

Transcending Knowledge Differences in Cross-Functional Teams

Ann Majchrzak, Philip H. B. More

Marshall School of Business, University of Southern California, Los Angeles, California 90089
{majchrza@usc.edu, phbmore@marshall.usc.edu}

Samer Faraj

McGill University, Montreal, Quebec H3A 1G5, Canada, samer.faraj@mcgill.ca

Knowledge differences impede the work of cross-functional teams by making knowledge integration difficult, especially when the teams are faced with novelty. One approach in the literature for overcoming these difficulties, which we refer to as the *traverse* approach, is for team members to identify, elaborate, and then explicitly confront the differences and dependencies across the knowledge boundaries. This approach emphasizes deep dialogue and requires significant resources and time. In an exploratory in-depth longitudinal study of three quite different cross-functional teams, we found that the teams were able to cogenerated a solution without needing to identify, elaborate, and confront differences and dependencies between the specialty areas. Our analysis of the extensive team data collected over time surfaced practices that minimized members' differences during the problem-solving process. We suggest that these practices helped the team to *transcend* knowledge differences rather than *traverse* them. Characteristic of these practices is that they avoided interpersonal conflict, fostered the rapid cocreation of intermediate scaffolds, encouraged continued creative engagement and flexibility to repeatedly modify solution ideas, and fostered personal responsibility for translating personal knowledge to collective knowledge. The contrast between these two approaches to knowledge integration—*traverse* versus *transcend*—suggests the need for more nuanced theorizing about the use of boundary objects, the nature of dialogue, and the role of organizational embeddedness in understanding how knowledge differences are integrated.

Key words: innovation; knowledge integration; emergent teams; agile teams; group creativity; cross-functional teams

History: Published online in *Articles in Advance* July 27, 2011.

Introduction

Many teams in organizations face situations where their members have not worked together before, they represent different knowledge domains, they are tasked with solving complex problems that have novel task demands, they have fluid team boundaries and temporary membership, and they need to finish their work quickly because of time pressure (Dougherty 2001, Edmondson and Nembhard 2009, Hackman 2002, Van Der Vegt and Bunderson 2005). A critical problem that these cross-functional teams¹ face is collaborating in a manner that transforms the different specialized knowledge possessed by the members into an integrative cogenerated solution (Carlile 2004, Dougherty 1992, Leonard-Barton 1995, Lovelace et al. 2001). Indeed, specialization leads to different thought worlds (Dougherty 1992) with different perceptions, situated representations (Boland and Tenkasi 1995), and localized practices (Sole and Edmondson 2002) that in turn create communication barriers (Bechky 2003b) and failures of interpretation and incorrect attribution (Cramton 2001). These barriers and difficulties are often compounded because, being temporary ad hoc associations, these teams lack deep ties (Hansen 1999), shared processes for integrating their ideas (Okhuysen

and Eisenhardt 2002), and previous common experiences in learning from each other (Tucker et al. 2007) that could facilitate knowledge integration.

Knowledge integration, particularly in novel settings, is complex because it involves more than the transfer of knowledge from one source to another (Carlile and Rebentisch 2003). It requires participants to transform their own existing knowledge into new knowledge that complements and stimulates the knowledge transformation of others, in a process of mutual influence and collaborative emergence (Carlile 2002, 2004; Hargadon and Bechky 2006; Tsoukas 2009). Novel situations, such as new task demands not faced previously, call into question existing differences and dependencies between members, requiring team members to reconsider their own assumptions and how those assumptions relate to the assumptions of others (Dougherty and Tolboom 2008, Skilton and Dooley 2010). Consequently, in novel situations, the problem-solving process requires individuals to repeatedly transform and integrate their knowledge with others.

A theoretical perspective on cross-specialty knowledge integration in teams has received significant attention in the literature. This perspective argues that the

transformation and integration process requires that team specialists externalize their “deep knowledge” in a manner that allows others to understand the boundaries, differences, and dependencies between each other’s knowledge to “traverse” the boundaries to cocreate a solution (Boland and Tenkasi 1995, Cook and Brown 2000, Dougherty 1992, Hargadon and Bechky 2006, Nonaka 1994, Tsoukas 2009). The “deep” knowledge that needs to be externalized includes assumptions about each other’s knowledge; dependencies between the different specialty areas; implicit causal mental models about the problem; and implicit constraints on, and priorities for, different solution paths (Carlile 2004). Once the deep knowledge is brought to the surface, and dependencies are clarified, the boundaries are traversed through negotiation to cocreate a solution.

To share this deep knowledge in a manner that fosters traversing the boundaries requires extensive deep-knowledge dialogue, whereby “each interlocutor potentially makes the other realize the limitations of their focal awareness and stimulates a search for an ever broader focal awareness” (Tsoukas 2009, p. 944). Specifically, the process the team follows is one in which team members engage in a dialogue where they question each other’s assumptions, ask for and then question each other’s rationale, probe or offer detailed explanations of other’s perspectives, and search for specific ways in which one’s perspective is dependent on others’ perspectives. This deep-knowledge dialogue results in finer, more complex distinctions between the parties (Boland and Tenkasi 1995, Tsoukas 2009) and a more complete understanding of the cross-boundary dependencies that need to be traversed (Bechky 2003b, Carlile 2004). This dialogue is often aided by the use of organizationally embedded boundary objects such as specialized documents, drawings, protocols, repositories, or organizational models that help to clarify differences and dependencies across the specialties (Bechky 2003a, Carlile 2002, Star and Griesemer 1989).

Recently, scholars have begun to question whether identification of differences and intensive deep-knowledge dialogue is necessary in temporary work teams (Cronin and Weingart 2007, Kellogg et al. 2006). Others have expanded on this possibility, suggesting that even when decision making requires mutually influenced integrative knowledge transformation, knowledge might be integrated without deep-knowledge dialogue that makes differences more salient (Dammann and Kieser 2010, Ewenstein and Whyte 2009, Schmickl and Kieser 2008). In this paper, we examine the issue of how knowledge is integrated in more detail.

In the Conceptual Development section, we explore the difficulties of knowledge integration in cross-functional teams, the extant theories that promote the need for integrative parties to identify their differences and dependencies, and the emerging literature questioning

this approach. We then describe an in-depth, longitudinal qualitative study of three different cross-functional teams facing novel situations. We find that the teams did not engage each others’ differences through the type of deep-knowledge dialogue that identified boundaries and traversed those boundaries through negotiation. Instead, we identified practices that fostered knowledge integration through minimizing differences and distinctions between the specialty areas. These practices helped to avoid interpersonal conflict, fostered the rapid cocreation of intermediate scaffolds, encouraged continued creative engagement and flexibility to repeatedly modify solution ideas, and fostered personal responsibility for translating personal knowledge to a collective knowledge. Because these practices explicitly avoided boundary distinctions, we refer to this approach as one in which the members cocreated their solution by *transcending* knowledge differences rather than *traversing* knowledge boundaries. In the Discussion section, we return to the extant literature, suggesting ways of expanding the literature on knowledge integration to encompass the possibility that both traversing and transcending knowledge differences may be complementary approaches to knowledge integration.

Conceptual Development

The difficulties of cross-functional teams in integrating their members’ knowledge have been described at length in the literature. The more extensive the functional diversity among team members with little shared experience, the greater the task disagreement is likely to be (Cronin and Weingart 2007, Jehn et al. 1999, Lovelace et al. 2001, Van Der Vegt and Bunderson 2005). Each team member, representing a different knowledge specialty, comes to a team with a different “thought world,” so that each member understands the problem, critical elements, and steps in solving the problem differently from each other member (Dougherty 1992, 2001). These individual thought worlds are internally coherent, with assumptions about causes and solutions, analytic criteria, and priorities embedded within them (Boland and Tenkasi 1995). The localized knowledge that each member brings to the team fosters further differences between members (Sole and Edmondson 2002). These differences create a lack of common ground, resulting in problems of information exchange, interpretation, and attribution (Bechky 2003b, Cramton 2001, Edmondson and Nembhard 2009). Without a common ground, members are likely to represent events, problems, and perspectives differently, and they may be unable to evaluate each other’s contributions to the dialogue. This, in turn, leads to further misunderstandings and misattributions (Cronin and Weingart 2007). In this section, we first describe an approach to overcome these difficulties that has received considerable attention in the literature. We then examine the challenges to this approach that lead to our research question.

The “Traverse” Approach to Knowledge Integration in Cross-Functional Teams

Previous research has examined the difficulties of cross-functional knowledge integration in teams from different streams. One stream of research has focused on how integration is facilitated by the creation and sustenance of a common task understanding or collective team orientation, so that actions and needs of teammates can be anticipated (Edmondson and Nembhard 2009, Okhuysen and Bechky 2009, Rico et al. 2008). For example, a detailed study of 12 teams facing change found that the teams that successfully engaged in change underwent a process of reflection and joint knowledge sharing before and during the change attempt (Edmondson 2002). Similarly, empirical work by Van Der Vegt and Bunderson (2005) found that teams with diverse experts that invested in building a collective team identification learned and performed better than their counterparts that did not engage in building a common team identification. Another stream of research on facilitating knowledge integration in teams has focused on developing psychologically safe work environments within the team by encouraging members to engage in risk taking and reflexive analysis (Edmondson 1999, Tucker et al. 2007). For example, in one study on medical teams, those teams that were more successful in adopting a complex innovation were more open to new behaviors and were more reflective toward their learning experience (Edmondson et al. 2001).

Crucial to these streams of research is that knowledge integration proceeds when specialists are aware of each other’s deep knowledge, i.e., each team member’s disciplinary principles, causal models, and implicit assumptions. For example, Argyris and Schön (1978, p. 16) suggested that specialists’ knowledge is more likely to be integrated when the specialists engage in a “continual, concerted meshing of individual images of self and others” in which deep knowledge is extensively shared between the specialists. Hargadon and Bechky (2006) suggested that specialists integrate their knowledge with others by sharing different implicit assumptions about the problem and learning about each other’s disciplinary perspective. Boland and Tenkasi (1995) argued that a critical and necessary element of bridging across epistemic community boundaries is to deeply engage with assumptions of other communities in a dialogic process referred to as perspective taking. This dialogic process builds on back-and-forth forms of dialogue in which each person engages with each other’s disciplinary perspective in sufficient depth to facilitate a conceptual combination, expansion, and reframing (Tsoukas 2009).

Overcoming boundaries between knowledge specialty areas requires understanding task dependencies and differences between perspectives, a process that becomes particularly complex when a team is faced with a novel situation (Carlile and Rebentisch 2003). In a novel

situation, problems are recurrently redefined, requiring that the deep knowledge that specialists bring to the task must be repeatedly transformed into knowledge understandable to others and recombining into new cogenerated solutions (Dougherty 2001, Skilton and Dooley 2010, Tsoukas 2009). To recombine their knowledge requires that the specialists have an understanding of how their knowledge differs from, and depends on, others; such an understanding helps team members recognize the possibilities and limits of the recombination, facilitating negotiation and accommodation toward a common solution (Carlile 2004). Thus, under novel situations, the specialists in the team are in particular need of engaging in deep-knowledge dialogue, confronting the differences in each other’s knowledge, and identifying and then traversing the boundaries between the knowledge specialty areas.

To facilitate team members’ understanding of each others’ deep-knowledge differences—particularly in teams facing novel situations—the use of boundary objects has been suggested. Boundary objects are pragmatic representations that simultaneously satisfy the information requirements of multiple communities (Star and Griesemer 1989). Boundary objects have been variously described as “tangible definitions” (Bechky 2003a, p. 326), physical products, components, prototypes, sketches, notes or drawings (Carlile 2002, 2004; Star and Griesemer 1989), and metaphors (Schön 1993, Tsoukas 2009) used in conversational interaction (Bechky 2003a, b; Leonard-Barton 1995; Star and Griesemer 1989). Boundary objects are viewed as helpful in facilitating knowledge integration by “invok[ing] the key differences in work contexts between [different] groups” (Bechky 2003b, p. 326). In Bechky’s (2003b) fieldwork, for example, she concluded that, compared to engineering drawings, machines provided a more appropriate boundary object between machine operators and engineers. The machine made the key differences between the assemblers and engineers more explicit in terms of language, locus of practice, and conceptualization of the product and process. Team members then used these differences to discuss and negotiate consequences of transforming each other’s own knowledge to accommodate the knowledge of others.

Because so many objects can be used to bridge differences, Ewenstein and Whyte (2009) have offered a useful differentiation between *concrete* boundary objects, which are stable recognizable classes of objects that act as containers of meaning useful for negotiation and coordination, and *epistemic* objects, which are fluid, incomplete, and continuously evolving to meet the needs of the knowledge work. Much of the research on the use of boundary objects in cross-functional knowledge integration has focused on the use of concrete knowledge artifacts (Bechky 2003a, Carlile 2002). In this view,

concrete boundary objects serve the purpose of making differences and dependencies more obvious so that negotiations can more efficiently focus on these areas of dependencies.

In sum, then, an approach on how cross-functional team members integrate their differentiated knowledge that has received considerable attention in the literature is one that focuses on first understanding each other's deep specialty knowledge, dependencies, and boundaries, and then traversing those boundaries through negotiation. Concrete boundary objects help make these differences and dependencies clear.

Critique of the Traverse Approach to Knowledge Integration

The traverse approach has been questioned by some scholars. The process of deep-knowledge sharing can take so much effort and create so much interpersonal conflict that it “wastes precious time and erodes team relationships” (Edmondson and Nembhard 2009, p. 124). The team becomes less inclined to engage in the needed dialogue (Hansen 1999). For example, the process of negotiation and dialogue in one cross-functional study required so much practical and political effort that participants refused to engage in it, causing the project to fail (Carlile 2004).

Furthermore, some teams may be able to develop integrative solutions without deeply sharing each other's knowledge. A series of studies has found instances in which teams successfully met their task assignment without deep-knowledge exchange, particularly when there are preestablished behavioral protocols. For example, Faraj and Xiao (2006) found that in trauma care, teams codeveloped treatment solutions not through deep-knowledge sharing but through the use of protocols that distinguished between anesthesiology, nursing, and surgery disciplines. In a study of decentralized departments in an ad agency with clearly delineated protocols for ad projects, Kellogg et al. (2006) found that participants did not engage each other in deep-knowledge exchange: “Instead of transforming local understanding into shared meanings and common knowledge, organizational actors juxtaposed their diverse efforts into a provisional and emerging collage of loosely coupled contributions” (p. 38).

In teams without preexisting protocols, research has also found that deep-knowledge sharing may not be critical. In an early study, Donnellon et al. (1986) found that organized action can occur among diverse parties without the parties sharing a common interpretation of the situation. Schmickl and Kieser (2008) studied successful cross-functional product design teams and found little deep-knowledge sharing, with the sharing limited to “rough” (i.e., general rather than detailed) knowledge and only enough to keep the generative dialogue going. They argue that their results “contradict the widespread

notion of an extensive need for shared detailed mental models and cross-learning” (p. 488). Other scholars have argued that knowledge integration can occur without the use of concrete boundary objects that make differences more salient (Dammann and Kieser 2010, Ewenstein and Whyte 2009). Finally, Faraj and Xiao (2006) found that in trauma care teams, sometimes the manner in which patients responded (or failed to respond) to standard treatment protocols created new task demands for the trauma teams. In these cases, they observed the trauma teams abandoning the protocols that clarified boundaries between anesthesiology, nursing, and surgery disciplines, and instead engaging in a rapid sharing of general knowledge and joint sensemaking that blurred the specialty distinctions.

Research Question

Therefore, it is an open question whether cross-functional teams facing novel situations need to engage in dialogue that confronts the tacit assumptions of different disciplines in a way that clarifies and then traverses the differences and dependencies. It may be that when facing novel situations, engaging in deep-knowledge dialogue and enacting concrete boundary objects that clarify differences places too heavy a demand on the team. In such cases, research is needed to understand how knowledge integration occurs over time in a manner that does not require clarifying differences and boundaries. In this research, we take a practice perspective (Bourdieu 1990, Giddens 1979) on the work of cross-functional teams to focus on how knowledge integration is actually done. As noted by Dougherty and Tolboom (2008), there is a need in the literature on knowledge integration in teams facing novel situations to move beyond an understanding of formal processes and coordination mechanisms to understand work as a situated activity where synchronization and participation are constantly evolving. Therefore, we focused on the practices used by teams to integrate member knowledge. We asked the following research question: *What practices do cross-functional teams engage in to transform and integrate knowledge in novel situations?*

Research Design

As an exploratory research question, we undertook an intensive case study research design. We studied three teams to determine whether patterns found within a team were also found in other teams.

Case Selection

In accordance with the definition of cross-functional teams offered by Edmondson and Nembhard (2009), teams were selected that were cross-functional; focused on problems that were complex because of the novel task demands and time pressure; and composed of a

membership that was temporary, fluid, and weakly tied. The teams were new process (not product) development teams, in which their novel task demands arose from new customer demands that the companies had not previously encountered, requiring the development of new organizational processes.

The three teams were from different companies, tasked to achieve different outcomes. The first team, *Team Strategy*, was part of a global Fortune 500 company. The CEO had become increasingly concerned that the company was losing its competitive edge by not leveraging the diversity of its worldwide workforce and customer base. Consequently, the CEO asked that a small set of culturally, geographically, and functionally diverse younger employees from across the globe with no facilitator experience be identified and tasked to do something that had not previously been done at the company. The group was tasked to develop and deliver a two-hour experiential module to help regional executives realize the potential this worldwide diversity among their employees as customers offered them as a competitive advantage in their regions. The team was given no other instructions. Team members met virtually for 26 hours spread across the three weeks they were given for planning and delivering the experience. Team members continued to perform their normal work duties during this period.

The second team, *Team Space*, was a small team of employees at a medium-sized industrial design consulting firm. Senior executives at the firm were increasingly concerned that the playful and open sharing culture among employees that had helped the company grow was being suppressed by how space was used in housing their growing staff. Team members were selected to represent the different functional roles at the company, including design, facilities, and management. The team was tasked with rethinking how space could be used to achieve the following goals: reignite the playfulness, increase knowledge sharing between consulting projects in ways that did not violate intellectual property protection agreements, continue to foster highly publicized and prized corporate tours of the space, consider whether all seven buildings on the campus were needed, incorporate future flexibility into the space plans to accommodate unpredictable future shifts in hiring and knowledge-sharing needs, and ensure that any space changes involved minimal resources as a result of the economic downturn. The team members met in a single “war room” for 30 hours over five days while continuing to perform their normal work duties. The team’s deliverable was a presentation of recommendations to senior management describing their new approach for how the company should use its space.

The last team, *Team Quality*, was part of a large, geographically dispersed, highly decentralized manufacturing company with a culture of independence. Each

independent division produced different products for different customers, complying with different regulations from different federal agencies. The senior executive team at the company was concerned about increasing problems with manufacturing quality enterprise-wide and felt that the divisions might benefit from best-practice sharing. A team of manufacturing managers and quality professionals across the divisions were asked to work together to identify the best practices of each division’s quality program and then to combine these best practices into an enterprise-wide quality control guideline that could be used across the diverse divisions.

Manufacturing managers on the team felt that the internal quality audit procedures promoted by the quality professionals on the team were both overly burdensome and not useful for solving the quality problems at their facilities; quality professionals across the divisions felt that managers refused to give quality problems the priority they deserved and thus wanted to include in the guidelines tighter audit procedures that forced manufacturing managers to do more. Team members initially agreed to a 40-hour commitment over three months via once-a-week telecons while continuing to perform their normal work duties. However, because of pressing demands of their full-time responsibilities, team members ended up spending the same amount of time (39 hours) spread over 10 (instead of 3) months and included a face-to-face meeting. The team’s output was the written set of guidelines and a presentation to senior executives for a new corporate-wide approach to quality to be customized and implemented by the independent divisions.

Although the three teams came from different firms with different expected outcomes, they were similar in several ways. For each team, the task was novel to that team and to the company. The members of each team were selected to represent a different specialization than the other members on the team (i.e., function and geographic region for Team Strategy, function and division for Team Quality, and function and experience for Team Space). All members of all three teams participated part time because the team was a temporary activity, not a permanent job assignment. Few of the members knew each other and thus were weakly tied socially. Finally, the teams performed under time pressure as each of the team members across the three teams had full-time jobs they had to perform even as they were doing the work of the temporary cross-functional team. Table 1 presents the three cases, describing the task requirements and membership of each team.

Data Collection

We attended and recorded every meeting of each team (30 hours for Team Space, 34 hours for Team Strategy, and 39 hours for Team Quality). We interviewed each team member beforehand to learn about the members’

Table 1 Case Descriptions

Pseudonym	Reorienting strategic planning (Team Strategy)	Rethinking space (Team Space)	New approach to quality (Team Quality)
Task of the group	Develop a two-hour experiential module to convince regional general managers to use cultural diversity as a strategic weapon	Develop a strategic plan for how space is used at the company	Identify a new approach to quality that could be used across the diversified company
Novelty of the task for the company	A module planned by “young employees” with no facilitator experience to change senior managers’ minds about how to do strategic planning had never been done	Devoting five days of consultants’ time to developing a new way of using space not done previously	Creating a white paper describing an approach to quality that could be implemented across the highly diversified company not done previously
Project time and pressure	Over 3 weeks, seven teleconferences of 90 minutes each, with prep work in between, plus 2 days on-site to complete tasks individually, in subgroups, and in full group; 34 hours total	Over 5 days, 30 hours total	Three 2-hour teleconferences before 3 days of f2f meetings, four teleconferences after f2f meetings dispersed over 10 months because members were pressured to perform other duties; 39 hours total
Team member jobs and perspective on problem (from initial interviews)	<p>(1) Brand manager in China: Disconnect between HQ’s direction and culture of the region</p> <p>(2) Marketing analyst in France: How historical references (e.g., sweatshop) affect employees’ and consumers’ view</p> <p>(3) HR trainer in Turkey and Israel: Match between employee needs and management expectation</p> <p>(4) Digital media analyst, Latin America: Social networking helps global employees feel part of a single company</p> <p>(5) Process analyst, United States: Employees ignored as consumers of improvement</p> <p>(6) Diversity analyst, United States: Use this as a model for future workshops</p> <p>(7) Footwear designer, United States: Managers’ view of product lines not view of consumers and athletes</p>	<p>(1) Manufacturing engineer: Reinstall early culture into current culture</p> <p>(2) Director of Operations: Concern re how all the pieces (people, buildings, support, management, budget, client tours) fit together w/space plan that can evolve in the future</p> <p>(3) Designer: How can support and space help me do my work?</p> <p>(4) Experience manager: Support services is a discipline in its own right</p> <p>(5) Prototyper: Give me specs to prototype</p> <p>(6) Facilities: People will not move willingly to new spaces</p> <p>(7) Architect and practice exec: How can workspaces encourage communication and “buzz”?</p>	<p>(1) Quality professional for low-volume production: Personal, hands-on</p> <p>(2) Quality professional for high-volume product line: Good formal system in place, but managers will not support</p> <p>(3) Quality software developer: Managers will not use tracking software</p> <p>(4) Plant manager: Too much bureaucracy in company’s quality program</p> <p>(5) Product manager: Too many useless quality citations</p> <p>(6) Project manager: Quality citations have unintended consequences that are ignored by quality professionals</p> <p>(7) Director, Quality Audits: Managers are the problem, not the quality program</p> <p>(8) Machine tool quality analyst: Partnering with operators will fix quality system</p> <p>(9) Medical devices quality professional: Our practice is best because it is FDA approved</p>
How were members selected for team	The Diversity VP contacted senior executives for each region and asked for a person who was “under 30,” at the company for less than five years, and came from the region	Asked by senior managers as representing a mix of people responsible for different aspects of space (facilities, service, hospitality, prototyping) and design community	Senior managers contacted personnel responsible for quality at each facility and asked them to serve with concurrence of their supervisors; three managers offered to serve as well
How familiar were members with each other?	None worked together previously	#4 and #6 worked for #2; #1 and #5 worked on a project before	Several pairings of individuals who knew each other: #4 and #7, #5 and #6, #2 and #3, #7 and #8

Note. f2f, face-to-face; FDA, U.S. Food and Drug Administration; HQ, headquarters; HR, human resources; VP, vice president.

perspectives on the task and their past personal and work experiences with each other member. We obtained all written material that was distributed or generated during and between the meetings. We interviewed members at several points throughout the project (on average, each member of each team was interviewed for a total of 2.5 hours). Our interviews were focused on understanding how the different perspectives were being brought to bear, such as, “Why did you ask this question during the discussion?” “Why did you make that interpretation of what someone else was saying?” and “What new knowledge has been created for you to this point?” We also interviewed the team members at the team’s completion. These interviews were used to determine team members’ views on whether the stated objectives of the team had been met and whether new knowledge had been created that integrated their own views. We interviewed the executive clients of each team to determine their views of the team’s outcome. Finally, we followed the three teams after their completion to determine how their outputs were used by their organizations. All interviews and observations were attended by at least two researchers to allow an opportunity for interpretive discourse among the researchers. Face-to-face sessions were videotaped then transcribed. All teleconferences were recorded and transcribed. In total, we obtained approximately 942 pages of transcribed notes (from 140 hours of audio and 120 hours of video recordings).

To determine the success of each team in creating an integrated solution, we interviewed the team members as well as each team’s executive sponsor. Through interviews conducted at the beginning and end of the project, we found that members in all three teams felt that the outcomes generated by their teams had not been expected at the outset of the project and reflected a transformation of their views. Interviews with the team sponsors confirmed, as well, that the team’s outcomes were judged as unlikely to have been generated by a single individual on the team, thus reflecting the transformation of different perspectives rather than just the acceptance of one person’s vocal opinion in the team.

The integrative solutions generated by the teams were well received by each team’s executive clients. Team Space generated a space plan that included removing public tours from certain areas, reconfiguring entrances to buildings, redesigning project rooms and a new service package to help the design staff, and reallocating desks to individuals in a way that allowed for growth and reorganization over time. Parts of the space plan were implemented immediately by upper management. Team Strategy provided an experience for senior executives that was reported by two people in attendance as successfully engaging senior executives in thinking about diversity in ways they had not previously considered. Several executives were so impressed with the experience that they asked the team member from their

region to develop a similar experience for managers at the next level down in the management hierarchy. Team Quality recommended a set of “beyond best practices” for an enterprise-wide quality program that was approved and released to the divisions by corporate senior management. In addition, the outcome was considered so successful that it was used as the model for further process improvement initiatives pursued by the senior executive leadership council.

Analysis

Our first step in the analysis was to create a video and audio record together with a written transcript for each team. The record included verbal statements, written materials generated or referred to, and notes about physical movements or artifacts made by the team (i.e., “team moves to a new location at this point,” “team looks at flip charts on wall at this point”). We then coded the transcripts to categorize the notes into the following: (1) suggested solutions (defined as ideas about ways to solve the problem), (2) observations (defined as a comment describing information about the problem), (3) issues (defined as concerns, problems, needs, or desires that a team member raised), and (4) “building” statements (statements in which one member reused or modified an observation, issue, or solution that was raised by another team member). The category coding for each team was carried out jointly by two members of the research team—one who had attended the team sessions in person and one who had not—so that both the standardization of coding across cases and proper implicit knowledge about each case was captured in the coding. Because we iteratively and discursively created the coding, we did not compute interrater reliabilities.

After coding the transcripts into one of these general categories (issues, solutions, observations, and building statements), a chronological timeline of the coded comments and the speaker for each comment was developed for each team. This allowed us to identify when and in what way each individual’s comments (including issues, solutions, and observations) were modified through their and others’ building statements. We analyzed how the comments changed to identify practices preceding the changed comments that facilitated knowledge integration within the team. We then examined the practices across the cases and were surprised to find how similar they were. The practices were presented to each team to validate that we had accurately depicted their activities. Note that, based on initial interviews, none of the three teams explicitly spoke about these practices during their life cycle or explicitly planned for them based on initial interviews. Thus, the practices can be construed as “implicit” (Rico et al. 2008) rather than formal and explicit.

Findings: Practices to Transcend Knowledge Differences

Our research question asked about practices that cross-functional teams engage in to transform and integrate knowledge in novel situations. We identified five practices in which the three teams engaged. These practices covered a range of activities that moved the team forward toward the goal of developing a solution that integrated the diverse knowledge of the team members. It is noteworthy that these practices provided a way to transform and integrate each member's knowledge into a common solution without emphasizing the differences between the specialties. The practices were as follows: (1) voicing fragments, (2) cocreating the scaffold, (3) dialoguing around the scaffold, (4) moving the scaffold aside, and (5) sustaining engagement. Table 2 summarizes our findings, and the appendix includes select quotes.

Practice 1: Voicing Fragments

One of the first practices all three teams engaged in was *voicing fragments*, in which team members surfaced a broad range of uttered fragments of observations without discussing, critiquing, or querying each other for more details. This practice involved team members engaging in a high-energy voicing of briefly worded statements about a variety of different aspects of the task. This voicing did not include elaboration, reflective dialogue, surfacing or confronting differences in assumptions, attributions or references to those who spoke the fragments, attempts at organizing the comments, or building on the comments.

Voicing fragments seemed to help the team quickly establish psychological safety (Edmondson 1999) as members rapidly shared a quick succession of sometimes surprising ideas and observations about the problem without critiquing or questioning others. Voicing fragments seemed also to jump-start the surfacing of new ideas as members voiced different perspectives, even though members did not have a shared understanding of the problem or each other's perspective. The voiced fragments focused the team immediately on sharing even those observations that were only remotely associated with the problem. The nature of the fragments was varied, including observations, possible solutions, loose associations, assumptions, and different definitions of the problem and constraints. The sharing was rapid, without any reference to who shared it, without interpersonal confrontations, and without domination by any single individual. Hundreds of comments were shared in a short period of time (over the first two of five days for Team Space, the first three out of eight 90-minute teleconferences for Team Quality, and the first two out of eight 90-minute teleconferences for Team Strategy). The lack of attribution of the voiced fragments to any individual member appeared to help depersonalize each

member's individualized knowledge into a collectively emerging landscape of available knowledge related to the task.

An example of this practice is illustrated with Team Strategy. As with all three cases, the voicing fragments practice occurred at the beginning of the team's activities, preceded only by a brief preliminary statement by the team coordinator about the team's mission, introductions by team members including only their name and the organization they represented, and an invitation by the team coordinator to share personal thoughts about the task. The voicing involved team members interrupting each other and energetically sharing short phrases that seemed to pop into their minds about a variety of aspects of the team's task in no particular order and with no effort to maintain attributions about who made what comment. No single utterance lasted more than a minute (most lasted only seconds with a single word). The content of the fragments for Team Strategy members was varied, including brief personal stories, observations of the seriousness or nature of the problem, issues that they believed would be important in solving the problem, concerns they had about contextual factors that might affect their ability to solve the problem, various definitions they had about the problem, solutions they thought might be useful, and success criteria that the team could use to determine when they had solved the problem. Some of these fragments were only tangentially related to the culture-shifting experience they were tasked to design: an observation about how Turkish and Israeli newcomers reacted differently to the same training program, how negatively some French consumers felt about the company, how plans for a world event in China were consuming a member's time, how managers never seemed to listen to employees' ideas, how one member felt after recently reading *Who Moved My Cheese?*, and concerns about how a recent organizational change in the company would affect their individual jobs. The comments were captured in e-mailed meeting notes taken by the team coordinator in the order in which the comments were offered, without reference to who said them and without any attempts to categorize or organize them (such as by solution or aspect of the problem, for example). Later interviews with team members confirmed that they were unable to correctly identify who said what.

The comments uttered by different team members were not discussed, even though they might be inaccurate, not fully understood by other team members, or in conflict with earlier comments by other members. In Team Strategy, for example, a member suggested that they should task the execs attending the event to read a 10-year-old management book, even though later interviews with other members indicated that they suspected at the time that the executives had already read the book. Despite inaccuracies, lack of understanding, and conflicting statements, members did not question each

Table 2 Practices Used by the Teams and Impact of Practices on the Group and Cocreation Process

Practice	Impact on group process	Impact on knowledge cocreation
<i>Voicing fragments</i>		
Team surfaces broad range of observational fragments without discussing, critiquing, or querying each other for more details.	Voicing fragments of observations helps to quickly establish psychological safety by sharing unexplained and surprising ideas for problem definition and potential solutions.	Voicing only fragments (1) focuses the team on sharing potential problem definitions and solutions and avoids focusing on interpersonal differences; (2) allows rapid accumulation of diverse observations, problem definitions, and ideas; and (3) depersonalizes the shared knowledge, making it easier for a collective problem definition to emerge.
<i>Cocreating the scaffold</i>		
Team quickly develops and then elaborates on a visual or verbal representation that encompasses many voiced fragments.	Cocreating the scaffold: (1) increases collaborative communication, (2) decreases time spent learning each other's language, and (3) increases members' felt responsibility for translating their own knowledge into the abstract language of the scaffold.	Cocreating the scaffold provides a common task experience that helps team members learn how to (1) share their experience to rapidly cogenerate ideas with others, (2) reduce the need to explain their deep knowledge so other members can quickly begin to elaborate, (3) continue to depersonalize their knowledge, and (4) reduce interpersonal confrontation by using a depersonalized scaffold to bridge between their specialized knowledge and joint solutions.
<i>Dialoguing around the scaffold</i>		
Team members dialogue about the scaffold, raising questions about possible alternative solutions suggested by the scaffold, leading to reframing the scaffold to foster more creative solutions.	Reframing the scaffold leads to (1) surfacing key underlying unresolved conflicts in current problem solutions that require new solution ideas, (2) focusing of task conflicts on a narrowed set of depersonalized conflicts rather than general task conflicts that might lead to interpersonal conflict, and (3) keeping the group's attention on common ideas rather than on any one individual's ideas.	Reframing the scaffold allows the team to (1) stay focused on a smaller set of solutions, (2) surface previously unidentified conflicts in different aspects of the problem, (3) identify the differences around specifics of the problem that cannot be solved simultaneously, and (4) develop new solutions unconstrained by the scaffold.
<i>Moving the scaffold aside</i>		
With an initial solution under consideration, team drops the scaffold as unnecessary and tries out the unfolding solution on external stakeholders.	Changing focus from internal cocreation to external stakeholders (1) reinforces a sense of accomplishment as the unfolding cocreated solution is shared externally, (2) reenergizes the team to reexamine their solutions from the stakeholder's perspective, and (3) reinforces psychological safety as members revise their earlier solutions.	Sharing a tentative solution externally helped the team learn to (1) shift the evaluation criteria from depersonalized scaffold to personalized stakeholder reactions, (2) continue cogeneration using stakeholder criteria to test evolving solutions, and (3) tailor solutions for stakeholders without needing to stay consistent with earlier scaffold.
<i>Sustaining engagement</i>		
Activities for sustaining and monitoring engagement are created in a manner that minimizes interpersonal differences and sustains cogeneration.	Processes to sustain engagement include (1) providing members with a sense that their contributions are valued and helpful by eliciting ideas, sharing the effort, and applauding small successes; (2) giving team members a sense of focus by deciding the direction to follow based on collective energy rather than input by any one individual; (3) providing team members with a sense of progress through status summaries that encourage collective ownership; and (4) continuously monitoring and acting to avoid frustration and concerns about team success.	Sustaining engagement helps the team to maintain cogeneration by minimizing (1) nongenerative time and (2) the need to confront interpersonal differences and conflict.

other's assumptions, confront these differences or inaccuracies, or discuss them—they seemed only concerned with briefly and rapidly reporting fragmented comments.

In sum, then, this practice of voicing fragments helped to quickly create a “landscape of knowledge assets” consisting of different perspectives, facts, observations, concerns, issues, problem definitions, and possible solutions. The knowledge assets were not attributed to any single individual on the team, did not require significant time or effort to surface, and were not used as points of discussion for sharing deeper knowledge about one's discipline or interests.

Practice 2: Cocreating the Scaffold

The second practice we refer to as *cocreating a scaffold*. In this practice, the team quickly develops, and elaborates on, a visual or verbal abstract representation that encompasses many of the voiced fragments. Cognitive scaffolds in educational research are temporary forms of support to help learners build on their current abilities to achieve higher-level nonprocedural cognitive strategies (Palincsar and Brown 1984, Rosenshine and Meister 1992, Wood et al. 1976). The participation of members in cocreating the scaffold was coupled with collaborative communication (Lovelace et al. 2001) as members focused on the representation they were cocreating rather than on individual differences and boundaries. As they focused on the scaffold, team members translated their own knowledge into the abstract language of the scaffold. Consequently, team members did not have to spend time and effort in learning each other's language, only in continuing to make their own personal contributions to the evolving scaffold. Moreover, by focusing on rapidly cocreating the scaffold, each member was able to quickly elaborate his or her knowledge with respect to the scaffold without directly confronting each other's differences.

The scaffold's representation only encompassed some of the voiced fragments of observations, ideas, and concerns about the problem, rather than as a solution to the problem or even as a characterization of the problem. Because it was neither a solution nor a description of the problem, the team was not constrained by how the scaffold might evolve, allowing members to modify the scaffold in any direction suggested. Consequently, the scaffold became part of the rapid and successful execution of cocreation, which energized the team's efforts.

Team Strategy provides an illustration of how this practice unfolded. A member from the product design team shared a drawing of his senior design project from college in which he depicted himself as a freshman entering the narrow end of a tunnel with future opportunities portrayed at the other, broader end of the tunnel. Then, in rapid succession, the following comments

were made:

- The process engineer suggested that one wall of the tunnel drawing should include suggestions employees make for improving the future of the company.
- The marketing analyst suggested that another wall of the tunnel drawing should include comments made by customers about the company.
- The digital media analyst suggested that the right end of the tunnel drawing should make references to digital media to represent the future of the company.
- The product designer suggested that the left end of the tunnel drawing should include something on the history of the company.
- The human resources staff member suggested that maybe the tunnel should be more than employee suggestions and include an experiential walk-through of a real tunnel for executives.
- Another member suggested that the walk-through alone would not be enough; it needed to be coupled with a reflection and sharing experience.

The evolution of the “tunnel” scaffold from a drawing, to an elaborated drawing, to a walk-through, to a reflection and sharing experience continued through two more teleconferences, evolving the tunnel from a drawing to a series of experiential exercises for the executives. The tunnel continued to be abstract and fluid because the members had no idea at the time whether the location of the strategic planning meeting would accommodate a real tunnel, whether they had the resources to prepare such a tunnel, and whether executives would walk through a tunnel. Moreover, based on later interviews, the team members did not share similar views on the concrete form that the tunnel could have taken, with some expecting it to be a closed-in, dark tunnel through which executives might have to crawl and others thinking it would be an artsy display.

In sum, then, this practice of cocreating the scaffold helped the team to rapidly generate a representation that incorporated their earlier voiced fragments. The scaffold then served as a way for members to limit the sharing of their specialized knowledge to the joint creation of a representation without the need to engage in a lengthy dialogue of surfacing knowledge differences and dependencies.

Practice 3: Dialoguing Around the Scaffold

In this third practice, *dialoguing around the scaffold*, the teams engaged in a rapid dialogue about the scaffold in an attempt to use the scaffold to generate solutions to the problem. Early in this dialogue, the scaffold proved to be inadequate for solution generation, leading all three teams to attempt to reframe it several times. The teams kept reframing the scaffold until one of the frames led to the articulation of key unresolved tensions in different parts of the problem and increased clarity that currently considered solutions were inadequate to address the tension.

To illustrate the dialogue and scaffold reframing practice, in Team Quality, the scaffold consisted of a matrix. The columns of this matrix depicted a growing list of possible characteristics of a best practice quality program, and the rows indicated what each division did for each characteristic and how well it was done. During the face-to-face meeting, team members began a session by openly reviewing each row of the matrix to make sure that the entries in the rows accurately reflected each division's current practices. The concept underlying the matrix was to use it to pick the "best" division for each characteristic and then combine the selections into a set of guidelines for an enterprise-wide quality program. As the members discussed each row (i.e., division), one member made the observation that, if one looked down each column for each quality characteristic, none of the "best" practices used by any one division would be best for every unique division. This observation surfaced a tension that had not previously been identified: the team was tasked to prepare a set of guidelines describing the best practices used throughout the company, but the unique nature of each division prevented reusing best practices across divisions. Once the tension rose to the surface, it became the focus of a dialogue that sparked the team to realize that the mission they were given by upper management—of creating a new approach to devising an enterprise-wide quality program by identifying best practices from each division—was misguided. Instead, the team's task needed to be to ignore existing best practices for the moment and "take a step back" to identify new practices that they referred to as "beyond best practices," which would be ideal and apply across the enterprise.

Another example of dialoguing around, and reframing, the scaffold occurred in Team Strategy. The dialogue revolved around the team's tunnel scaffold. As the team dialogued about the cultural change they needed to create in the senior executive experience, a tension between two parts of the problem became apparent. For the experience to be successful, the executives needed to come—emergently and unpredictably—to their own realization that the strategic planning processes they currently used were broken, yet this emergent and unpredictable realization of the need for change had to be accomplished within the confines of a two-hour, carefully scripted session. The identification of this tension sparked Team Strategy members to take the creative leap that decisions about whether the tunnel should be walked through or not were less important than ensuring that the experience was personal for each executive. This led team members to design an experience for the senior executives that started with each team member sharing private thoughts about the company in front of the senior executives—an action that would be appreciated by the senior executives as highly risky and personal. The wide diversity among

the team members, when sharing their personal thoughts, was then intended to catalyze the senior executives to share risky, highly personal thoughts about diversity as a strategic weapon. The tunnel was therefore reframed to be a personal metaphorical tunnel that each senior executive needed to walk through.

In sum, then, this third practice involved dialoguing not about differences between members but in ways that repeatedly reframed the scaffold to eventually promote the type of creative tension that led to a creative breakthrough. By keeping the focus on the scaffold, the dialogue never devolved into an interpersonal conflict nor did it involve learning about each other's knowledge.

Practice 4: Moving the Scaffold Aside

In this fourth practice, *moving the scaffold aside*, the team took a highly preliminary solution and tried it out on external stakeholders. The team revealed a very preliminary proposal to external stakeholders to get early feedback, rather than waiting until the ideas were well developed. Explaining their proposed solution to the external stakeholders required that the team change its focus from an internal need for knowledge integration to the needs of external stakeholders. To do so, the team members initially tried to include the scaffold in their dialogue with the stakeholders. They quickly found, however, that the stakeholders did not understand the scaffold or its relevance to the solution they proposed, so the scaffold was dropped.

The extent to which the team members quickly and completely dropped the scaffold from their problem-solving process was striking. Interviews with team members afterward indicated that not only had they dropped the scaffold but they *could not recall* creating or using the scaffold, despite statements to the contrary in mid-project interviews and transcript evidence indicating the centrality of the scaffold to their earlier solution-generation dialogue.

Because efforts to include the scaffold in explaining the solution to stakeholders did not help stakeholders understand the solution, moving the scaffold aside appeared to help the team focus on that aspect of its problem solving that reinforced its sense of accomplishment. Changing the focus away from the scaffold also helped to reenergize the team by providing it with a new focus that was closer to the actual implementation of the team members' ideas. This reenergizing was particularly important because the team, at this point, still needed to continue to significantly modify the solution to meet stakeholder needs. Changing the focus from internal scaffold to external stakeholders extended knowledge creation without engaging differences and dependencies between individuals because it provided new criteria for evaluating the solution that did not privilege one member over another. The evaluation criteria for the solution

now became specifically the stakeholder's needs relative to the initial solution. As such, although the solution had initially been made possible because of the scaffold, the reorientation toward the external stakeholders encouraged the team to cogenerate ways to tailor the solution to the stakeholders without needing to stay consistent with the scaffold. By dropping the scaffold, the team members did not need to engage in the cognitively complex effort of maintaining two versions of reality—one internalized and one externalized (Wixted 2004).

Team Space illustrates this practice. On Day 3, Team Space members asked outsiders to listen to a short presentation about their draft space plan. They explained how they derived their solution by describing their scaffold, which was the notion that buildings have personalities that need to be leveraged in a space plan. The outsiders provided positive feedback about the space plan; however, they reported that the connection between “building personalities” and the draft space plan was unclear. Although the scaffold of building personalities had provided a focus central to the team members in creating their plan, outsiders did not understand the scaffold. Team Space then stopped using the building personality metaphor in their dialogue during the remaining 20 hours of cocreation. They so completely dropped the scaffold that in their final presentation to top management when they described the process they used to develop their solution, the notion of building personalities was barely mentioned.

In sum, then, moving the scaffold aside facilitated the team's reconnection with their external stakeholders early after they had an initial solution but before the solution was well developed and thus harder to change. This not only ensured a smooth transition of the dialogue from a collectively created scaffold to an external stakeholder but also encouraged continued cogeneration.

Practice 5: Sustaining Engagement

Teams with disparate viewpoints working under novel circumstances can fall victim to interpersonal, task, and process conflict that can drain team members' motivation, direction, and purpose (Jehn et al. 1999). As the team members spend more time in lengthy discourse, they can become anxious that the team's direction will not lead to a successful problem resolution (Kelly et al. 1997). They can begin to question their own process and direction. In the worst cases, this can lead to withdrawal or exhaustion; members are just too tired or too frustrated to continue generating new ideas and simply acquiesce to a more vocal member (Karau and Kelly 1992). To overcome these challenges, we observed three sets of activities that sustained engagement in the teams. We label them as follows: (1) repeated summarizations, (2) sharing the unexpected, and (3) using enthusiasm to drive the process.

Repeated summarizations describe the activity of the teams to use members' comings and goings as excuses for repeatedly reviewing and summarizing the team's progress. This activity allowed the team to make progress despite the conflicting commitments of its members that pulled members away from the team. For example, at Team Space meetings, there were always members missing. To get returning members engaged, those team members who were present would interrupt their dialogue to summarize and review the decisions that had been made in the member's absence. The repeated comings and goings of team members meant that summaries and reviews happened frequently. For each summary, members would elaborate on the summary, adding detail, and indicating some sense of satisfaction about what they had accomplished in the member's absence. Repeated summarization allowed the team to celebrate small victories by sharing the work they thought was energizing. It also encouraged in-process corrections and interpersonal congruence (Polzer et al. 2002).

Sharing the unexpected involves members articulating different perspectives that were beyond their organizational role responsibilities, thus blurring boundaries between areas of expertise. For example, in Team Quality, a quality professional surprised the other quality colleagues on the team by taking the side of management in discussing an ideal element of a quality program. This catalyzed another quality professional, who was an open critic of company managers, to muse about the interesting complexities of being a manager. (As a side note, to the astonishment of his quality colleagues, this individual later applied for a management position at the company!) When members shared unexpected perspectives, this appeared to free other members from implicit assumptions about how other members would approach the problem, generating renewed enthusiasm for continuing the idea-generation process. In another example, Team Space's designer, who had only recently joined the company, offered a detailed depiction of the myth around the company's early culture. The depth of the designer's knowledge about this myth initially surprised the other team members, especially one older team member who had experienced the early culture for himself. However, other team members consequently offered their own views of the early culture myth as well. In effect, sharing unexpected comments both helped to sustain engagement and blur boundaries.

Using enthusiasm to drive the process allows the direction of discourse to be guided by enthusiasm rather than explicit criteria, technical analysis, or agreed-upon steps that might have differentiated members from each other. If certain topics or ideas did not garner much enthusiasm, they were ignored—even if they were technically sound. The focus of the collective enthusiasm became a primary signal for how the team's discussions

would unfold. For example, in Team Space, an idea about redesigning the company's library garnered enthusiasm by only two members who had apparently visited the library; the idea was essentially ignored by the other members. The library idea was never mentioned in later conversations as part of the solution. Allowing the direction to be set by enthusiasm helped to minimize differences because it was only those ideas that were enthusiastically received by all the members that were carried forward.

In sum, instead of confronting individual differences that may draw down energy (Lovelace et al. 2001), the teams practiced building and sustaining engagement through repeatedly summarizing, the sharing of the unexpected, and the use of collective enthusiasm to drive the process.

Discussion

Cross-functional teams are increasingly used to develop new processes and products (Edmondson and Nembhard 2009). These teams offer the promise of diverse viewpoints and expertise, transformed and integrated for higher-quality problem solving (Dougherty and Tolboom 2008). However, integrating the knowledge of team members, particularly when faced with novel situations, is challenging (Bechky 2003b, Carlile 2002, Dougherty 2001, Hargadon and Bechky 2006, Tsoukas 2009).

We identified five practices that our three cross-functional teams used to integrate their knowledge to cocreate a solution. The practice of *voicing fragments* focused the team on assembling a common landscape of individual statements and parts of solutions without discussing, clarifying, or resolving knowledge differences; this practice avoided the negative effects of contentious interpersonal conflict that often surface when differences between specialists are confronted (Jehn et al. 1999, Lovelace et al. 2001). The practice of *cocreating a scaffold* allowed convergence on a tentative, fluid representation that provided a common cocreation and elaboration experience; this practice helped the team to develop a collective team orientation to the problem-solving effort (Tsoukas 2009, Van der Vegt and Bunderson 2005). The practice of *dialoguing around the scaffold* made possible the surfacing of previously unappreciated tensions that fostered creative solution generation without creative abrasion between individuals (Leonard-Barton 1998, Skilton and Dooley 2010). The practice of *moving the scaffold aside* fostered further cocreation to account for complex implementation requirements of external stakeholders (Dougherty 2001). Finally, the practice of *sustaining engagement* throughout the problem-solving effort helped the team maintain the energy and focus needed to continue the process of personally transforming one's knowledge to collective knowledge as new

ideas were generated without retreating to the confines of one's current bounded knowledge and confronting others with that knowledge (Dougherty and Tolboom 2008).

The practices, then, helped the teams to overcome a number of challenges of knowledge integration. By sharing fragmentary comments early in the team's process, team members were able to express task-related doubts collectively and obtain reassurance that their doubts were not misinterpreted as a lack of commitment to the team (Lovelace et al. 2001). The manner in which the scaffold was iteratively cocreated and became the focal object for discussion fostered the type of risk taking, open reflection, and rapid and fluid cogeneration needed for knowledge integration in novel settings (Dougherty and Tolboom 2008, Edmondson et al. 2001). The practices also helped to overcome challenges of knowledge integration by invoking collective sensemaking about the task and about one's expertise with respect to the task (Dougherty and Tolboom 2008, Drazin et al. 2008). By cogenerating a scaffold and then collectively evolving and transforming the scaffold, the observations about how each team member reacted to others on the team allowed members to anticipate others' actions and needs—a necessary condition for knowledge integration (Edmondson and Numbhard 2009, Okhuysen and Bechky 2009, Rico et al. 2008). The teams were able to overcome the knowledge transformation challenge associated with different languages and perspectives in the team—not by clarifying these differences and negotiating to resolve them—but by iteratively cocreating new scaffolds that offered a neutral depersonalized common ground to which individual members transformed their own knowledge without the need for deep-knowledge dialogue.

Thus, the practices we observed build and extend existing literature on knowledge integration. The practices more specifically depict how knowledge integration challenges are overcome over time as a team goes from individuals representing specialist knowledge areas to the creation of a collectively integrative solution. The practices describe how sensemaking evolves, how the actions of previously unknown others become anticipated, how members create a psychologically safe environment to engage in iterative and rapid reflection, how creative breakthroughs occur without creative tensions between individuals, and how knowledge transformation occurs between different languages and perspectives without deep-knowledge dialogue.

Theoretical Implications

How cross-functional teams transform their specialist knowledge to create a new solution is a topic that has received substantial research attention (Carlile 2002, 2004; Dougherty 1992, 2001; Lovelace et al. 2001;

Tsoukas 2009). To overcome cognitive and organizational boundaries, one approach in the literature—that we have labeled the *traverse view*—argues that dialogue is needed that reveals assumptions, identifies and confronts these differences, and negotiates across boundaries. Such a dialogue is particularly needed when the tasks are novel, requiring not only integration but knowledge transformation and cocreation (Carlile and Rebentisch 2003). However, concerns have been raised with this approach because of the time and resources involved (Edmondson and Nembhard 2009, Hansen 1999). Moreover, other studies have found that spending time identifying and confronting each other's differences, learning from each other, negotiating common interpretations of events, and revealing assumptions is not always needed (Donnellon et al. 1986, Faraj and Xiao 2006, Kellogg et al. 2006, Schmickl and Kieser 2008).

Our findings provide support for the critical role of dialogue in the knowledge transformation and integration process, particularly when the task is novel for the team. We found that our practice of voicing fragments was followed by dialogue to create a scaffold, then dialogue to repeatedly modify the scaffold until a preliminary solution emerged, and more dialogue to incorporate needs of external stakeholders into that solution. Knowledge integration within cross-functional teams facing novel situations clearly benefits from dialogue even when the members have few shared perspectives and shared coordination protocols. Thus, unlike Kellogg et al. (2006), who argue for a nondialogue-based trading zone between members, and Schmickl and Kieser (2008), who argue that a transactive memory system provides a sufficient coordination protocol for knowledge integration, our findings provide support for the *traverse view* of knowledge integration that dialogue is essential to the knowledge integration and transformation process. *Our contribution then is in delineating the nature of the dialogue.* Thus, although we agree with previous literature that calls the value of deep-knowledge dialogue into question (Donnellon et al. 1986, Faraj and Xiao 2006, Kellogg et al. 2006, Schmickl and Kieser 2008), we extend beyond that literature to identify the dialogue-based practices that replace deep-knowledge dialogue.

Although we agree with the *traverse view* of the importance of dialogue, our findings paint a very different picture about the nature of that dialogue than that depicted in the *traverse view*. Our practices collectively offer a view on the nature of dialogue that we label as one that *transcends* knowledge differences such that knowledge differences are *not* first clarified with deep-knowledge dialogue and then bridged through negotiation (Bechky 2003b; Carlile, 2002 2004; Tsoukas 2009). Instead of confronting differences between specialty areas as would be expected in a *traverse view*,

the practice we identified of *voicing fragments* made salient a general landscape of the team's collective perspective on the problem. Instead of using concrete and organizationally embedded boundary objects, the practice of *cocreating a scaffold* evolved a boundary object that was abstract because it kept changing and was never interpreted in the same way by team members. Instead of treating the resolution of differences between members as the source of creative abrasion, when *dialoguing around the scaffold*, team members used the neutral scaffold as a focal point for seeking out creative tension between parts of the problem. Instead of limiting their knowledge integration to members of the team, the team members used the practice of *moving the scaffold aside* to extend their knowledge integration and solution generation to include outsiders. Finally, instead of using the comments of each member as an opportunity for deep-knowledge dialogue and learning about each other, the practice of *sustaining engagement* encouraged the team to ignore comments of team members unless there was a collectively energetic response.

This distinction between the *traverse* and *transcend* views of the nature of dialogue when integrating knowledge in cross-functional teams facing novel situations has theoretical implications for furthering our understanding of the knowledge integration process. Boundary objects may play different roles depending on whether the emphasis is on transcending or traversing knowledge differences. When the emphasis is on traversing differences, boundary objects may need to be concrete, making differences clearer. However, when the emphasis is on transcending knowledge differences, the same boundary object may need to be treated as abstract and fluid. For example, Bechky (2003b) appeared to adopt a *traverse view* when she argued that a machine served as a helpful boundary object between assemblers and engineers because it concretely depicted what assemblers do, making differences and boundaries clearer. However, the machine could be conceived as an abstract boundary object that provided value to assemblers and engineers not because it *clarified differences* but because it helped them to realize the more abstracted knowledge they *collectively held* about the machine. That is, boundary objects may facilitate knowledge integration between different parties not because they make boundaries clearer but because they help to identify what knowledge is held in common between the parties. The distinction between the *traverse* and *transcend* views on how knowledge integration occurs helps to clarify questions about the role of boundary objects for future research. Do boundary objects need to be concrete or abstract? Do they need to clarify differences or should they obfuscate those differences? Are there conditions when one role for boundary objects versus the other is more facilitative of productive dialogue?

The distinction between the traverse and transcend views offers another theoretical implication concerning structures that enable dynamic solution cogeneration in teams. In studies of cross-functional product innovation teams, the paradox of how to structure an inherently unpredictable but generative process has been well documented (Dougherty 2001, Sheremata 2000, Skilton and Dooley 2010). In the traverse view of knowledge integration, those structures define boundaries, dependencies, and negotiations that help to focus the generative process. In the transcend view of knowledge integration, the practices also appear to focus the generative process, but they do more: they appear to also foster a context of agility, flexibility, and rapid reflection throughout the problem-solving process. The cogenerated scaffold repeatedly changed form and substance, in the nature of a fluid object (Law and Singleton 2005). Similarly, repeated summarizations, brief voicing of fragmentary comments, continuing ideas based on collective enthusiasm rather than logical argument, and being willing to set aside cocreated assumptions about the scaffold when confronted with new information (i.e., from stakeholders) encouraged rapid reevaluations and continued generation. These practices appeared to create what Dougherty and Tolboom (2008) refer to as a creative mind-set that “enables people to gather up and assimilate large amounts of complex and ambiguous knowledge and shape it into multiple product concepts and business models” (p. 241). For example, the repeated summarizations allowed the team to develop standards for their work to evolve through mutual adaptation (Dougherty 2001, Leonard-Barton 1998). The fluid scaffold fostered a focus on action and knowing through action that helps to invoke collective sensemaking (Cook and Brown 2000, Dougherty 2001, Drazin et al. 2008). Therefore, although the traverse view emphasizes focusing structures that support knowledge integration in cross-functional teams faced with novel situations, the transcend view for knowledge integration emphasizes to a greater extent structures that foster a creative mind-set within the team. The extent to which focusing- and mind-set-oriented structures can be combined is an area ripe for future research.

The distinctions we have drawn between the two views on how knowledge integration occurs may provide a compelling explanation for how knowledge integration occurs under different conditions. In our three cases, all three tasks were not intensively analytic; none of the three required detailed and complex simulation models, for example, as they did in Carlile’s (2002) works on knowledge integration. In our three teams, there may have been less “staking” (Carlile 2002, Tsoukas 2009) of each member’s knowledge, allowing the members to more easily transform their knowledge to accommodate an evolving scaffold. Consequently, the transcend view

may apply to a greater extent under less staked conditions than the traverse view. Organizational factors may also be relevant to understanding the conditions under which the different views apply. All three of our teams were embedded in culturally innovative organizations. It may be that practices supporting knowledge integration, by transcending differences, are more feasible in companies with an established innovation habitus. The effect of these task and organization factors on the applicability of the different knowledge integration views raise questions for further research. Are there times when the traverse or the transcend view is needed? Are there conditions when hybrids are most appropriate? Could the application of each view change its surrounding conditions; for example, could the application of the practices for transcending knowledge differences overcome organizational barriers to innovation such that they foster knowledge integration even when the team is situated in a less innovative organization?

Limitations

We have offered a practice-based perspective on how knowledge integration transpires within cross-functional teams faced with novel situations. The lack of the teams’ efforts to establish clear differences and learn from each other initially surprised us, leading us to reconsider our assumptions about the process by which knowledge integration occurs in such teams. Clearly, a significant limitation of this research is that we only have three teams, all embedded in culturally innovative organizations and all focused on difficult, novel, but not intensely analytic or staked problems. We have suggested that the uniqueness of our sample has provided us with the opportunity to identify a transcend-based view about how knowledge integration occurs. Further research is needed to determine whether the practices we identified are found in other contexts and conditions.

Practical Implications

Managers are increasingly faced with the need to use cross-functional teams of relative strangers with temporary membership to solve complex novel problems under time pressure. This requires knowledge integration through transformation. Despite the wide diffusion of best practices for encouraging cross-functional team performance, organizations continue to struggle (Dougherty and Tolboom 2008). The five practices we identified suggest specific ways in which members can shortcut deep-knowledge sharing to achieve this integration. Teams can be designed to encourage the voicing of fragments, cocreate a scaffold, dialogue around the scaffold, move the scaffold aside to reconnect early to stakeholders, and ensure that members remain engaged in the generation process in a manner that minimizes their differences through a focus on their collectivity. Our findings

suggest that managers should consider these practices as they look for ways to foster knowledge integration.

Conclusion

At the outset of our research, we asked a question: What practices do cross-functional teams engage in to transform and integrate knowledge in novel situations? By examining in detail team members' interactions throughout problem solving, we were able to identify five specific practices that the teams implicitly used to overcome the difficulty of integrating their very different perspectives on the problem. These practices suggest extensions to the existing literature on knowledge integration—extensions that allow for more emergence in the process, including evolving and shifting scaffolds; a greater emphasis on how knowledge differences are transcended rather than clarified, confronted, and traversed; and a greater focus on structures for creative mind-sets.

Acknowledgments

This research was sponsored by the U.S. National Science Foundation [SES 0725088] to the first two authors and by the Canada Research Chairs program to the third author. The authors thank Jeremiah Johnson and Arlene Williams for assistance with data collection, the company sponsors and teams who allowed the authors to observe them so carefully, and the senior editor and reviewers from *Organization Science* for helping to sharpen the authors' arguments. Any errors are the authors'.

Endnote

¹We use the term “cross-functional” to refer to the different perspectives that team members bring with them. It represents the individual's specialized knowledge from his or her past or current intrapersonal experience or tenure diversity and his or her intrapersonal educational discipline diversity (Bunderson and Sutcliffe 2002). This specialized knowledge represents the degree of variety and separation, and not discrepancy, in the team (Harrison and Klein 2007). It does not refer to their demographic diversity (e.g., gender, race).

Appendix. Select Examples of Practices

Voicing fragments

Team Strategy

During the first telecom, team members shared in short phrases the following: an observation about training programs the member was conducting in Turkey, how negatively friends of the French member view the company, how plans for a world event were consuming the China member's time, how managers never seem to listen to employee ideas, how a member felt after recently reading *Who Moved My Cheese?*, and concerns about how a recent organizational change in the company would affect them.

Illustrative comments:

- “We should include social media tools.”
- “Managers don't understand the effect of the reorganization on us.”
- “We should have them read the Cheese book.”
- “They [managers] need to listen to employees not just customers.”
- “My friends still remember the company's bad reputation.”

Team Space

During the first two-hour session, the following Post-its were generated: New seating plan, Systems, Protocols, Tools, Approach to these questions, Way to think about evolution and the future, behaviors, Movie Set, Content Café, Neighborhoods, Support different work styles, adaptability/meaning/connectivity, community, easy adaptability, what is the optimum efficiency (sq f/hr), plan for change?/when you didn't know what the change is? Horses for courses...spaces for different projects, celebrate young people and different points of view & ways of working values, space should enable but be transparent, constant evolution..., how to plan for future?/analogous industry? what is good building “feel,” Prototype changes, Bug list: What are the common complaints we hear about space?

Illustrative verbal comments:

- “Spaces should differ on where you live versus where you visit.”
- “We have noise problems.”
- “People should be able to be wild; I miss the time of the rat caves.”
- “But there should be an aesthetic.”
- “There should be a value of self-serve [not waiting for support personnel].”
- “Maybe create default settings for desks.”
- “We need a library, Barry's library.”
- “Some people are heads-down types.”
- “Maybe there's a Maslow desk hierarchy.”

Appendix. (cont'd)

Cocreating the scaffold

Team Strategy

J: "I have this idea, for my senior thesis; it's really hard to represent your journey from freshman year when you couldn't draw to senior year when you're sketching like a genius.... So one of the things I did was an exercise in... changing people's environment which alters their perception, which forces their eyes to look at different places... by creating this really narrow uncomfortable tunnel to recreate the freshman experience, coming into this new place, feeling like you're all alone. Eventually, by the time I got towards my senior year, it opened up into this grand room, and I just used that as a physical representation of all the opportunities that would come from me just opening up and exploring more. What if we physically made every VP line out in a single row, like create this real[ly] tight, narrow space where they had to walk through and see our history and quotes... then they hit a dead-end and then they have to move horizontally... that opens up into the bigger space where we unveiled information about the culture and future and what it could be."

V: "Wow! That's amazing."

B: "So they'll see the quotes we've been talking about?"

N: "We could add the social media stuff, right?"

Team Quality

J: While the folks have been presenting [on their quality systems], I've put together a spreadsheet by facility of all the high points that I thought I saw in these two presentations. Motivation for a CAR [citation for quality problem]? Who could generate the CAR? Is there a filter? Who owns it? What forms are used? so forth. Let's populate this for our facilities... and have people throw rocks at it. Maybe we can put all of what I would call attributes of the various processes from the different groups and sites into one spreadsheet and use that as a grounding rod for us. And pick and choose what we like and what [we] don't like, maybe. [This spreadsheet was heretofore referred to as "J's Matrix."]

Team Space

Y: "Maybe we should rethink how we use buildings, not space within buildings. It's not about spaces within buildings, but whether there is a purpose for a building? Maybe this is a framework."

S: "Building 8, for example, is a great project space and group meeting space, nothing else."

D: "That is it. Don't try to make it anything else. So maybe it's something about articulating the role of a building so that we know each one of our buildings should play a very distinct role."

Y: "That resonates well with me because, like, before, we were trying to make everything do everything, which doesn't work."

D: "This is so exciting."

Dialoguing around the scaffold

Team Quality

Illustrative comments as the accuracy of each cell in J's Matrix was being evaluated:

"Hey, let's look down the columns and compare them to identify the best practices for each column."

"It looks like few of us have best practices that could work for everyone and that don't have problems."

"This may be best practice, but it doesn't mean it's ideal for my facility or other facilities."

"How about looking at ideals and see[ing] how they're better than best and work for all the facilities."

Team Space

At Day 3, the team began creating a seating chart for the different buildings, explicitly referring to the need to develop contrasting personalities for each of the two main design buildings. They discussed different ideal-type personalities: one building was labeled "design factory" and the other "idea garden." They found that in discussions about the different potential personality types for each building that the differences in building personality types were insufficient to generate new ideas because it only led to moving people around without a particular focus: "This feels subprimo" and "We need huger ways to liven the area up." Then one of the members commented, "What is exciting is that by moving people around, we get different energy in different space." Another said, "But we need to give everyone private spaces to hide." These comments led them to the discovery of contrasting the buildings not simply by the personality labels but by the energy and private space that each building affords. They discussed how the building they labeled the design factory currently had "high energy" (i.e., camaraderie) but little private space for quiet thinking time. They discussed how the other building labeled the idea garden had low energy and little private space as well. These contrasts sparked the team to analyze how private spaces could be created for both buildings, realizing a creative solution that would be different for both (in one, private space could be provided by taking the building off of the public tour route, and in the other building, private spaces could be provided by creating small cubbyholes). These contrasts also sparked the team to realize that they needed to add energy to one building without subtracting energy from the other building, inspiring a creative solution of adding energy to the low-energy building by incentivizing a high-energy group from the high-energy building to move to the low-energy building by creating project rooms in that building that they referred to as "tricked out" and "super cool." Thus, they used the two contrasts—of energy and privacy—between the two buildings to spark new ideas. One member summed up their solution: "The thing is, what's nice about this is that what you get here is the buzz if you're this [cubby-hole] design group, but over here, what you get is you get the open freedom to go around."

Appendix. (cont'd)**Moving the scaffold aside***Team Space*

The “building personality” idea had been absolutely critical to the ability of the group to create seating charts for the two main buildings on the campus. Interviews with the members immediately after the seating charts had been created, as well as videotapes of the seating chart creation process, indicated repeated references to the building personalities. On Day 3, after the seating charts were created, the group followed a practice of the firm by holding an impromptu peer review of the group’s ideas thus far. The group assembled eight designers from other parts of the company and presented a rationale for their proposed seating chart that relied heavily on the notion of building personalities. Although the outsiders indicated that they liked the proposed seating chart, they noted, “It’s interesting, though, in that all this work that you guys have done here to try and create personality . . . I don’t see it mapped here at all.” After the outsiders left, the group discussed the feedback at some length, with some in the group arguing that building personalities was still a critical notion for explaining their problem-solving process (“As we’re presenting this to everyone, the first thing that we need to do is paint the personality of the campus and how everyone plays an integral part in making that happen”), whereas others countered (“I think [the reviewers made] a good observation. It just makes me realize the importance of the communication piece; it is going to be paramount to our ongoing success.”). There was no resolution at this point. However, on the fifth day, when the group prepared their presentation on their recommendations for senior executives, they no longer included “building personality” as playing a key role in how they derived the seating charts. Instead, they relegated the role of building personalities to a single bullet on a multibulleted slide marked “Design Principles.” Moreover, in after-project interviews, members were asked about the role of building personalities in their success at cogeneration. None of the members indicated that the building personality idea was any more critical to their process than other idea—despite the fact that our observations and transcripts indicated few references to these other ideas after the first day.

Team Quality

J’s Matrix was absolutely essential to the group’s progress. Without J’s Matrix, the group would not have been able to compare each other’s quality program and identify ways to analyze and brainstorm about best and ideal practices. The main body of the final white paper delivered focused on each of the elements in J’s Matrix. However, at no place in the white paper was there a mention of a matrix. On the last day of the face-to-face meeting, as the group was outlining the white paper, one of the managers offered a suggested outline that had J’s Matrix included in the white paper. The quality professionals in the group reacted quite negatively to the outline, indicating that they never intended that the matrix would be in the quality white paper. They offered three reasons for not including the matrix. First, the matrix was not that important, they argued; it was the text that was written that would be important. Second, the cryptic language used in J’s Matrix would have little meaning to others. Third, because the entries in J’s Matrix implicated site practices, the quality professionals felt that their managers would want to be consulted prior to any publications describing their sites—a consultation that they felt would inevitably lead to managers requiring that the cells only display their site as having best practices. Thus, J’s Matrix was never included or mentioned in the final white paper. Moreover, in after-project interviews, we asked group members to describe what they did that helped them succeed in collaborative cogeneration. J’s Matrix was mentioned only as a tool for jotting down site practices; none of the members indicated that the matrix helped them to share in new ways, compare, or generate new ideas, despite our transcripts and observations.

Sustaining engagement*Team Space*

Example of repeated summarization:

D: “How’d things go yesterday?”

Y: “We had a great conversation about yesteryear; there were certain things that enabled people to take risks; there was accountability to how it happened; it added to overall essence of space.”

D: “That was a ritual.”

E: “Could you create a default?”

S: “Behind the curtain, define spaces that people could be like that.”

Y: “We also talked about a notion of Maslow’s Need Hierarchy: basic needs like power, light bulb, desk, then what other attributes to map to that, then map project group into that level.”

Y: “What else to add?”

S: “Being clear to give people permission, as building the spaces, not having to make everyone equal.”

D: “Now I feel like I was here yesterday.”

D: “What do you want to get out from today?”

Appendix. (cont'd)

Team Quality

Example of sharing the unexpected:

As the team discussed each characteristic of a quality program, the managers argued for the need for a new characteristic that would involve quality professionals to consider unintended consequences when they proposed a correction to a quality problem, a suggestion that the quality professionals vociferously rejected on the grounds that this would give managers an excuse to not implement their quality corrections. Later, the team divided up into subteams of quality professionals and managers to develop “beyond best practices” for each quality program characteristic. The quality professionals subteam discussed each characteristic, and then the following issue was raised:

D: “What do we do about unintended consequences?”

J: “Does anyone know what this means? [J] reported later that he had expected the other subteam members to spend the time complaining about the managers. To J’s surprise, D proceeded to define “unintended consequence.”]

D: “Everything that has a cost associated that was not intended, is what it means. But don’t know how to measure it.”

J: “But I’m an operations person; I take an action, something else will happen, of course.”

D: “But any proposed corrective action has a negative side, so you have to do something about it.”

B: “We need to think about unintended costs of a corrective action, which is what management is always interested in; you have to think of your audience.”

J: [sounding surprised] “Really? You’re saying that?”

B: “If you can relate what these kinds of things cost your profit share or raise next year. Don’t you think that people would be more involved in helping; you would buy into it, you own the company. You feel the same pains that higher management [feels] because it’s affecting you. This is something we don’t do a lot of. We avoid it. We just absorb it. What are we going to get back? That’s why I’m thinking that it is an important thing. What are we going to get for these thousands of dollars. But how do we measure it?”

J: “But managers will just say, ‘Don’t do that because it costs money.’ When it gets to that point when people talk about cost, my animal reaction [is] where we were a long time ago when you knew it was a problem. I see that a lot. We’ve gone down the road. We’ve proliferated the problem. We’ve cloned it. Now, it’s all over the place. The cost of fixing it. I react in a very emotional way about that. Just to put the word cost.”

B: “That’s what I’m saying, you have to do that evaluation to help people figure out if they should spend that money. J, you’re the authority to make changes, but maybe you shouldn’t make one small change and should wait until you have 10 changes to make; it may be more cost effective.”

J: [now seeming convinced of the importance of unintended consequences] “Okay, what metrics should I enter into the matrix?”

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Ann Majchrzak is a professor of information systems, Marshall School of Business, University of Southern California, Los Angeles. Her research interests include symbiosis, creativity, emergence and fluidity in online communities, ad hoc collaborations, and virtual organizations. She is a senior editor at *Organization Science* and *MIS Quarterly*.

Philip H. B. More is a professor of management and organization at the Marshall School of Business, University of Southern California. He received his Ph.D. from the University of Washington, Seattle. His research interests include strategy formulation and implementation, with an emphasis on technology-based organizations in global markets.

Samer Faraj is an associate professor and holds the Canada Research Chair in Technology, Management and Healthcare at the Desautels Faculty of Management at McGill University. His research focuses on complex work coordination and how technology mediates collaboration with a focus on health care and online communities. He is senior editor at *Organization Science* and serves on the editorial boards of the *Journal of Association for Information Systems* and *Information and Organization*.

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