Task Conflict, Problem-Solving, and Yielding: Effects on Cognition and Performance in Functionally Diverse Innovation Teams

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Abstract

Although research on team cognition has focused mostly on sharedness and its benefits, differences in team member cognition (i.e., representational gaps) may not always have negative effects. In this article, we develop theory and test the positive and negative effects of representational gaps (rGaps) among team members in cross-functional product development teams and the central role of task conflict and conflict management (problem-solving and yielding) in predicting team cognition. rGaps are examined both in terms of average level within the team and the patterns of shared representations across members from different functional areas. These patterns capture potential asymmetries within the team.

Organizations often rely on multifunctional teams to innovate because the teams' diverse skills and breadth of knowledge advances their creative potential for the task at hand (Amabile, 1983; Van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998). Ideally, the distinct functional viewpoints will blend together synergistically and lead to a higher-quality new product (Bantel & Jackson, 1989) or greater innovation (Dougherty, 1992). However, the same diversity that is designed into the team can create gaps in perceptions of the problem that subsequently interfere with communication and coordination, cause conflict, and ultimately undermine information integration and team performance (Cronin & Weingart, 2007). Increasing similarity among team members' perceptions may improve coordination (e.g., Cannon-Bowers, Salas, & Converse, 1993; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000), but at a cost to innovation because it removes the creative abrasion (Leonard & Straus, 1997).

We show that a balance can be struck by focusing on the size and distribution of a team's *representational gaps* (rGaps, see Cronin & Weingart, 2007). Representational gaps capture incompatibilities or incongruities within a team's joint representation of

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the task at hand, the aggregate of the problem definitions held by team members. rGap theory complements research on team mental models by focusing on what parts of the problem definition are incongruent across team members, which are a subset of what is not shared among teammates (cf. Smith-Jenstch, Mathieu, & Kraiger, 2005). Functional diversity can produce rGaps, and while they have been argued to degrade team performance (Cronin & Weingart, 2007), there might be a utility to rGaps when we examine the magnitude of the difference (i.e., the *size*) and distribution of the differences (what we call *heterogeneity*). In particular, we posit that rGaps are a central mechanism through which task conflict promotes team innovation (see Figure 1). Task conflict involves active debate and disagreement about what should be done in order to accomplish team objectives (Jehn, 1995). If task conflict either eliminates incongruence entirely or exacerbates the divergence in the representations of the functional areas, it can hinder innovation. Task conflict must resolve disagreement while preserving the differences in functional perspectives, and whether this happens depends on the use of cooperative conflict management approaches.

Our intended contributions are first, an empirical test of rGap theory that goes beyond considering the *average* level of inconsistency to understanding how asymmetric configurations of rGaps might influence team effectiveness. Second, rGap theory has treated rGaps as a predictor of team conflict (Cronin & Weingart, 2007; Weingart, Cronin, Houser, Cagan, & Vogel, 2005); we consider how team conflict influences rGaps. This approach is in line with prior work suggesting the importance of studying the effects of group processes on the emergent state of shared cognition (Cronin & Weingart, 2007; Kennedy & McComb, 2009; Rico, Sanchez-Manzanares, Gil, & Gibson, 2008; Wildman, Pavlas, & Salas, 2009). Third, most of the prior work on team cognition has examined well-structured intellective coordination tasks such as airspace control (Cannon-Bowers et al., 1993; Lim & Klein, 2006; Marks, Zaccaro, & Mathieu, 2000; Mathieu et al., 2000); we examine ill-structured innovation tasks. Requirements for sharedness and allowances for incongruities should differ across these types of tasks.

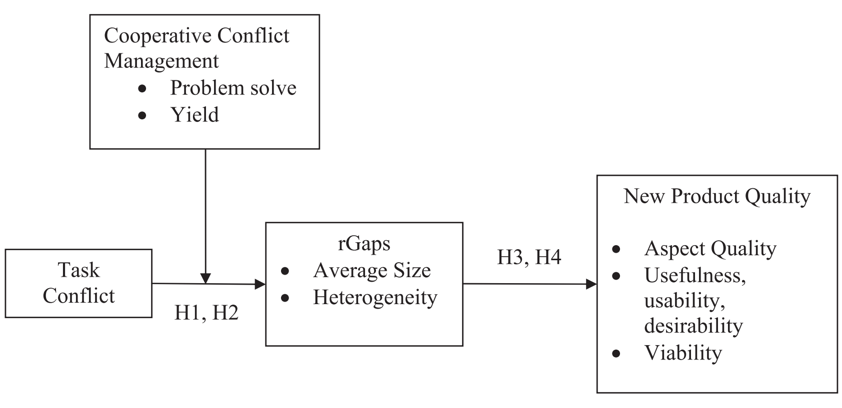

Figure 1. Hypothesized model.

Representational Gaps Defined

Cronin and Weingart (2007) define the concept of representational gaps *as incompatible differences between team members' fundamental definitions of a team's problem* (i.e., their problem representations, see Chi, Feltovich, & Glaser, 1981; Hayes & Simon, 1974; Newell & Simon, 1972). Gaps can exist in team members' goals, assumptions, elements, and operators, which constitute the fundamental building blocks of cognitive representations (Hayes & Simon, 1974; Newell & Simon, 1972). Of these, the most important are the goals (Cronin & Weingart, 2007); as others have written, compatible goals represent the "sine qua non for integrating knowledge diversity to meet task requirements for teamwork" (West, 2002, p. 369).

RGaps arise when individual team members create different representations of the team's problem based on their own often functionally based knowledge and values (Cronin & Weingart, 2007; Weingart et al., 2005). For example, when engineers believe a product's functionality drives sales while designers believe esthetics do, each will conceptualize the desired end state (i.e., the goal) differently. Such differences are more than simple differences in magnitude as goals tend to be conceptualized using functions' own metrics that may not be comparable (e.g., engineers will not be thinking in terms of "theme," MBAs will not be thinking in terms of "shearing force," designers will not be thinking in terms of "market share"). These differences can therefore manifest across a variety of product attributes. For example, an engineer may evaluate a product as being in need of rework, while a designer may see the product as very good as is because they are evaluating the product using different goal systems. This asymmetry creates incongruence in that the engineer will want to change product attributes, and the designer will not. Such a gap persists when, as the result of changes, an engineer may think the product is better, and the designer may think it is worse because the attributes that were sacrificed for the change may have a higher cost to one than the other. As such, rGaps related to goals can manifest in team members' representations about the current product state and how well that state satisfies performance objectives (i.e., goals). In this study, we examine gaps in representations of goal achievement.

The Structure of rGaps

At the team level, rGaps are the levels of incongruence among the representations that constitute the joint representation. Incongruence can exist between all pairs of functional areas. A team composed of three functional areas [e.g., design (d), engineering (e), and marketing (m)] can have incongruity between functional pairs (d vs. e; e vs. m; m vs. d). The amount of difference across each pair can also vary (d may have a lot of incongruities with e and m, who may have few with each other). Thus, at the team level, the average incongruence among functions captures how much incongruence exists within the team (i.e., the size of rGaps); the variation among the level of incongruence between each functional pairing represents how evenly distributed that disagreement is and is what we call *heterogeneity*.

Heterogeneity in rGaps represents asymmetry within the team by capturing the configuration of similarities and differences. In teams comprised of three functional areas (as used in this study), those with high heterogeneity have one function that differs from the other two, which are alike—a minority perspective of sorts. In contrast, when all pairs of functions have gaps of the same size, (i.e., teams with homogeneous rGaps), there is no dominant viewpoint. Thus, high heterogeneity is a general concept related to distribution of disagreement, but has a specific meaning in a three-function team context.

The Effects of Task Conflict on rGaps

Task conflict can have both positive and negative effects on innovation (De Dreu, 2006; De Dreu & Weingart, 2003a; Nemeth & Nemeth-Brown, 2003; Van Dyne & Saavedra, 1996). We argue that task conflict can be beneficial depending on whether it enlarges functional perspectives, erases functional differences, or drives the team apart. We hypothesize that the use of a cooperative conflict management approach will determine which of these takes place.

Task Conflict Effects via Enlargement

When team members engage in task conflict, they surface information on the rationale for their different preferences and learn about divergent viewpoints. Confronting these differences increases the odds that underlying incongruities can be discovered, and resolving these may provide new ways for teammates to see how value can be added to the product. As such, task conflict can lead to a process of representation *accommodation*, where people expand their representation to include the perspectives of others (Fiske & Linville, 1980; Piaget, 1952). This expansion reduces the size of the rGaps by increasing the amount of overlap in the cognitive representations of team members. In this way, enlargement results in a convergence of perspectives.[1]

Task Conflict Effects via Divergence

Task conflict might alternatively result in divergence of perspective across functional areas. Research on negotiation suggests that when group members get too focused on arguing their positions, they tend to take a win–lose approach, focus on claiming value for themselves, and do not engage in more creative, value-creating strategies (Hyder, Prietula, & Weingart, 2000; Weingart, Hyder, & Prietula, 1996). As functions argue for their ‘‘right’’ answer, it can reinforce the subgroups, making the arguments from the

[1]However, accommodation is not the same thing as assimilation (Piaget, 1952). Assimilation involves incorporating others' perspectives into one's existing (and largely fixed) representation. When incompatibilities exist, assimilation requires a team member to change the new information to fit in with what they already know. When task conflict acts through accommodation, it requires the team member to expand his/her existing representation rather than change the new information to fit that representation.

other "outgroups" less persuasive. Research on group polarization across subgroups shows that novel arguments are persuasive only when they are perceived as valid (Vinokur & Burnstein, 1978). As Isenberg (1986, p. 1148) states, "given the ubiquity of intergroup phenomena (e.g., Sherif, 1966) we would expect that when an outgroup is perceived as "bad," their arguments will be perceived as invalid, and thus novel arguments (and rational discussion) will be unpersuasive." When task conflict becomes argumentative, it will pull the team apart as functions become more committed to their position, and it will prevent them from being open to broadening their own representations as they become entrenched.

The Moderating Role of Cooperative Conflict Management

It is not easy to expand one's representation by capitalizing on task conflict because it is very difficult to make sense of information that does not correspond to one's own thought world (Dougherty, 1992). New information is most often assimilated to fit within the framework of the existing representation (Hayes & Simon, 1974), even when the incoming information has to be distorted to do so (Fiske & Linville, 1980; Schwarz & Bless, 1992). Representations become engrained and taken for granted (Dougherty & Heller, 1994) from long-time habit and experience, both of which bias thinking against seeing new ways of approaching problems (Ford, 1996). To change this habitual way of thinking requires concerted effort and attention to develop new understandings and new habits.

For representations to enlarge, teams must avoid an argumentative spiral and put in the attention and effort to learn to think differently about a problem. We argue that this will be a function of the conflict management approach used. Several have suggested (De Dreu & Weingart, 2003b; Jehn & Bendersky, 2003; Ury, Brett, & Goldberg, 1989; Weingart et al., 2005) and others have shown (Alper, Tjosvold, & Law, 2000; Behfar, Peterson, Mannix, & Trochim, 2008; DeChurch & Marks, 2001; Goncalo & Staw, 2006; Greer, Jehn, & Mannix, 2008; Kuhn & Poole, 2000) that the positive versus negative effects of team conflict might be explained by the conflict management approaches used by the team. We argue that the use of two cooperative conflict management approaches, problem-solving and yielding, will influence the relationship between task conflict and rGaps.

Cooperation is largely driven by some level of concern for another person's outcomes (Pruitt & Rubin, 1986), a likely situation because of members' shared fate. Cooperative conflict management is evidenced via problem-solving (when they also care about their own outcomes) or yielding (when they care less about their own outcomes) (Pruitt & Rubin, 1986). Problem-solving and yielding might be negatively related strategies as cooperative social motives (high concern for self and other) result in more problem-solving in negotiation except in situations where people are willing to yield (De Dreu, Weingart, & Kwon, 2000). Hence, we consider problem-solving and yielding as opposite strategies on a continuum of cooperative strategies where problem-solving incorporates a high level of self-interest and yielding involves a low level of self-interest (Pruitt & Rubin, 1986). We propose that the use of these strategies will affect the likelihood that task conflict will influence rGaps via convergence (a la enlargement) or divergence.

Problem-solving focuses people on understanding why other's views are different but nonetheless useful and represents a serious commitment in attention as team members attempt to find mutually beneficial and often novel solutions to conflicts in which their goals cannot easily be achieved simultaneously (Pruitt, 1981). When successful, problem-solving integrates divergent perspectives into a novel one that can accommodate both; much the way one can find creative solutions to accommodate multiple interests. Yielding requires little attention as one simply gives in and sublimates his/her own self-interest resulting in little integration of perspectives.

The dual concern model of negotiation proposes that yielding occurs when people have low concern for their own outcome and high concern for the other's outcome (Pruitt & Rubin, 1986). However, in team conflict situations, team members are less likely to enter into conflicts over issues they do not care about, and because the group is rewarded or punished based on team output and goal achievement, all team members have an incentive to care. As a result, yielding can occur when people care about their own outcomes, but are working toward other goals as well. For example, an engineer might yield to a designer if she believes that the designer's goals are more important to meet than her own for that particular decision. Or giving in could be in service of obtaining agreement so that work can move forward. A team member might yield to make progress or meet a deadline, with the expectation that others will do the same at some later point in time (Weingart, Bennett, & Brett, 1993). Team members might give in because they feel forced to do so—either because they are low status or because they realize they cannot "win" the argument. As such, yielding can serve several purposes in teams not considered by the dual concern model and create unintended consequences with respect to representation enlargement. In each of these cases, giving in does not reflect fundamental changes in team members' own beliefs and therefore does not support change of perspectives. Moreover, it can result in divergence of perspectives if team members feel marginalized or disrespected.

Predicting the Size of rGaps

Teams that rely on problem-solving to resolve their conflicts will have smaller rGaps because the problem-solving process provides the requisite attention and motivation to accommodate multiple perspectives. Yielding does not imply such engagement and should therefore result in little accommodation of perspectives. Teams that rely on yielding should therefore not reap the convergence via enlargement benefits of task conflict on rGaps. Minimally, we would expect a weaker negative relationship between task conflict and rGap size in teams that rely on yielding—such teams would not benefit from the debate and discussion of problem-solving. However, yielding may go further and strengthen the divergence effect of task conflict on rGaps size. If yielding is about giving in "in word," but not "in spirit," yielders might feel marginalized and disrespected as a minority or a "losing" side to the conflict. Yielding should then exacerbate the positive relationship between task conflict and rGap size.

Hypothesis 1: The cooperative conflict management approach used will moderate the relationship between task conflict and the size of rGaps. Task conflict will be negatively related to rGap size in groups that rely on problem-solving, but not yielding. Task conflict will be positively related to rGap size in groups that rely on yielding, but not problem-solving.

Predicting the Heterogeneity of rGaps

In a group with multiple functional perspectives, it is possible that some functions will converge while other functions will diverge. One reason is the "common enemy" effect described in balance theory (Heider, 1958). Fundamentally, balance theory states that in a three-node network (the structural equivalent of our team), stable structures exist where everyone is in harmony or there is one common enemy. So for example, if engineering and marketing were generally in agreement, but engineering was in conflict with design while marketing was not, this may require marketing to "take a side" because of pressure from either engineering or design. Building a coalition can be seen as advantageous and is most attractive and simple between those with the least incongruence. In addition, the function that is singled out may become defensive and more extreme in their beliefs, increasing the size of the rGaps with the other two functions. The resulting 2 vs. 1 coalition structure will make the team rGaps more heterogeneous.

Again, the conflict management approach used should influence rGap heterogeneity. If yielding is used, then heterogeneity of rGaps should increase. Yielding is an "I lose, you win" strategy (Johnston, 1982) and is likely to follow a debate or argument over an issue. When team members argue their positions, they come up with more and better arguments so that they develop more sophisticated representations associated with their positions, believe in them more, and become more rigid in their beliefs (Hyder et al., 2000; Janis & King, 1954; Wilson, 1990). Ending this process by yielding will give the isolate reason to feel "one down" (they lost), and thus the isolate could become more entrenched and differentiated from the other team members.

In contrast, if problem-solving is used, then heterogeneity of rGaps should *decrease*. Reduction of heterogeneity requires that the distinct perspective be accommodated and "brought into the fold." Problem-solving is a well-suited strategy for doing so because it addresses team members' underlying concerns and interests, keeping all perspectives on the table. In addition, if teams are likely to identify and be motivated to address their more severe problems (Moreland & Levine, 1992), they may focus their problem-solving on resolving the larger rGaps. Resolving the larger rGaps will directly reduce the heterogeneity, as the largest rGaps become more similar in size to the smaller ones.

Hypothesis 2: The cooperative conflict management approach used will moderate the relationship between task conflict and the heterogeneity of rGaps. Task conflict will be negatively related to rGap heterogeneity when teams rely more on problem-solving and less on yielding to manage their conflicts. Task conflict will be positively related to rGap heterogeneity when teams rely more on yielding and less on problem-solving to manage their conflicts.

The Effect of rGaps on Team Performance on an Innovation Task

Creative insight is driven by changes in problem representations (Ohlsson, 1992) that ultimately beget innovation (Amabile, Conti, Coon, Lazenby, & Herron, 1996). In multifunctional product development teams, representations can change by enlarging to accommodate the points of friction among representations. Closing rGaps in this way implies representational change (Cronin & Weingart, 2007) and so may indicate that creativity has taken place. Additionally, a team with large rGaps and thus differing beliefs about whether the product meets its goals will have a hard time coordinating their actions. In essence, teams with larger rGaps will have members who want to move in different directions based on their perception of the current state of the product, ultimately limiting the ability to produce a high-quality product on deadline.

Hypothesis 3: Teams with smaller rGaps will develop higher-quality new products.

Although smaller rGaps should help teams develop better new products, even when perspectives remain distinct, teams can serve to reinforce a dominant perspective while suppressing others (Levine & Russo, 1987). In three-function teams, such as the ones studied here, high heterogeneity in rGaps implies a kind of minority viewpoint. This configuration capitalizes on both similarity (between two functions) and diversity (from the third). The existence of a singular, dissenting viewpoint may encourage the voicing of opinions that differ from the majority (Gibson & Vermeulen, 2003), while teams without a dissenting voice can push conformity of thinking on members (Krackhardt, 1999). As has been shown, minorities stimulate creativity because minority dissent leads to more issue-relevant and divergent thinking, whereas the lack of minorities leads to conformity and convergent thinking (De Dreu & West, 2001; Moscovici, 1976; Nemeth, 1986, 1995). As such, teams with heterogeneous rGaps will be more likely to innovate than those whose rGaps are more homogeneous.

Hypothesis 4: Teams with more heterogeneous rGaps will develop higher-quality new products.

Methods

Sample

Engineering, industrial design, and MBA students enrolled in a multi-disciplinary product development course participated in this study. Data were collected from 21 integrated product development teams consisting of 5–6 students (n = 122 participants) across 4 years. Students were assigned to teams at the beginning of a 15-week semester, and the teams were composed of at least two engineers, two designers, and one MBA student. Both undergraduate and graduate students were enrolled in the course, which was sponsored by a company.

Task

Teams worked through a 4-phase product development process over 15 weeks to develop a novel, useful, and viable new product. The process focused on early stages or the "fuzzy front end" of product development, including Phase I: identifying an opportunity, Phase 2: understanding the opportunity, Phase 3: conceptualizing the opportunity, and Phase 4: realizing the opportunity (Cagan & Vogel, 2002). At the end of each phase, each team turned in a written report, made a verbal presentation to the class and company representatives, and completed an online survey regarding their team processes. At the end of the fourth phase for the final presentation, students also fabricated a prototype of their product.

The team project was highly engaging for students. The entire class met once weekly to learn about the product development process. Each team also met at least once weekly with the faculty teaching team (comprised of four professors—mechanical engineering, industrial design, marketing, and organizational behavior). They also met three times during the semester (after completing the end-of-phase survey) with one faculty member to review and discuss their team dynamics. Adding to the level of realism of the course, the sponsoring company could patent any products that emerged from the course, and team members' names were listed on any resulting patents. Finally, team members whose products were patented (or used in any other way by the sponsoring company) were financially compensated.

Self-Report Measures

Measures of task conflict, problem-solving, yielding, and rGaps were collected 4 weeks after the beginning of the course and at the end of Phase 3 (Week 11). New product quality was assessed by three independent raters after the end of the semester (Week 15). We used independent ratings of innovation to avoid problems of self-report bias.

Cross-Functional Representational Gaps

RGaps were assessed at the end of Phase 3 by measuring and comparing team members' assessments of their product in relation to the goals they were trying to achieve. This approach is a more objective measure of rGaps than directly asking team members whether they believed team members held differing beliefs about the product quality because the latter is predicated on teammates having knowledge of others' beliefs.

We used a Q-sort methodology (Block, 1961) to assess differences between functions. First, participants were presented with 16 adjectives that addressed new product quality across several domains: usefulness, usability, desirability, innovativeness, and product quality. These descriptors were derived from the course requirements for new product quality and can be found in Appendix A. Participants were asked to indicate how well the words described their product (that is, how well their product satisfied the outcome goals that were prescribed by the faculty teaching the course) at the end of Phase 3 using a 5-point scale, ranging from strongly disagree to strongly agree. This set of adjectives was used as a *boundary object* to assess discrepancies in team members' thought worlds. People across (functional) boundaries refer to boundary objects to develop a shared context for their work (Carlile, 2002; Star, 1989). The boundary object in this case represented a shared set of descriptors regarding what the final product should achieve. Discrepancies in how team members evaluated their product using these descriptors are indicative of incongruence among their representations of the task. In essence, incongruence in representations is similar to a latent construct that can be detected by differences in the evaluations of the boundary object. The evaluation differences should be caused by different goal structures because goal structures are how people evaluate how well an end state matches what is desired (Galotti, 1989).

When a functional area (i.e., marketing, engineering, design) consisted of more than one team member, we aggregated to the function level by averaging the ratings given by each member from that function. This yielded a vector of ratings corresponding to the product ratings for each function, allowing us to focus on cross-functional rGaps. These vectors could then be correlated with each other as a measure of how similar or different those functions' views were to each other; the lower the correlation, the more different the two subgroups' beliefs about how well their product met the requirements, the larger the rGap between those functions. To calculate the size of the team rGap, we averaged the three pairwise correlations (design/engineering, design/MBA, and engineering/MBA). Thus, a team's average rGap score was the average of three correlations: engineer–designer, engineer–MBA, and MBA–designer.

Five teams, spread across the years of data collection, did not provide complete enough data for us to compute Phase 3 rGaps. As a result, we imputed missing data for those teams. We used mean substitution after testing alternative methods and found no differences (Montaquila & Ponikowski, 1995). Results of a 1-way ANOVA showed that the responses were missing at random and that imputation should not bias the results—there were no differences in new product quality and viability between teams with missing data on rGaps and those without ($F(1, 20) = 2.16$, $p = .16$). Furthermore, we conducted an additional analysis of the hypothesized relationships using the subsample without the imputed cases to ensure that the imputation did not change the results.

Average rGaps ranged from .02 to .80 ($M = .46$, $SD = .19$), with larger correlations indicating smaller gaps. For ease of interpretation, we reversed the sign of the relationships between average rGaps and other variables in the correlation table and path models. We also calculated the variance among the three rGaps for each team as a measure of rGap heterogeneity. The variance of rGaps ranged from .00 to .10 ($M = .04$, $SD = .03$). The average and variance of rGaps were not correlated ($r = .10$, *ns*). Teams with no variance in rGaps had both large and small gaps. The team with the highest variance was characterized by two large rGaps and one small rGap; teams with moderate variance were characterized by one large, one moderate, and one small rGap.

Task Conflict

Our measure of task conflict included four items adapted from Behfar, Mannix, Peterson, and Trochim (2008) (see Appendix A) assessing the amount of disagreements around how to perform the task ($\alpha = .83$). We averaged responses to the team level (average $r_{wg} = .97$, ranging from .94 to .99 across teams, ICC(1) = 2.09, $p < .05$; ICC(2) = .52).

Cooperative Conflict Management Approaches

Participants were asked to report how regularly conflicts were resolved in their team using five different conflict management approaches (Pruitt & Rubin, 1986). We used the two cooperative conflict management approaches for our analysis: "yielding (e.g., giving in)" (1-item) and "problem-solving (e.g., working together to come up with a solution that meets everyone's needs)" (1-item) (1 = never to 6 = consistently). Within-group agreement for each of these items was acceptable [problem-solving average team $r_{wg} = .83$; ICC(1) = 1.86, $p < .05$, ICC(2) = .46, yielding average team $r_{wg} = .77$, ICC(1) = 2.28, $p < .01$, ICC(2) = .56]. Therefore, we proceeded to aggregate the constructs to the team level.

As expected, problem-solving and yielding were highly negatively correlated ($r = -.72$, $p < .01$). Therefore, we averaged the two items (after reverse-scoring the yielding item) to form an index of cooperative conflict management approaches that ranges from high yielding/low problem-solving to low yielding/high problem-solving. Because of a technical error, four teams were not asked to respond to questions on conflict management styles. We did an imputation of the missing values with the mean and tested whether the imputation changed our results in a subsequent analysis.

New Product Quality

New product quality was measured across multiple output goal categories using expert ratings of the teams' final product concepts and business plans. Three former students of the course with backgrounds in design, engineering, and business who were currently working in industry provided assessments using the final report and presentation from each team. The final reports included detailed information about the opportunity, target market, product features and design, manufacturing plan, and business plan. The presentation included additional images and motivation for the product.

New product quality was assessed by the expert raters using 13 items related to three aspects of the team's product and business plan: (a) product engineering, styling, and functioning quality; (b) new product usefulness, usability, and desirability; and (c) business plan quality (1 = strongly disagree to 7 = strongly agree) (see Appendix A). Each of these aspects represents an important component of new product quality: quality relative to functional perspectives (*product aspect quality*), new product usefulness, and desirability as it relates to the user (*useful*, *usable*, *and desirable*) and product *viability* (as laid out in the business plan) (Amabile, 1988; Cagan & Vogel, 2002; Sanders, 1992, 2006). ICCs for each item were acceptable (ranging from .44 to .76, $M = .53$) and statistically significant (for one of the items the ICC was marginally significant). We used the items to create a composite measure of the dimensions of new product quality. The measure of each of the three dimensions exhibited high reliability (Cronbach Alphas > .83). We then averaged the three dimensions into a composite measure of new product quality.

Results

Table 1 shows the descriptive statistics and the correlations among the variables.

The Influence of Conflict on rGaps

Average Size of rGaps

Hypothesis 1 posited that task conflict would be negatively related to rGap size in groups that rely on problem-solving, but not yielding and it would be positively related to rGap size in groups that rely on yielding, but not problem-solving. We ran ordinary least squares (OLS) hierarchical regression analysis, with the cooperative conflict management index to test the hypothesis.

When we tested for the interaction effect using the cooperative conflict management index, the equation was not significant, $R^2 = .06$, $F(3, 20) = .37$, *ns*, and the interaction was not significant ($b = -.32$, $p = .39$). Thus, Hypotheses 1 was not supported. In addition, the main effects of task conflict ($b = -.31$, $p = .35$) and the cooperative conflict management index ($b = -.11$, $p = .71$) on rGap size were not significant.

Heterogeneity of rGaps

Hypothesis 2 posited that task conflict would be negatively related to rGap heterogeneity when teams rely more on problem-solving and less on yielding to manage their conflicts, and task conflict would be positively related to rGap heterogeneity when teams rely more on yielding and less on problem-solving to manage their conflicts. In the OLS regression analysis, we identified two outliers with observed values more than 2 standard

Table 1
Descriptive Statistics and Correlations

	Mean	*SD*	1	2	3	4	5	6	7
1. Task conflict	4.06	.34	1						
2. Problem-solving	4.78	.45	.46*	1					
3. Yield	2.80	.57	−.30	−.72**	1				
4. Cooperative conflict management index†	2.10	.47	.40	.91**	−.95**	1			
5. Average rGaps	.45	.19	.13	.02	−.06	.05	1		
6. Variance of rGaps	.04	.03	−.03	−.15	.40	−.31	−.09	1	
7. New product quality	6.01	.73	.03	−.08	.35	−.25	.32	.14	1

Notes. $N = 21$. In the measures of average rGaps, larger values represent smaller gaps. For ease of interpretation, we reversed the sign of the relationships between average rGaps and other variables in the correlation table.
†Cooperative conflict management index averages the problem-solving item and the reverse-scored yielding item.
*Correlation is significant at the .05 level (2-tailed).
**Correlation is significant at the .01 level (2-tailed).

Table 2
The Interactive Effect of Task Conflict and Cooperative Conflict Management Index on Heterogeneity of rGaps

Model		Unstandardized coefficients *B*	Unstandardized coefficients *SE*	Standardized coefficients Beta	*t*	Sig.
1	Intercept	.04	.01		5.81	.00
	Task conflict	.02	.02	.18	.74	.47
	Cooperative conflict management index (CCMI)	−.03	.02	−.43	−1.80	.09
2	Intercept	.04	.01		6.19	.00
	Task conflict	−.02	.03	−.28	−.95	.36
	CCMI	−.04	.02	−.63	−2.72	.02
	Interaction task conflict × CCMI	−.06	.03	−.65	−2.18	.04
	Adjusted R^2 = .28					

Notes. $N = 21$. The variables in the regression equations are centered.

deviations from the expected value. We solved the problem with the outliers by using weighted least squares (WLS) regression analysis to test the hypothesis.

The model including the interaction between task conflict and the cooperative conflict management index predicting variance in rGaps was significant, $R^2 = .28$, $\Delta R^2 = .17$, $F(3, 20) = 3.52$, $p < .05$. The main effect of task conflict was not significant ($b = -.28$, $p = .36$); however, the interaction effect was negative and significant ($b = -.65$, $p < .05$ 95% CI [−.11, −.002]) (see Table 2, Model 2). Thus, the cooperative conflict management approach used did moderate the effect of task conflict on the heterogeneity of rGaps. A plot of the interaction (2 *SD* above and below the mean—Aiken & West, 1991) shows that higher task conflict resulted in lower variance in rGaps only when the use of problem-solving was high and yielding was low, supporting Hypothesis 2 (see Figure 2). When the use of problem-solving was low and yielding was high, increased task conflict led to an increase in variance in rGaps. Interestingly, the main effect of cooperative conflict management approach was also statistically significant ($b = -.63$, $p < .05$). Teams that relied more on problem-solving and less on yielding evidenced lower variance in rGaps.

The Influence of rGaps on New Product Quality

To test for the effects of average rGaps and heterogeneity of rGaps on new product quality, we used OLS regression (see Table 3). When we ran the OLS regression, we identified two teams that were outliers with observed values more than 1.5 standard deviations from the expected values. Because of the structure of the residuals, WLS did not sufficiently correct the problem. Instead, we chose to remove these teams from the sample for the hypothesis test, in recognition of the sensitivity of smaller samples to outliers. First, we entered the average rGaps into the regression model. The effect of average rGaps

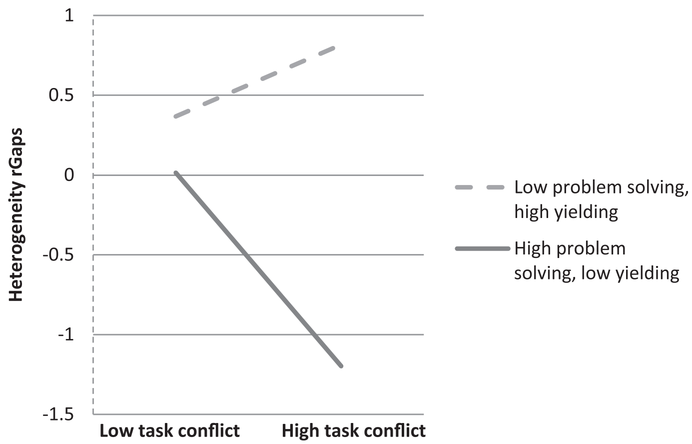

Figure 2. Interaction between task conflict and cooperative conflict management approach index on heterogeneity of rGaps (±2 *SD*).

Table 3
The Effects of rGaps on New Product Quality

		Unstandardized coefficients		Standardized coefficients		
Model		*B*	*SE*	Beta	*t*	Sig.
1	Intercept	6.48	.39		16.61	.00
	Average rGaps	.83	.83	.24	1.01	.33
	Adjusted R^2 = .01					
2	Intercept	5.92	.37		15.90	.00
	Average rGaps	.68	.69	.19	.99	.34
	Variance rGaps	14.98	5.01	.58	2.99	.01
	Adjusted R^2 = .32					

Notes. *N* = 19. The variables in the regression equations are centered.

was not statistically significant, $R^2 = .01$, $F(1, 18) = 1.01$, $p = .33$ ($b = .24$, $p = .33$, 95% CI [−2.59, .92]). Thus, we did not find support for Hypothesis 3. Then, we entered the variance of rGaps. The equation predicting new product quality became significant, $R^2 = .32$, $\Delta R^2 = .34$, $F(2, 18) = 5.21$, $p = .02$, and the effect of variance of rGaps when controlling for the effect of average rGaps was statistically significant and positive ($b = .58$, $p < .01$, 95% CI [4.36, 25.60]).[2] Thus, Hypothesis 4 was supported. Teams with larger heterogeneity of rGaps developed higher-quality new products, characterized by higher aspect quality, usefulness, usability, desirability, and viability.

[2]We analyzed the relationship between rGaps and new product quality using a subsample without the imputed data. The results were substantively the same, but did not reach standard levels of statistical significance.

Discussion

Building on Weingart et al.'s (2005) and Cronin and Weingart's (2007) representational gaps perspective on multifunctional teams, we examined how task conflict affects team cognition and the quality of new products designed in functionally diverse product development teams. Results pointed to the central role of heterogeneity of rGaps rather than the average size of rGaps: task conflict (the amount and how it was managed) influenced the heterogeneity of team cognition and ultimately new product quality. That is, teams with asymmetric rGaps produced higher-quality new products (i.e., more useful, usable, desirable, and viable), and the asymmetry in rGaps was more likely to occur in teams that experienced more task conflict and managed their conflict via yielding. Together, our results demonstrate a previously unidentified mechanism through which task conflict can increase team performance in innovative tasks and provide some counter-intuitive insights regarding the effects of conflict management on team performance.

Heterogeneity of rGaps and New Product Development

Perhaps the most important finding in this study is that team performance on an innovation task was highest when one functional area retained a distinct perspective within the group—that is when rGap heterogeneity was high, regardless of the overall level of rGaps within the team. Interestingly, the average size of the rGaps did not influence quality of output at all. This finding is in contrast with rGap theory and research on shared mental models, which suggests that on average larger rGaps should interfere with team performance (Cronin & Weingart, 2007; Lim & Klein, 2006; Mathieu et al., 2000). However, it supports our theorizing that heterogeneity in rGaps can be good for product innovation.

The fact that average rGap size was neither related to conflict nor team performance was surprising. This could have occurred because we did not have a large enough sample to detect relationships. However, the effect sizes were so small that it is unlikely that a larger sample would have resulted in statistical significance. Instead, we believe that the nature of the task or the setting may have diminished the need for teammates to all have aligned assessments of their product's end states. Innovation tasks are ill structured so that team members may never have fully articulated the end state in their minds (Galotti, 1989). This would admit greater possibility for variation among goals than, for instance, a coordination task (e.g., Marks, Sabella, Burke, & Zaccaro, 2002; Mathieu et al., 2000) where people have to see the same objective in order to play the game properly. This finding suggests the need to modify rGap theory to accommodate differences in task demands.

Our findings demonstrated how heterogeneous rGaps occurring late in the process can keep creative tension alive. In three-function teams, such as the ones studied here, high heterogeneity in rGaps results in a configuration where two functions have more commonality in their viewpoints than with the third. This configuration capitalizes on both similarity and diversity. The commonality can be a basis for efficient team coordination regarding how to perform the task, as shown by research on shared mental models (e.g., Lim & Klein, 2006; Mathieu et al., 2000). Thinking about the current state of the product in the same way (implying a shared mental model) probably enabled better coordination of activities and resources. The alternative perspective represented by the third functional area provided a minority viewpoint that may have challenged the other team members and fostered continued innovation, even late in the process. This result is in line with research on minority influence which shows that divergent thinking and innovation are higher when minorities influence the ways of thinking and the acts of majorities (Moscovici, 1976; Nemeth, 1986, 1995). Having the minority perspective not acquiesce (even 3/4 the way through the process) appears to be the key to new product quality in our integrated product development teams. However, this could only have occurred if the team was willing to accommodate that perspective rather than isolate it.

Research on minorities and diverse information in small groups suggests that the receptiveness to a distinct viewpoint and subsequent accommodation may have occurred because the minority function was expected to have a different viewpoint. As Phillips, Mannix, Neale, and Gruenfeld (2004) have shown, when a minority group member is *expected* to have different information, the majority group will be more likely to try to accommodate this perspective. Teams with heterogeneous rGaps represented a similar situation where a majority comprised of two functions had an alternative viewpoint to a minority comprised of one viewpoint. Just as in the research by Phillips et al. (2004), these groups accommodated the minority perspective.

A related question is whether these findings would generalize to larger groups. We consider the three-function group and its resultant minority perspective as a specific case of heterogeneity; however, our theory is more generally about heterogeneity and should generalize to larger groups as well. That is, heterogeneous rGaps should provide opportunities for creative friction when there are more than three subgroups. Future research that examines teams with more than three subgroups will need to consider additional configurations within which creative friction might occur.

One might ask whether the same functional area (i.e., design, engineering, or business) was the minority perspective in all the teams. It seems logical that the designers, coming from a qualitative rather than quantitative discipline (as were the engineers and MBAs), would be the most likely candidate for this role. However, examination of the rGaps among pairs of functions showed that this was not the case. Instead, the MBA student was the most different in four of the five most heterogeneous rGaps teams at the end of Phase 3.

The importance of heterogeneity of rGaps to innovation corroborates recent research showing that teams with moderate levels of task conflict are also more innovative (De Dreu, 2006). Because we had teams with three functional perspectives, high heterogeneity of rGaps (including two large rGaps and one small rGap) corresponds to teams with moderate rGaps on average. This suggests a curvilinear relationship—that teams with moderate-size rGaps are more innovative and teams with smaller or larger rGaps overall are less innovative. If moderate rGaps are also likely to engender moderate amounts of task conflict, and moderate task conflict leads to high innovation (De Dreu, 2006), then our results provide insight into one factor underlying the curvilinearity of the conflict—innovation effect (De Dreu, 2006).

The finding that heterogeneity of rGaps improves team performance on an innovation task also contributes to the research on asymmetry in teams. Research by Jehn et al. points to the negative effects of asymmetry in perceptions of conflict on individual and group outcomes (Jehn, Rispens, & Thatcher, 2010; Jehn, Rupert, & Nauta, 2006), whereas our research suggests that asymmetries in goal-related rGaps improves creative task performance. A mundane explanation might be simply that heterogeneity in perceptions of the task is an opportunity for learning, while heterogeneity in perceptions of conflict is not. Alternately, it might be that the *expectation* of similarity of perception determines whether asymmetry in groups has positive or negative effects on team performance. That is, in a group where heterogeneity is obvious, such as with the functional background of our team members, team members will expect asymmetry and react less negatively to it (Phillips, 2003; Phillips et al., 2004). But if a team has a shared experience of some level of conflict, absent some other signal, team members may expect that others will assess the level of conflict similarly to the way they have. Team members may be disturbed when they find that others do not, and this could create suspicion or negative attributions. Theory development is needed as we move forward in this domain.

Task Conflict, Cooperative Conflict Management, and the Heterogeneity of rGaps

Whether task conflict increased rGap heterogeneity depended on the type of conflict management used by the team. Our index of cooperative conflict management approaches recognized the fact that problem-solving and yielding are somewhat opposing strategies. Multifunctional product development teams that used problem-solving did not rely on yielding to resolve their conflicts and vice versa. We argued that the two strategies differ in terms of their levels of expression of, and willingness to fight for, self-interest within the collaborative setting.

As predicted, when teams relied on yielding rather than problem-solving, task conflict increased the heterogeneity in rGaps. Thus, conflict resulted in the minority perspective becoming more distinct when conflicts were resolved using yielding, meaning that at least one team member acquiesced. This finding suggests that when yielding, team members are "giving in" in word rather than in spirit—they are holding on to their distinct perspective. In contrast, when teams relied on problem-solving rather than yielding, they were better able to bring the minority function "back into the fold." This finding speaks to the strength of problem-solving in changing or blending people's beliefs about the task at hand.

What is ironic in this case is that changing people's minds was *bad*, as reducing heterogeneity in product representations ultimately reduced new product quality. Thus, rather than merely blending team members' beliefs, problem-solving might be said to be *blanding* their beliefs such that the nuances that made their alternative perspectives powerful were lost. Along these same ironic lines, yielding turned out to be *good* because teams that relied on yielding experienced more heterogeneity in their rGaps. The bigger gaps were bigger (resulting in more polarization among differing views) and the small gaps were smaller (resulting in more homogenization among similar views). This is in line with what balance theory would predict (Heider, 1958; Tannenbaum, 1966). Further, when yielding was used in combination with high task conflict, the heterogeneity of rGaps was even bigger. As a result, the team was more polarized in its view of the output, and again greater heterogeneity resulted in higher-quality new products.

We think that the core issue needing further exploration is that somehow teams must maintain creative abrasion (Leonard & Straus, 1997) such that their conflict is productive rather than destructive and isolating. For creative abrasion to work, some enlargement of perspectives must take place to ''heal the abrasion'' so that new solutions can actually be discovered and integrated without homogenizing all perspectives. These findings suggest re-examining both problem-solving and yielding as conflict management strategies in teams striving to develop new products. Future research will need to determine how to maintain what seems to be a fairly delicate balance.

Our measures do not allow us to differentiate between problem-solving that expands versus shrinks and homogenizes problem representations. Future research could discover what leads to one result rather than the other. In addition, while yielding may appear to be cooperative in that the other party's desires are being met, the yielder may be acceding in word, but not spirit. This finding has implications for our use of the dual concern model (Pruitt & Rubin, 1986), which treats yielding as a strategy that is employed when there is low concern for own outcomes and high concern for other's outcomes. An alternative conceptualization of yielding does not require low concern for own outcomes, but rather low promotion of one's self-interest.

We also must consider the possibility of alternative causal relationships between conflict and rGaps. One alternative is that rGap heterogeneity led to higher conflict rather than vice versa. We were unable to conduct a direct test for the reverse causality because we did not have a measure of rGaps at the end of Phase 2. However, we do not believe this was the case for two reasons. First, our measures of task conflict and conflict management approaches reflected their frequency of use by the group over time, up through the end of Phase 3, whereas the measure of rGaps was an objective measure at a point in time at the *end* of Phase 3. Thus, conflict preceded rGaps temporally. Second, the significant interaction between conflict and conflict management approaches reinforced our beliefs about the causal order, as it would not be logical that rGaps would interact with conflict management to influence the amount of task conflict. A second alternative causal model would be that functional diversity within the team influenced both the level of conflict and the heterogeneity of rGaps, making their relationship spurious. Our teams did not differ in terms of functional diversity, so this explanation is not likely. However, it is possible that even teams with similar functional diversity might differ in their cognitive diversity a priori. To test this possibility, we used an indicator of cognitive diversity, measured at the end of Phase 2, tapping into their assumptions about team process (differences in assumptions about how an integrated product development team should function). Results showed that differences in team process assumptions at the end of Phase 2 did not influence team conflict nor rGap heterogeneity in Phase 3, providing some evidence that the relationship was not driven by other types of cognitive diversity within the team.

Methodological Limitations and Mitigating Factors

There are several limitations to this study that deserve mention. The first is our small sample size. Because of changes to the integrated product development course, we were unable collect additional data, thus limiting our sample size. This increased the likelihood of type II errors because of low power. It also increases the possibility that some of our results are unstable. We tried to ameliorate these risks by limiting our model to only a few variables and by collecting an independent measure of new product quality. However, future research with larger samples is needed to replicate and extend these results.

Second, student teams were not interacting in an organizational context. Thus, the teams were not influenced by the pull of functional areas in terms of functional silos and misaligned incentives that often occur within organizations. These forces could exacerbate the hypothesized negative effects of rGaps. Thus, future research is needed to see whether our results generalize to situations where functional divides are seen as a hindrance rather than benefit. This is especially critical because students in this class were all rewarded the same way, and in organizations the different functions can be rewarded for only what is relevant to their function (e.g., engineering is rewarded if products are within weight specifications, but not if they have groundbreaking design, see Cronin & Weingart, 2007). While one may conjecture that this implies that multifunctional teams in organizations simply need to all be rewarded the same way, this answer would require further exploration given the negative effect of extrinsic motivators commonly found in creativity research (Amabile, 1988). Our results suggest that the interaction between conflict, conflict management, and perspective yields a more complicated process than one that is simply solved by incentives.

In addition, whereas the quality of their product mattered to the sponsoring company, participants' personal careers were not at stake. While this might limit the engagement students had with the course, the presence of a company sponsor and the possibility of receiving a patent and an accompanying cash payment did raise the stakes for students.

Finally, student teams received instruction and coaching within the context of the course that organizational teams might not receive. While this could result in demand effects when responding to the survey, we were able to mitigate the problem in several ways. First, we collected data prior to, rather than after feedback sessions, making it more difficult for respondents to simply parrot back what they thought our model of effective teamwork would imply for their answers to the survey. Second, our measures of rGaps were calculated by directly identifying differences among team members' perspectives, rather than having them report on their perceptions of their differences. Third, we obtained independent assessments of new product quality. Finally, the variance among teams suggests that while team members might be aware of issues relating to team processes, they were not reporting their team as being the best or brightest, thus there was not a presentation bias. Instead, there was ample variance among the teams to test our hypotheses.

Despite these differences in context, many proxies for organizational realities were in place, including the following: (a) prior course experience mostly in their own discipline served as a proxy for the reality of functional silos and independent thought worlds, (b) simultaneously having to satisfy course goals and company sponsor's goals served as a proxy for having to serve multiple constituents such as a functional boss and project leaders, (c) the compressed time frame in having to complete the project in 15 weeks with no possibility for deadline slippage represented working under time pressure in an organizational setting, and (d) students were enrolled in other courses simultaneously, just as team members often have to work with competing demands for their time when working on multiple projects. We believe that the cognitive and interpersonal mechanisms that we tested are basic to interpersonal interaction. While our context is in an educational rather than organizational setting, thinking is thinking and relating is relating. These basic processes may be influenced by other factors within organizations, but their basic functions should remain relatively constant. Future research should be conducted to test the generalizability of our findings to teams working within organizations.

Conclusion

Multifunctional product development teams are used in organizations to bring together diverse perspectives in service of innovation. Their use recognizes the fact that innovation usually happens at the intersection of alternative points of view, results in active disagreement, and requires conflict management to integrate those perspectives. Our results demonstrate how some of the conflict in multifunctional product development teams might not need to be "resolved" and those perspectives fully integrated for effective new product development to occur. Maintaining heterogeneity in rGaps among functional areas, where some functions are more aligned than others, can result in high-quality, more useful and more viable new products. And as such, reducing that heterogeneity via problem-solving may not serve the new product development goal. A challenge for organizations will be to encourage teams to push for accommodation of diverse perspectives, but not conformity. Organizations must consider how best to maintain diverse functional perspectives within a supportive interdisciplinary team atmosphere to get the most innovation from their product development process.

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Appendix A: Survey Items

Representational Gaps: Adjectives for Rating a Team's Product

(1) The product styling is of high quality.
(2) The product engineering is of high quality.
(3) The product functioning is of high quality.
(4) The product is innovative in its styling.
(5) The product is innovative in its construction.
(6) The product is innovative in its functioning.
(7) The product required much rework.
(8) The product fulfills a need.
(9) The product fits in with people's lifestyle.
(10) The product performs a useful task.
(11) The product is ergonomic.
(12) The product is easy to use.
(13) The product is intuitive.
(14) The product is desirable.
(15) The product is pleasing.
(16) The product is wanted.

Task Conflict

(1) To what extent does your team debate different ideas when solving a problem?
(2) To what extent does your team argue the pros and cons of different opinions?
(3) How often do your team members discuss evidence for alternative viewpoints?
(4) How frequently do members of your team engage in debate about different opinions or ideas?

New Product Quality

Product Aspect Quality
(1) The product engineering is of high quality.
(2) The product styling is of high quality.
(3) The product functioning is of high quality.
Product Usefulness/Usability/Desirability
(4) The product performs a useful task.
(5) The product fulfills a need.
(6) The product ergonomics reflected an understanding of the user group's physical and psychological traits.
(7) The product is easy to use.
(8) The product is intuitive.
(9) The product is pleasing.

Product Viability: Business Plan Quality
(10) The competitive analysis was of high quality.
(11) IP protection potential is well explored.
(12) The plan showed realistic assessment of production and distribution development
(13) The cost of production analysis was of high quality.

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