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Task Bubbles, Artifacts, Shared Emotion, and Mutual Focus of Attention: A Comparative Study of the Microprocesses of Group Engagement

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Based on a comparative field study of two software development projects, we use ethnographic methods of observation and interview to examine the question of how interdependent individuals develop and maintain mutual focus of attention on a shared task, which we define as the group engagement process. Drawing on Randall Collins' interaction ritual theory, we identify how mutual focus of attention develops through the presence of a task bubble that focuses attention by creating barriers to outsiders and through the effective use of task-related artifacts. Shared emotion both results from mutual focus of attention and reinforces it. Through our comparison between the two projects, we show that the group engagement process is enabled by factors at the individual (individual engagement), interaction (frequency and informality of interactions), and project (compelling direction of the overall group) levels. Our focus on group interaction episodes as the engine of the group engagement process illuminates what individuals do when they are performing the focal work of the group (i.e., solving problems related to the task at hand) and how they develop and sustain the mutual focus of attention that is required for making collective progress on the task itself. We also show the relationship between the group engagement process and effective problem solving.

Key words: work engagement; groups; interaction ritual; problem solving; qualitative
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Introduction

Groups must often perform at high levels to solve everyday problems in organizations. For this, group members need to engage with one another and to develop and maintain mutual focus of attention on a task. Consider, for example, a team of computer software engineers, working together on the complex, lengthy, and interdependent task of building a new software product. Solving problems that arise in creating a new product such as this often involves not just the solitary contributions of individuals but also important interactions between individuals because these engineers both "translate" their code for others and pool their knowledge and insights in order to achieve breakthroughs. Harnessing the motivation and individual engagement of individuals and transforming it into seamlessly coordinated group engagement is often critical for group members to effectively solve problems together. But this is hard work, and many teams never achieve the high levels of mutual focus of attention that are required.

Existing research on groups and teams suggests that providing the right inputs, such as the knowledge and skills, performance strategies, and individual effort and motivation on the part of team members, is needed for teams to perform effectively in solving problems (Hackman 1987). Moreover, scholars of groups and teams point to important processes designed to motivate people and give them the information and resources they need to perform the group task effectively (see Marks et al. 2001, LePine et al. 2008). These processes include inspiring team members to work harder and in a more coordinated fashion by specifying goals, managing conflict so that team members can focus on the work, and monitoring the progress of the team and availability of resources so that the team has the support it needs to advance. Such processes are important for ensuring that team members are not distracted by non-task-related factors (e.g., interpersonal conflict, a lack of resources) so that they can focus effectively on the task at hand. However, much less research has examined what individuals do when they are performing the focal work of the group (i.e., solving problems related to the task at hand) and how they develop and sustain the mutual focus of attention that is required for making collective progress on the group task itself. The few studies that directly examine task-focused group interactions have studied processes related to communication, interruptions, knowledge sharing, and the timing and sequencing of individual actions (e.g., Bechky 2003a; Gersick 1988, 1989; Okhuysen 2001;

Okhuysen and Eisenhardt 2002). Implicit in these studies that examine task-focused group problem solving is the assumption that group members are mutually focused on the task at hand. However, this implicit condition of mutually focused attention is an important assumption that deserves attention in its own right. Understanding how group members develop and sustain mutually focused attention over time in complex interdependent teams may be a critical condition for determining which groups can collectively make progress and effectively solve group problems and which groups cannot. Thus, in our study, we illuminate this process and focus on how group members engage with each other to achieve mutual focus of attention on the task at hand. We define *group engagement* as the process by which interdependent individuals engage with each other around work tasks to develop and maintain mutual focus of attention in an interaction episode, and we suggest that it enables more effective problem solving.

A key aspect of our approach is that we identified interaction episodes that occurred between group members as the critical level of analysis needed to understand this phenomenon. Thus, our work departs from a central assumption in much of the existing research on groups, that group process should be examined in teams and even subgroups whose membership is stable and bounded (Hackman 1987, cf. O'Leary et al. 2011). However, in organizations, a main challenge of group work is that the process takes place over time and often with a changing set of actors. People join the group and leave. Work gets done in subgroups with different combinations of group members, based on the needs of the task. Consequently, our study takes a more fluid and dynamic approach, examining how people get work done by interacting with one another in temporary subgroups that quickly emerge and re-form based on the specific task at hand. A focus on group interactions is critical for understanding the group engagement process primarily because it is in these interactions of a subset of the team members that problem solving often occurs (Bechky 2003a, Hargadon and Bechky 2006, Okhuysen and Eisenhardt 2002). Thus, if we want to understand how people develop and maintain mutual focus of attention on a group task, the place to look is in the interactions between group members. Indeed, it was in interaction episodes, consisting of dyadic, triadic, and larger interactions, that we observed the microprocesses of how group engagement was built. Using an ethnographic approach and a comparison of two software development projects, we examine groups that were highly engaged with each other and those that were not, and we show the elements that make up the group engagement process as well as its enabling conditions and consequences for problem solving.

Group Engagement: Theoretical Underpinnings

Prior literature can inform our conceptualization of the group engagement process in several ways. First, although we focus on group engagement—that is, individuals engaging with one another—it is important to recognize that individual-level factors such as group member motivation and engagement with work roles are important (Kahn 1990, Rothbard 2001), particularly in the case of innovative, creative work, characterized by ambiguity such as research and development and product innovation. Individual engagement is a motivational construct that focuses on the work itself and is associated with high levels of activation. Rothbard (2001) defines engagement as having two main dimensions: focus of attention, or the amount of time spent thinking about work; and absorption, defined as the intensity of one's work involvement. Thus, synthesizing past research, we define individual engagement as a person's cognitive focus on a role or task that includes both the focus of attention and the intensity of that attention. The vast majority of research on engagement has been done at the individual level (Kahn 1990, 1992; Rich et al. 2010; Rothbard 2001; Schaufeli and Bakker 2003, 2004; see Rothbard and Patil 2012 for a review). However, although recent research suggests that engagement with work tasks may also be a property of groups (Drazin et al. 1999, Hargadon and Bechky 2006), to our knowledge no study documents the phenomenon in detail.

At the core of the question of group engagement is the sense that groups need strong collective motivation and a common focus of attention for problem solving. Although there is a voluminous literature on individual motivation, little research examines the notion of collective motivation,[1] with the exception of research on motivation gains (Ringelmann 1913). Research on motivation gains asks the question of how individual effort, which is akin to individual engagement, translates to group-level outcomes. This literature suggests that the whole can be more than the sum of the parts, i.e., that motivation gains can be found in all kinds of tasks, from simple physical tasks (Köhler 1926, 1927; Hertel et al. 2000) to complex cognitive tasks in a laboratory setting (Hertel et al. 2003). The research on motivation gains suggests that because people feel socially accountable to one another, they increase their individual efforts and try harder, but it does not explicitly address how these individual efforts get coordinated as people interact with one another in their efforts to solve everyday problems in organizations. Thus, in this literature there is the hint that task-focused interactions among group members are important, but it is not the focus of the research.

Indeed, as we move to the collective level of analysis, coordination of effort and group cognition become critical factors in understanding how individual efforts are transformed into collective ones. There are a number of coordination processes that have been examined by

the groups literature that can help us conceptualize what highly motivated people do when they interact with one another as they collectively engage to solve group problems. These processes include the synchronization of group activities through sequence and timing (see Marks et al. 2001, LePine et al. 2008); the notion of collective mind, which serves as an intragroup communication process (Wegner et al. 1985, Weick and Roberts 1993); and research on transactive memory systems, which has shown that interaction patterns play an important role in group problem solving because they allow group members to retrieve not only individual information but also knowledge about others' expertise and ways of doing things (Liang et al. 1995).

The literatures discussed above have informed our understanding of the importance of both motivation and coordination for group problem solving and effectiveness. However, they tend to look at teams with stable and bounded group membership (Hackman 1987). Moreover, these literatures tend to focus on the processes that relate to setting teams up for successful interactions rather than looking at the task interactions themselves (Marks et al. 2001, LePine et al. 2008). However, we contend that a focus on task-related interpersonal interactions is critical for understanding the group engagement process. Indeed, reviews of group process and dynamics (Marks et al. 2001, Weingart 2012) have highlighted the importance of task-related dyadic and group interactions as well as the paucity of such research since early classic work by Bales (1950) and Bales and Strodtbeck (1951). There are a few recent studies that have highlighted the importance of group interactions for problem solving and task advancement. For example, research on transactive memory systems (e.g., Liang et al. 1995) explicitly highlights the importance of groups interacting together when training and later when performing for the exchange of tacit knowledge. Moreover, Gersick's work (1988, 1989) shows that particular types of interactions, those occurring at the midpoint in a group's life, are essential in focusing and defining the task. Okhuysen (2001) finds that interruptions in groups (which take the form of non-task-based interactions) lead groups to approach their tasks in ways that are more flexible, leading to greater change in how the group approaches the task. Okhuysen and Eisenhardt (2002) provide one of the few examples of research that explicitly examines task-based group interactions and find that interventions that prompt group members to question others and better manage their time improve knowledge integration in groups by leading to richer interactions.

In addition, there are several qualitative studies that illuminate what happens within group interactions. For example, Hargadon and Bechky (2006) find that specific types of interactions are instrumental in bringing about moments of collective creativity in groups; through help seeking, help taking, and reflective reframing, highly focused individuals are able to coordinate and pay attention to one another's needs, willingly assist the work of others, and respectfully attend to and build on the comments and actions of others. These moments of collective creativity are instantiated in highly focused, intense dyadic, or small group interactions that occur repeatedly in the groups they studied. The importance of both coordination and motivation is also apparent in the intense dyadic and group interactions observed in Murnighan and Conlon's (1991) study of string quartets, whose "collective task is to reach a high level of coordinated sound" (p. 166). These string quartet members were highly attuned to one another and to one another's music, both cognitively and emotionally: "The ability to listen and respond to each other was the most important characteristic that differentiated quartet players from soloists" (Murnighan and Conlon 1991, p. 165). Implicitly, the success of these quartets rested on particular types of interactions among their members, interactions characterized by members' focus on one another and on the task, as well as their emotional responses to one another. By examining the ways in which these groups interacted together, both the Hargadon and Bechky (2006) study and the Murnighan and Conlon (1991) study give us new insights into what group members do in order to collectively focus their efforts and engage with one another to perform effectively.

Studies such as those discussed above have pointed to the importance of examining group interactions—in all their cognitive and emotional richness—to better understand problem solving and task accomplishment. However, the microprocesses of interaction among individuals and how these interactions lead to collective or mutual focus of attention on the task (i.e., group engagement) have not been explicitly examined. Because solving complex interdependent problems in groups can require synchronized focus of attention, it is important to understand how mutual focus of attention is fostered. Our study follows the qualitative tradition of examining what happens in group interactions and adds to it by focusing on how mutual focus of attention is developed and leads to problem solving in everyday group interactions.

Interaction Ritual Theory as a Lens for Understanding Group Engagement

Despite the importance of examining group interactions, much of the research on groups has not extensively examined the dynamics of groups at the interaction level (Hackman 1987, Weingart 2012). As a result, to understand what people do to foster mutual focus of attention, we turned to a theory that explicitly focuses on interactions as the critical unit of analysis—Collins' (1990, 2004) interaction ritual theory. Building on the classic work of Durkheim ([1912] 1965) and

Goffman (1967, 1969), Collins' (1990, 2004) interaction ritual theory provides useful building blocks for understanding what people do when interacting and how that leads to greater mutual focus of attention.

Collins' (1990, 2004) theory of interaction rituals is firmly rooted in the interactional situation as the unit of analysis and examines both the cognitive and emotional elements that pervade such interactions. Collins defines interaction ritual as "a mechanism of mutually focused emotion and attention producing a momentarily shared reality, which thereby generates solidarity and symbols of group membership" (2004, p. 7). He contends that successful interaction rituals are characterized by collective effervescence and that a set of factors—mutual focus of attention, shared emotion, bodily copresence, and barriers to outsiders—leads to collective effervescence and enhances individual emotional energy. In his theorizing, mutual focus of attention means that people attend to "the same . . . activity, and [have] mutual awareness of each other's attention" (Collins 1990, p. 31). Shared emotion refers to the common mood or underlying tone rather than to dramatic emotions. Bodily copresence means that people in the interaction have close physical proximity (Collins 1990, 2004). Last, the idea of barriers to outsiders refers to the boundaries that protect interaction participants from those who could weaken the mutual focus of attention and emotion (Collins 1990, 2004). Collins contends that people get energized by mutually focused interactions and that they will seek them out time and time again in chains of interaction rituals. Interestingly, this claim is supported by research in psychology that has found that cognitive stimuli affect energetic arousal (Thayer 1989, Haidt 2000). Interactions with others are among such stimuli, and Thayer (1989) gives an interesting conversation as an example of a stimulus that can affect energetic arousal. Furthermore, being part of or simply witnessing positive, helpful interactions in which people are focused on one another's needs affects not only one's subjective state of energy, triggering the positive emotion of elevation, but also one's own behavior (Haidt 2000).

Collins' largely theoretical work on interaction rituals provides an important starting point for our examination of the group engagement process. It helps us understand in a systematic, theoretically informed manner the microprocesses of how interactions in a group can affect the group engagement process and lead to mutual focus of attention in a group. It is a useful framework for several reasons. First, it places primary importance on the situational interaction understood "not as a cognitive construction but as a process by which shared emotions and intersubjective focus sweep individuals along" (Collins 2004, p. 32). Second, it takes into account both the cognitive focus of attention and the emotion involved in intense interactions of the type we saw in the settings we observed. Third, by acknowledging the reciprocal relationship between mutual focus of attention and shared emotion, Collins' framework captures the dynamic nature of these interactions and their effects on group life. In other words, the process of group engagement that emerges temporarily in interaction episodes can, in some cases, have more prolonged effects as the outcome of these interactions feeds into future interactions.

Collins' (1990, 2004) interaction ritual theory, although quite relevant to our research question about how group engagement gets built, has not explicitly examined everyday workplace interactions. In the few cases where Collins does examine work settings (e.g., firefighters after 9/11), the outcome that he focuses on has been the emotional energy created from mutual focus of attention in an interaction. Thus, we extend this theory by examining the microprocesses of how mutual focus of attention develops and is sustained in a work setting where groups repeatedly interact to solve everyday work problems.

Our study provides an in-depth inductive examination of the process of group engagement, how it develops, what conditions enable its development, and its consequences. To briefly preview our findings, group engagement, defined as the process by which interdependent individuals engage with each other around work tasks to develop mutual focus of attention, was developed through the effective use of task-related artifacts that helped develop shared understanding and the presence of a task bubble that focused attention through barriers to outsiders. Shared emotion both resulted from mutual focus of attention and reinforced it. Individual-level, interaction-level, and project-level factors such as individual engagement, the frequency and informality of interactions, and the presence of a compelling project direction were conditions that influenced whether people were able to engage with each other and develop mutual focus of attention in groups. We also found that developing group engagement resulted in effective problem solving.

Methods

To form a grounded theoretical understanding of how groups develop and sustain group engagement, we studied two work settings in which group engagement was important for group outcomes. Both settings needed employees to be highly engaged with their tasks as well as with their coworkers. Thus, we followed a strategy of theoretical sampling (Strauss and Corbin 1990) to compare processes of group engagement in two software development projects, "Shield" and "Gateway," that were similar in several essential dimensions. However, by comparing these projects, we were able to study work processes in different settings, increasing the likelihood of generating robust theory.

Data Sources

Over five months, the first author conducted a field study using ethnographic methods of observations and interviews at Shield and Gateway.[2] She spent a total of two weeks at Gateway and six weeks at Shield (1–3 weeks at a time, 5 days a week, 8–12 hours/day). The initial research question was broad, focusing on the group processes that led to effective teams. At the time observation began, the two projects had been in existence for three or four years, and both were going through major changes in their architecture and design.

As soon as the researcher arrived at each site, the project managers introduced her to all the developers. At Shield, the engineers worked in individual offices, most of which were adjacent. Many developers also worked in the lab, either individually or in small groups. The researcher stationed herself in this lab, which was located in the middle of most developers' offices. From this central hub of activity, she was able to observe numerous interactions, which she often followed into engineers' offices. At Gateway, the majority of developers worked in individual offices; several worked in cubicles. The pattern of location of offices and cubicles was more dispersed than at Shield.

Observation. The fieldwork included observing interactions among software developers—the researcher was rarely a participant, although on a few occasions, she was asked to "test" a website or to check a document. In the field, whenever the researcher saw two or more developers working together or having a work-related conversation, she would approach them and take notes. At the end of such interactions, she would ask participants to give her their interpretation of the event. The researcher also participated in numerous design and strategy meetings (with the entire team or with a smaller group), in several conference calls, and in social events. In the field the researcher took handwritten notes, which she typed up each evening. The goal throughout the fieldwork was to obtain a variety of perspectives from many different participants, as recommended by the grounded theory approach developed by Glaser and Strauss (1967).

Interviews. In addition to observation, the researcher also conducted a series of semistructured interviews while in the field. She interviewed each developer at least once and most of them twice, in addition to the numerous informal conversations that occurred while she observed the work. The initial semistructured interview occurred at the beginning of the observation period, and it lasted between 30 minutes and 2 hours. Developers were asked to describe their work, their views of the project, the types of interactions with coworkers, and how interdependent their work was with others'. During this initial interview, the researcher assured developers of the confidentiality of all data about to be gathered. The last interview occurred before the end of the observation period.

Analytic Approach

There are few models for comparative field studies, even though their benefits for advancing knowledge have long been recognized (Barley 1986, O'Mahony and Bechky 2006, Strauss and Corbin 1990). For specific ways of performing comparative field studies, we used Barley's (1986) study of technicians, as well as a recent study by O'Mahony and Bechky (2006) on contract workers. For basic guidance on collecting and analyzing qualitative data, we relied on Glaser and Strauss's (1967) method of comparing and contrasting work episodes and interpretations.

There were two main stages of data analysis. The first was performed by the field researcher as she observed the two projects. To make sense of the data collected, she performed periodic analyses that resulted in the creation of categories such as engagement, which were then further developed and researched. As the main theme of engagement emerged clearly from the data, the researcher wrote periodic memos in which she developed specific subcategories such as the presence of outsiders, focused interactions, and group engagement. To gain depth and richness in the analyses, she looked for disconfirming evidence for the categories and patterns she was observing.

The second main stage of the analysis occurred after the fieldwork was completed, when both authors analyzed the data (field notes, memos, artifacts) separately and then in concert. They determined that the process of developing and sustaining group engagement—how the group members engaged with each other to develop and sustain mutual focus of attention—was an important feature to consider in understanding these teams. In particular, in the second stage of analysis, each author analyzed the data pertaining to the two projects, trying to understand the main processes and issues in each. In this step, the importance of group engagement for understanding the two groups became clearer. Although the striking differences in the feel of the two projects, and in their final results, were obvious to the field researcher, it was at this point that both authors concluded that group engagement was a key process that explained differences in the dynamics of the two groups. Within each project, we found evidence of the elements that fostered group engagement (the task bubble, use of task-related artifacts, compelling direction, informality, and frequency of interactions). Through numerous discussions and refinements of the categories developed individually, we agreed on the main categories that made up the group engagement process.

Once the process of group engagement became clearer, we went back to the data to check the similarities and differences between the groups. For example, once

we determined that interaction informality was important, we analyzed all the interactions to determine the effect of informality on group engagement. At this point in the data analysis, our analyses revealed systematic and enduring differences between the two projects. Thus, the examples we use in the text are but a few from a much larger set.

Overlaid with these complex data analysis procedures was an iterative process of studying the relevant literature in light of our findings, as well as analyzing the data while taking into account the concepts advanced in existing studies and in light of our own concepts. A big breakthrough in our conceptualization came from the realization that interaction episodes constituted the appropriate level of analysis and that the theory of interaction ritual was particularly useful because some of its categories mapped onto the categories that emerged through our inductive analyses.

Research Settings

The two projects we examined, "Shield" and "Gateway," were part of a Fortune 500 company, TechCo (a pseudonym), headquartered on the east coast of the United States.[3] Shield was a suite of software components that provided an end-to-end solution for the tracking and protection of digital property rights over the Internet or within a corporate intranet. It enabled content owners to attach rights and conditions to digital content such as documents or music files, enforced those rights during distribution, and tracked usage and royalties. Its main technological strengths were the language for expressing digital rights and the security component. The language for expressing digital rights was patented and licensed for free so that it could become the industry standard.

Gateway was a complex product aiming to allow fast and high-quality delivery of rich content and documents on mobile devices. It had two main components. The first was a conversion service that would convert all kinds of content (e.g., Word, PowerPoint, GIF, JPEG, PostScript) into a format that would be easily delivered and shared on various devices. It aimed at the low-end market, where the customers would install the software themselves and use it. The second component was a more complex and sophisticated product that aimed at the higher-end market, where jobs could be fairly complex but still automated, and could come with a lot of services.

Commonalities. The two projects, Shield and Gateway, were similar in many important respects. Both projects were developed and operated within the same company, TechCo. They addressed the same content area (digital rights management). Both were innovative projects in that they aimed to find new solutions to new problems. They were at the same stage of product development (the goal was to create a prototype by June). Both used a nonstructured development process whereby design and coding and the gathering of requirements happen iteratively rather than sequentially. Likewise, both were written in the same language (Java and C++) and used similar technologies (XML, Gini). Both projects were developing products that were composed of different interdependent modules—four in Shield, two in Gateway.

In both projects, although the developers themselves had great autonomy, the vast majority of the work depended on the rapid accomplishment of interdependent tasks. In part, this high degree of interdependence was due to the interactive nature of software development, which generated the need to coordinate among team members even after individual tasks had been carved up (Glass 1995). Interdependence was heightened in the projects because both products were going through a major rearchitecture at the time the researcher was observing them.

Table 1 provides demographic data for team members on the two projects. As the data in the table show, the two projects were comparable in terms of the number, age, and experience of collocated developers. Almost all developers held bachelor degrees in engineering; two developers in each project held doctoral degrees.

Last, individual engagement, a key motivational element for groups to do well, was also generally high across both projects. At both Shield and Gateway, we observed that the developers were cognitively focused, had high levels of attention, and worked hard on their individual tasks, demonstrating high levels of individual engagement in the work task.

Differences. Despite these commonalities, these projects differed in four key dimensions. The first difference was in the use of contractors. Although both teams used contractors heavily (for 50% and 60% of the development work at Shield and Gateway, respectively), the collocated presence of contractors differed. Shield relied on Indian contractors located in Bangalore (who came to the U.S. site occasionally), whereas Gateway's contractors were collocated with full-time TechCo employees. The collocation of full-time employees and contractors at Gateway made the contractors much more salient and integrated into the work processes at Gateway.

The second key difference between the two projects was the number of interactions observed among

Table 1 Demographic Information

	Shield	Gateway
Number of developers	13	19
Median age	33.6	38.5
Work experience (avg.)	108 months	139 months
Proportion of women (%)	23	32
Proportion of U.S.-born (%)	31	63
Proportion of contract workers (%)	0	63

Table 2 Interactions in the Two Projects

	Shield (%)	Gateway (%)
Time spent in interactions (avg.)	46	25
Range	20–75	5–50
Mode	50	10

Note. These percentages were determined by participants' responses to the question "What percentage of your time would you say you spend interacting with coworkers?"

Table 3 Types of Interactions in the Two Projects

	Shield (26 days)	Gateway (10 days)
Dyadic	56 or 2.15/day	6 or 0.6/day
Three developers	13 or 0.5/day	1 or 0.10/day
Four or more developers	14 or 0.54/day	7 or 0.7/day

Note. Interactions here include the instances people mentioned in interviews as well as the interactions that were observed.

developers. Whereas at Shield it was common to see small groups of developers working intensely together in front of a whiteboard, or at a computer, at Gateway such episodes were rare. Table 2 shows the number of interactions developers reported participating in across the two projects. The difference in the number of interactions was striking. In March 2000, U.S.-based engineers at Shield reported, on average, that they were interacting with coworkers about 46% of the time (the other 54% being spent working on their own), whereas at Gateway developers interacted on average only about 25% of the time. Moreover, at Shield there were many dyadic and three-person interactions that we did not observe at Gateway, as shown in Table 3.

Another key difference between the two projects was the degree to which group interactions were formal or informal. At Shield most of the interaction time was spent in "informal interactions," which occurred ad hoc, whereas at Gateway much more of the interaction time was spent in formal meetings, which we define as planned meetings with an agenda. Of the total interactions at Shield, 17% were formal (14 out of 83) compared with a larger percentage (42%) of formal interactions at Gateway (6 out of 14).

Last, a key contrast between Gateway and Shield regarded the degree to which developers felt there was a compelling direction for the project, an important element of team effectiveness (Hackman 2002). At Shield developers viewed the direction of the project as challenging and exciting, whereas at Gateway it was viewed as business as usual and not particularly meaningful. One Shield developer stated, "It's very exciting to me [to be working on Shield]. It does not happen very often to be working on something that grows, that has an impact, that doesn't disappear quietly—as so many pieces of software nowadays." In contrast, Gateway developers did not have the sense that their project was meaningful and exciting. As one developer said, "We are trying to catch up with HP [Hewlett-Packard], IBM, and Microsoft on this product. We're just trying to focus on TechCo's strengths, and do it better, faster, cheaper." Another Gateway developer stated, "The new commandment for the project looked a bit strange. It was like building Noah's Ark. The question is, for what? Would people need it?" These statements were representative of the general sense at Gateway that there was not a compelling direction for the project. The main similarities and differences between the two projects are presented in summary form in Table 4.

The Process of Group Engagement

The key elements that comprised the group engagement process were visible in the interaction episodes that took place between group members. Specifically, we observed

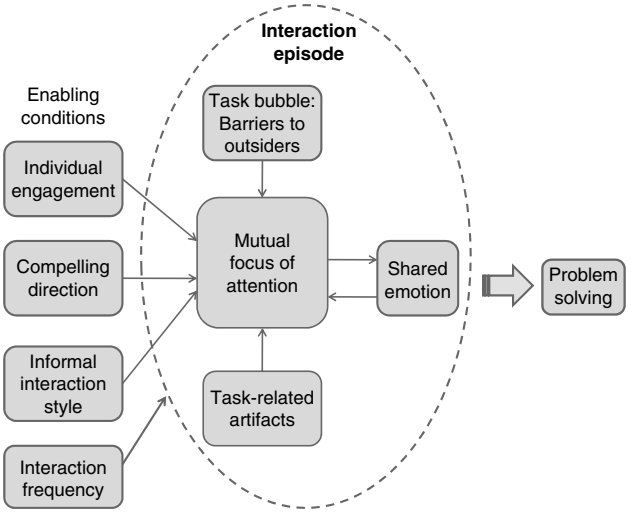
Table 4 Comparison of the Two Research Settings

	Shield	Gateway
Commonalities		
Same company	TechCo	TechCo
Type of product	Innovative; multiple modules	Innovative; multiple modules
Type of work	Nonstructured, interdependent, rapid-development project lacking clear requirements	Nonstructured, interdependent, rapid-development project lacking clear requirements
Type of workers	Highly educated, ethnically diverse, with average levels of work experience—as the data in Table 1 show.	Highly educated, ethnically diverse, with average levels of work experience—as the data in Table 1 show.
Individual engagement	High	High
Differences		
Presence of contractors	Less visible—Located in India	Highly visible—Collocated
Frequency of interactions	High	Low
Informality of interactions	Preponderance of informal, small interactions	Preponderance of formal, large interactions
Compelling direction	High	Low

that the group interactions where participants developed high levels of mutual focus of attention were characterized by three factors. First, they were characterized by the presence of a task bubble that created a barrier to outsiders, enabling group members to develop intense mutual focus of attention on a problem. Second, they were characterized by effective use of task-related artifacts that helped group members develop shared understanding and maintain a common focus of attention. Third, they were characterized by shared emotion that reinforced mutual focus of attention and sustained each group member's ability to continue to engage in intense group interactions over time. In analyzing our data, we observed that a number of factors that characterized the group engagement process related very closely to Collins' interaction ritual theory, which we described earlier (Collins 1990, 2004); some, however, such as the use of task-related artifacts, diverged from Collins' framework and arose inductively from our observations of the work context. Figure 1 illustrates the model that emerged from our findings.

As Figure 1 shows, the relationships among these elements were complex. They were also characterized by feedback, an aspect we discuss later in the paper. In this figure, the elements within the dashed oval refer to factors specific to each interaction. The elements that are to the left of the oval are enabling conditions that contribute to the likelihood of the interaction occurring and being characterized by mutual focus of attention. In our analysis we give exemplars of such interactions and show how each factor led to mutual focus of attention and, ultimately, to improved problem solving. At Shield there were many such interaction episodes, in part because of the number of interactions; at Gateway we saw fewer of these interactions, and our description of the enabling conditions may suggest why this is the case. To explain how this model emerged, we walk through examples of interaction episodes to show the elements that comprise the group engagement process and how they relate to one another.

Figure 1 The Process of Group Engagement



Development of Mutual Focus of Attention

To illustrate how mutual focus of attention developed, we use two examples of interaction episodes from Shield, where such episodes were frequent. The first interaction episode took place in the computer lab between two Shield developers—Allan, the project Web designer, and Juan, the system administrator—whose work was interdependent. This example illustrates how the task bubble, task-related artifacts, and shared emotion play a role in bringing about and maintaining developers' mutual focus of attention:

> At 3 P.M., Allan and Juan walked into the computer lab, talking. They went straight to two adjacent computers. For about 15 minutes, they alternated between working on their own, each at their own computer; browsing through code and Web pages; making modifications; and asking and answering each other's questions. At one point, Allan needed clarification about what the clients would see.
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> Allan pointed at his screen: "Does it have to look like this? When they [i.e., the users] 'submit,' are they going to a page like this, or do you know if they have a pop-up?" Allan raised his hands to make a gesture that mimicked a rectangular pop-up. Juan answered, touching his screen with his finger, to point to various icons: "This right here, at the top, and this right here, at the bottom. Just make it look like this, and I'll put the stuff in. Just work off of this one to make it look like this." Both had very intent facial expressions, and Allan leaned toward Juan's computer to see better; his nose was almost touching the screen. Then Allan sent some of his code to Juan. Juan examined it and pointed at the screen to determine exactly where his and Allan's code differed: "This is your stuff, right?" Allan again leaned very close to Juan's computer screen and followed the code with his finger: "Yeah, this is all form stuff." Allan pushed his finger onto the screen: "The info, here." Both looked at the screen. Juan ran another test. They got to the screen they wanted, after which they again got the message "unable to generate license." Juan reassured Allan, saying, "But that's fine. That one's working. We just need to figure out that last step." By this point they had solved some inconsistencies and identified the last modification they need to make. Allan was relieved. He smiled and said, "Then we'll do the same thing with the other one."
>
> From the time they walked into the lab, it had been 30 minutes. During this time, several developers came into and left the lab. Some glanced at Allan and Juan, but no one interrupted. Neither Allan nor Juan raised their eyes from their computers or from each other to look at the other people in the lab. Nor did they pay any attention to the researcher who was sitting next to them. After this 30-minute period, presumably because he understood a lot of things as a result of this interaction—including future steps to implement—Allan rushed out of

> the lab, only to return immediately with a pad of paper on which he started taking notes about what he had just done, checking with Juan to confirm that his notes were correct. This took another 15 minutes, in which they worked closely together, focused on the screen and on Allan's notes.

This apparently simple interaction episode illustrates many of the elements of the group engagement process that resulted in mutually focused attention. As Allan explained later in the day, the problem was old Java code "that was way, way in the back of it, but we [he and Juan] dug far enough to find and fix the problem." The help was given effectively, suggestions were made by Juan, and Allan understood what the problem was—all of which was facilitated by their working at adjacent computers on which each could see exactly what the other was seeing. The two developers were highly engaged, individually, with their work—Allan wanted to produce a good website that would be satisfactory to the client, Juan helped him do so. But what was striking about this example was the way the two developers were singularly and mutually focused on the problem they needed to solve and on each other. Each question was answered; each suggestion was acknowledged. Both were focused on the computer screen and keyboard, and later, on the screen and notepad. The intense focus of attention and their preoccupation with solving the problem was apparent to each other, as they were sitting physically close, with elbows virtually touching. Another behavioral manifestation of the intensity of their focus was that they leaned toward each other's computer, physically touched the computer screen as they pointed to lines of code where they thought the problem might lie, oblivious to the fingerprints they were leaving behind. This episode of intense mutual focus of attention lasted about 45 minutes, almost without break. Allan felt relief and joy as his problem got solved, and Juan was smiling along with Allan toward the end, clearly satisfied that he was able to help. This episode shows that the two developers shared both heightened *mutual focus of attention* and *positive shared emotion*.

An important element that helped these two developers maintain their mutual focus of attention was the fact that they did not interrupt their interaction, nor were they interrupted by outsiders. They were effectively in a *task bubble* where the world was shut out. The field researcher was sitting right next to them, and they did not pay any attention to her at all—it was as if she and others in the room did not exist. They did not get distracted by any other task or interaction, or by the comings and goings into and out of the lab; they stayed completely focused until they solved the problem.

The use of task-related artifacts—such as computer screens, code, notes—was another element that helped them maintain their intense mutual focus of attention. Task-related artifacts have been found in research on engineers and scientists to support shared work episodes, in what Suchman (1988) calls "shared interactional space." Latour and Woolgar (1986) also show that interactions among scientists tended to take place around task-related artifacts (specimens, graphs, papers) that focused the encounter and reified the results of their work. We observed that the use of these task-related artifacts was critical in interactions that generated and maintained mutual focus of attention. In the example described above, Juan's explanations were very brief, but they were effective nevertheless, because Allan could see the computer screen and grasp immediately the gist of Juan's points. They were working on a graphical user interface, a complex arrangement of icons, buttons, and colors that Allan had created, and it was easier to refer to the entire arrangement as "this" instead of describing it. When Allan said that they have to replace "this" right here with "that" right there, their use of the same focusing task-related artifact—in this case, the computer screen—made communication effective because they avoided the need to say out loud or to type the names of the entities they were working on, or to read the lines of code or the long file names.

Such episodes leading to high levels of mutual focus of attention occurred not only with dyads as described above but also within groups of three or more individuals. Our second example from Shield showed mutual focus of attention emerging in an interaction episode among a group of three developers:

> Two Shield developers—Maria and Charlie—had been working for over an hour in front of the whiteboard in Maria's office, drawing and trying to identify the points of divergence in their views of the design of a submodule. They were debating the virtues and weak points of two different designs when Antonio, the assistant project manager, walked in. He had been walking in the hallway and, through the open door, overheard the topic of conversation, because Charlie was talking loudly. Antonio stopped in the doorway briefly, listening to the two developers who continued to talk and debate without acknowledging him. For about two minutes, Antonio's eyes moved quickly back and forth between Maria and Charlie, who continued their exchange, and then glanced over at the whiteboard. Quietly, he entered the room, went over to the whiteboard, and started drawing next to Maria's design his own understanding of the submodule. Antonio then said, "If you change the label, this is how it looks. . . ." He pointed at an entity on the whiteboard: "This label is actually creating the entire module." Charlie picked up and continued Antonio's thought, saying ". . . to store generic labels."

This interaction episode illustrated the way the spontaneous involvement of a developer who happened to be more familiar with the task requirements pierced the initial "task bubble" surrounding the two developers who had already been engaging in an episode of mutually focused attention. Antonio overheard the interaction

between Maria and Charlie and smoothly inserted himself into it.

There are several key elements of the group engagement process that can be seen in this example. The first was the intense *mutual focus of attention* in which Maria and Charlie were immersed, which was also apparent to the researcher who had been feeling like a fly on the wall, observing the interchange for over an hour, and to Antonio, who was standing in the door while the developers did not even glance at him. Antonio must have noticed the intensity of the interaction, because he did not interrupt it before making sure he indeed had something valuable to contribute. Once he determined that he could help, he did not hesitate to join the interaction. As the conversation about storing versus creating labels continued among the three developers—Maria, Charlie, and Antonio—they were completely focused on one another and the task at hand. After making a statement or adding on to the whiteboard drawing, they looked each other in the eyes to detect if there were any signs of a lack of understanding, to see if there were any questions, and to check if they were on the right track. Everyone's eyes were focused either on the whiteboard or on each other. The concentration and focus were palpable, as the continuation of this example shows:

> At this point, Nina, another TechCo developer who often had lunch with Maria, entered the room. As with Antonio earlier, she stopped in the doorway and looked at the three developers, who were immersed in their interaction. Noticing the intense work atmosphere, she quietly picked up one of the two wrapped sandwiches sitting on the edge of Maria's desk and simply walked out without interrupting at all. If Maria, Charlie, and Antonio noticed her, it was not apparent. They did not acknowledge her with their words, gestures, or eyes. Charlie continued on with his train of thought without break, mentioning the need to have a remote developer help them.

As this example shows, the mutual focus of attention among developers was visible and obvious to other developers who knew not to interrupt a moment that could be important for project advancement. This example illustrates several important aspects of the emergence and sustainment of group engagement. First, just like the previous interaction with Antonio, this example illustrates the role played by *task-related artifacts*—in this case, the whiteboard—in maintaining people's intense mutual focus of attention. On the whiteboard, developers could draw, modify, and check one another's understandings. Maria's and Charlie's designs were drawn on the board, next to which Antonio could also draw his. The differences were clear and apparent to all three, and they represented a concrete basis for further development of the design. Thus it was easy for Antonio to get involved and help in a very concrete way.

Second, the example also shows how the visible *task bubble* in which mutually focused coworkers were encased acted as a coordination mechanism in a group of coworkers attuned to one another's needs. Once the group was engaged, people were able to weave in and out of various focused interactions, either contributing if they had valuable suggestions or avoiding interruption because they were aware of how important the mutual focus of attention was. In contrast to Antonio, Nina realized she was an *outsider* to this interaction, and she did not cross that boundary. Last, in this interaction, we again saw the emergence of *shared emotion* that sustained mutual focus of attention, but here, it was a lower-energy shared positive emotion. Before Antonio entered into the interaction, the two other developers were very animated, talking loudly, and gesticulating. However, as the interaction episode progressed, they became calm, which enabled them to follow up on the implications of Antonio's clarification.

In contrast to the frequent interactions at Shield, where mutual focus of attention was strong and apparent, at Gateway there were some fleeting moments of mutual focus of attention, but they did not reach the same frequency or level of intensity as at Shield. The few interactions we observed that were characterized by a moderate level of mutually focused attention tended to take place in smaller meetings, such as a design meeting in a developer's office. We observed one such interaction and heard about another one. In the interaction we observed, Sara, a developer, stood in front of the whiteboard in her office and explained to three coworkers, Rich, Hank, and Bill, the design she had developed. The coworkers listened and asked questions about implementation. However, even in this moderately focused interaction, the task-related artifact—the whiteboard—was not used fully, as no one apart from Sara wrote on it to modify or further develop her design. There was a small amount of shared emotion at the end of the interaction where Sara smiled, because Rich, the more senior colleague, seemed to appreciate the work she had done.

At Gateway intense interactions did not happen as often as at Shield for several reasons. First, there were simply fewer interactions (see Table 2). Second, the proportion of informal interactions was much lower. Larger formal meetings were not conducive to the process of group engagement because they were used mostly for information dissemination rather than for in-depth problem solving where all parties were mutually attentive. This may be because in larger formal interactions, each participant experienced a lot of downtime in which individual attention and engagement tended to drift as people paged through thick stacks of design documents. This is how one Gateway developer, Andy, talked about a formal meeting that he and the field researcher had attended the previous day:

> Yesterday in the meeting, did you understand what they were talking about? I was trying hard to stay awake. That

> was not about software development. I just don't understand what good will it do to keep track of all that stuff, how one feature will affect the others. I can tell you one thing, and I trust you, I'll resist as much as I can doing that; I hope they'll have someone else doing that.

This type of comment revealed the extent to which formal meetings were seen as a drain on people's time and energy and not contributing to mutual focus of attention. The meeting referred to above involved a long PowerPoint presentation that did not focus people's attention in the way it was intended to. Also, even when helpful suggestions were made in large formal meetings, a subset of developers could not develop a task bubble while several others waited around the table. The episode contrasts sharply with those at Shield, where formal meetings—while still used mostly for information dissemination—were rarer, shorter, and with a lack of extensive documentation, an aspect that enhanced the need for direct interactions among developers.

The interaction episodes analyzed above show that mutual focus of attention was brought about by several elements—the presence of a task bubble and effective use of task-related artifacts—and led to and was sustained by shared emotion. It did not arise when these elements were missing. We will examine each of these three elements in more detail below.

Task Bubble: Barriers to Outsiders

Collins (1990, 2004) contends that barriers to outsiders protect interaction participants from those who could weaken mutual focus of attention. We saw how individuals made self-determinations as to their insider or outsider status, and how these determinations were critical for sustaining the intensity and mutuality of the group members' focus of attention in given interaction episodes. In particular, the episode described above, in which the three Shield developers were working on the design on the whiteboard, is a striking instance that shows the smooth coordination and assessments people made regarding their own insider or outsider status. Both Antonio and Nina walked into the room where Maria and Charlie were intensely working. After a couple of minutes of silent observation, both made a determination as to whether they were relevant to the task or not. Consequently, Antonio made his contribution, spontaneously and determinedly, whereas Nina withdrew without the slightest interruption. It is important to note that here, insider or outsider status was based on one's potential to contribute to the task. At Shield, the task bubble stayed intact as Nina determined correctly her outsider status, and as Antonio, also correctly, determined that he was an insider whose intervention was helpful. The task bubble effectively constituted a coordination mechanism whereby task-relevant others became involved in the interaction, whereas task-irrelevant others maintained a respectful distance. In this way, the semipermeability of the task bubble enhanced—or at least helped sustain—mutual focus of attention.

Determinations about insider versus outsider status did not happen in the same way at Gateway. There, people were invited into the few interactions that occurred not only on the basis of task-relevant knowledge but also based on whether they were full-timers and not contractors. Moreover, the presence of contractors created an internal tension that was not conducive to interactions where mutual focus of attention could arise among contractors and full-time employees. This is because the full-time employees did not fully trust the contractors and because the contractors realized they were not fully trusted. As a result, the contractors felt reluctant to approach the full-timers, and the full-timers were reluctant to engage with the contractors. Thus, the interactions that took place did not have the invisible semipermeable barrier that would keep irrelevant others out while drawing the relevant others in. Contractors at Gateway admitted that their situation made them reluctant to share their skills and potentially help others. As one contractor said, "Being a contractor, you don't always want to share skills or who you are. See, you never know why people hire you . . . here no one would give the source code to me." This example highlights the lack of trust that made it more difficult for them to engage with others. In contrast, the Shield examples illustrate how mutually focused interactions created a task bubble around those involved and, at the same time, an invisible but permeable barrier around them.

Task-Related Artifacts

Interacting with task-related artifacts was also important in the development of mutually focused attention because people could use the artifact to better understand and focus on the task. We observed that in most cases, mutual focus of attention was facilitated by a common focus on a particular task-related artifact or object, such as a whiteboard, code on a computer screen, or a document. Although Collins (1990, 2004) argues that physical copresence is needed for mutual focus of attention to occur, our observations and developers' own beliefs (based on experience) suggest that an artifact, which can focus people's attention, may be more important than physical proximity, per se. Thus, it is possible that mutual focus of attention can occur in distributed settings if there is an artifact that can focus people's attention and effort. Of course, physical copresence may enhance people's ability to develop mutual focus of attention. Indeed, the observed interaction episodes were often among collocated developers who were working in close physical proximity (e.g., touching elbows in front of a computer, taking the marker from one another to draw on the whiteboard, taking the mouse from each other to add another line of code). However, we should be careful not to conflate the physical proximity aspect

with their common focus of attention on the same entity (code, screen, document, whiteboard). For example, the field researcher also witnessed an episode in which Leo, in California, worked intensely with Mario, a developer in Bangalore, via Yahoo! Messenger for more than eight hours. As the field notes describe,

> Walking into Leo's office at 1:15 P.M., I saw he was preoccupied, even feverish: his hands were tapping the desk, grabbing and releasing the mouse constantly; his eyes were moving quickly over the many files open on his desktop. He heard me as I entered the room and glanced over. He turned back at his screen and whispered, "I'm with Mario, from Bangalore; he's helping with the build [of a submodule]. We've been working since 10:00 A.M." Leo remained completely focused on his exchange, as if I weren't there. I could see a Yahoo! Messenger session open on his screen.
>
> As I observed, Mario promptly answered the many questions Leo typed. He advised Leo on how to do the build, on what files to look for, on what the error messages might mean. From time to time, Leo looked back at the record of his exchange with Mario, to check on files Mario had mentioned. I stayed for 10 minutes watching this completely focused interchange.
>
> Two hours later, at 3:35 P.M., I found Leo working in the lab. He was still working with Mario via Yahoo! Messenger, even though it was 4 A.M. for Bangalore-based Mario. Leo said to me, "That's OK; yesterday it was I who stayed up late to work with Mario."
>
> Over the course of four hours, I kept checking back and found Leo still engaged with Mario. Even when he walked from the lab to his office and back, because he needed files, he was still completely focused on his work with Mario. At 6:00 P.M., Leo was still in the lab; he and Mario had not yet finished the build. They continued to type messages back and forth, to answer each other's questions. Mario's coworkers in India had started coming to work, while Mario had not left yet.

This example shows that people can engage in an interaction episode that leads to mutual focus of attention across physical distance (enabled by technology). Both developers were motivated and intent on solving the problem, and they spent their day (as well as the previous day and part of the next one) single-mindedly working on this particular task. The task-related artifact, the "build" in this case, along with the files involved and the text-based conversation thread, focused their attention and facilitated their arriving at a common understanding. At least Leo, the developer that was observed directly, did not allow any extraneous tasks to capture his attention; and from the way Mario answered Leo's messages with astonishing speed, we surmise that Mario was also single-mindedly focused on the build. They were clearly working in a task bubble like those that we saw in the face-to-face interactions described previously.

What is important in this example is that the two developers were moving in synchrony with each other, as opposed to the outside world, for an extended period of time and in the absence of physical proximity. They may have been out of step with their collocated colleagues who, for this particular task, were outsiders. Based on this example, we suggest that mutual focus of attention can exist in the absence of physical presence, as long as artifacts help to sustain the interaction. The difference was with the visibility to others who would not have been able to notice it as easily or get involved in it (in contrast with the previous Antonio example). However, what seems more important than physical proximity was using a task-related artifact to facilitate the work.

It is fair to say that non-face-to-face interactions did not always achieve the level of intensity and mutual focus of attention observed regularly in face-to-face settings at Shield. However, several technology-mediated interactions like the one described above were highly focused and displayed all the elements of group engagement. In both distributed and face-to-face interactions, task-related artifacts may be critical for team members to attain the mutual focus needed to advance the project. As one developer said, "We need to have documents for teleconferences; otherwise, it's just a waste of time." For both reasons—the importance of artifacts in focusing attention and the possibility of group engagement in noncollocated settings—"task-related artifacts" seemed to be the more relevant category in this context than the category of "bodily copresence," as discussed by Collins (1990, 2004).

In contrast with Shield, at Gateway similar task-related artifacts—code, documents, whiteboards—were not used to the same extent or in the same way. Even in the interaction in which Sara described her design in front of the whiteboard, the other participants, Rich, Hank, and Bill, did not draw next to her design or engage at the same deep level as we saw in the Charlie, Maria, and Antonio interaction. In the large formal meetings prevalent at Gateway, developers leafed through individual copies of documents on which they made comments and notes, but they did not solve problems or resolve misunderstandings in a focused and concrete way. Moreover, some artifacts such as PowerPoint presentations were not interactive enough to fully engage people in a mutually focused way. Thus, the coordination provided by the task-related artifacts at Shield was not evident at Gateway.

The Reciprocal Influence of Shared Emotion

Our observations suggested that shared emotion was both an outcome and a reinforcer of mutual focus of attention. After episodes of mutual focus of attention, which most of the time led to problem resolution, participants expressed a shared emotion that seemed to create a bond that made it easier to initiate these types of interaction episodes in the future. The shared emotion also seemed to sustain the mutual focus of attention in some of the interaction episodes themselves. For example, we

observed several interaction episodes where developers shared the success of a breakthrough that led to positive shared emotion (as in the case of Charlie, Maria, and Antonio). Such shared emotion was important because it gave an energy boost to the developers who, replenished, could continue with their work. The following episode occurred in the computer lab at Shield, where Allan and Juan—whom we had discussed previously—continued working together for several days:

> Allan yelled unexpectedly, "Yes, we did it! Give me a high-five!" He turned to Juan, who was sitting next to him, and gave him a high-five. Allan said, beaming with satisfaction, "It was great; that was a big thing. There were too many steps." Juan, smiling broadly, chimed in, explaining to Steve (the only other developer in the lab at that moment) and the researcher, "We simplified the steps from 18 to 3." Allan and Juan returned to the task, smiling.

This example shows how the joy of overcoming a hurdle can be shared and replenishing. It is important to note that such interludes were short, not impeding the general atmosphere of hard work. The shared joy reinvigorated Allan and Juan for continued focus on their own task, reinforcing their mutual focus of attention over time.

Thus, mutual focus of attention seemed to not only lead to shared emotion and motivation but also to feed off of it. Energy and motivation increased after mutually attending to a problem, sharing success, and feeling one's own sense of efficacy be enhanced by the group process (Bandura 1986, Thayer 1989, Haidt 2000). The link between shared emotion and mutual focus of attention is crucial (in Collins' theory and in our setting). Collins argues that after a successful interaction ritual, people walk away with increased levels of energy and confidence, whereas after a weak or unsuccessful ritual, they feel emotionally battered (Collins 2004). In this sense, the shared emotion that is part of the group engagement process is a social emotion: it is generated by the interpersonal situation and is carried by individuals to other interpersonal encounters through a process of emotional contagion (Barsade 2002).

Enabling Conditions

In the above analysis of interactions, we showed how the process of group engagement led to mutual focus of attention in multiple interaction episodes on the basis of several elements—the presence of a task bubble and effective use of task-related artifacts—and both resulted in and were reinforced by shared emotion. However, by comparing the two projects, we also observed that the process of group engagement was more likely to unfold in the presence of several enabling conditions operating at three levels of analysis: the individual, the interaction, and the larger project level. At the individual level, we observed the importance of individual engagement in enabling the process of group engagement. At the interaction level, we saw that the frequency and informality of interactions was a critical enabler of the group engagement process. Finally, at the project level, it was the compelling direction that provided an important ingredient that enabled the group engagement process.

Individual Level: Individual Engagement

Individual engagement was an essential enabler of the group engagement process because only people who were deeply involved with their individual tasks could then start contributing to the various interactions. Although individual engagement was a necessary condition for group engagement, it was, however, not a sufficient one, in that we observed similar levels of high individual engagement in both projects such that the developers were cognitively focused and worked hard on their individual tasks. For example, here is how one Shield developer expressed her engagement with her work to a colleague who had asked her if, after several weeks on the project, she still liked it:

> I love it! I simply love it! It may be because it's new and interesting, but I work all the time. I work in the evening after I get home and have dinner and exercise; I read, research. And the same over the weekend.

This example illustrates the focus on the work as well as the excitement of working on something new and important, and the intense effort deployed both within the workplace and outside of it. The tenor of this quote is by no means extreme, as other developers exhibited similar sentiments and behaviors. However, Gateway employees also expressed high levels of individual engagement with their tasks. Celia, a developer who was highly engaged with her work, tried to explain the passion that a software developer may feel for her work by recommending the book *Close to the Machine* (Ullman 1997), in which the author describes programming as a fever that can be thrilling, filled with pleasure. Xiao, another Gateway developer, said, "I like it because I work on something I have no clue about, so it's a great learning opportunity." Learning opportunities offered by the project were important motivators for individual engagement with one's task in this software development environment (Lakhani and von Hippel 2003).

Individual engagement with tasks did not automatically translate into group engagement, however, as illustrated by the following example. Here, Leo, who was at the time of this interview a newcomer to Shield working part-time, expressed his individual engagement with the task but also articulated that he did not yet feel sufficiently engaged with others in the group. Here is how he initially expressed his desire to work longer hours and deepen his engagement with the team and the project:

> I feel kind of bad that I am only working 20 hours a week. When you only work part-time, you cannot get

> into the specifics of what others are doing. Now it's great; I'm on this project, but I feel like I'm missing a great opportunity. I can only start full-time on June 12.

When the researcher asked if he saw this as an opportunity to prove himself, Leo responded,

> No, it's that I can look at what others are doing, I can go and ask people, "What are you working on right now? Can I help?" You can only do that when all you do is work. Right now, at 20 hours a week, all I can do is work on my piece, making sure I get something done.

Leo's words articulated that his individual engagement and motivation with the task was different from engaging with others and being part of interactions characterized by mutual focus of attention. His stated high level of engagement with his individual task, or his "piece," was manifested in the effort he put into learning about the existing code, and it was visibly evident in the growing stack of books on his desk. As his words made clear, though, he was not sufficiently interacting with his colleagues at that time.

Thus, in both Gateway and Shield, there was evidence of high individual engagement of the group members with their individual tasks. Yet through our comparison of these two projects, we observed that individual engagement seemed to be a necessary, but not sufficient, condition for the group engagement process to emerge. The two projects also differed markedly in the degree to which and how team members interacted with one another, the degree to which there was a compelling direction, and the degree to which we observed evidence of the group engagement process.

Interaction Level: Frequency and Informality of Interactions

Frequency of Interactions. We observed two conditions at the interaction level that enabled the process of group engagement—the frequency and informality of interactions. First, the frequency of interactions was both an indicator and a source of high levels of mutual focus of attention. That is, for mutual focus of attention to emerge in interaction episodes, interactions had to occur. As Tables 2 and 3 indicated, the number of self-reported and observed dyadic and group interactions was much higher at Shield than at Gateway. At Shield, the presence of such interactions was viewed as important by the developers. For example, in the two months after Michelle, a developer, joined Shield, she started initiating interactions, walking into people's offices with questions and suggestions, paying greater attention when issues related to the overall project were discussed, and excitedly declaring, "Now we're at a different place, I interact more with others." In contrast, interviews with Gateway developers suggested that the paucity of interactions was salient to them. As Nick, a developer, stated, "In other places where I've been, there was a lot more interaction." Furthermore, at Gateway, people did not have the same opportunities to develop mutual focus of attention because key people were not available for interactions. For example, Gateway's architect, Jerry, had a very different work schedule from the rest of the group, which made it difficult for him to coordinate with others, despite the fact that his role as architect made his presence very valuable to his colleagues. As Jerry stated,

> I am the chief architect of the whole thing. I usually come in, in the afternoon. In the morning, I work at home, but they have my phone number, so they call me. I need to come in because of meetings; there are people looking for me. Also, the firewall prevents me from working from home in the same way as when I am in the office. Sure, I could use a virtual private network that would make me appear as I am inside the firewall, but I haven't looked into that closely yet.

According to this statement, even though he was aware that a virtual private network would have enhanced his communication and interaction with the rest of the group, Jerry had not looked into the possibility of setting one up. Nor did he go to great lengths to modify his schedule in order to accommodate the needs for interaction of his coworkers. At the same time, other Gateway developers would have welcomed more interactions. One developer stated,

> I mostly work on my own. I have my own work, enough to keep me busy. There are days when I come in, then go home in the evening, and don't speak with anyone. We only meet in meetings . . . I'd like more interaction.

Another Gateway developer remarked, "I have never had a conversation with anyone around my cubicle. Sometimes I hear them, but I've never spoken with them. And sometimes it is those impromptu conversations that may spur a solution a few days afterwards." This statement shows that developers were aware that interactions had the potential to coordinate their efforts and spur mutual focus of attention around a problem and that they were lacking such potentially productive interactions.

Informality of Interactions. The second factor at the interaction level of analysis was the type of interaction that occurred. The majority of interactions at both Shield (83%) and Gateway (58%) were informal. However, the much higher percentage of informal interactions at Shield led people to engage more with each other and facilitated the group engagement process. It is interesting to note that although the developers were under similar pressures regarding time and performance expectations, their interaction patterns differed starkly. At Shield the high pressure led to lots of informal interactions, whereas at Gateway it led to an emphasis on individual work. As Archie, a Gateway employee, said, "Informal interactions are not happening at the moment, as there is a lot of pressure." Indeed, the most important

interaction venues for Gateway developers were the two core meetings that took place every week. As George, the manager, explained to the field researcher when she arrived at the site, these formal prescheduled meetings were the occasions for groups of select developers to resolve technical issues. However, this type of formal meeting did not allow for the same level of information exchange that emerged in informal interactions among developers at Shield. Informal interchanges occasionally occurred at Gateway and were seen as important when they did occur. Celia emphasized how important it was to exchange her ideas in this way with her colleagues: "I presented the design at the meeting on Tuesday. Jerry and Matthew made a couple of comments, made me think, then I had a conversation with Jerry last night that I think moved us forward a lot; we may have reached a milestone." Such exchanges of knowledge and discussions achieved the necessary level of coordination that allowed the project to advance. However, such intense informal exchanges were infrequent.

In contrast, the informality of interactions at Shield meant that people were comfortable sharing ideas, expressing enthusiasm and doubts, and getting into the task bubble in which unguarded, free, creative, and rich exchanges took place. When these interactions were informal, as they primarily were at Shield, they made it easier for people to initiate or join mutually focused interactions. This is how one developer from India talked about the work processes in Shield: "In terms of ideas, it is much better here. I can walk into Howard's office any time. It's been the same with all other U.S. companies I worked for; this is just great in the [United States]," he said with a broad smile. He emphasized the informal style of the entire Shield team, starting with Howard, the manager, and how that kind of style was very good for fostering new ideas.

In contrast, in formal interactions there was a prevalence of information dissemination as opposed to the types of back-and-forth exchanges that led to mutual focus of attention. For example, one Gateway developer stated, "Now we have formal meetings. There's way too little time for group processes in our meetings, not enough time allowed for figuring out who's doing what" and thus to coordinate with coworkers. As the developer suggests, and as the example we presented earlier also states, the large formal meetings could be experienced as a drain, and thus they did not foster mutual focus of attention.

Project Level: Compelling Direction

At the project level of analysis, we observed that it was the compelling direction of the project that was an important enabler of the group engagement process. The comparison between Shield and Gateway revealed that developers perceived that there was a compelling direction at Shield that was absent at Gateway. There were two primary ways in which having a compelling direction seemed to enhance mutual focus of attention. First, a compelling direction led people to be inspired and motivated to work hard on group tasks (Hackman 2002). We saw earlier in the section on the differences between the two projects that the compelling direction experienced at Shield infused developers with energy and passion about the product and project itself, making them want to contribute to the project as a whole rather than focus only on their individual tasks (akin to notions of collectivistic motivation; see Deutsch 1973, Shamir 1990). One Shield developer, who was contrasting her experience with a former manager that had not been able to provide a compelling direction, explained,

> We thought of him as a technical person. He was able to always satisfy us on technical issues, but not about the direction, where are we were headed. For example, it makes a difference when you tell people that they need to paint something in this or those colors versus when you tell them that they are making the halo of Jesus Christ. Then they feel that they are part of something bigger than themselves. Then they put all they've got into the task.

In contrast, at Gateway developers did not view the direction of the project as compelling or inspiring and were somewhat baffled about what they were doing. As described earlier, Gateway developers questioned the project's direction and were deploring the fact that they were in a follower position when compared with other companies. Although playing catch-up with other industry players could in principle be motivating and lead to focused interactions, because they questioned the direction, its feasibility, and its chances of success, the developers were not engaging in the types of interactions that would be needed in order to successfully build this creative (and loosely defined) product.

Second, the presence of a compelling direction acted as a mechanism for harnessing and coordinating motivation because developers had a vision of the collective goal they were trying to achieve. As a result, they proactively reached out to one another and interacted with each other willingly and spontaneously in coordinated ways as they tried to solve problems. At Shield, a developer expressed his enthusiasm for the project's direction and at the way the project was developed:

> I've been with four organizations in TechCo so far—perhaps I shouldn't say these things—but I never was in a project like this, where I believed in the product. Shield is the very first job in my life time where I both like the people and I believe the product is going somewhere. I've worked on projects where people would not help you, you'd go to them to ask a work-related question, and they'd view you as a competitor, and not help. Here, that hasn't happened once. There are no politics here.

This quote shows that not only was the direction or objective of the group inspiring but a lot of the

motivation and effort came from the way people interacted and helped one another. In contrast, the lack of a compelling direction at Gateway led to a reactive rather than a proactive approach. For example, when asked how he kept up with the changes in the product, a Gateway developer said, "I assume Sridhar will tell me about changes that will affect my work." Thus, because developers were not reaching out to one another, opportunities for quick advancement and problem solving might have been missed and were not approached in a coordinated way.

The Process of Group Engagement Leads to Group Problem Solving

A central element of the group engagement process, mutual focus of attention, was associated with problem-solving breakthroughs. In each of the examples above that illustrate the group engagement process and mutual focus of attention, there was a breakthrough where the group was able to make significant progress toward solving a difficult and important problem. For example, in the episode where Antonio joins the interaction of Maria and Charlie, the outcome of their mutual focus of attention was a deeper understanding of the problem to be solved by Maria and Charlie. As the interaction concluded,

> Antonio left, saying, "You understand now." Charlie acknowledged his deepened understanding by saying to Maria, "Now I understand why they want to do it that way. Because Antonio has this requirement to be able to reference to other labels."

Based on this improved understanding, Maria and Charlie redesigned the submodule in the next two days.

In the other primary example of the group engagement process analyzed, we saw how Allan and Juan's intense work together led to simplifying the steps from 18 to 3, as well as their satisfaction at this accomplishment. Another example of the relationship between group engagement and problem solving occurred at Shield. Two developers, Doris and Hari, had been working together on a request from one of Shield's very first clients. At one point they were in the computer lab, working on files open on one computer. Suddenly, Doris turned to the field researcher and exclaimed, laughing, "You know, we finished it!" Hari beamed with satisfaction and hurried to give the details: "Yes, we're almost done. After we gave them an 18-day estimate, we finished it in a day." The two laughed. This episode also illustrated the elements of the mutual focus of attention described previously: Hari and Doris had been intensely focused on their work, using the code on the computer screen as a task-related artifact and concentrating on the task in synchrony with one another. They were not distracted by the presence of other developers or of the field researcher; the only time when they acknowledged the researcher's presence sitting next to them was to share their enthusiasm as they achieved another task breakthrough.

In contrast, the Gateway project, where there were few interactions characterized by the group engagement process, was advancing slowly and tentatively, with few clear breakthroughs. The Gateway interaction episode in which Sara explained to three coworkers the design she had worked on showed that progress was being made at Gateway as well. However, the pace was very different, and such accomplishments were rare. For example, one developer stated, "Do you see the pace of work here? People are walking very slowly in the hallways."

To better understand the relationship between interactions and problem solving, we also contrasted the two projects in terms of the proportion of interactions that led to problem resolution. Out of a total of 74 observed interactions at Shield, 56 (or 76%) were characterized by mutual focus of attention, in the sense that the participants attended to the same object or activity and were aware of one another's focus of attention. Out of these 56 interactions, a full 50 (or 89%) led to some positive outcome such as a coding or design solution, a clarification of priorities and task ownership, learning something new and relevant, and making suggestions that had the potential to advance the project significantly. Even many of the interactions developers told us about (as opposed to interactions that were observed) seemed to have been characterized by mutual focus of attention as well as by a positive outcome. These examples show that in the project in which the group engagement process was prevalent, it led to effective problem solving. Of course, there was problem solving at Gateway as well, as any functioning project must have. Out of eight observed interactions, seven were information dissemination sessions in that they clarified an issue in terms of task allocation and identified priorities. However, they did not lead to design clarification and concrete task advancements. Thus, at Gateway progress was in the form of identifying problems for individuals to work on individually, instead of coming up with solutions during the interaction. Progress seemed much slower, and instances in which problems did get solved were not obvious to others; the subdued emotion of the group and the lack of group engagement prevented others from partaking in the positive emotions generated by breakthroughs. This contrast illustrates that when group engagement takes hold and is sustained, it can be highly effective, such that problems are solved quickly in an atmosphere of intense concentration and participation.

Discussion

Our study contributes to the understanding of groups by identifying microprocesses that underlie and sustain problem solving and high performance in groups.

We do so by observing group interactions, which shed light on how group members engage with each other to develop and sustain mutual focus of attention on work tasks. Specifically, we found that motivational elements (e.g., individual engagement, compelling direction, shared emotion) and coordination processes (e.g., the frequency and nature of the interaction itself, the task bubble, and task-related artifacts) were both important for the emergence of mutual focus of attention. Our findings suggest that the group engagement process is complex and facilitated by the interplay of both motivation and coordination: people are inspired by a meaningful project and by their coworkers to engage in great effort and apply their effort in a way that is mindful of others (Weick and Roberts 1993). These findings deepen our understanding of the microprocesses of how individuals achieve collective task focus in groups, leading to more effective problem solving and performance, and they provide extensions to theory on interaction rituals.

Group Engagement Process

One contribution of our approach to the study of the group engagement process has been to highlight the importance of examining episodic group interactions for understanding group process and effectiveness (Bales 1950, Bales and Strodtbeck 1951). In doing so, we depart from traditional approaches to teams that examine groups with intact membership and stable boundaries. Our study of such teams found that interactions did not always have to involve all project team members; dyads, triads, and other small groups were what was needed for problem solving in task-focused interactions. Moreover, the team members participating in these interactions changed depending on the specific task requirements. Thus, taking the level of analysis to the situated interaction, where the group was defined by the task and relevant set of actors, helped to clarify the elements that contribute to how task-related processes influence group effectiveness.

By focusing on interactions as the level of analysis, we extend the literature on task-based group process in several ways. First, we observed that the presence of group interactions in field settings should not be taken for granted. In one setting, such interactions were frequent, allowing for the development of mutually focused attention through the group engagement process. In the other setting, however, such interactions were rare. Thus, our comparative study allowed us to see the importance of interactions for the group engagement process, and the fact that these interactions did not always arise naturally in groups. There was significant variance in terms of interaction level even between projects doing a similar type of work such that the number of interactions was somewhat discretionary.

Second, we found that these fluid, task-based subgroup interactions became the engine of the group engagement process and group task accomplishment. This perspective that interaction episodes are what helps groups make progress on interdependent group tasks has been suggested in review articles (Marks et al. 2001, Weingart 1997) as well as in the few empirical studies of task-related interactions; these studies have shown how interactions enable knowledge sharing and transformation (Bechky 2003a) and creative moments (Hargadon and Bechky 2006) and how interactions can help focus a group's attention and lead to a redefinition of its task (Gersick 1989, Okhuysen and Eisenhardt 2002). We add to this work and show in detail the elements and linkages that make task-focused interactions central to understanding how groups accomplish their work. Specifically, within the interaction episode, we found that mutually focused attention was the centerpiece of the group engagement process. Several other elements characterizing the interaction were key to the development of mutual focus of attention. First, the task bubble that protected the space in which problem solving took place highlights the importance of boundaries in group work, but in a different way than in past research. In particular, Perlow's (1999) study of software engineers highlighted the importance of individual boundaries for getting work done. In her setting, she instituted posted signs indicating "quiet time periods" for individual work, which served as a reminder to developers to not violate the boundaries around their coworkers. In our setting, boundaries around mutually focused interactions were also important, but these boundaries were permeable so that task-relevant others could get involved as needed. Moreover, in our context, there was no need for physical artifacts like posted signs, as the intensity of purpose around these group-based, mutually focused interactions was visible and palpable. Instead, task-related artifacts served a different role: to focus mutual attention around the problem at hand in a way that enhanced mutual understanding. Thus, in contrast to Perlow's (1999) study, which showed the importance of creating *nonpermeable* boundaries around *individual* work so that developers could concentrate without interruption, in our software development context, the task bubble suggests that *permeable* barriers around *groups* of people interacting were important to facilitate the emergence of *mutual* focus of attention.

Task-related artifacts are the second element that characterized mutually focused interactions. Existing work on how artifacts influence group cognition and coordination highlights how artifacts help create a shared interactional space where group members can synchronize their thinking and their behaviors (Suchman 1988, Henderson 1999, Bucciarelli 1994, Hutchins 1995, Bechky 2003b). These studies have examined similar populations to ours, scientists and engineers, working in collocated teams. Our findings are consistent with this prior research. However, our findings also extend this work by showing that

task-related artifacts have the ability to help coordinate group interactions in a way that facilitates understanding and enhances mutual focus of attention even when group members are not physically collocated.

The third element, shared emotion that resulted from interactions, also becomes an important sustainer of frequent and extended interactions. This shows how emotional contagion from group members (Barsade 2002; Totterdell 1999, 2000) can play an important role in enhancing group engagement. These elements—the task bubble, task-related artifacts, and shared emotion—were closely related to mutual focus of attention. A common focus on an artifact and the ability to keep outsiders at bay were critical for facilitating mutually focused attention in group interactions. Moreover, mutual focus of attention seemed to enhance shared emotion, which in turn sustained mutual focus of attention over time. Our observations of the group engagement process also suggest that interactions that resulted in mutual focus of attention often led to effective problem solving. When this process led to high levels of mutual focus of attention, shared emotion, and problem solving, it was enriching rather than depleting to the energy of people in the group (Collins 1990, 2004; Marks 1977; Rothbard 2001). Moreover, the problem solving that resulted from this process at Shield led to a sense of swift and shared progress, in contrast to the sense of halting progress experienced at Gateway.

Our findings indicate that when there are many interactions characterized by mutual focus of attention and a compelling direction, groups may sustain their intensity over time. Such was the case at Shield. However, this raises the inevitable question of whether it is possible for there to be too much of a good thing. In other words, is there some threshold beyond which high levels of mutual focus of attention can lead to burnout (Kunda 1992)? We did not observe this at Shield, but future research should explore these threshold effects and other conditions that might disturb the delicate balance among the numerous elements that contribute to high levels of mutual focus of attention in the group engagement process. Indeed, this type of intense mutual focus of attention may still be very difficult to sustain over long periods. We studied interactions that at the very longest lasted for eight hours and were typically much shorter than that. As our research shows, there are many elements that contribute to mutual focus of attention, and thus its achievement and sustainment may be fragile.

The complexity of the linkages among the elements in our model calls for further systematic research on the group engagement process. It is possible that some of the elements that we have identified as contributing to the group engagement process may substitute for one another; for example, compelling direction may make up, for a while, for a lack of barriers to outsiders. On the other hand, it may be that, as with the groups we observed here, these elements are all necessary conditions for the development of high levels of mutual focus of attention.

Our analysis of the group engagement process also has implications for work on group synergy and motivation gains (Ringelmann 1913; Köhler 1926, 1927; Hertel et al. 2000, 2003) by identifying the importance of shared emotion for synergy. By showing how group engagement was built in small-group interactions, characterized by mutual focus of attention, we observed that when there were many of these interactions, they seemed to aggregate in both additive and nonadditive ways to influence the overall project. Specifically, there was an additive effect at the project level in terms of the number of breakthroughs and greater problem solving, which led to greater feelings of efficacy in the larger group (at Shield) (Bandura 1986) and a willingness to continue to interact with others. However, the synergistic effect seemed to operate through the role of shared emotion. Positive feelings resulting from mutually focused interactions and the willingness to continue to contribute to the group seemed to lead to a virtuous cycle (Thayer 1989, Haidt 2000). As a result, at Shield there was a buzz that was almost palpable. Indeed, based on our observations, group members had intense interactions in which they were highly focused on one another's issues. Such mutual focus of attention led to a feeling of urgency and focus that infused both individual and group efforts and became a reservoir of energy on which individuals drew. In contrast, although group members at Gateway were deeply concentrating while working on their individual tasks, there was far less frequency and intensity of small-group interactions than at Shield. Even though there *were* small numbers of interaction episodes at Gateway, they were infrequent and never reached a threshold where they were visible and commonly experienced by all group members. This was due to the structural and situational factors there: formal, infrequent interactions; a lack of compelling direction; a lack of a permeable task bubble; and limited use of task-related artifacts. As a result, shared emotion was not experienced.

In sum, our research points to a way to define and characterize a group that displays group engagement. We define group engagement as the process by which interdependent individuals engage with each other around work tasks to develop and maintain mutual focus of attention in an interaction episode. Using this definition, we suggest that the key feature that characterizes interaction episodes where group engagement is present is *mutual focus of attention*. The emergence of group engagement seems to depend on people being able to determine insider versus outsider status interaction by interaction, as well as effectively using task-related artifacts and generating shared emotion to sustain mutual focus of attention. It may also depend on high

levels of individual engagement, frequent and informal interactions, and the presence of a compelling direction.

Interaction Ritual Theory

A second key contribution of our study is to extend Collins' (1990, 2004) work on interaction rituals. First, we show that mutually focused interactions can also occur in the absence of participants' bodily copresence. Moreover, we highlight the importance of task-related artifacts in helping focus mutual attention on a task. Collins (1990, 2004) mentions that objects can enable the emergence and sustainment of mutually focused interactions because they help people see that they share a common focus of attention. Our study further develops the role of these artifacts and suggests that they can substitute for bodily copresence. It should be noted, however, that our context was a high-technology one, and software developers may be more likely than other groups to use technology to engage in focused interactions with physically distant others.

We also add to Collins' basic framework and articulate several enabling conditions at the individual, interaction, and group levels of analysis, which can trigger work-based mutually focused interactions: individual engagement, frequency and style of interactions, and compelling direction. Collins (2004, p. 48) touches upon the conditions under which mutually focused interactions occur, suggesting that a common action or event and transient emotional stimuli can prompt such interactions. Our comparison between two work projects, Shield and Gateway, showed that some of these enabling conditions are quite consistent with Collins' interaction ritual chains theory (frequency and informality of interactions), whereas others are consistent with the motivation and groups literatures (individual engagement and compelling direction). Perhaps because we examined interactions in an organizational context, compelling direction and individual engagement emerged as enabling conditions.

Moreover, through our comparative data, we showed that these enabling conditions vary across work settings and that mutually focused interactions emerged much more in one setting than in another. Our study revealed that mutual focus of attention was more likely to emerge in small informal group interactions of the type that were prevalent at Shield. By contrast, there were very few instances of mutual focus of attention at Gateway, despite the fact that individuals were individually engaged with their tasks. Thus, it was not sufficient to hire smart motivated individuals; instead, a meaningful, compelling direction in which people could believe (Hackman and Oldham 1976, Hackman 1987) and coordinate their activities around (Sherif et al. 1961, Saavedra et al. 1993, Wageman 1995), as well as sufficient interactions among team members, seemed to be essential for creating and maintaining the level of energy and intensity that was needed for the development of mutual focus of attention (Collins 1990, 2004).

Conclusion

Our findings are based on a field study using ethnographic methods comparing two projects whose goal was to develop an innovative product in a short time in an environment of competition and uncertainty. These conditions may have fueled the processes we observed, and certainly, more studies are needed before clearer boundary conditions for the process of group engagement can be identified. As the use of teams in organizations increases, the issue of group process and problem solving is of utmost importance in many organizations. The process of group engagement depicted in this paper may help lay the foundation for an approach to group effectiveness that would focus on the task-related microinteractions among group members, at least in equal measure as it does on individual effort and engagement. Our comparative work has yielded several useful new concepts that should be taken into account by future research on interdependent, high-performance groups. Not surprisingly, from the processes analyzed in our paper, six months after observations of the two project teams were concluded, the Shield project was successfully developed and spun off by TechCo. In contrast, Gateway's product never came to fruition, and in a year's time, developers were moved to other projects.

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Endnotes

[1]Recent work on the relationship between team and individual motivation by Chen et al. (2009) has begun to explore the interplay between these levels, but it focuses on how team-level processes influence individual outcomes. In contrast, our focus is on the collective level as the outcome.

[2]The study reported in Metiu (2006) uses data collected from Shield but not Gateway. Moreover, the research question and data analyzed in that study (with the exception of one quote) are distinct from the research question and data reported in this study.

[3]One main difference between the two projects was that Shield was located on the West Coast, whereas Gateway was on the East Coast. This might be relevant insofar as the two regions, both highly technically advanced, differ markedly in terms of their subcultures. At the macro, regional level, the West Coast—specifically, Silicon Valley—is characterized

by high levels of innovation that draw heavily on the networks of communication and exchange among organizations (Saxenian 1994). In contrast, the East Coast companies—in Saxenian's study, those located in the Route 128 corridor in Massachusetts—tend to be more autocratic and vertically integrated. Whereas firms in Massachusetts were concerned with protecting their intellectual property, Silicon Valley companies were relaxed about the sharing of skills and information. The two projects we studied—Shield and Gateway—displayed similar patterns of cultural differences despite being part of the same organization; one can say that the culture of the two projects mirrored larger regional differences.

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