." Information stickiness could be due to the attributes of the information itself (such as it being tacit, the technological complexity of the object, the amount of information, and its encoding as usable to the receiver); or it may be due to attributes of the information receivers or providers (such as the absorptive capacity of the receiver and the existence of technological gatekeepers). In either case increased incremental effort is required for the team members to share information about the work-object, the situation, or the information object itself, thereby increasing the intensity of the collaborative activities. Therefore, higher

levels and more frequent communicative and observational interactions may be required the more sticky the information is.

Stickiness of information increases dramatically when the team members (information seekers and providers) come from and exist in their own unique, local contexts (Engeström et al., 1995; van Fenema, 2002). In their local lives, people encounter and shape knowledge that makes sense in their own context. Beyond their own setting, people do not have access to the same level of richness, meaningfulness and nuance of local experiences[2]. At best, people encounter representations of events of other contexts through media like paper or verbal reports, TV, film, Internet, and interpersonal communications (Potter, 1996). These mediated experiences only partially overcome the stickiness of local knowledge (Szulanski, 1996; von Hippel, 1994). Artifacts like plans, papers-in-progress, and draft designs do not sufficiently speak for themselves but become meaningful to knowledgeable actors (Ngwenyama & Lee, 1997). To come to a shared understanding of the artifact requires constant interaction and active and joint interpretation by the participants in the task (Bechky, 2003). Stickiness also depends on past inclusion of people in another context. Cross-site visits contribute later to 'unstickying' information and rendering it meaningful. People can complement limited information with their own memories of past visits to a site (Abel, 1990).

C. Tightness of coupling

[2] For instance, HSBC corporation – claiming to be the world's local bank – presented unique local practices and artifacts in an advertising campaign around local knowledge (http://www.hsbc.com/public/groupsite/insight/local_knowledge/en/speciality.htm, accessed June 17, 2004).

Third, intense collaboration may also be a result of tight work coupling between various elements of a team, that is, its activities and members. We conceptualize tightness of coupling by reversing the concept of loose coupling (Glassman, 1973; Orton & Weick, 1990; Weick, 1976). Organizational units are loosely coupled when they (a) have few variables in common or the variables they have in common are weak (Glassman, 1973); (b) their elements retain evidence of separateness and identity, and (c) when they affect each other only "suddenly (rather than continuously), occasionally (rather than constantly), negligibly (rather than significantly), indirectly (rather than directly), and eventually (rather than immediately)" (Orton & Weick, 1990; Weick, 1976).

Reversing the definitions, a tightly coupled system is one in which its (a) elements of the team have a large number of strong (not weak) variables in common, (b) element's identity is subsumed within the system's (the team's) identity, and (c) the elements affect each other continuously, constantly, significantly, directly, and immediately. Tight coupling between the elements of the team therefore implies that the member's identity is to an extent subsumed within the team. They closely connect, and experience persistent and considerable impact of others' activities on their own functioning. As a result, team members need to maintain constant awareness of their coworkers and interrelate their activities (Weick & Roberts, 1993) thereby increasing the intensity of collaboration. This in turn implies that frequent, continuous and strong (not weak) communicative, observational, and anticipatory interaction is required, indicating a high level of collaborative intensity.

D. Task uncertainty

And fourth, intensity in collaboration can be a consequence of task uncertainty. Information processing theorists define this concept as lack of information or know-how concerning the work people are supposed to do (Galbraith, 1973). This basic form of uncertainty has been referred to as variability, i.e., people do not yet know a few aspects of their pending work (Van de Ven et al., 1976). A more fundamental form of uncertainty is equivocality, i.e., actors have difficulty in making sense of and analyzing the situation (Perrow, 1967). Organizations commonly setup teams to deal with uncertain situations and increased information processing needs (McCann & Galbraith, 1981; Van de Ven et al., 1976). High levels of task uncertainty require continuous communicative and observational interactions between the actors to continuously calibrate and coordinate their individual actions.

Collaborative Intensity as the Confluence of the Above

Collaborative intensity in a team is a result of one or more of the above factors in a team situation. Table 2 presents examples of assessing a variety of team situations along these dimensions (temporal arrangements, stickiness of information, tightness of coupling, and situation uncertainty) to understand the collaborative intensity of the situation. If the assessment of a team is low along all four dimensions, we have a team situation with low collaborative intensity. On the other hand uniformly high ratings suggest very high collaborative intensity. Combinations of low, medium, and high assessments would imply intermediate levels of intensity.

Table 2 ABOUT HERE

GLOBAL DISTANCES AND INTENSE COLLABORATION

Groups working in geographical distributed arrangements face three new challenges in addition to normal issues associated with intense teamwork. First, geographical distance, except for occasional meetings between a few representatives, makes rich, face-to-face team meetings difficult (Kraut & Galegher, 1990). Second, distance is often associated with time zone differences unless people are located only in a strict north-south configuration along a longitude on the globe (e.g., Ecuador – US east coast, South Africa – Turkey, Western Australia - China). When people do not work according to the same clock time, they cannot count on opportunities for spontaneous communication during their working day (Boland & Citurs, 2001; van Fenema, 2002). Synchronous communications depend on a window of overlapping hours. Third, people working at global distances are also working in different social, environmental, economic, and sometimes organizational contexts. Being in different contexts, they are subject to different local constraints, and are likely to have access to different resources. For example, a member of a global petroleum refinery design team stationed in Nigeria may have access to a different set of tele-communication resources than his counterpart in Dallas Texas and is likely to be subject to somewhat different regulatory and social constraints.

Additionally, often global distribution of teams means that team members may be recruited from different sites around the globe. It is commonly accepted that individuals bring their cultures of origins to work. Moreover, cultural differences explain a large part of attitudes and social behaviors in a work situation (Gibson & Zellmer-Bruhn, 2001; Hofstede, 1991). In cognitive terms, national culture is a set of shared meanings embedded in a set of shared mental programs that influences the observation, communication, and information processing behaviors of

individuals (Hofstede, 1980). Gibson and Zeller-Bruhn (2001: 277) observe: “Team collaboration requires information exchange and collective information processing (…) and is therefore rich in cognitive content; however, (since) cultural contexts around the globe are infused with very different cognitive frameworks…” Consequently, cultural differences across a globally distributed team are likely to impede the communication, observation, and anticipation interactions, thereby affecting the development of shared meanings and programs necessary for functioning in a high collaborative intensity environment.

High levels of collaboration intensity in teams require rich and intense communication between team members, high levels of information processing, and continuous mutual awareness by team members of each other. On the other hand, geographical and time differences, and often, cultural and contextual differences at global distances, create barriers to communication and observation. Moreover, as these distances reduce observe-ability, they drastically reduce mutual awareness and shared understanding. Consequently, global distribution of work creates barriers to collaboration intensity that is fundamental to teamwork.

However, often practical and socio-economic realities require that teamwork be distributed across global distances. Organizations react to this paradox by either pulling work back at a single location, that is collocating work, thereby foregoing the potential benefits of work distribution. Or they adopt strategies for ameliorating the consequences of work distribution. As, in the long run, circling the wagons is not a sustainable option, in this article we explore the latter strategy. The remaining chapter is aimed at organizations determined to make intense collaboration in globally distributed teams work.

STRATEGIES FOR *REDUCING* THE INTENSITY OF COLLABORATION BETWEEN SITES

Researchers have found that organizations develop different responses to the challenge of accomplishing intense collaboration in distributed work settings. Sometimes, they revert to traditional collocated teamwork because they find geographical dispersion too difficult to deal with. For instance, some multinationals concentrate their R&D efforts in collocated centers of excellence (Chiesa, 1995). In this chapter we focus on evolving patterns of work-organization (differentiation and integration) that sustain geographical dispersion. These organizations have made an attempt to accomplish intense collaboration in a globally distributed environment.

We identify two sets of strategies for doing so. The first set of strategies is aimed at reducing the intensity of collaboration. This is realized by (1) sequentializing teamwork, (2) using representations and mediating artifacts, and (3) modularizing work. Each of these strategies is discussed here. The following section then analyzes strategies that instead of reducing the intensity of collaboration provide support for enabling intense dispersed collaboration.

Strategy 1 - Sequentializing Teamwork: Changing the Temporal Order of Work

The first, somewhat common, strategy for dealing with intense collaboration is sequentializing teamwork. A string of solo acts substitutes for concurrent teamwork. Work is passed back and forth by means of asynchronous media like fax, email, SMS messaging, vmail, e-cards, and video messaging. Individuals externalize (Nonaka & Konno, 1998), and hand-off ideas, suggestions, work artifacts, and documents with comments. On one hand, sequential work has the advantage of not disturbing the receiver's activities. This is important in projects that cross multiple time zones. Time differences could even been used advantageously when teams master the skill of passing on work at the beginning and end of local working days (Carmel, 1999).

Meadows (1996) cites a team member located in India and participating in a project with Australians:

> *"Before we go home, we collect all issues and send them to Australia. When they get into office, they have them all, and no time is wasted. We adapt our work-shifts for the people in Australia so they overlap enough to teleconference" (Manager, Finance Co. #2 Project).*

However, disadvantages of sequentialization have also been identified. Sequentializing work means that work cycles may become stretched over time. Asynchronous communications being sent back and forth lack richness of cues (Trevino, Lengel, & Daft, 1987), making it difficult to explain a complicated topic. Organizations loose the energy and dynamics of simultaneous playing with ideas (Quinn & Dutton, Forthcoming). Kraut and Galegher (1990: 163) quote one researcher's experience with the shift from collocated to dispersed collaboration:

> *"This was the first project that I had done long distance and it certainly made it more time consuming. I was used to being able to walk down the hallway from my office to (my collaborator's) office to talk to him about a problem (…). (In the long distance collaboration) we either relied on the mail going back and forth or even phone conversations and that just wasn't as satisfactory as talking face-to-face. (…) It took a long time, and I wasn't used to having that much of a lag for the turn-around. (...) I was used to being able to make it much faster."*

Nemiro (2000: 112-113) quotes a team member who became frustrated with the lack of discussion when people shift to asynchronous media:

> *"(…) It should have been a fun project. It was not fun because there were a lot of assumptions made, which I think sometimes a problem with [a] virtual environment is that assumptions are made by one party sitting in their office, closed door, typing away, and they said, oh yes, this must be what this meant, so they fire off an e-mail. We interpret it in a completely different way. We don't have the luxury of a dialogue back and forth. Instead we have the aggravation of e-mails back and forth, one shot e-mails. So there was a tremendous amount of unclarity, and there was a lot of assumptions made about which party would do what, and who would pay for what, and what the end result would be, and basically people's role's roles would be (…)"*

And finally, sequentializing introduces artificial hand-offs that tend to be sticky. Teams often work on ill-defined problems that require more specific local knowledge than for instance baton passing in a relay race (which could already be challenging). Sequentializing intense collaboration might increase stickiness and uncertainty, and require very tightly coupled hand-offs to cater for knowledge transfer. Hand-offs demand intense coordination to unsticky knowledge related to the work just completed and about to be continued by someone else. In a sense, sequentializing means a return to the old days of waterfall development (Beynon-Davies, Carne, Mackay, & Tudhope, 1999), with its negative connotation of limited adaptation, limited information processing capacity, and careless throwing work over the wall (Clark & Steven, 1994).

Strategy 2 - Using Representations and Mediating Artifacts: Reducing Stickiness and Uncertainty

With the second strategy, the locus of intense collaboration shifts from interpersonal interaction towards technology mediated teamwork. Individuals participate in digital environments – also called virtual environments – that represent and connect their own to others' contributions. CASE repositories in systems development are an example of such environments (Orlikowski, 1993). Another, more spectacular example is Boeing company's use of design visualization and repository software in designing the Boeing 777 aircraft. Boeing used CATIA software to develop and test a completely digital version of the Boeing 777 aircraft (Bouwman, 2004; Sabbagh, 1996). The system identified task and component dependencies and potential design conflicts between teams, and notified those involved. Projects aimed at developing and deploying artifacts such as new products, Information Systems, or marketing campaigns benefit from extensive environments for representation, testing, simulation, and modification. For instance, in the Apollo 13 project, NASA could simulate the spacecraft's situation and develop new emergency procedures in Houston without extensive contact with the space crew. More recently, digital environments have evolved at a rapid pace to include immersive 3D interactive mockups (Bao, 2002). Similarly, sharing of 3D brain imaging technology enables tele-health conferences, consultation and surgeries. Von Hippel (1994) points at the role of user-friendly Computer-Aided Design (CAD) technology in the business-to-business silicon industry that enables customers to design their own products instead of interacting with development engineers. Intense collaboration changes from a person-to-person undertaking towards person-technology-person work.

Virtual environments decontextualize work from local settings, individuals, technology, and time. Individuals from different corners of the world can access these digital environments at any time and observe how the work is proceeding (Ciborra et al., 1996; Malhotra, Majchrzak, Carman, & Lott, 2001). The evolving artifact becomes a boundary object that substitutes for interpersonal communications. It reduces stickiness of work and task uncertainty.

Apart from these advantages, researchers also report some disadvantages of this strategy. They found that some teams complained about the transparency associated with digital environments (Ciborra et al., 1996). Other than oral communications, developmental processes evolve in a digital environment and are potentially accessible for any project stakeholder. Therefore private areas of solitary, risk-free experimentation, unless specifically designed for, may not be available to team members. Furthermore, some digital environments, in addition to providing a joint representation and the ability to access and modify it, also try to formalize and structure the interaction processes between the team-members. They may automatically direct or channel notifications, communications, and observations, and impose controls that are contrary to the common modes of intense collaboration in development teams that rely on fluidly evolving informal conversations and impromptu meetings (Malhotra et al., 2001). This may disrupt the working style of the team thereby introducing inefficiencies in the work processes.

Strategy 3 - Modular Work Division and Integration: Loosening the Coupling of Work

Sometimes teamwork can be split up into independent chunks that can be performed in parallel. This applies to cases where coupling is loose and intense collaboration is not a primary necessity. Examples include large scale projects such as software development where people assemble separate modules in daily builds to test integration (Cusumano, 1997). Aircraft engineering

consists of multiple components that can be developed in isolation within predefined standards (Galbraith, 1973).

Modular work packages can be assigned to sites in order to minimize cross-site coupling and the need for intense collaboration (van Fenema & Kumar, 2000). A precondition for this strategy is that a task architecture can be fixated in advance, and that uncertainty is limited (Henderson & Clark, 1990; Sanchez & Mahoney, 1996). Otherwise, people must regularly check to make sure that their piece of work fits in the whole (Loch & Terwiesch, 1998) – like hitting a moving target.

Partitioning and parallelizing work requires that at the end of all work activities, all partitioned work elements are brought back together and integrated. Unless the partitioning was perfect, a high level of intensity is generated at the time of integration when the separately produced work units are adjusted to each other and sometimes re-worked to fit with each other. Thus this strategy, while reducing continuous simultaneous intensity, results in a burst of intense collaboration at the time of integration.

STRATEGIES FOR *ENABLING* INTENSE COLLABORATION BETWEEN SITES

With the second set of strategies, organizations realize that there is no escaping intense collaboration. Intensity cannot be reduced in cases where people must discuss different perspectives on complicated or sensitive issues. Sometimes time pressure and criticality of an issue (PR concerns, disturbance of financial markets, disasters, and political sensitivity) makes

real-time contact necessary. The two strategies discussed here are simultaneous virtual collaboration, and boundary spanning.

Strategy 4 - Real-time Remote Interaction: Virtual Waltzing

Advanced telecommunications infrastructures support real-time communications through technologies such as teleconferencing, videoconferencing, videowalls, real-time distributed groupware sessions, desktop sharing, chatting, GPS, satellite communications, and interpersonal radio communications. Fast moving representations of a remote counterpart (phone, videoconferencing) offer to some extent the impression of real-life collocated interaction. People use synchronous rather than asynchronous technology for what Markus (1994) calls "the personal connection". One of the respondents in her research remarked:

> *"We (each of my direct subordinates and I) talk (on the telephone) once a week whether we need it or not (i.e., for work-related issues). We talk for different reasons than we message. We talk for the personal connection (…). Mail messages don't work if it goes on too long (without telephone or face-to-face interaction). We have to talk once a week or it gets impersonal."*

Real-time contact across sites demands adaptation of local working life. In our own research on a multi-site software implementation project, people in Singapore waited until late at night to talk to US-based experts in urgent cases:

"It depends on how critical the issue is. If we say that it is a critical issue and the US person has to support us, then we really stay back till late and we try to call and solve the problem over the phone. When the problem is critical you can solve it very fast."

People must also adjust their way of communicating to real-time communications. Electronic media have led to new protocols and norms for interpersonal interactions. After the introduction of the telephone, people had to learn how to take turns in telephone conversations between two or more sites. Similarly, Abel (1990: 499-500) quotes a Xerox researcher mentioning rules developed at Xerox Palo Alto Research Center (PARC) for effective videoconferencing between Palo Alto, CA and Portland, OR:

"We have become sensitized to the different social protocols of the link. For example, we have adapted to the technology in giving cross-site demos in the following ways:

- *Wearing bright colors to give more cross-site presence,*
- *Preparing ahead of time because glitches are much more difficult to deal with over the link (the communication mechanism and demo are using the same channel),*
- *Trying not to move too much so that the video compression doesn't dominate the conversation,*
- *Doing things "on cue,"*
- *Speaking loudly, and choosing carefully when to speak, etc"*

In our research we found that teams deploy multiple technologies for intense remote collaboration. A respondent from the software implementation project described how she used

Windows NetMeeting to operate a remote colleague's machine while conducting a teleconference:

> *"We can have this setup on our PC called Windows NetMeeting where we can run an application and they can see what I am doing here. So I can give a demo to them. It's quite good. Anytime they can take over control of the application. So if they want to show me something, sometimes it's very difficult for them to tell me over the phone what they have done and what problems they have encountered. So they can simulate and we can see on the screen after which step they will hit this problem. It's a very good tool. We use the speaker, we can just talk like that."*

Strategy 5 - Boundary Spanning

And finally, a fifth strategy relies on people as representatives between sites. Information processing theorists introduced the idea of a linking pin to improve coordination between organizational departments (Galbraith, 1973; McCann & Galbraith, 1981). People performing this role move back and forth between two worlds, for instance between R&D and marketing. The concept has gained new relevance in an era of globally dispersed teams. This time boundary spanners are not connecting functionally diverse departments but sub-groups at far flung sites working on the same project. They travel thousands of miles to meet with their project counterparts. Some operate more like ambassadors, a strategy fine-tuned by multinational firms who appoint ex-pats to their sites in the Far East, Africa and South America (Edström & Galbraith, 1977). Currently, Indian software vendors parachute skilled professionals close to or even directly at their Singaporean and western customers' sites to work with local teams. These ex-pats have the geographical advantage of easy access to customer contacts, and the experiential

advantage of intimately knowing their co-workers back in India (Carlson & Zmud, 1999). Meadows (1996) found that representatives from offshore vendors traveled to Europe at the beginning of a project to gain insight in the customer's context and perspective. This social capital was leveraged during subsequent periods of remote collaboration:

> *"When I was on-site at the beginning of the project, we developed our "common language." Then, when the client came here, we had no problems communicating. Now, I understand European clients better. I can usually assess whether perceptions are in synch, and I can foresee and try to preempt some problems" (Offshore Manager, Transportation Co. #1 Project).*

Some researchers found that boundary spanning introduces new problems. The role of boundary spanning is very taxing because he must handle a variety of work processes that require multiple competence sets. Boundary spanners form an additional hub in inter-site communication processes. This indirectness may delay and distort communications as illustrated in Meadows' (1996) research:

> *"The risk is that we (offshore team) do not talk directly to the user (onshore), so the level of interpretation is high. Our on-site coordinator interprets what the users say and passes it to us, and we interpret what he says. It's just like the telephone game (Offshore Manager, Computer Co. #5 Project).*

In our research, an Indian offshore staff member who worked on a project for Ford USA and Europe complained about a multi node communication chain:

"When the information goes from the users (in the US) to JF (also in the US, IT department), to HN (European IT department), to BW (representative of vendor at European IT department), to us (offshore team), it can get distorted or diluted. When one person in the link has not understood what the user meant, it will show in the product. Errors in understanding will be passed down the link."

THE ART OF STRATEGY SELECTION, COMBINATION AND DEPLOYMENT

Managers of globally distributed teams can select, combine and appropriate the five strategies that emerged from current research.

The first strategy of sequentializing teamwork is useful when time pressure is high and people must work in a continuous mode. They can pass on work from east to west, that is follow the sun (Carmel, 1999; Carmel & Agarwal, 2002; Kumar & Willcocks, 1996). On the other hand, the lack of synchronous contact puts the pressure on daily hand-offs.

Companies can benefit from the second strategy based on virtual environments and mediating artifact when they work on projects that demand information sharing, visualization and simulation. Examples include global architectural projects, NPD, and software teams. Virtual environments offer rich spaces for collaboration to professionals with a similar community background (e.g., Linux developers, engineers, architects, etc.).

Companies deploy the third work partitioning and parallelization strategy when working on large scale projects that can be split up in loosely coupled modules. Infrequent contact between representatives of sub-teams can ensure sufficient coordination between sites (Ayas, 1996).

The fourth strategy of using technology for creating real-time remote interaction is useful when there is no option but for all team members to jointly work and deliberate simultaneously. This is often the case when multiple ideas and views need to be confronted and tested against each other, and when expression of some idea evokes or stimulates other related ideas in real-time. Team members often tend to favor this strategy when they kick off a project or when sometimes they get stuck during the project. Diverse teams working on complex tasks may need this type of strategy to promote cross-site learning and align different points of view (Boland & Tenkasi, 1995).

Companies deploy the final boundary spanning or linking pin strategy in the case of large scale projects that need boundary spanners for maintaining overview of inter-site communications. Many offshore outsourcing vendors offer boundary spanners as a service to western customers. These multi-skilled people promote shared understanding between customer staff accustomed to European, North American, Japanese and Singaporean culture on one hand, and vendor staff in China, India, Eastern Europe or the Philippines on the other hand.

Finally,

IMPLICATIONS FOR RESEARCH AND PRACTICE

In this paper we have developed the idea of collaboration intensity and examined the impact of global distribution of teamwork on this intensity. In addition we have identified a number of strategies that are being used by global teams to manage the intense collaborations.

The ideas presented in this paper are useful for both researchers and managers of globally distributed teams. From a research perspective, the paper introduces two ideas that are not common in the literature on teams. First, instead of examining teams from an organizational behavior perspective such as relationships, trust, leadership, power, conflict, cohesion, and team building, the paper takes a work-perspective on teams. It explains how collaborative intensity differentiates teamwork from other forms of work and examines teams from a work design perspective. Thus it connects the idea of teams with potentially rich streams of research dealing with work-design, coordination and control of work, and technology-support for work, thereby enlarging the scope of research in this complex area. Second, it introduces and unpacks the concept of collaborative intensity. Since Van de Ven et al.'s landmark 1976 paper, the concept of intense or team dependency has been accepted as part of ideas on work and coordination design. However, the concept of intensity has not been examined beyond its temporal definition stated in the Van de Ven article. This paper, by defining collaboration intensity as the level and frequency of interactions, provides an operational definition of intensity and leads us into an examination of various sources of intensity in teamwork. Thus it provides a basis for differentiating teamwork from non-team work carried out concurrently but in a solitary manner by a number of individuals.

From the perspective of managers, the concepts of collaboration intensity and its four underlying dimensions presented in this paper, provide the manager with a basis for understanding and assessing the demands for intense teamwork. Managers can use these dimensions to assess the sources of intensity in a team environment and evaluate the potential impact of global distribution on teamwork. Moreover, by outlining intensity reduction and intensity enabling

strategies for managing intensity in a collaborative situation, the paper provides managers with guidance in the design of distributed teamwork. Finally, by providing the managers with concepts that can help them identify low collaborative intensity situations, it helps them avoid the unnecessary creation of a team and its associated overheads where a team may not be the most appropriate form of organizing.

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TABLES AND FIGURES

		Cultural diversity: Low	Cultural diversity: High
Physical separation	Collocation	Collocated mono cultural team E.g. A local Mexican basket ball team	Collocated diverse team E.g. collocated multicultural surgery team
	Distributed	Globally distributed homogeneous team E.g. multi site all Indian software team	Globally distributed diverse team E.g. multi cultural international product development team

Table 1 Defining multi-national and globally distributed teams

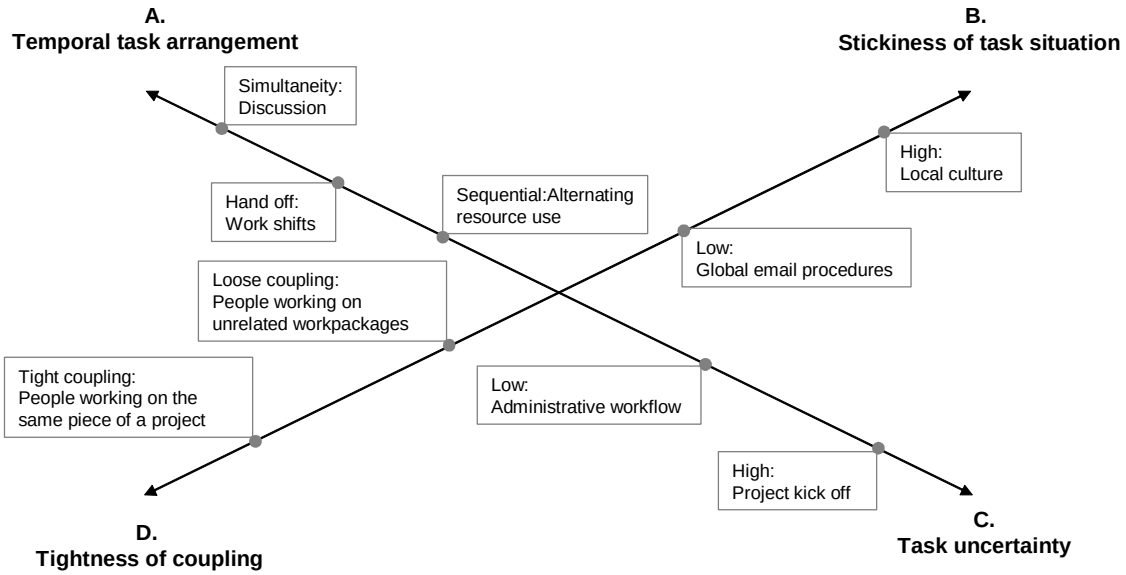

Figure 1 Interpersonal collaboration: four dimensions

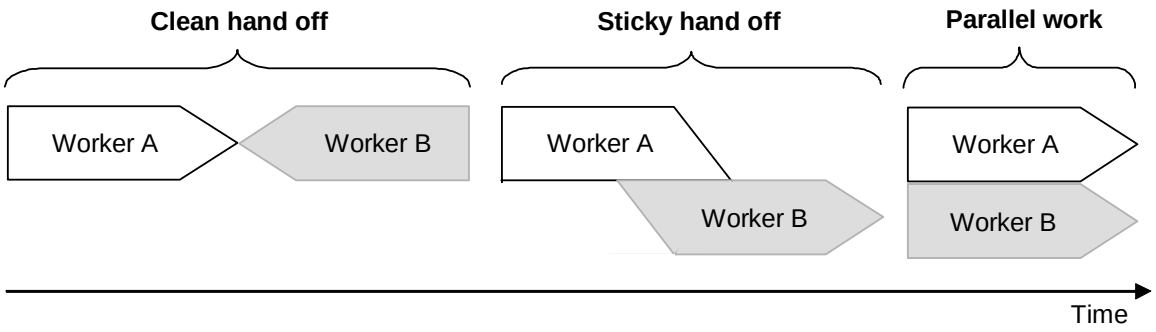

Figure 2 Temporal arrangement of work accomplishment

Dimensions		*Examples of teamwork*					
		Relay racing team	*Basketball team*	*Formula 1 pitstop team*	*Team of heavy material movers*	*Co-authoring an article*	*New Product Development team*
A.	Simultaneity of work processes	Sequential except at hand-off	Sequential and simultaneous	Sequential and simultaneous	Simultaneous	Sequential and simultaneous	Sequential and simultaneous
B.	Stickiness of task situations	Low	Low	Low	Low	High	High
C.	Task uncertainty	Low	Medium	Low	Low	Depends on task	High
D.	Tight coupling of tasks	High at hand-off, other times none	High	High and low (people working on different wheels)	High	High	Depends on task requirements

Table 2 The dimensions of intense collaboration applied to examples of teamwork

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