Fluid Tasks and Fluid Teams:
The Impact of Diversity in Experience and Team Familiarity on Team Performance

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In this paper, we consider how the structures of tasks and teams interact to affect team performance. We study the effects of diversity in experience on a team's ability to respond to task changes, by separately examining *inter*personal team diversity (i.e., differences in experience across the entire team) and *intra*personal team diversity (i.e., whether individuals on the team are more or less specialized). We also examine whether team familiarity — team members' prior experience working with one another — helps teams to better manage challenges created by task changes and greater *interpersonal* team diversity. Using detailed project- and individual-level data from an Indian software services firm, we find that the interaction of task-change with *intra*personal diversity is related to improved project performance, while the interaction of task-change with *inter*personal diversity is related to diminished performance. Additionally, the interaction of team familiarity with *inter*personal diversity is related to improved project performance in some cases. Our results highlight a need for more nuanced approaches to leveraging experience in team management.

Key Words: Diversity, Knowledge Work, Project Flexibility, Task Change, Team Familiarity

1. Introduction

Many manufacturing and service operations consist of *fluid teams* executing projects for different customers (Edmondson and Nembhard 2009; Huckman et al. 2009). A team is characterized as "fluid" if its members bring their diverse experience sets together to generate output, after which the team is disassembled and its members move on to new projects (Arrow and McGrath 1995). Not only are teams more fluid in many contexts, but so, too, is the work those teams perform. Tasks change frequently — often in-process — as a result of a number of factors, including: co-production with customers' in-service work (Fuchs 1968; Frei 2006), mass customization in manufacturing (Pine 1993), and changing requirements in knowledge work (Staats et al. 2010). In this paper, we consider how fluid tasks and fluid teams interact to affect team performance.

The expected impact of fluid tasks on team performance is negative (Fisher and Ittner 1999; Bohn 2000; Repenning 2001): when work is changed in-process, a team's existing processes are disrupted and the team may find its previous efforts to be of little value (e.g., due to wasted set-up times, Hopp and Spearman 2008) or it may not have adequate or appropriate resources to complete new tasks. In this paper, we identify moderating variables that may help teams remain flexible in responding to changing tasks. The concept of fluid teams suggests two possible moderators: (1) diversity in team member experience and (2) team familiarity (i.e., members' prior shared work experience).

Diversity in team member experience may help a team respond to changing tasks. As team members with diverse experience interact, they may discover new uses for and combinations of their diverse knowledge sets (Harrison and Klein 2007; Sosa 2010). Working in concert, team members may better filter new information (Wiersema and Bantel 1993). Even if diversity in members' experience is useful in theory, it may be less so in practice due to coordination challenges among team members that it can create (Bunderson and Sutcliffe 2002). The fact that a team's members have relevant knowledge does not guarantee their success in using it (Faraj and Sproull 2000; Pfeffer and Sutton 2000). These points suggest that a team's diversity could *positively or negatively* impact performance when tasks change.

To examine this issue further, we draw on the concepts of *interpersonal* and *intrapersonal* diversity (Bunderson and Sutcliffe 2002). While *inter*personal diversity captures the difference in experience sets *across* team members, *intra*personal diversity is a team-level measure that captures differences *within* team members (i.e., is the team comprised of members who are individually more, or less, diverse?). With more diverse individual experiences, team members might map current problems to past experiences more accurately (Gavetti et al. 2005) or use differing cognitive representations more effectively to define and solve problems in new ways (Prahalad and Bettis 1986). Also, more intrapersonally diverse teams may be less likely to suffer from cognitive biases such as overconfidence (Burke and Steensma 1998) and more likely to engage in information-sharing within the team (Bunderson and Sutcliffe 2002). Since each of these factors may prove helpful when tasks change, we hypothesize a positive interaction from task change and intrapersonal diversity on team performance.

Alternatively, controlling for intrapersonal diversity, our expectation is that interpersonal diversity may interact with task changes to create the opposite effect (i.e., worse team performance). For example, prior research has noted that interpersonally diverse teams encounter process difficulties such as more conflict, less cohesion, and less trust (Tsui et al. 1992; Jehn et al. 1999; Pelled et al. 1999). These issues may prove particularly problematic in a context of changing tasks. We therefore hypothesize that interpersonal diversity and task change will have a negative interaction effect on performance.

In addition to considering the diversity of team members' experiences, we examine team *familiarity*. Prior investigations of fluid teams have identified the important role that shared work experience plays in successful team performance (Reagans et al. 2005; Espinosa et al. 2007; Huckman et al. 2009). Huckman, Staats, and Upton (2009) used a dataset smaller than that employed in the present study, to identify a positive effect of team familiarity on project team performance. Here we are interested in whether this effect is contingent on two circumstances: task change and interpersonal diversity in experience. Individuals on a team who have worked together previously may help their team cope with changing tasks, which often render existing codified procedures less useful. Given that shared prior work experience enables tacit coordination between individuals, this shared experience might provide a robust system for teams to respond to changing tasks (Weick and Roberts 1993). We therefore hypothesize that team familiarity and task change have a positive interaction effect on team performance.

Shared prior work experience may also prove useful as an aid for teams that are more interpersonally diverse: Members who have worked together before are better able to accurately locate knowledge in a group, effectively share the knowledge they possess, and then use this knowledge to reach a desired outcome (Liang et al. 1995; Reagans et al. 2005). These benefits may be particularly salient for interpersonally diverse teams. We therefore hypothesize that team familiarity may have a positive interaction effect with interpersonal team diversity on project team performance.

The empirical setting for this paper is Wipro Technologies, a leading knowledge-based organization that competes in the global software services industry. One challenge in studying the effects of fluid tasks and fluid teams on team performance has been identifying business settings that offer the combination of detailed information on the experience of individual team members, objective measures of team performance, and the requisite controls. Our setting offers all three. We evaluate the performance of software development projects completed from 2004 through 2006, yielding a final sample of several hundred projects. We then couple this information with detailed human capital data that tracks the experience accumulation of the thousands of project team members over a longer time period.

We define diversity in experience in terms of team members' prior activities at the firm. In particular, we focus on the different customers for which employees have worked. In our setting, customer experience is relevant because the execution of a project requires significant customer interaction; customer experience thus provides potentially useful information about the process used by specific customers and within particular industries (Boone et al. 2008). In addition to collecting individual experience data, Wipro tracks detailed project-level data, including the percentage of requirements changed during the course of a project. After controlling for several project and team characteristics, as well as the independent effects of task change, intrapersonal diversity, interpersonal diversity, and team familiarity, we test for evidence of interaction effects between the relevant constructs on a project's performance with respect to its effort and schedule estimates.

This paper makes three main contributions. First, it theorizes about and empirically investigates how team composition can lead to project flexibility in knowledge work. As more operational activity shifts to knowledge work completed by teams, there is a need to understand the complex dynamics of those teams in more detail (Senge 1990; Edmondson and Nembhard 2009). By examining individuals' interactions and prior experience, our work responds to recent appeals to build more behavioral theory into operations (Boudreau et al. 2003; Loch and Wu 2007; Gino and Pisano 2008). Second, we gain insight into how diversity in team experience is a double-edged sword under conditions of task change. We find it necessary to distinguish between *interpersonal* and *intrapersonal* diversity within a team. While diverse individuals in a team may help address knowledge gaps, this diversity may be detrimental if team coordination issues are not addressed. Holding *inter*personal diversity constant, we find that teams with relatively more generalists (i.e., higher intrapersonal diversity) are more likely to deliver projects successfully when tasks change. Alternatively, holding *intra*personal diversity constant, we find that teams of individuals with experience that is more dissimilar (i.e., higher interpersonal diversity) are less likely to deliver a project successfully. Finally, while prior work finds a consistent main effect for the impact of team familiarity on performance (Reagans et al. 2005; Espinosa et al. 2007; Huckman et al. 2009), we empirically examine conditions under which team familiarity may be especially valuable. In particular, we find that team familiarity helps a team manage differences in prior experience across its members (i.e., interpersonal diversity) in some cases.

2. Task Change, Team Diversity, and Team Familiarity

To motivate our hypotheses, we examine the independent and interacted effects of task change, interpersonal diversity, intrapersonal diversity, and team familiarity.

2.1 Fluid Tasks and Team Diversity

The expected effect of in-process task change on team performance is negative (Fisher and Ittner 1999; Bohn 2000; Repenning 2001). When tasks are changed in process, a number of operational disruptions may occur (Wallace et al. 2004; Rai et al. 2009). The first, and most straightforward, concern is that additional work is created. In addition to a potentially increased total amount of work, changes disrupt existing processes and information flows within the team (Sosa et al. 2004; Sosa 2008; Gokpinar et al. 2010). New connections may be required to tie additional work into existing tasks. At a minimum, work complexity increases. If the initial work was not designed for such interconnections (e.g., with well specified interfaces), then significant rework may be necessary on parts of the project that had been considered complete (Baldwin and Clark 2000). Task change may also negatively impact team performance by disrupting the team's time pacing (Harrison et al. 2003). Social entrainment theory notes that internal processes of a team may become synchronized with an external source such as a deadline (McGrath and Kelly 1986). When a disruption occurs, the team must allocate valuable time to readjusting its processes and rhythms. Finally, when tasks are changed, a team may learn that the new work requires knowledge or resources the team lacks. If the team cannot access such knowledge or resources, performance may be compromised.

Given the frequency with which tasks change during a project, there is an increasing need for flexibility in projects' management (De Meyer et al. 2002). The concept of *fluid teams* suggests two possible ways to increase the flexibility of a project team: (1) diversity in team member experience and (2) team familiarity. We first consider diversity in team member experience, drawing on a long tradition of research on diversity in teams and organizations (for reviews see, Harrison and Klein 2007; van

Knippenberg and Schippers 2007). Drawing on that literature, we first examine the concept of interpersonal diversity, or the difference in experience *across* team members.

Interpersonal diversity can positively impact a team's (1) information-processing capacity (Hinsz et al. 1997) and (2) overall knowledge set, both of which can improve team performance. As team members interact, they may discover new uses for and combinations of their diverse knowledge (Harrison and Klein 2007; Sosa 2010). Working in concert, they may be better able to filter new information (Wiersema and Bantel 1993),as individuals may interpret events differently. Interpersonal diversity may also result in greater aggregate knowledge among team members (Wheelwright and Clark 1992), which can increase the likelihood that at least one will have previously encountered any given problem (Hargadon and Sutton 1997; Narayanan et al. 2009).

For a team's knowledge base to translate into improved performance, however, members must effectively locate, share, and apply that knowledge (Argote 1999). Though interpersonal diversity has the potential to positively impact team performance, this potential can be thwarted by coordination problems in processing information and turning knowledge into output. The problem can be a binding constraint in the context of interpersonal diversity, as team learning is a social phenomenon (Edmondson 2002), and team members' actions are often interdependent in producing output (Hackman 2002). Prior work highlights the difficulty team members face in recognizing each other's valuable experience (Littlepage et al. 1997). This recognition challenge may be exacerbated by interpersonal diversity, as team members may rely on assumed cues that do not necessarily match actual expertise (Bunderson 2003).

Given the many potential theoretical effects of interpersonal diversity, it is not surprising that empirical work finds it can both help and hurt project team performance (Harrison and Klein 2007). With this theoretical landscape as a backdrop, Bunderson and Sutcliffe (2002) introduced the concept of team *intrapersonal* diversity. Intrapersonal diversity is a team-level measure that captures the degree to which team members' prior experience is individually more (or less) diverse. A team that includes more generalists than specialists enjoys a number of potential benefits. First, the problem-solving of individuals on the team may be improved. When an individual has relatively more diverse personal experiences, she has a broader repertoire of experience to draw upon and may also be more likely to map the current problem more accurately to one of those experiences (Gavetti et al. 2005). Also, when an individual has more schemas, or differing cognitive representations of how the world works, she may define a problem differently than most others, which can create opportunity to solve it more effectively (Prahalad and Bettis 1986). In addition to such individual benefits, intrapersonal diversity may improve team processes. Teams composed of generalists may be less likely to suffer from cognitive biases such as overconfidence, due to the broad experience of their individual members (Burke and Steensma 1998). Intrapersonally diverse teams may also be more likely to engage in information-sharing within the team, which can aid performance (Bunderson and Sutcliffe 2002).

Each of these factors may help intrapersonally diverse teams cope with the challenges of task change. For example, when tasks change and new interactions are required within such a team (Sosa et al. 2004; Sosa 2008; Gokpinar et al. 2010), the information-sharing benefits of intrapersonal diversity may be particularly salient. Similarly, the relative flexibility and decreased likelihood of cognitive bias in a team's decision-making processes may help the team respond better to changing tasks. While we expect that intrapersonal diversity helps teams respond to task change, it is also possible that task change may lead to effects of intrapersonal diversity being even more salient: for example, some benefits of intrapersonal diversity may not be necessary for teams in completing daily work, but task changes may activate capabilities that are latent in intrapersonal diversity.

Interpersonal diversity and intrapersonal diversity are related but distinct concepts, both theoretically and empirically. When a team lacks diversity in experience, both values are zero. However, both measures can move independently and even in opposite directions. For example, a team of individuals, all of whom have focused backgrounds with different companies, would be high on interpersonal diversity but low on intrapersonal diversity. Alternatively, a team consisting of individuals with diverse backgrounds who have worked at the same set of diverse companies would have high intrapersonal diversity and low interpersonal diversity.

While we expect that intrapersonal diversity helps a team cope with changing tasks, our expectation is also that, controlling for intrapersonal diversity, interpersonal diversity and changing tasks interact to lower team performance. Changing tasks may exacerbate the coordination problems interpersonally diverse teams may face (e.g., more conflict and less trust), preventing a team from responding effectively to the changing environment and thereby decreasing its performance. Therefore, our first two hypotheses are:

HYPOTHESIS 1: A *team's intrapersonal diversity in terms of customer experience interacts with task change to positively affect team performance.*

HYPOTHESIS 2: *A team's interpersonal diversity in terms of customer experience interacts with task change to negatively affect team performance.*

2.2 Fluid Tasks and Team Familiarity

We now turn to the second aspect of fluid teams — *team familiarity*, or individuals' previous experience working with other members of their current team — to examine whether it, too, can help project teams respond flexibly to changing tasks. For several reasons, a group of individuals who have spent time working together may perform better than a group with the same amount of task experience but less experience working together. Individuals who work together develop a shared representation of which individuals have what knowledge within the team (Wegner 1987; Mathieu et al. 2000). By knowing who knows what within the team, individuals are better able to locate the knowledge needed to solve particular problems. Even after relevant knowledge has been identified, it still must be transferred between team members. As individuals work together, they develop a shared language and communication channels (Monteverde 1995; Weber and Camerer 2003). Prior experience working together also creates opportunities to create team beliefs such as psychological safety and positive social acceptance (Gruenfeld et al. 1996; Edmondson 1999; Tucker 2007; Siemsen et al. 2009). When these beliefs are in place, individuals might increase the quantity and quality of knowledge they share, resulting in better performance. Finally, even after relevant knowledge has been transferred, it still must be used. With prior experience working together, the likelihood that the right person is assigned the right task increases (Reagans et al. 2005). Additionally, prior work shows individuals are more likely to use the knowledge of known team members relative to information shared by unknown individuals (Kane et al. 2005). Thus, familiarity aids team functioning by helping members locate knowledge within a group, share knowledge with each other, and apply that knowledge (Katz 1982).

Weick and Roberts (1993) suggest that team familiarity leads to a common platform for rapid response that helps teams operate successfully in a dynamic environment. When tasks change, existing work methods are disrupted. Teams may no longer be able to rely on existing, codified processes, and instead find it necessary to adjust their actions. Changing tasks may create unplanned interactions within both the product architecture and team communication network (Sosa et al. 2004; Sosa 2008; Gokpinar et al. 2010). By leveraging individuals' tacit (i.e., unwritten) knowledge, team familiarity helps members develop a shared representation of who knows what in the team and enables them to specialize in different areas (Lewis et al. 2005). If team familiarity does in fact provide a common platform for learning and action, it may help teams respond better to task change. Familiar teams can find new information and coordinate more easily than unfamiliar teams. On a related note, task change possibly increases the value of team familiarity, as it creates opportunities to exercise previously unexploited coordination skills present in the team.

While the above literature suggests positive interactions between team familiarity and task change, the opposite effect is possible, as well. As project team members work together, they develop communication channels (Henderson and Clark 1990). When tasks are changed in complex development projects, there is often a resulting change in the architecture of the work, which may yield new personal interactions (e.g., instead of needing to talk to person A to complete one's work, it becomes necessary to talk to person B; Sosa et al. 2004; Sosa 2008; Gokpinar et al. 2010). Familiar teams may become stuck in established communication patterns and unable or unwilling to adapt their internal processes when an external change necessitates doing so (Okhuysen 2001). Harrison et al. (2003) hypothesize that familiar teams may struggle with task changes due to issues of social entrainment, although they may find no support for their hypothesis. Even if familiar teams adapt their communication processes, they may not incorporate new knowledge, due to the "Not Invented Here syndrome" (Katz and Allen 1982).

While the literature points to the possibility of either effect, we expect the positive effect to dominate in our setting. Any negative effect may be more likely with teams of individuals who are friends (such as the fraternity and sorority members in the Harrison et al. study), as opposed to individuals with shared prior work experience. While Katz and Allen (1982) examine such effects in an industrial setting, the negative effect sets in only after teams have worked together for many years. Thus, in a setting such as ours — where teams work together for months, not years — we may be less likely to see this effect. Nevertheless, the question is eventually an empirical one. As such, we test the following hypothesis:

HYPOTHESIS 3: *Task change and team familiarity have a positive interaction effect on team performance.*

2.3 Interpersonal Diversity and Team Familiarity

Finally, we consider whether, controlling for intrapersonal diversity, team familiarity helps teams leverage benefits of interpersonal diversity by alleviating the coordination problems it may create. Though team familiarity improves teams' coordination of activities in general, it may be particularly valuable for teams with large-scale coordination challenges, such as interpersonally diverse teams. As discussed earlier, interpersonal diversity can result in problems of translating team members' knowledge into action (Reagans and Zuckerman 2001). Because team familiarity aids in the locating, sharing, and application of knowledge resident within a team, team familiarity may address many problems created by interpersonal diversity without compromising the potential benefits. Also, team familiarity and interpersonal diversity may have a positive interaction effect on performance since interpersonal diversity makes the coordination benefits of team familiarity more salient.

Our premise is consistent with studies that find increased time working together may help teams take advantage of individuals' deeply held differences (Harrison et al. 1998; Harrison et al. 2002). This work in organizational behavior focuses on differences in psychological views (e.g., individual conscientiousness or task meaningfulness). We are agnostic regarding such psychological beliefs, being interested instead in individuals' work backgrounds. This leads to our fourth hypothesis:

HYPOTHESIS 4: A *team's interpersonal diversity in terms of customer experience and team familiarity have a positive interaction effect on team performance.*

Given that we have no ex-ante priors about the relationship between intrapersonal diversity and team familiarity, we do not explicitly hypothesize about that interaction effect. However, we include it in the model for completeness. If team familiarity and intrapersonal diversity jointly affect performance, the interaction effect likely would be substitutive (i.e., negative). First, Bunderson and Sutcliffe (2002) find that intrapersonal diversity improves information-sharing within a team. Such sharing is also seen as one potential mechanism through which team familiarity improves performance (Reagans et al. 2005). Second, intrapersonal diversity may reduce conflict within a team as members are better able to take the perspective of others, given their individually diverse experiences (c.f., Galinsky and Moskowitz 2000). Team familiarity may also reduce conflict due to team members' shared perspective. Given these overlapping mechanisms between intrapersonal diversity and team familiarity, it seems possible they could be substitutes in terms of their effects on team performance.

3. Setting, Data, and Empirical Strategy

Our empirical analysis focuses on software development projects. These involve complex and uncertain activities (Boh et al. 2007), typically including designing a solution, writing code, then testing and implementing the solution. An analysis of software development projects in 2004 found that only 35% were considered successful in meeting cost and schedule estimates while satisfying the customer's needs (Hartmann 2006).

The setting for our analysis is Wipro Technologies, a leading firm in the outsourced software services industry. Headquartered in India, the company executes projects for clients globally, both at customer locations and Wipro's own delivery centers (primarily in India). In 2006, the company's annual revenues exceeded $3 billion, with more than 66,000 employees throughout the world. Wipro's multiple business units are structured as "verticals" through which the company markets its services to targeted industries; both sales and project staffing take place at this level. Project teams at Wipro typically have three levels: At the top is the project manager (PM) with full operational control of the project, responsible not only for managing day-to-day operations of the team but also for serving as the primary interface with a customer. Middle managers, often known as module leaders, manage a subunit of the project and report to the PM. A middle manager usually supervises three to five "reports" (project engineers) in the subunit and also helps write code. The project engineers at the foundation of the project hierarchy are responsible for writing code. Individuals typically work on a single project at any time.

3.1 Data

The sample for our analysis is drawn from the universe of 1,137 software development projects completed at Wipro from January 2004 through December 2006. We supplement the project-level data with detailed human capital information on the 12,709 unique individuals who took part in these projects. Project-level controls and performance data cover development projects only back to 2004, but data on individual team members participating in these projects extends back to 2000. Though we cannot use the individual data to evaluate earlier project performance, we are able to track over time the experience accumulated by individuals, including customers for whom these individuals have worked, the individuals' roles on specific teams, and other personnel with whom they have worked. To build our sample, we remove projects that are missing data as well as those with fewer than four team members. Of the projects excluded from the sample, 468 lack a value for kilolines of code (KLOC), an important control for project complexity, because not all development projects use KLOC as their unit of measurement (e.g., some use a customer-specific measure) and some development projects do not include coding and therefore have no KLOC value. A comparison of excluded projects against those in the sample shows no meaningful differences in the variables of interest. The median project in the sample lasted six months (μ=232 days, σ=156 days) and included twelve team members (μ=18.4, σ=17.9).

3.1.1 Dependent Variables

Despite the well-known difficulty in finding objective measures of information technology (IT) project performance (Banker and Kemerer 1989), our data allow us to examine measures for both project efficiency and project quality (Boehm 1981; Faraj and Sproull 2000). We use these categories as they are the dimensions along which Wipro personnel are evaluated both internally and externally, and they capture results over which the team has significant control.

Project Efficiency Measures. Before a project begins, sales personnel at Wipro create estimates for the project's effort and schedule. These estimates are formally agreed to by the customer — often they serve as the basis for winning the project for Wipro in the first place — and are entered into Wipro's project management system. Given the significant competition Wipro faces from Indian firms (e.g., TCS and Infosys) and global providers (e.g., IBM and Accenture), the company cannot add excessive slack to its estimates, as it may lose the opportunity to execute a given project. Once an estimate is formally accepted by a customer, project personnel, including the project manager, are selected to staff the project. The managers do not select their own teams. Also, the teams are not built to stay together for multiple projects or long periods of time, but rather are fluid from inception, coming together to execute a particular project, then breaking up so the members can move on to other engagements.

As a project progresses, both its effort and schedule estimates are subject to alteration. Changes to estimates usually occur as a result of adjustments in project scope by the customer. Given the importance of estimates to contract fulfillment and internal evaluation, the revision process is monitored closely. As the first step in the process, the project manager has the customer formally sign off on the change. Then finance and quality managers at Wipro review the change request to make sure the PM is not attempting to subvert the system (e.g., changing estimates because a project falls behind). In our analysis, we use the revised estimates, as these most accurately reflect a project's final, definitive goals.

To quantify a project's delivery performance, we construct separate variables for performance with respect to effort (*effort deviation)* and schedule (*schedule adherence and schedule deviation*). Effort deviation is a continuous variable created by subtracting the estimated effort from the actual effort used and then dividing by the estimated effort. Dividing by estimated effort normalizes for project size, as we would anticipate that larger projects would have greater absolute differences. For schedule performance, we also construct a continuous measure, schedule deviation, by subtracting the estimated delivery date from the actual delivery date, yielding the number of days the project was ahead or behind schedule. We again normalize by dividing this number by the estimated duration in number of days. Though we can calculate a continuous measure, the underlying data and conversations with the company suggest that any given project schedule is not truly continuous; rather, values below zero (i.e., early delivery) are often truncated. For example, more than 70% of projects in our data delivered exactly on the day the project was due. According to the company, the reason for this is that if a project finishes early, it is typically not possible to deliver early, as the customer has scheduled its own resources to accept delivery on a specific date. (For example, one large customer requires thirty days' notice to reschedule delivery.) Therefore, we analyze schedule deviation using the censored regression methods described below. As an additional test for robustness, we also analyze for schedule performance using a dichotomous variable, *schedule adherence*, which is set either to one if a project meets its schedule estimate or to zero if it does not.

Project Quality Measures. In addition to examining the efficiency of a project team's performance, we also examine the quality of the team's output. To do so, we use two measures. The first, *defects*, is a count of the number of defects that occur in customer acceptance testing. This testing occurs at the end of a project, and is completed by either the customer or another third party on the customer's behalf. Not all projects undergo a customer acceptance test. Our second measure, *post delivery defect rate* (PDDR), divides the *defects* variable by the number of kilolines of new source code written in the project, to normalize quality performance for the project scale. Both measures are commonly used to evaluate quality in the software engineering literature (Boehm 1981; Fenton and Pfleeger 1997).

3.1.2 Independent Variables

Our study has three categories of independent variables: *task change*, *diversity in experience*, and *team familiarity*. To help interpret the interaction terms, all continuous variables are standardized by subtracting the mean from each and dividing by the standard deviation.

Task Change. A project's requirements are specified prior to its start. During the course of a project, typically as a result of new customer needs, the existing requirements change. To analyze task change, we examine the percentage of requirements that are changed over the course of a project. It is important to note that after requirements are changed, estimates are often changed, as well. Given the interconnectedness of the various parts of most software projects, once tasks begin to change, a project's overall complexity increases significantly (Wallace et al. 2004; Rai et al. 2009). Therefore, even accounting for revised estimates, we anticipate a negative main effect for task change on performance.

Contract theory would predict that an outsourcing firm might engage in holdup whereby the outsourcer uses the change to appropriate additional rents (Klein et al. 1978). While our conversations with Wipro yielded no evidence of this and the repeated and relational nature of Wipro's interactions make such behavior unlikely in this context (Baker et al. 2002), it is important to consider whether this manipulation could affect our empirical results. First, our project quality dependent variables should be less susceptible to this risk, as they are not revised in the same way as the estimates for project efficiency. Second, with respect to project efficiency, we would expect that holdup would result in larger estimates. Therefore, holdup would make it more difficult to find the negative effects of task change on performance that we see in our results. Finally, since revised estimates are completed closer to a project's end than the original estimates, the accuracy of the revised estimates could be greater than that of the initial estimates. While we would expect this to work against our expectation that task change is related to worse performance, not better performance, our project efficiency results should be interpreted with caution, given the potential remaining bias.

Diversity in Experience. Prior work on diversity in experience often operationalizes the variable as a difference between individuals' functional experience (e.g., Bunderson and Sutcliffe 2002). Though functional experience is an important way to capture the types of jobs an individual has held, here we exploit the detailed nature of our data to focus on another key element of the project-specific experience that an individual gains: customer experience. Customer experience is important in software services, as the execution of a project requires significant customer interaction (Ethiraj et al. 2005). Customer experience thus provides information about customer processes that may help team members solve problems for a focal customer (Boone et al. 2008). We note that diversity in customer experience may be correlated with diversity in other experience variables (e.g., technology) that we do not measure.

We focus on customer experience not only for its practical and theoretical importance, but also because of the realities of the data. The historical data provide information on customer experience for all individuals and all projects. Other variables of interest (e.g., technology) are available only for certain project types. Thus, by focusing on customer experience, we capture an organizationally relevant variable with great accuracy. Team members in the data have worked for a total of 437 customers. While Wipro was growing rapidly during the time this data was being collected, resulting in significant new additions to the firm, the average individual project team member captured in the data worked for two different customers. While the total customer population is 437, there are 90, 71, and 63 unique customers in our regressions for effort and schedule deviation, schedule adherence, and quality, respectively. We consider *all* customer interactions for individuals to completely capture an individual's customer experience.

Diversity in experience can be measured many different ways (Harrison and Klein 2007). We are interested in measuring both interpersonal customer diversity and intrapersonal customer diversity. We calculate the variables for each project in the data using all team members who worked on the project and consider the individuals' prior experience (i.e., excluding the focal project). For intrapersonal diversity, we use the approach introduced by Bunderson and Sutcliffe (2002) using customer experience, rather than functional experience, as our underlying measure. . Thus, we first calculate the *intrapersonal* diversity for each individual before averaging it across the entire team using the following formula, $\sum_{i=1}^{n}\left(1-\sum_{j=1}^{437}p_{ij}^2\right)/n$, where p_{ij} is the share of individual *i's* projects that involved customer *j* over the prior three years, and *n* is equal to the size of the team. To evaluate the *interpersonal* diversity of the team, we rely on a Euclidean distance measure. We use Euclidean distance because we aim to capture differences between the distribution of the prior experience of team members. Mean Euclidean distance captures exactly that separation of individuals on a team (Tsui et al. 1992; Harrison and Klein 2007). The measure is calculated using the following formula: $\frac{\sum_{i=1}^{N}\sum_{k=1}^{N}\sqrt{\sum_{j=1}^{437}\left(\left(p_{ij}-p_{kj}\right)^2\right)}}{n(n-1)}$, where p_{ij} and p_{kj} are the share of individual *i's* or *k's* projects that involved customer *j* over the past three years, and *n* is equal to team size.

We use a three-year time period for both theoretical and practical reasons. First, it accounts for the fact that, similar to the concept of organizational forgetting (Argote et al. 1990; Benkard 2000), experience *may* decay over time (although we do not test this assumption). Second, the three-year period incorporates the realities of the data, as the average employee has two years of Wipro experience and the median project lasts six months. This cutoff thus includes multiple projects per person and most employees' total Wipro experience. Finally, it avoids censoring data, as the historical employee data goes back to 2000 and the first project is from 2004. As a robustness check, we conduct analyses with two- and four-year cutoffs, and obtain similar results.

Team Familiarity. To calculate team familiarity, we first count the number of times that each unique pair of individuals on a team has worked with each other on a prior project over the previous three years. We then divide this number by (*n*(*n*-1))/2, where *n* is the size of the team (Reagans et al. 2005). Because we count multiple interactions between individuals, this variable does not capture the percentage of the team that has worked together previously (see the robustness checks for that analysis), but rather as Reagans et al. (2005) note, "The variable indicates the average amount of experience that team members have working with each other" (p. 873). We use a three-year time period for the same reasons we used it for the diversity variable. We again conduct analyses with two- and four-year cutoffs, and obtain similar results.

3.1.3 Control Variables

The data also offer numerous controls. Although we are interested primarily in the interaction effects discussed, we wish to control for a number of factors relating to team human capital and project characteristics. Table 1 describes the control variables, and Table 2 provides summary statistics.

*****************************Insert Tables 1 and 2 about here*****************************

3.2 Empirical Strategy

Given that our dependent variables consist of a continuous, count, dichotomous, and censored variable for *effort deviation* and *post delivery defect rate* (PDDR), *defects*, *schedule adherence*, and *schedule deviation*, respectively, we use a different regression model in each case. Our dataset consists of multiple projects per customer, and we wish to control for any time-invariant characteristics of customers that may impact performance. Therefore, with respect to effort deviation and PDDR, we use a generalized least squares (GLS) random-effects regression model (Stata command: xtreg, re). A Hausman test fails to reject the null hypothesis that the random effects model is consistent in either case. Additionally we use heteroskedasticity robust standard errors, clustered by customer. After we remove from our sample those customers who participated in only one project, we are left with 562 and 349 projects to analyze for effort deviation and PDDR, respectively. To evaluate project defect performance — since *defects* is a count variable, the data exhibit overdispersion, and we want to control for customers' time-invariant attributes — we use a conditional fixed effects negative binomial model (Stata command: xtnbreg, fe, Cameron and Trivedi 1998). As is the case with PDDR, the sample is 349 projects.

Schedule adherence is a dichotomous outcome variable, so we evaluate the schedule performance of project teams using a logistic regression model. In particular, we use a conditional logistic model to control for any time-invariant characteristics of customers (Greene 2003, Stata command: clogit). We also use robust standard errors clustered by customer. Because the models condition on the customer, our final sample excludes those customers who participated in only one project and any customers for whom the dependent variable does not differ across projects. This leaves us with 409 projects for our analyses on schedule adherence. Next, *schedule deviation* is a dependent variable, left-censored at zero. Since we again wish to control for time-invariant effects of customers, we use a random-effects Tobit regression model (Wooldridge 2002, Stata command: xttobit, re). Similar to the *effort deviation* models, the final sample excludes customers with only one project in the sample, leaving 562 projects for analysis.

4. Results

Columns 1 and 2 in Table 3 present results from the GLS random-effects regression of effort deviation on task change, team diversity, team familiarity, and their interactions. While the main effects of the independent variables are not a primary focus of this paper, we note that, as seen in Column 1, the coefficients on the variables are in the expected direction and statistically significant, with the exception of interpersonal diversity — a negative sign, corresponding to better performance, for team familiarity and intrapersonal diversity, and a positive sign, corresponding to worse performance, for interpersonal diversity and task change. In Column 2, we add the two-way interaction terms to test Hypotheses 1 through 4. Examining the interactions of task change with first intrapersonal diversity and then interpersonal diversity, we find support for Hypotheses 1 and 2, as the coefficient on the former is negative and significant while that on the latter is positive and significant. Next we find that the coefficient for the interaction of task change and team familiarity is not significant; thus, Hypothesis 3 is not supported. Finally, the coefficient for the interaction of team familiarity and interpersonal diversity is negative and significant, providing support for Hypothesis 4.

*******************************Insert Table 3 about here *******************************

Columns 3 and 4 in Table 3 present the results for our conditional logistic models with schedule adherence as the dependent variable. Column 3 includes the independent variables without interaction terms. Though the coefficient on intrapersonal diversity is positive and significant, implying a relationship with better performance, the coefficients on team familiarity, interpersonal diversity, and task change are not statistically significant at conventional levels. In Column 4, we add the two-way interaction terms. The coefficients for the interactions of task change with first intrapersonal diversity and then interpersonal diversity are positive and significant and negative and significant, respectively. Thus, Hypotheses 1 and 2 are supported. However, Hypothesis 3 and 4 are not supported as the coefficients on the remaining interaction terms are not significant.

Next, Columns 5 and 6 in Table 3 present results of our models with schedule deviation as the dependent variable. In Column 5, the model without interaction terms, the coefficients on interpersonal diversity and task change are positive and significant (the latter at the ten percent level) suggesting worse performance. Also, the coefficients on intrapersonal diversity and team familiarity are both negative, although the former is significant only at the ten percent level while the latter is not statistically significant at conventional levels. In Column 6, we add the two-way interaction terms. The coefficient on the interaction term for task change and intrapersonal diversity is negative and significant, providing support for Hypotheses 1, while that on the interaction of task change and interpersonal diversity is positive and significant at the ten percent level, providing partial support for Hypothesis 2. The coefficient on the interaction of task change and team familiarity is again not significant, thus failing to support Hypothesis 3; however, the interaction of team familiarity and interpersonal diversity is negative and significant, providing support for Hypothesis 4. Additionally, we note that the interaction of team familiarity and intrapersonal diversity is positive and significant, suggesting a potential substitution effect between these two variables.

Finally, in Columns 7 through 10 in Table 3, we examine the models with the dependent variables for project quality. In Column 7, which uses defects as the dependent variable, the coefficients have the predicted sign; however, only the coefficients for intrapersonal familiarity and team familiarity are statistically significant (the latter at ten percent). Examining Column 8, we find support for Hypothesis 1, as the coefficient on the interaction of task change and intrapersonal diversity is negative (i.e., related to fewer expected defects) and significant. These results do not support the other three hypotheses. Moving to Column 9's results for PDDR, we see the signs for coefficients of the study's main effects are in the expected direction and all except for interpersonal diversity are statistically significant (although team familiarity is at a ten percent level). Adding the two-way interactions in Column 10, we see support for Hypothesis 1, as the coefficient on the interaction of task change and intrapersonal diversity is negative and statistically significant. Additionally, the interaction of task change and interpersonal diversity is positive and significant, providing support for Hypothesis 2. The results do not support either Hypothesis 3 or 4, however.

In summary, we find at least partial support for three of our four hypotheses. Specifically, we see a positive relationship with performance from the interaction of task change and intrapersonal diversity (Hypothesis 1) with respect to all outcomes. We find a negative performance relationship from the interaction of task change and interpersonal diversity (Hypothesis 2) with effort deviation, schedule deviation, schedule adherence, and PDDR although the relationship with schedule deviation is only significant at the ten percent level. We also see support for a positive relationship with performance for the interaction of team familiarity and interpersonal diversity (Hypothesis 4) with respect to effort and schedule deviation, but not with respect to schedule adherence or project quality. Finally, we see no support for a moderating role of team familiarity on task change (Hypothesis 3).

4.1 Alternative Explanations

To examine the robustness of our results, several issues warrant further examination. The first relates to our conceptualization of team familiarity. Consistent with prior literature (i.e., Reagans et al. 2005; Espinosa et al. 2007), our measure of team familiarity captures both the breadth (i.e., whether team members have worked together) and depth of team member experience (i.e., the number of times team members have worked together). The benefits of team familiarity may possibly be due simply to breadth. Thus we construct a variable, *Team Familiarity Binary*, that first assigns a one to a pair if they have worked together at all over the prior three years (and a zero if not), before summing these up and averaging across the entire team (μ=0.26 and σ=0.25). These results appear in Table 4. In examining the interaction effects, two differences are worth noting. First, for effort deviation, the interaction of team familiarity binary and interpersonal diversity is significant only at the ten percent level. Second, for schedule deviation, the interaction of task change and interpersonal diversity is positive but not significant. All other results hold in sign and significance.

********************************Insert Table 4 about here ********************************

Given the role of team familiarity in our analysis, the threat of selection bias is a meaningful concern. We first note that project managers do not directly select their teams. Instead, project team members are selected by the HR group based on estimates prepared by sales personnel. However, the PM is able to reject individuals sent by the HR group. In practice, the organization's culture discourages exercising this power and, as such, managers report that rejection seldom occurs. We note that while we ideally would examine cases where project managers reject team members, Wipro does not track that information. Nevertheless, if rejection is systematically used to remove "bad" team members, it might bias our estimates. To examine this possibility, we consider two groupings of team members: (1) all dyads on teams and (2) each PM–team member dyad. The first grouping allows us to capture the possible selection in all team member relationships and the second focuses on PM–team member interactions. We use a Cox proportional hazard model and define failure as a pair that is currently working together – not working together on the following project. We examine whether poor performance on the dependent variables predicts failure. Results in Table 6 show that none of the project performance variables are significant predictors of the likelihood of two individuals continuing to work together. We also run these analyses as logistic regression models and generate similar results.

*******************************Insert Table 5 about here*******************************

Another concern is our measure of task change. Ideally, we would capture not only the percentage of requirements changed, but also the magnitude of the change. Unfortunately, only the former information is available for our analysis. An alternative conceptualization of task change, however, could include not only the requirements that are changed but also the percentage change from the original to final estimates for both effort and schedule. This measure captures the magnitude of the change across several dimensions, and so we examine it as a robustness check. We conduct a principal components analysis for the three variables together and find they load on the first principal component with positive coefficients (0.64, 0.54, and 0.55, for task change, effort change, and schedule change, respectively). Additionally, the first component has an Eigenvalue of 2.39 (compared to 0.55 for the second) and explains 80% of the variance. We use the coefficient values from the first principal component to construct a variable, *task change composite*, and repeat all of the following analyses with this variable instead of the *task change* variable. Comparing results in Table 6 with the related columns in Table 3, we see a similar pattern of results on the interaction terms of interest. Thus, while future work might unpack the concept of task change in more detail, we find our results in this area to be robust.

*******************************Insert Table 6 about here ******************************

We also conduct several other robustness checks. When interacted variables are correlated, the interaction terms may capture nonlinearities in the underlying variable (Cortina 1993). Thus, we add quadratic terms to the models in Table 3 and find the results for our interaction terms do not meaningfully change (and the quadratic terms do not significantly relate to performance). Additionally, to check for multicollinearity, we run all models with ordinary least squares in order to calculate variance inflation factors (VIF) and the models' condition index (CI) and find the values are well below suggested thresholds (10 for VIF and 30 for CI, Cohen et al. 2003). Second, given that repeated experience with the same client may prove beneficial, we construct a variable that counts and then averages across the team the number of times individual team members have worked for the same focal client over the prior three years. Including this variable in the regression models does not change the findings with respect to our hypotheses. Third, we repeat all analyses with the interaction terms entered into the models individually, and the results are consistent. Fourth, to control for the effect of new hires at Wipro (over and above what is captured by our team role experience variable), we repeat all analyses with a variable that measures the percentage of the team that is new to Wipro. This variable is not statistically significant at conventional levels and all results are consistent with our base findings. Finally, we examine whether a three-way interaction effect between team familiarity, interpersonal diversity, and task change has a positive effect on performance, and find that the coefficient is statistically indistinguishable from zero. Altogether, these models increase our confidence that the reported results are robust.

4.2 Limitations

As do all studies, ours has limitations. First, any nonrandom assignment of individual project team members to different customers could create bias. For example, there would be cause for concern if Wipro had a customer rotation program for “star” engineers. The firm, however, does not have such programs. Second, any nonrandom assignment of individuals to teams might also bias our results. The hazard analysis provides suggestive evidence that such selection is not taking place. Interviews with Wipro managers highlight that processes are designed to prevent the “cherry picking” of personnel. A related issue is that the same individuals work on different teams, creating the potential for correlated standard errors. For example, if a star performer worked on multiple teams in the sample and she was the reason each team was successful, then this could create an omitted variable bias (e.g., it could be problematic for our analysis if the star performer also was able to demand her own team, and thus the omitted variable was correlated with team familiarity or another independent variable). Neither our discussions with management nor our empirical analysis reveal evidence of this, but we are not able to control for every individual and interaction, and thus cannot categorically rule out this possibility.

Third, while we are able to capture diversity in customer experience, we are not able to investigate other types of diversity (e.g., technology or task). These other variables could introduce omitted variable bias into our results. However, we would expect our theoretical motivation to hold for other types of diversity in experience. Future empirical studies of other measures would be valuable both to identify whether the theory holds and to evaluate the relative importance of different types of experience. Fourth, while we find significant interaction effects, our empirical design cannot determine which variable is the moderator and which variable is moderated. For example, we know not whether intrapersonal diversity is valuable and becomes even more so in the presence of task change, or if task change is bad but becomes less so in the presence of intrapersonal diversity — or if both effects are present. Future work should examine the precise relationships between the different variables.

Fifth, our study considers just one firm in one industry, so the question of whether its findings will generalize to other settings is fair. We believe this limitation to be a necessary consequence of the detailed quantitative data and in-depth fieldwork that has allowed us to unite deep knowledge of the setting with large-scale empirical testing of the research question. Further, we feel that many other manufacturing and service settings mirror the conditions found here. Finally, a dataset, such as the one we study, is by itself a strength and limitation. While the data captures the reality of its setting, the analyses in this paper are inherently limited by the data that the company chooses to collect.

5. Discussion

Prior work highlights that teams with diverse prior experience are often brought together because of varied knowledge demands (Brusoni et al. 2001; Lapré and van Wassenhove 2001). Here we find that such diversity can be a double-edged sword when it comes to helping teams cope with changing tasks. In our setting, where cognitive problem-solving demands are high, diverse experience may improve performance by enabling access to a wider base of knowledge and improved information processing. In interviews conducted at Wipro, one project manager noted:

> On a project, we needed to create functionality in order to backup and restore within an application. When we were discussing this requirement it turned out that one of the team members had developed an automated tool that could do this when he was working on a project for a different customer. We were able to incorporate this tool and save a great deal of time and effort.

This quote highlights a potential problem in terms of both participation and awareness. The other team members were unlikely to know about the engineer's prior useful experience, and he could have simply remained quiet when the discussion turned to backing up and restoring within an application. Also, without communication in the group, the engineer may not have learned about the need for the backup and restore functionality until after someone had already written new, redundant code. Thus, diverse team-member experience offers a promise, but no guarantee, of better team performance. While diverse individuals in a team may help to address knowledge gaps, this benefit of diversity may be lost if team coordination issues are not also addressed. We help disentangle this effect with respect to task change by separately considering interpersonal and intrapersonal team diversity.

Controlling for individual team members' breadth of experience (i.e., intrapersonal diversity), we find that increasing the interpersonal difference in experience across team members relates to worse performance under conditions of task change. When tasks change, project teams need to adapt efficiently. This heightens the coordination and integration demands on a team (Wheelwright and Clark 1992; Heath and Staudenmayer 2000), and a diverse team of relative specialists may be unable to meet this challenge.

Similarly, our results suggest that holding the interpersonal diversity of experience constant within a team while shifting its composition from specialists to generalists heightens the team's ability to respond effectively to task change. Supporting the contention that interpersonal diversity results in coordination challenges, we find that teams with a mechanism to improve coordination (i.e., team familiarity) perform better than do less familiar teams in the face of interpersonal diversity.

Project teams today often face a dynamic, uncertain environment. In such settings, flexibility in project teams becomes more important than ever. Discussing a land development project, the project leader noted, "Every play we run is an option play. I want my people to be able to make decisions in the field without having to report back to me every time something comes up" (De Meyer et al. 2002: 65). As noted by the leader, such decision-making requires knowledgeable, empowered individuals. Relevant knowledge elsewhere on a team may not be accessible *enough* to affect the team's performance, enabling individual members to make timely decisions in the field. Teams of relatively more generalists thus may be better prepared to respond dynamically to changing circumstances than teams of specialists might be. This notion brings to mind Wheelwright and Clark's (1992) concept of a heavyweight project team — that by constructing teams with more generalists and fewer specialists, efficiency might possibly be improved.

Two results in the models for schedule deviation merit additional discussion. First: while we find no support for Hypothesis 4 — seeing no positive interaction of team familiarity with interpersonal diversity — in our model of schedule adherence, we *can* detect support for it in the model of *schedule deviation*. This result has at least two possible explanations: The first might have to do with the fact that, in our data, 82% of projects are delivered on time. Such limited variation in schedule adherence may limit our ability to see an effect with this dependent variable. However, the additional granularity of schedule deviation may allow us to identify more of a signal within that noisier environment. A second possible answer is that the difference tells us something about where team familiarity proves most valuable. Namely, in this context, the net effect of interpersonal diversity on delivering a project on time is unclear (the coefficient in Column 3 is negative but not significant) and team familiarity does not appear to help teams leverage their interpersonal differences. However, if a project starts running behind, team familiarity may help the team mitigate (though not eliminate) the resulting loss. Our second main consideration about the schedule deviation results concerns our finding a positive and significant coefficient, implying worse performance, for the interaction of team familiarity and intrapersonal diversity. As discussed above, this result suggests there may be potential substitution between intrapersonal diversity and team familiarity in their combined effect on performance. Future work should explore this idea further.

Additionally, we fail to support Hypothesis 3 — the expectation that team familiarity helps a team cope with changing tasks. Prior work notes the beneficial role of familiarity in helping teams manage complexity (Espinosa et al. 2007). At least in our context, these benefits of tacit coordination do not appear to translate into dealing with task change. Additional study is needed to understand why familiarity does not moderate the impact of in-process task changes in this setting. As discussed in our motivation of this hypothesis, team familiarity under conditions of task change presents potential benefits *as well as potential costs*. For example, while our data records the amount of task change in a project, we do not know if the task change altered the underlying product architecture, creating a need for new communication channels and interactions (Sosa et al. 2004; Sosa 2008; Gokpinar et al. 2010). It is possible that team familiarity aids teams facing incremental change, but hampers those who encounter architectural change. Future work should explore the circumstances under which either effect dominates.

In addition, we see no support for a positive interaction effect of team familiarity and interpersonal diversity with respect to either *quality* variable. This lack of result may be due to innate differences in project quality as compared to project *efficiency*. The development of quality software requires significant coordination of team members and interactions between them. Perhaps for quality, neither is team familiarity enough to overcome the coordination challenges that interpersonal diversity may create, nor are the latent benefits of team familiarity sufficiently available to be activated by conditions associated with task change. Future work should examine these relationships in more detail.

A final point to note is the relatedness of different tasks. Here we consider all customer experience to be equivalent in constructing our diversity measures. However, different customers may operate in the same industry or geographic area, creating more broadly applicable knowledge. Future work should consider these aspects of relatedness in exploring the effect of diversity on team performance.

6. Conclusion

Understanding the relationships between task change, diversity in team member experience, team familiarity, and subsequent team performance is important because, as Senge (1990: 236) notes, teams may be "the key learning unit in organizations" and organizational learning is an important source of competitive differentiation (Argote 1999; Edmondson 2002). As organizations continue to depend on the output of project teams and teams, in turn, rely on members with diverse prior experience (Edmondson and Nembhard 2009), all while work becomes increasingly dynamic, it becomes increasingly critical for teams to manage these differences and dependencies successfully (Faraj and Sproull 2000). In our setting, we are able to track multiple measures of experience for team members over several years and link this experience with project performance. This linkage permits us to gain insight into how diversity in experience and team familiarity relate to project flexibility and, more generally, to team performance.

Both this paper and our earlier one (Huckman, Staats, and Upton 2009) contribute to a stream of research examining fluid teams, project team member selection, and team performance (Arrow and McGrath 1995; Cohen and Bailey 1997; Edmondson and Nembhard 2009). This research provides insight as to what levers managers can use to improve team performance. In Huckman, Staats, and Upton (2009), we find that team familiarity is related to improved team performance, leading to the managerial advice to keep teams together. Unfortunately, factors such as employee turnover, firm growth, and varying client project requirements can make such advice difficult to follow. Because all team members cannot work on teams with high team familiarity, managers are faced with questions of which team members to keep together and working on which project types. The current paper examines this question and finds that team familiarity is more beneficial for teams that are more interpersonally diverse. Isolating both where team familiarity should be built and where it can be deployed identifies a powerful managerial lever to impact team performance.

This paper also extends our prior work by examining interpersonal diversity, intrapersonal diversity, and task change. Our findings indicate that the type of diversity present in a team (i.e., inter- or intrapersonal) is predictive of how that team will perform under conditions of task change. Just as all project teams cannot have high team familiarity, neither can all project teams consist solely of generalists. Managers therefore need to identify ex-ante conditions, such as a high likelihood of task change, to prioritize their allotments of generalists as particularly valuable team resources for such purposes. Also, managers should know the interpersonal diversity of their teams, to target interventions whenever a team high in interpersonal diversity becomes challenged by a change of tasks.

Finally, our work offers a lens through which to consider the management of diversity and experience in organizations more generally. The question of how to build focused, efficient operations while remaining flexible is an important one that has received substantial attention (e.g., Abernathy 1978; Adler et al. 2009; Huckman 2009). Our results suggest that although organizations may be constrained by experience variables in their staffing decisions (e.g., even if they wish to limit experiential diversity across teams, market conditions may prevent such a focused staffing strategy), they may be able to do better with the same resources by developing a rich conception of the sets of experience their individual team members hold. If companies' most valuable assets are indeed their employees, then organizations need to shift from thinking only about their project portfolios to considering their employee-experience portfolios, as well. Managing employee-experience portfolios will require managers to consider their employees' breadth of experience (focused vs. generalist) and types of experience (customer, technology, etc.), as well as familiarity with each other. An employee-experience portfolio perspective will also help organizations with project allocation as they seek to build desired sets of employee profiles. Doing so will offer managers an additional way for improving their organization's performance.

Tables and Figures

Table 1. Control variables included in the regression models.

Control Variable	Explanation
Team Role Experience	To control for the baseline experience of the team we use the team's average role experience — the time each individual has spent in her hierarchical role. We build the team value by weighting each individual's value according to the number of days she was on the project and averaging across team members. Less than 5% of project managers are promoted before the historical data begins, so, we impute role experience for these PMs. Substituting a wide range of values does not change the reported results. Instead of using team role experience, an alternative approach would be to use team firm experience (i.e., the average years of firm-specific experience for the team). Substituting this control variable yields the same pattern of results for the hypotheses.
Contract Type	An indicator variable, which equals one if a contract is fixed price (set price and Wipro bears the risk of overage) or zero if the contract is time and materials (i.e. cost plus) (Banerjee and Duflo 2000).
Offshore Percentage	Percentage of the project's total hours which are completed offshore (at Wipro's locations in India).
Complexity	To measure the complexity of a project we use four variables to construct a composite measure. These variables are: • Log (Kilolines of Code) – Log of the kilolines of new source code (KLOC) written • Log (Estimated Effort) – Log of the estimated total person-hours for the project. • Log (Team Size) – Log of the total number of individuals who were part of the project. • Log (Estimated Duration) – Log of the estimated project length (in days). We conduct a principal components analysis and all four variables load with positive values (0.47, 0.55, 0.52, and 0.46, respectively) on the first component. The first component has an Eigenvalue of 2.98 and explains 74% of the variance. We use these values to construct our composite measure. Putting the four variables in the models separately does not change our results in a substantive manner with respect to our hypotheses.
Software Language	Indicator variables for six classes of software languages.
# of Software Languages	Indicator variable equal to one if a project uses more than one software language and zero otherwise.
Technology	Indicator variable equal to one if a project uses more than one technology and zero otherwise. Examples of technology categories include mainframe, ecommerce, client server, etc.
Start Year	Indicators for the year in which the project started.

Table 2.

Summary Statistics and Correlation Table of Dependent, Independent, and Control Variables of Interest –
n = 562, except for schedule adherence (n = 409).

	Variable	Mean	σ	1	2	3	4	5	6	7	8	9	10	11	12
1.	Effort Deviation	-4.70	19.28												
2.	Schedule Deviation	1.23	8.84	**0.64**											
3.	Schedule Adherence	0.82	0.38	**-0.32**	**-0.51**										
4.	Defects	26.5	111.6	0.08	0.03	-0.10									
5.	PDDR	0.23	0.61	**0.13**	0.08	-0.10	**0.44**								
6.	Team Familiarity[a]	0.40	0.49	**-0.10**	**-0.07**	0.06	-0.09	**-0.12**							
7.	Intrapersonal Diversity[a]	0.36	0.18	**-0.10**	-0.04	-0.04	**-0.15**	0.02	**-0.40**						
8.	Interpersonal Diversity[a]	0.67	0.23	0.08	**0.12**	**-0.15**	0.02	0.09	**-0.51**	**0.43**					
9.	Task Change[a]	0.19	0.27	**0.20**	**0.10**	-0.08	**0.20**	**0.15**	-0.06	-0.01	0.07				
10.	Team Role Experience[a]	1.24	0.57	-0.05	-0.01	0.09	-0.08	**-0.17**	**0.22**	**-0.20**	**-0.13**	-0.04			
11.	Offshore Percentage[a]	0.85	0.15	0.07	**0.11**	-0.05	-0.06	0.04	0.06	0.03	-0.03	0.03	**-0.16**		
12.	Contract Type[a]	0.68	0.47	-0.05	**0.09**	-0.03	-0.07	-0.01	**0.09**	**-0.11**	-0.02	**-0.16**	**0.16**	**-0.09**	
13.	Complexity	0.00	1.72	0.07	-0.01	-0.06	**0.32**	0.01	**-0.20**	0.00	0.05	**0.19**	-0.02	**-0.13**	**-0.16**

Note. Bold denotes significance of less than 5%.
[a] In models this variable is standardized by subtracting the mean and dividing by the standard deviation. Values here are before standardization.

Table 3. Results of the regressions of effort deviation, schedule adherence, schedule deviation, defects, and post-delivery defect rate (PDDR) on diversity in experience, task change, and team familiarity (*n* =562, 409, 562, 349, and 349, respectively).

	Dep Variable: Effort Deviation		Dep Variable: Schedule Adherence		Dep Variable: Schedule Deviation		Dep Variable: Defects		Dep Variable: Post Delivery Defect Rate (PDDR)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Team Familiarity[a]	-2.909***	-4.241***	0.067	0.243	-0.741	-2.188	-0.248*	-0.227	-0.076*	-0.085
	(1.007)	(1.463)	(0.174)	(0.361)	(2.688)	(3.079)	(0.133)	(0.147)	(0.045)	(0.055)
Intrapersonal Diversity[a]	-3.959**	-2.294**	0.466**	0.385	-3.902*	-0.237	-0.194**	-0.192	-0.118***	-0.069
	(1.563)	(1.094)	(0.198)	(0.259)	(2.099)	(2.337)	(0.094)	(0.124)	(0.037)	(0.048)
Interpersonal Diversity[a]	0.650	-0.751	-0.189	-0.040	7.733***	4.036	0.120	0.114	0.026	-0.015
	(0.700)	(0.876)	(0.239)	(0.276)	(2.527)	(2.648)	(0.104)	(0.128)	(0.046)	(0.053)
Task Change[a]	3.390**	2.579**	0.036	0.207	2.786*	0.259	0.032	-0.021	0.099***	0.052
	(1.516)	(1.153)	(0.158)	(0.189)	(1.673)	(2.008)	(0.077)	(0.086)	(0.034)	(0.034)
Task Change × Intrapersonal Diversity		-4.452**		0.462**		-4.660**		-0.185**		-0.163***
		(2.172)		(0.204)		(2.170)		(0.092)		(0.036)
Task Change × Interpersonal Diversity		2.893**		-0.560**		3.789*		-0.004		0.091**
		(1.455)		(0.229)		(2.153)		(0.098)		(0.042)
Task Change × Team Familiarity		-1.105		-0.345		0.227		-0.156		-0.058
		(1.366)		(0.309)		(2.675)		(0.142)		(0.049)
Team Familiarity × Interpersonal Diversity		-2.826**		0.226		-5.686**		0.008		-0.068
		(1.433)		(0.334)		(2.723)		(0.157)		(0.057)
Team Familiarity × Intrapersonal Diversity		2.707		-0.154		7.493**		0.041		0.100
		(1.655)		(0.294)		(3.217)		(0.188)		(0.069)
Role Experience[a]	-1.354	-1.633	0.272	0.256	-1.692	-1.668	-0.187**	-0.204**	-0.092**	-0.095***
	(1.083)	(1.105)	(0.176)	(0.165)	(1.903)	(1.824)	(0.092)	(0.093)	(0.036)	(0.035)
Offshore Percentage[a]	0.177	-0.107	-0.415*	-0.382	5.858***	5.536***	-0.002	-0.004	0.030	0.024
	(0.871)	(0.918)	(0.245)	(0.268)	(2.177)	(2.094)	(0.080)	(0.081)	(0.035)	(0.034)
Contract Type	0.722	1.287	-0.610*	-0.854***	12.115***	12.328***	0.356*	0.350*	-0.070	-0.081
	(2.000)	(2.086)	(0.319)	(0.331)	(4.253)	(4.067)	(0.191)	(0.192)	(0.083)	(0.080)
Project Complexity	0.520	0.367	-0.191	-0.179	1.582	1.473	0.237***	0.235***	0.002	-0.006
	(0.519)	(0.497)	(0.124)	(0.126)	(1.161)	(1.121)	(0.051)	(0.052)	(0.022)	(0.021)
Constant	-5.794**	-6.535**	-	-	-42.493***	-42.240***	-1.590***	-1.569***	0.184	0.219
	(2.617)	(2.691)	-	-	(9.289)	(9.172)	(0.343)	(0.352)	(0.154)	(0.151)
Observations	562	562	409	409	562	562	349	349	349	349
Log Pseudolikelihood	-	-	-96.83	-91.65	-476.9	-469.6	-721.5	-719.1	-	-
Overall R^2 / Pseudo R^2	0.0800	0.1090	0.1669	0.2114	-	-	-	-	0.1101	0.1807
Wald chi-squared	52.11***	66.89***	82.82***	89.06***	47.08***	57.65***	67.61***	75.91***	53.95***	86.68***

Notes. *, ** and *** denote signficance at the 10%, 5% and 1% levels, respectively. All models include, but results are not shown for the following variables: number of languages, start year, software language, and number of technologies.

[a] Variable is standardized by subtracting the mean and dividing by the standard deviation.

Table 4. Results of the regressions of effort deviation, schedule adherence, schedule deviation, defects, and post-delivery defect rate (PDDR) on diversity in experience, task change, and *binary* team familiarity (*n* =562, 409, 562, 349, and 349, respectively).

	DV: Effort Deviation		DV: Schedule Adherence		DV: Schedule Deviation		DV: Defects		DV: PDDR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Team Familiarity Binary[a]	-2.678**	-2.911**	0.046	0.190	-0.446	-1.059	-0.129	-0.113	-0.063	-0.050
	(1.130)	(1.315)	(0.182)	(0.270)	(2.266)	(2.238)	(0.104)	(0.103)	(0.041)	(0.041)
Intrapersonal Diversity[a]	-4.049**	-2.404**	0.464**	0.384	-3.860*	-0.324	-0.183*	-0.241**	-0.119***	-0.090**
	(1.623)	(1.070)	(0.198)	(0.265)	(2.103)	(2.284)	(0.095)	(0.117)	(0.038)	(0.046)
Interpersonal Diversity[a]	0.783	-0.658	-0.200	-0.124	7.858***	4.637*	0.162	0.193	0.034	-0.004
	(0.711)	(0.923)	(0.230)	(0.257)	(2.476)	(2.500)	(0.102)	(0.119)	(0.045)	(0.050)
Task Change[a]	3.367**	2.503**	0.035	0.237	2.777*	0.218	0.032	0.004	0.099***	0.058*
	(1.503)	(1.107)	(0.158)	(0.191)	(1.673)	(2.013)	(0.078)	(0.086)	(0.034)	(0.035)
Task Change × Intrapersonal Diversity		-4.565**		0.469**		-4.740**		-0.183**		-0.163***
		(2.185)		(0.212)		(2.165)		(0.091)		(0.036)
Task Change × Interpersonal Diversity		2.838**		-0.475**		3.133		-0.017		0.091**
		(1.436)		(0.215)		(2.069)		(0.092)		(0.038)
Task Change × Team Familiarity Binary		-1.280		-0.090		-1.337		-0.161		-0.052
		(1.411)		(0.264)		(2.303)		(0.103)		(0.038)
Team Familiarity Binary × Interpersonal Diversity		-1.842*		0.218		-4.648**		-0.074		0.066
		(1.098)		(0.289)		(2.294)		(0.137)		(0.052)
Team Familiarity Binary × Intrapersonal Diversity		2.593*		-0.088		6.163**		0.103		-0.011
		(1.378)		(0.294)		(2.610)		(0.117)		(0.044)
Constant	-5.585**	-5.885**	-	-	-42.440***	-42.185***	-1.545***	-1.529***	0.193	0.242
	(2.620)	(2.702)	-	-	(9.290)	(9.094)	(0.341)	(0.351)	(0.153)	(0.150)
Observations	562	562	409	409	562	562	349	349	349	349
Log (Pseudo)likelihood	-	-	-96.85	-92.12	-476.9	-469.1	-722.5	-719.1	-	-
Overall R^2 / Pseudo R^2	0.0800	0.1090	0.1667	0.2074	-	-	-	-	0.109	0.185
Wald chi-squared	56.31***	55.69***	79.56***	94.34***	47.07***	59.14***	67.02***	77.41***	53.23***	87.54***

Notes. *, ** and *** denote signficance at the 10%, 5% and 1% levels, respectively. All models include, but results are not shown for the following variables: role experience, offshore percentage, contract type, project complexity, number of languages, start year, software language, and number of technologies.

[a] Variable is standardized by subtracting the mean and dividing by the standard deviation.

Table 5. Summary results of Cox hazard models to examine potential selection effects.

	Dep Var: Failure (i.e., dyad not working together again)			
	All Dyads		Project Manager - Team Member Dyads	
	(1)	(2)	(3)	(4)
Effort Deviation	0.0003	0.0002	-0.0001	-0.0003
	(0.0003)	(0.0004)	(0.0002)	(0.0003)
Schedule Adherence	-0.0163		-0.0219	
	(0.0225)		(0.0188)	
Schedule Deviation		0.0006		0.0010
		(0.0011)		(0.0009)
Defects	(0.00003)	(0.00003)	0.00002	0.00002
	(0.00002)	(0.00002)	(0.00003)	(0.00004)
Contract Type	0.0272	0.0286	0.0159	0.0173
	(0.0245)	(0.0242)	(0.0246)	(0.0245)
Offshore Percentage	-0.0067	-0.0070	-0.0438	-0.0424
	(0.0846)	(0.0845)	(0.0742)	(0.0738)
Complexity	0..0170***	0.0165***	0.0138	0.0136
	(0.0064)	(0.0063)	(0.0056)	(0.0056)
Observations	126,731	126,731	14,361	14,361
Log Likelihood	-1,357,133	-1,357,133	-127,212	-127,212

Notes. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively. The following variables are included in the regressions but are not shown in the table: project start year, software language, # of languages, # of technologies, and customer fixed effects. Standard errors are clustered by project.

Table 6. Results of the regressions of effort deviation, schedule adherence, schedule deviation, defects, and post-delivery defect rate (PDDR) on diversity in experience, *composite* task change, and team familiarity (*n* =562, 409, 562, 349, and 349, respectively).

	DV: Effort Deviation		DV: Schedule Adherence		DV: Schedule Deviation		DV: Defects		DV: PDDR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Team Familiarity[a]	-2.959***	-4.155***	0.068	0.230	-0.742	-1.826	-0.238*	-0.237	-0.072	-0.088
	(1.019)	(1.429)	(0.174)	(0.358)	(2.740)	(3.127)	(0.133)	(0.149)	(0.046)	(0.055)
Intrapersonal Diversity[a]	-4.078**	-2.385**	0.465**	0.379	-4.274**	-0.618	-0.201**	-0.205*	-0.124***	-0.072
	(1.649)	(1.144)	(0.197)	(0.255)	(2.126)	(2.345)	(0.093)	(0.124)	(0.037)	(0.049)
Interpersonal Diversity[a]	0.748	-0.589	-0.186	-0.085	8.170***	4.614*	0.134	0.107	0.038	-0.009
	(0.725)	(0.889)	(0.241)	(0.270)	(2.582)	(2.684)	(0.104)	(0.129)	(0.046)	(0.053)
Task Change Composite[a]	2.127*	1.908*	0.032	0.217	0.716	-2.026	-0.036	-0.059	0.063*	0.042
	(1.249)	(1.052)	(0.151)	(0.189)	(1.766)	(2.464)	(0.085)	(0.093)	(0.033)	(0.034)
Task Change Composite × Intrapersonal Diversity		-4.429**		0.438**		-5.094**		-0.243**		-0.152***
		(2.228)		(0.200)		(2.254)		(0.103)		(0.039)
Task Change Composite × Interpersonal Diversity		3.565**		-0.576**		5.606**		-0.055		0.090**
		(1.788)		(0.272)		(2.850)		(0.124)		(0.041)
Task Change Composite × Team Familiarity		-0.650		-0.358		2.351		-0.204		-0.064
		(1.330)		(0.364)		(3.124)		(0.171)		(0.056)
Team Familiarity × Interpersonal Diversity		-2.910**		0.232		-5.928**		0.051		0.098
		(1.469)		(0.329)		(2.743)		(0.187)		(0.070)
Team Familiarity × Intrapersonal Diversity		2.815*		-0.142		7.833**		-0.001		-0.070
		(1.709)		(0.289)		(3.257)		(0.157)		(0.058)
Constant	-4.731**	-5.825**	-	-	-41.690***	-41.206***	-1.546***	-1.541***	0.230	0.261*
	(2.282)	(2.352)	-	-	(9.427)	(9.288)	(0.342)	(0.350)	(0.153)	(0.151)
Observations	562	562	409	409	562	562	349	349	349	349
Log (Pseudo)likelihood	-	-	-96.84	-92.29	-478.1	-469.9	-721.5	-718.4	-	-
Overall R^2 / Pseudo R^2	0.0800	0.1090	0.1668	0.2059	-	-	-	-	0.101	0.160
Wald chi-squared	52.01***	59.38***	81.87***	88.87***	44.75***	55.98***	67.24***	76.21***	48.04***	76.02***

Notes. *, ** and *** denote signficance at the 10%, 5% and 1% levels, respectively. All models include, but results are not shown for the following variables: role experience, offshore percentage, contract type, project complexity, number of languages, start year, software language, and number of technologies.

[a] Variable is standardized by subtracting the mean and dividing by the standard deviation.

7. References

Abernathy, W. J. (1978). *The Productivity Dilemma Roadblock to Innovation in the Automobile Industry*. Baltimore, Johns Hopkins University Press.

Adler, P. S., M. Benner, D. J. Brunner, J. P. MacDuffie, E. Osono, B. R. Staats, H. Takeuchi, M. Tushman and S. G. Winter (2009). "Perspectives on the productivity dilemma." *J. of Oper. Management* **27**(2): 99-113.

Argote, L. (1999). *Organizational Learning: Creating, Retaining, and Transferring Knowledge*. Boston, Kluwer Academic.

Argote, L., S. L. Beckman and D. Epple (1990). "The persistence and transfer of learning in industrial settings." *Management Sci.* **36**(2): 140-154.

Arrow, H. and J. E. McGrath (1995). Membership dynamics in groups at work: A theoretical framework. *Research in Organizational Behavior*. B. Staw and L. Cummings. Greenwich, CT, JAI. **17:** 373-411.

Baker, G., R. Gibbons and K. Murphy (2002). "Relational contracts and the theory of the firm." *Quart. J. of Econ.* **117**(1): 39-84.

Baldwin, C. Y. and K. B. Clark (2000). *Design Rules: Volume 1*. Cambridge, Mass, MIT Press.

Banerjee, A. V. and E. Duflo (2000). "Reputation effects and the limits of contracting: A study of the Indian software industry." *Quart. J. of Econ.* **115**(3): 989-1017.

Banker, R. D. and C. F. Kemerer (1989). "Scale economies in new software development." *IEEE Transactions on Software Engineering* **15**(10): 1199-1206.

Benkard, C. L. (2000). "Learning and forgetting: The dynamics of aircraft production." *Amer. Econ. Rev.* **90**(4): 1034-1054.

Boehm, B. (1981). *Software Engineering Economics*. New York, Prentice Hall.

Boh, W. F., S. A. Slaughter and J. A. Espinosa (2007). "Learning from experience in software development: A multilevel analysis." *Management Sci.* **53**(8): 1315-1331.

Bohn, R. (2000). "Stop fighting the fires." *Harvard Business Rev.* **78**(4): 82-91.

Boone, T., R. Ganeshan and R. L. Hicks (2008). "Learning and knowledge depreciation in professional services." *Management Sci.* **54**(7): 1231-1236.

Boudreau, J., W. Hopp, J. O. McClain and L. J. Thomas (2003). "On the interface between operations and human resources management." *Manufacturing Service Oper. Management* **5**(3): 179-202.

Brusoni, S., A. Prencipe and K. Pavitt (2001). "Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make?" *Admin. Sci. Quart.* **46**(4): 597-621.

Bunderson, J. S. (2003). "Recognizing and utilizing expertise in work groups: A status characteristics perspective." *Admin. Sci. Quart.* **48**(4): 557-591.

Bunderson, J. S. and K. M. Sutcliffe (2002). "Comparing alternative conceptualizations of functional diversity in management teams: Process and performance effects." *Acad. of Management J.* **45**(5): 875-893.

Burke, L. A. and H. K. Steensma (1998). "Toward a model for relating executive career experiences and firm performance." *J. of Managerial Issues* **10**(1): 86-102.

Cameron, A. C. and P. K. Trivedi (1998). *Regression Analysis of Count Data*. New York, Cambridge University Press.

Cohen, S. G. and D. E. Bailey (1997). "What makes teams work: Group effectiveness research from the shop floor to the executive suite." *J. of Management* **23**(3): 239-290.

Cortina, J. M. (1993). "Interaction, nonlinearity, and multicollinearity: Implications for multiple regression." *J. of Management* **19**(4): 915-922.

De Meyer, A., C. H. Loch and M. T. Pich (2002). "Managing project uncertainty: From variation to chaos." *Sloan Mgmt. Rev.* **43**(2): 60-67.

Edmondson, A. (1999). "Psychological safety and learning behavior in work teams." *Admin. Sci. Quart.* **44**(2): 350-383.

Edmondson, A. C. (2002). "The local and variegated nature of learning in organizations: A group-level perspective." *Organ. Sci.* **13**(2): 128.
Edmondson, A. C. and I. A. Nembhard (2009). "Product development and learning in project teams: The challenges are the benefits." *J. of Product Innovation Management* **26**(2): 123-138.
Espinosa, J. A., S. A. Slaughter, R. E. Kraut and J. D. Herbsleb (2007). "Familiarity, complexity, and team performance in geographically distributed software development." *Organ. Sci.* **18**(4): 613-630.
Ethiraj, S. K., P. Kale, M. S. Krishnan and J. V. Singh (2005). "Where do capabilities come from and how do they matter? A study in the software services industry." *Strategic Management J.* **26**(1): 25-45.
Faraj, S. and L. Sproull (2000). "Coordinating expertise in software development teams." *Management Sci.* **46**(12): 1554-1568.
Fenton, N. E. and S. L. Pfleeger (1997). *Software Metrics: A Rigorous and Practical Approach*. London, International Thompson Computer Press.
Fisher, M. L. and C. D. Ittner (1999). "The impact of product variety on automobile assembly operations: Empirical evidence and simulation analysis." *Management Sci.* **45**(6): 771-786.
Frei, F. X. (2006). "Breaking the trade-off between efficiency and service." *Harvard Business Rev.* **84**(11): 92-101.
Fuchs, V. (1968). *The Service Economy*. New York, Columbia University Press.
Galinsky, A. D. and G. B. Moskowitz (2000). "Perspective-taking: Decreasing stereotype expression, stereotype accessibility, and in-group favoritism." *Journal of Personality and Social Psychology* **78**(4): 708-724.
Gavetti, G., D. A. Levinthal and J. W. Rivkin (2005). "Strategy making in novel and complex worlds: the power of analogy." *Strategic Management J.* **26**(8): 691-712.
Gino, F. and G. P. Pisano (2008). "Toward a theory of behavioral operations." *Manufacturing Service Oper. Management* **10**(4): 676-691.
Gokpinar, B., W. J. Hopp and S. M. R. Iravani (2010). "The impact of product architecture and organization structure on efficiency and quality of complex product development." *Management Sci.* **56**(3): 468-484.
Greene, W. H. (2003). *Econometric Analysis*. Upper Saddle River, N.J., Prentice Hall.
Gruenfeld, D. H., E. A. Mannix, K. Y. Williams and M. A. Neale (1996). "Group composition and decision making: How member familiarity and information distribution affect process and performance." *Organ. Behav. Human Decision Proc.* **67**(1): 1-15.
Hackman, J. R. (2002). *Leading Teams: Setting the Stage for Great Performances*. Boston, HBS Press.
Hargadon, A. and R. I. Sutton (1997). "Technology brokering and innovation in a product development firm." *Admin. Sci. Quart.* **42**(4): 716-749.
Harrison, D. A. and K. J. Klein (2007). "What's the difference? Diversity constructs as separation, variety, or disparity in organizations." *Acad. of Management Rev.* **32**(4): 1199-1228.
Harrison, D. A., S. Mohammed, J. E. McGrath, A. T. Florey and S. W. Vanderstoep (2003). "Time matters in team performance: Effects of member familiarity, entrainment, and task discontinuity on speed and quality." *Personnel Psychology* **56**(3): 633-669.
Harrison, D. A., K. H. Price and M. P. Bell (1998). "Beyond relational demography: Time and the effects of surface- and deep-level diversity on work group cohesion." *Acad. of Management J.* **41**(1): 96-107.
Harrison, D. A., K. H. Price, J. H. Gavin and A. T. Florey (2002). "Time, teams, and task performance: Changing effects of surface- and deep-level diversity on group functioning." *Acad. of Management J.* **45**(5): 1029-1045.
Hartmann, D. (2006). "Interview: Jim Johnson of the Standish Group."   Retrieved March 11, 2008, from http://www.infoq.com/articles/Interview-Johnson-Standish-CHAOS.
Heath, C. and N. Staudenmayer (2000). Coordination neglect: How lay theories of organizing complicate coordination in organizations. *Research in Organizational Behavior*. B. M. Staw and R. I. Sutton.

Henderson, R. M. and K. B. Clark (1990). "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms." *Admin. Sci. Quart.* **35**(1): 9-30.

Hinsz, V. B., R. S. Tindale and D. A. Vollrath (1997). "The emerging conceptualization of groups as information processors." *Psychological Bulletin* **121**(1): 43-64.

Hopp, W. J. and M. L. Spearman (2008). *Factory Physics*. New York, NY, McGraw-Hill.

Huckman, R. S. (2009). "Are you having trouble keeping your operations focused?" *Harvard Business Rev.* **87**(9).

Huckman, R. S., B. R. Staats and D. M. Upton (2009). "Team familiarity, role experience, and performance: Evidence from Indian software services." *Management Sci.* **55**(1): 85-100.

Jehn, K. A., G. B. Northcraft and M. A. Neale (1999). "Why differences make a difference: A field study of diversity, conflict, and performance in workgroups." *Admin. Sci. Quart.* **44**(4): 741-763.

Kane, A. A., L. Argote and J. M. Levine (2005). "Knowledge transfer between groups via personnel rotation: Effects of social identity and knowledge quality." *Organ. Behav. Human Decision Proc.* **96**(1): 56-71.

Katz, R. (1982). "The effects of group longevity on project communication and performance." *Admin. Sci. Quart.* **27**(1): 81-104.

Katz, R. and T. J. Allen (1982). "Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R&D project groups." *R&D Management* **12**(1): 7-20.

Klein, B., R. G. Crawford and A. A. Alchian (1978). "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process." *Journal of Law and Economics* **21**(2): 297-326.

Lapré, M. A. and L. N. van Wassenhove (2001). "Creating and transferring knowledge for productivity improvement in factories." *Management Sci.* **47**(10): 1311-1325.

Lewis, K., D. Lange and L. Gillis (2005). "Transactive Memory Systems, learning, and learning transfer." *Organ. Sci.* **16**(6): 581-598.

Liang, D. W., R. Moreland and L. Argote (1995). "Group versus individual training and group performance: the mediating role of transactive memory." *Personality and Social Psychology Bulletin* **21**(4): 384-393.

Littlepage, G., W. Robison and K. Reddington (1997). "Effects of task experience and group experience on group performance, member ability, and recognition of expertise." *Organ. Behav. Human Decision Proc.* **69**(2): 133-147.

Loch, C. H. and Y. Wu (2007). *Behavioral Operations*. Delft.

Mathieu, J. E., T. S. Heffner, G. F. Goodwin, E. Salas and J. A. Cannon-Bowers (2000). "The influence of shared mental models on team process and performance." *J. of Applied Psychology* **85**(2): 273-283.

McGrath, J. E. and J. R. Kelly (1986). *Time and Human Interaction: Toward a Social Psychology of Time*. New York, Guilford.

Monteverde, K. (1995). "Technical dialog as an incentive for vertical integration in the semiconductor industry." *Management Sci.* **41**(10): 1624-1638.

Narayanan, S., S. Balasubramanian and J. M. Swaminathan (2009). "A matter of balance: Specialization, task variety, and individual learning in a software maintenance environment." *Management Sci.* **55**(11): 1861-1876.

Okhuysen, G. A. (2001). "Structuring change: Familiarity and formal interventions in problem-solving groups." *Acad. of Management J.* **44**(4): 794-808.

Pelled, L. H., K. M. Eisenhardt and K. R. Xin (1999). "Exploring the Black Box: An Analysis of Work Group Diversity, Conflict, and Performance." *Admin. Sci. Quart.* **44**(1): 1-28.

Pfeffer, J. and R. I. Sutton (2000). *The Knowing-Doing Gap: How Smart Companies Turn Knowledge Into Action*. Boston, Harvard Business School Press.

Pine, B. J. (1993). *Mass Customization: The New Frontier in Business Competition*. Boston, Mass., Harvard Business School Press.

Prahalad, C. K. and R. A. Bettis (1986). "The dominant logic: A new linkage between diversity and performance." *Strategic Management J.* **7**(6): 485-501.
Rai, A., L. M. Maruping and V. Venkatesh (2009). "Offshore information systems project success: The role of social embeddedness and cultural characteristics." *MIS Quart.* **33**(3): 617-641.
Reagans, R., L. Argote and D. Brooks (2005). "Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together." *Management Sci.* **51**(6): 869-881.
Reagans, R. and E. W. Zuckerman (2001). "Networks, diversity, and productivity: The social capital of corporate R&D teams." *Organ. Sci.* **12**(4): 502-517.
Repenning, N. P. (2001). "Understanding fire fighting in new product development." *J. of Product Innovation Management* **18**(5): 285-300.
Senge, P. M. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York, Doubleday/Currency.
Siemsen, E., A. V. Roth, S. Balasubramanian and G. Anand (2009). "The influence of psychological safety and confidence in knowledge on employee knowledge sharing." *Manufacturing Service Oper. Management* **11**(3): 429-447.
Sosa, M. (2008). "A structured approach to predicting and managing technical interactions in software development." *Research in Engineering Design* **19**(1): 47-70.
Sosa, M. E. (Forthcoming). "Where do creative interactions come from? The role of tie content and social networks." *Organ. Sci.*
Sosa, M. E., S. D. Eppinger and C. M. Rowles (2004). "The misalignment of product architecture and organizational structure in complex product development." *Management Sci.* **50**(12): 1674-1689.
Staats, B. R., D. J. Brunner and D. M. Upton (Forthcoming). "Lean principles, learning, and knowledge work: Evidence from a software services provider." *J. of Oper. Management*.
Tsui, A. S., T. D. Egan and C. A. O'Reilly (1992). "Being different: Relational demography and organizational attachment." *Admin. Sci. Quart.* **37**(4): 549-579.
Tucker, A. L. (2007). "An empirical study of system improvement by frontline employees in hospital units." *Manufacturing Service Oper. Management* **9**(4): 492–505.
van Knippenberg, D. and M. C. Schippers (2007). Work group diversity. *Annual Review of Psychology*. M. I. Posner and M. K. Rothbart. Palo Alto, CA, Annual Reviews. **58:** 515-541.
Wallace, L., M. Keil and A. Rai (2004). "How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model." *Decision Sciences* **35**(2): 289-321.
Weber, R. A. and C. F. Camerer (2003). "Cultural conflict and merger failure." *Management Sci.* **49**(4): 400-415.
Wegner, D. M. (1987). Transactive memory: A contemporary analysis of the group mind. *Theories of Group Behavior*. G. Mullen and G. Goethals. New York, Springer-Verlag**:** 185-208.
Weick, K. E. and K. H. Roberts (1993). "Collective mind in organizations: Heedful interrelating on flight decks." *Admin. Sci. Quart.* **38**(3): 357-381.
Wheelwright, S. C. and K. B. Clark (1992). *Revolutionizing Product Development*. New York, Free Press.
Wiersema, M. F. and K. A. Bantel (1993). "Top management team turnover as an adaptation mechanism: The role of the environment." *Strategic Management J.* **14**(7): 485-504.
Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge, Mass., MIT Press.