

CARNEGIE MELLON UNIVERSITY

**RESOLVING THE CONFLICT-CREATIVITY TENSION IN
FUNCTIONALLY DIVERSE INNOVATION TEAMS**

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A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy to the Tepper School of Business at Carnegie Mellon
University

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Acknowledgements

I wish to thank Laurie Weingart, Anita Woolley, and Denise Rousseau for all inspiring ideas and thoughtful comments on my dissertation research. I had the privilege to be trained by Laurie Weingart and I am very grateful for all her brilliant advice and unfailing support. I appreciate the openness and availability of all faculty members in the Organizational Behavior Department at Tepper School of Business, I learned a lot from working with them. I wish also to thank my family for all their love and support.

Abstract

More and more organizations structure their innovation projects around functionally diverse teams. Why are some diverse teams more innovative than others? In my dissertation research, I investigate how cognitive diversity, conflict, and creativity affect the success of functionally-diverse innovation teams. Some research points to the importance of cognitive diversity for stimulating group creativity and innovation. Other researchers have shown that cognitive diversity leads to misunderstandings, tensions, and conflict that harm innovation. Thus, paradoxically, cognitive diversity both benefit and harm innovation processes through the opposing forcing of conflict and creativity. To provide insights for understanding and managing the conflict-creativity tension, I study functionally diverse innovation teams. Cognitive diversity based on functional training and experience is particularly interesting because it comprises differences in perspectives, goals, approaches, values, and language that are hard to reconcile.

In three studies of functionally diverse innovation teams, I examine the effects of interpersonal creative processes, i.e., idea sharing and idea building, as well as conflict processes on innovation success. Furthermore, I investigate the relationship between interpersonal creative processes and conflict: when idea sharing and idea building can be stimulated or inhibited by conflict. To address these questions, I collect and analyze data from three different settings: interdisciplinary research groups, new product development teams in an integrated product development course, and teams developing entertainment and technology products.

The first dissertation study shows that task conflict stimulates the interpersonal creative process of *idea sharing* in diverse groups only if work design and diversity salience are managed appropriately. Using field data from 148 researchers in 29 interdisciplinary research labs, I

provide evidence on the importance of social categorization states (i.e., diversity salience) in understanding both task conflict and idea sharing in groups with expertise diversity. Furthermore, the study shows that idea sharing affects group performance in interdisciplinary academic research over and above the effects of task conflict and expertise diversity.

The second dissertation study, a study of integrated product design teams, provides insights on how task conflicts in teams where functionally different team members trust each other can stimulate the interpersonal creative processes of *idea building* and thus make teams more innovative. Using a multilevel longitudinal approach, I examine the dynamic effects of both the forces that can bring functionally diverse team members together (such as cross-functional trust) and the forces that pull them apart (such as discovering how different others are after gaining more experience working with them).

The third dissertation study extends our understanding of the cognitive and affective mechanisms through which conflict affects the interpersonal creative processes of *idea sharing* and *idea building* in innovation teams. Using data from 180 master students in 41 new product development teams, the study shows that task conflict reduces the harmful cognitive differences in functionally diverse teams, i.e., the deep level value diversity, and increases the beneficial cognitive differences, i.e., the cognitive division of labor within transactive memory systems. Furthermore, the study provides evidence that although negative emotions of fear engendered by task conflict interfere with idea sharing, task conflict spurs the group creative processes and innovation through its effects on team cognition, i.e., on deep level value diversity and transactive memory systems. Thus, in contrast to prior research on creativity and conflict that assumed only negative effects of conflict on creativity, this research provides evidence on both

the positive and negative effects of task conflict on group creativity and innovation in functionally diverse teams.

Members of groups with creative tasks (such as brainstorming groups) are often discouraged from expressing disagreements while generating ideas based on the belief that it will interfere with members' willingness to take risks and "think outside the box". In three studies, I provide evidence whether and when team members with different functional backgrounds can be more creative not in spite, but because of engaging in disagreements and conflict. These studies shed light on the conflict-creativity tension and how it can be successfully managed. They extend our understanding of work diversity, conflict, creativity, innovation, and team cognition.

CHAPTER 1

Introduction

For creativity and innovation to occur, teams must first have a variety of resources available to draw from and second, must combine those resources in novel ways (Nijstad, Rietzschel, and Stroebe, 2006). The value of functional diversity lies in the *availability* of diverse domain knowledge which increases the creativity potential of groups (Amabile, 1983; Williams and O'Reilly, 1998; van Knippenberg and Schippers, 2007). The creative potential can be then realized if teams engage in interpersonal creative processes. However, cross-functional diversity can be detrimental to the interpersonal creative processes of resource *combination* because of conflict, misunderstandings, and tensions (Cronin & Weingart, 2007). Thus, functional diversity may hinder the realization of the team's creative potential (Dougherty, 1992; Cronin and Weingart, 2007; Lau and Murnighan, 1998; Bezrukova, Jehn, Zanutto, and Thatcher, 2009). In sum, functional diversity both benefits and harms innovation through the opposing forces of conflict and creativity. To provide insights for understanding and managing the conflict-creativity tension, I investigate how and when conflict stimulates or hinders the interpersonal creative processes in functional diverse teams engaged in new product development.

In the study of teams in a successful new product development firm, Sutton and Hargadon (1996) show that it is important to understand creative processes not only in standalone brainstorming groups but also in the context of new product development teams.

Furthermore, recent research on product development suggests that the circumstances around the emergence of new ideas predict new product success (Goldenberg, Lehmann, & Mazursky, 2001). Extending the research on creativity in new product development settings, I examine the interpersonal creative processes that underlie idea emergence in functionally diverse new product development teams and how and when they are affected by group conflict.

Interpersonal creative processes defined

I focus on ideas as a specific type of resource that teams involved in creative tasks must process and combine. In the dictionary, individual's ideas are commonly defined as the result of mental activity: an idea is what is formed or represented in the mind as a result of mental activity (American Heritage Dictionary, Collins Essential English Dictionary). This broad definition can refer to different mental activities such as decision making, learning, or creativity and different tasks. I narrow the definition down and link it to the phenomenon of interest, i.e., creativity. Based on research in cognitive psychology and creativity, *I consider the mental activity that underlies individual creativity and idea generation as a problem solving activity involving search through problem space (Metcalfe & Wiebe, 1987; Newell & Simon, 1972). Therefore, in this dissertation research ideas are defined as creative solutions to problems.*

To understand how teams process ideas coming from different functional perspectives in order to combine them, I build on the theory of group creativity developed by Nijstad, Rietzschel and Stroebe (2006). In their combination of contributions perspective on group creativity, Nijstad and colleagues distinguish between two determinants of group creativity: the *group creative potential* and the *realization of the creative potential*. High group creative potential results from the availability of a broad area of skills, expertise and knowledge in the group. Functionally

diverse teams represent one of the common approaches to designing teams with a broad area of skills and expertise. Functionally diverse teams have high creative potential but it is important to understand better how this creative potential is realized.

The realization of the creative potential occurs if individual ideas are processed and combined by the group members into a group idea. First, individuals in groups come up with individual ideas based on their processing of information during problem solving. Generation of individual ideas, however, must be followed by processing of the individuals' ideas by the group so that group creativity could occur. I focus on understanding the realization of the creative potential through idea processing and develop the theoretical underpinnings for understanding the interpersonal creative processes involved in it (see Figure A).

To extend the theoretical understanding of group idea processing and define interpersonal creative processes, I integrate theories and research on diversity with theories and research on group creativity/innovation. Drawing on the combination of contribution perspective on group creativity (Nijstad et al., 2006), brainstorming research (Paulus et al., 2002), the representational gaps perspective on functionally diverse team (Cronin and Weingart, 2007) and the information processing and social-categorization perspectives on work in diverse teams (Van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998), I define the construct space of interpersonal creative processes and develop theoretical models about the antecedents, components, moderators, and outcomes of interpersonal creative processes. First, I define the interpersonal creative processes that represent the components of idea processing. Just like in the classic communication model of information processing, idea processing consists of the expression, the communication channel (which is not the focus of my research), the receipt, and the

decoding/interpretation of idea. I capture the components of idea expression and receipt in groups through the concept of *idea sharing* (Nijstad et al., 2006).

Based on the combination of contribution, brainstorming research, and the representational gaps perspective, I extend the classic communication model through the addition of *idea building* as a key component of idea processing. In order for idea building to occur, team members must perceive, understand, and build on the ideas of other team members. In addition, ideas that result from combination of individuals' ideas must be somehow stored or *encoded* in group responses such as group mental models, task representations, and/or products in order to affect group outcomes. Therefore, I propose that group idea processing consists of four main components: three interpersonal creative processes, i.e., idea sharing, idea building, and idea encoding, and the communication channel (idea encoding and communication channels are not included in the dissertation studies). In each of the dissertation papers, I examine different antecedents, moderators, and outcomes of interpersonal creative processes with a focus on the tensions between interpersonal creative processes and conflict processes in diverse teams.

In my dissertation, I examine both the interpersonal creativity processes and conflict processes in diverse innovation teams characterized by differences in team cognitive structures. The dissertation studies focus on the effects of initial cognitive diversity in terms of functional expertise diversity and emergent cognitive diversity on conflict and creativity processes in innovation teams.

Overview of the Dissertation

My dissertation consists of three papers. Each of the papers addresses a different research question related to interpersonal creative processes and conflict in functionally diverse

innovation teams. Each of the three papers represents a stand-alone paper with a separate research question, theoretical background, research methods, findings, and conclusions. The papers are based on three different research projects.

The goal of the dissertation papers is to extend the current understanding of creativity and conflict in cognitive diverse innovation teams. Prior research on creativity shows that cognitive differences stimulate group creativity and team performance during innovation tasks. Other researchers have shown, however, that cognitive difference lead to misunderstandings, tensions, and conflict that harm team performance and innovation. Thus, paradoxically, cognitive diversity both benefits and harms innovation teams. Figure B depicts the tension resulting from the conflicting effects of conflict and creativity on innovation in teams with cognitive diversity.

While most research focuses on the relationship between conflict and innovation or between creativity and innovation, I argue that conflict and creativity forces in innovation teams can be better understood and managed if we examine also the relationships between conflict and creative processes. *If conflict can stimulate interpersonal creative processes in some situations and thus enhance innovation through its effect on creative processes, then the direct negative effects of conflict on innovation can be counteracted by that indirect positive effects of conflict on innovation.*

I identify and use *two approaches for understanding these relationships and thus resolving the tensions between conflict and creativity*: first, understanding the moderators or boundary conditions that influence the effects of conflict on creative processes and thus on innovation, and second, understanding the mechanisms of the relationships between conflict and creative processes in innovation teams.

Paper 1

In my first dissertation paper (co-authored with M. Brake and L. Weingart), I examine group cognition, conflict and creative processes with a focus on the first important interpersonal creative process, namely idea sharing. Idea sharing has often been assumed to take place in innovation teams especially in teams engaged in task conflict. I show that idea sharing differs from task conflict both theoretically and empirically and that it can be both stimulated and hurt by task conflict.

Idea sharing in diverse groups can be stimulated by task conflict only if diversity salience is low and the appropriate task and work design are in place. Using field data from 148 researchers in 29 academic research labs, I provide evidence on the importance of social categorization states (i.e., diversity salience) in understanding both task conflict and the interpersonal creative process of idea sharing in groups with expertise diversity. Furthermore, I show that idea sharing affects group performance in interdisciplinary academic research over and above the effects of task conflict and diversity.

Paper 2

In my second dissertation paper (co-authored with L. Weingart), I integrate research on brainstorming and research on new product development to examine cross-functional idea building in functionally diverse innovation teams. Although researchers of group creativity often assume that idea building occurs and argue that it is the source of the creativity advantages of heterogeneous teams, prior research has not empirically captured and examined cross-functional idea building. I demonstrate that cross-functional idea building helps teams create more innovative products.

Using a multilevel longitudinal approach, I provide evidence on the dynamic effects of both the forces that can bring functionally diverse team members together (such as cross-functional trust) and the forces that pull them apart (such as discovering how different others are after spending more time working with them). Furthermore, I show that task conflict does not harm cross-functional idea building. On the contrary, it provides the opportunity for team members to capitalize on their interpersonal trust and thus stimulates cross-functional idea building. My first dissertation study contributes to research on diversity and group creativity by considering the dynamics of the interpersonal creative process of cross-functional idea building and relating it to cross-functional experience, cross-functional trust, and task conflict over time.

Paper 3

The goal of my third dissertation study is to disentangle the effects of conflict on creativity in diverse teams and to examine the tension between the cognitive and emotion-based mechanisms of the relationship between conflict and creativity. To better understand and manage conflict and creative processes, I investigate two types of emergent structures of cognitive diversity and conflict emotions as the mechanisms through which conflict affects the creative processes of idea sharing and cross-functional idea building in functionally diverse teams.

The results from the SEM analysis of data from 180 masters students in 41 new product development teams support the hypotheses that task conflict reduces the harmful cognitive differences, i.e., the deep level value diversity, and increases the beneficial cognitive differences, i.e., the cognitive division of labor within transactive memory systems. Furthermore, although negative emotions of fear engendered by task conflict interfere with idea sharing, task conflict spurs the group creative processes and innovation through its effects on the emergent structures

of cognitive diversity. Thus, in contrast to prior research on creativity and conflict that assumed only negative effects of conflict on creativity, the study provides evidence on both the positive and negative effects of task conflict on group creativity and innovation in functionally diverse teams.

CHAPTER 2 (Paper 1)

Task conflict and idea sharing in interdisciplinary research groups: Diversity salience matters

Abstract

Although interdisciplinary research attracts more and more interest and effort, the benefits of this type of research are not always realized. To understand when expertise diversity will have positive or negative effects on research efforts, we examine how expertise diversity and diversity salience affect task conflict and idea sharing in interdisciplinary research groups. Using data from 148 researchers in 29 academic research labs, we provide evidence on the importance of social categorization states (i.e., expertise diversity salience) in understanding both the information processes (i.e., task conflict) and the creativity processes (i.e., idea sharing) in groups with expertise diversity. We show that expertise diversity can either increase or decrease task conflict depending on the salience of group members' expertise in a curvilinear way: at a medium level of expertise diversity the moderating effect of diversity salience is strongest. Furthermore, enriched group work design can strengthen the benefits of task conflict for creative idea sharing only when expertise diversity salience is low. Finally, we show that idea sharing predicts group performance in interdisciplinary academic research labs over and above task conflict.

Keywords: Expertise diversity, task conflict, field research

Task conflict and idea sharing in interdisciplinary research groups:

Diversity salience matters

Expertise diversity provides work groups with distinct perspectives and a wide base of knowledge, skills, and abilities (Dahlin, Weingart, & Hinds, 2005; Dunbar, 1995; Lovelace, Shapiro, & Weingart, 2001). As a result, interdisciplinary groups have more creative potential than homogenous groups (e.g., Williams & O'Reilly, 1998). However, the creative potential in such groups is often not realized because of tensions, misunderstandings, and conflict (Cronin & Weingart, 2007; Dougherty, 1992). As a part of the combination of contributions perspective on group creativity, Nijstad, Rietzschel, and Stroebe (2006) introduce the “effective idea sharing principle,” which states that a group’s creative potential will not be realized without an adequate exchange of the group’s diverse creative inputs, that is, their ideas. Thus, idea sharing represents a central theoretical mechanism through which expertise diversity affects creativity and innovation. We do not know much, however, about when expertise diversity and conflict stimulate or hinder idea sharing in groups involved in innovation tasks such as doing research and whether idea sharing actually affects group outcomes.

The goal of this paper is to disentangle the effects of expertise diversity on task conflict and idea sharing in interdisciplinary groups. We seek to understand when and how expertise diversity positively or negatively affects groups engaged in creativity tasks. To answer this question we examine the moderating role of expertise diversity salience and work design and their effects on task conflict and idea sharing (see Figure 1). We argue that not only task conflict but also idea sharing represent central predictors of effective performance in expertise-diverse groups engaged in innovation tasks.

Idea sharing has often been assumed to take place in innovation teams especially in teams engaged in task conflict. That is, task conflict can stimulate idea sharing. In this paper we investigate idea sharing and when it can be stimulated or hurt by task conflict. Our basic tenet is groups with expertise diversity will not always engage in more task conflict and that task conflict will not always stimulate more idea sharing in diverse teams. Members of teams with high expertise diversity will engage more or less in task conflict depending on how salient the differences in expertise are for them. Furthermore, how much group members will share ideas will depend not only on the level of task conflict but also on the level of expertise diversity salience and the work design (see Figure 1). Finally, we study whether teams with task conflict and idea sharing will perform better on interdisciplinary research tasks.

Our goal is to contribute to theories and research on diversity, conflict, group creativity, and work design in three ways. First, we extend the understanding of group processes that explain the effect of expertise diversity on group outcomes and in particular on innovation. We investigate both processes of task conflict and idea sharing. In contrast, prior research on conflict focuses primarily on task conflict and often assumes that idea sharing happens. Prior research on group creativity focuses on idea sharing mostly assumes that conflict is dysfunctional and prohibits it. We investigate idea sharing as a group process and show that it can be distinguished from task conflict both theoretically and empirically. We also show that task conflict is not always dysfunctional. Second, studying the moderating role of enriched group work design (Campion, Medsker, & Higgs, 1993) recognizes that the same interdisciplinary innovation-driven work can take on different forms and be more or less motivating to perform. We contribute to understanding how the group work design context affects the relationship between group processes and group outcomes in expertise-diverse groups (Bamberger, 2007; van

Knippenberg & Schippers, 2007). Finally, we extend the understanding of group work during interdisciplinary research. We investigate the effects of interdisciplinary diversity in academic research labs and whether work design can be used to improve performance in interdisciplinary academic research.

THEORETICAL BACKGROUND

Idea sharing defined

We focus on *ideas* as a specific type of resource that must be combined to generate a novel product that captures the diversity of expertise in an interdisciplinary group (Nijstad et al., 2006). Individual's ideas are commonly defined as what is formed or represented in the mind as a result of mental activity (American Heritage Dictionary, Collins Essential English Dictionary) such as problem solving (Metcalf & Wiebe, 1987; Newell & Simon, 1972). Therefore, throughout the paper we define *ideas* as creative solutions or novel approaches to problems.

Group creativity has been studied mainly in the context of brainstorming groups. There is scarce research on when and why groups can be more creative on other creative tasks such as research tasks (Fiore, 2008; Sutton & Hargadon, 1996). One of the main outcome variables in this stream of research has been the number of type of ideas generated by the group. We shift the focus to study the group processes that are involved in group idea generation and examine idea sharing in groups. Thus, we are able to investigate what predicts group creativity in groups whose meaningful output is not only number of ideas like in brainstorming groups but more complex creative products such as research.

Prior research on group creativity examines the barriers to idea sharing in brainstorming groups. For example, members of brainstorming groups are often reluctant to share their ideas,

despite instructions to the contrary (Diehl & Stroebe, 1987), because of evaluation apprehension, free riding and social loafing, and production blocking (Paulus & Dzindolet, 1993; Paulus & Yang, 2000; Paulus, Dugosh, Dzindolet, Coskun & Putman, 2002). Since Osborn (1957) introduced the rule that group members should not express disagreements with ideas of other group members during idea generation, creativity researchers assume that disagreements and conflict hinder idea sharing. However, research on group creativity, i.e., research on brainstorming, typically examines individuals with similar expertise and educational backgrounds. Questions remain regarding idea sharing in expertise-diverse groups.

When Does Diversity Increase versus Decrease Idea sharing?

It's long been recognized that diversity can have differential effects on group performance because it influences both social and information processes (van Knippenberg, De Dreu, & Homan, 2004; Williams & O'Reilly, 1998). We do not know, however, how diversity affects creative processes in groups and in particular idea sharing. Prior research on social categorization in diverse groups demonstrates a propensity for subgroup formation and stereotyping (Early & Mosakowski, 2000; Harrison et al., 1998, 2002) that may impede idea sharing between diverse experts. In contrast, expertise diversity may lead to *more* idea sharing because of easier problem identification and more consideration of the diverse information through task conflict (Jehn, Northcraft, & Neale, 1999). In this vein, idea sharing might be greater in interdisciplinary groups because of broader and deeper information processing that enhances both individual creative problem solving and the exchange of creative solutions with others. To reconcile these conflicting predictions and to better understand the effects of expertise diversity on idea sharing, we investigate how social categorization processes and states (i.e., expertise diversity salience) and information processes (i.e., task conflict) affect the creative

process of idea sharing in interdisciplinary groups. Furthermore, we want to understand whether the task and work characteristics may determine the direction and strength of the diversity effects.

Work context characteristics may amplify or dampen the effects of expertise diversity on group processes and outcomes, but the work context is often ignored in research on work groups (Joshi & Roh, 2009; van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998). Research on groups suggests that designing an appropriate group task and work structure represents an important source of collective motivation for members to work together and contribute to achieving group goals (Campion, Medsker, & Higgs, 1993, Campion, Papper, & Medsker, 1996). However, it is not clear how group work design affects the processes of idea sharing in interdisciplinary groups. We investigate whether and when a motivating group-work design can counteract the effects of stereotype activation and stimulate idea sharing in expertise-diverse research groups with different levels of task conflict.

We investigate the role of task conflict and idea sharing in expertise-diverse groups in the setting of academic research labs. Although interdisciplinary research attracts more and more federal funding, the benefits of this type of research are not always evident. Although science efforts increasingly occur in teams (Wuchty, Jones, & Uzzi, 2007), we know little about the group processes such as conflict and creativity in science research labs and how they can be managed when scientists work together in science research labs (Dunbar, 1995; Fiore, 2008). Our paper investigates the drivers and mechanisms of creativity and innovation in interdisciplinary research labs. Thus, we aim at both the understanding of the important setting of science research labs and of idea sharing in small innovative groups.

HYPOTHESES DEVELOPMENT

The Effect of Expertise Diversity on Task Conflict: The Role of Expertise diversity salience

Expertise diversity can influence task conflict via information processing benefits and social categorization detriments. As such, both processes need to be considered when hypothesizing the role of expertise diversity on idea sharing. First we present each process separately, and then combine them to predict how expertise diversity and diversity salience jointly influence task conflict.

Information processing. The information processing perspective on diversity centers around the value of diverse knowledge, skills, and ideas in group work (van Knippenberg et al., 2004). The positive effect of diversity, especially information-related diversity, results from processes of elaboration of information and use of diverse information. Task conflict (i.e., disagreements about the task to be performed) represents one of the core processes through which this elaboration and use of information takes place in diverse teams (Cronin & Weingart, 2007; van Knippenberg & Schippers, 2007). Prior research provides evidence that diversity leads to task conflict (Lovelace et al., 2001) as a result of potentially conflicting knowledge, skills, and viewpoints (Jehn et al, 1999; Pelled, Eisenhardt, & Xin, 1999). Through the discussion of disagreements, group members both identify the differences between their opinions and consider more carefully the task. Jehn et al. (1999) provide empirical evidence that task conflict mediates the positive effect of information diversity on group performance. As such, task conflict represents a key information processing mechanism.

However, research suggests that diverse perspectives might not surface unless group members are aware of their differences (Stasser, Stewart, & Wittenbaum, 1995). Randel (2002)

develops the concept of identity salience – that is, how prominently a demographic category is used to describe one’s work group members. Prior research uses the concepts of identity salience based on diversity-related characteristics and diversity salience interchangeably. Researchers provide evidence that diversity salience acts as a moderator of the effect of diversity on group outcomes (Homan, Hollenbeck, Humphrey, van Knippenberg, Ilgen, & van Kleef, 2008; Randel, 2002).

Group members who view their work group as being composed of distinct expertise identities may be more likely to discuss, and disagree about, their diverse opinions and views. Although groups are biased towards the exchange of information that is commonly held by all group members (Stasser & Titus, 1985), research shows that when experts are identifiable, unshared information is more likely to be shared (Stasser et al., 1995). Thus, when group members are aware that other group members have expertise in a different domain they are more likely to exchange information from their diverse perspectives. Research also shows that expert role assignment increases not only the mentioning of the information from different domains but also its active consideration (Stasser et al., 1995). Assuming that mentioning and considering more diverse information will surface latent disagreements, group members for which expertise identities are highly salient are more likely to share information and engage in disagreements resulting from differences across their diverse perspectives. This should be evident in the amount of task conflict engaged by the group.

Based on these arguments, we might hypothesize that expertise diversity salience positively moderates the effect of expertise diversity on task conflict. More specifically, *the more salient that expertise identity is in the group, the stronger the positive effect of expertise diversity*

on task conflict. However, while expertise diversity salience can help expert identification and thus stimulate task conflict, it can also have negative effects.

Social categorization. When in-group/out-group distinctions are salient (e.g., based on race, gender, or expertise), people will depersonalize themselves such that being part of the in-group is part of their identity, resulting in self-categorization (Turner, 1987). When members of the same group categorize themselves differently, these distinctions could lead to subgroup formation and conflict across subgroups. Along these lines, men in work groups where the gender composition was imbalanced reported more relationship conflict when gender identity was salient to them (Randel, 2002). This research shows that gender diversity can lead to more tensions, negative emotions, and worse relationships when group members think about the group in terms of the diversity of their gender (Randel, 2002). We argue that expertise diversity salience could play a similar role in predicting task conflict within a group.

If this finding extends to other types of diversity, then expertise diversity should be more likely to have a negative effect on group work when group members are more aware of the differences within the group and if they have strong subgroup identity. Developing this argument, when expertise diversity salience is low, group members should identify less with the expertise subgroup and more with the group as a whole (Turner, 1987). Identification with the group as a whole should reduce the amount of task conflict that results from expertise diversity. Thus, groups with low expertise diversity salience (and thus with fewer identities), will engage in less task conflict as a result of their expertise diversity. That is, *the more salient the expertise identity in the group, the stronger the negative effect of expertise diversity on task conflict.*

Levels of expertise diversity and subgroup formation. Embedded in our theorizing about the moderating role of expertise diversity salience is the presence or absence of subgroups within a group. The information processing approach makes no statements about the role of subgroups and largely assumes them away. The social categorization approach brings subgroups front and center. Although the literatures on diversity and subgroups are often distinct, the two processes co-occur (van Knippenberg & Schippers, 2007). Research shows that social categorization effects are most likely to occur in groups with moderate heterogeneity in which distinct (i.e., strong) subgroups can form (Earley & Mozakowski, 2000). Groups that are highly diverse and groups that are homogeneous do not have the opportunity to form subgroups, and thus are less likely to experience social categorization (Cramton & Hinds, 2005; Earley & Mozakowski, 2000).

Thus, we expect that the interactive effects of diversity and diversity salience on task conflict will depend on the level of expertise diversity (and the possibility of sub-grouping). When expertise diversity varies from low to moderate, the possibility of subgrouping increases and we expect that the positive relationship between expertise diversity and task conflict to grow stronger as expertise diversity salience increases. When diversity varies from moderate to high, the possibility of subgrouping decreases because everyone is different and there is no critical mass in any one subgroup. In such groups, we expect that a negative relationship between expertise diversity and task conflict will grow stronger as expertise salience increases (see Figure 2). Taken together the two hypotheses predict a curvilinear effect of expertise diversity on task conflict and that the curvilinear effect depends on the strength of diversity salience. Prior research provides evidence of curvilinear effects of diversity on group outcomes (Dahlin et al.,

2005; Gibson & Vermeulen, 2003; Thatcher, Jehn, & Zanutto, 2003). We extend the research by examining the role of expertise diversity salience in understanding this curvilinear relationship.

Hypothesis 1: *Expertise diversity salience will moderate the curvilinear relationship between expertise diversity and task conflict.*

Hypothesis 1a: *As expertise diversity varies from low to moderate, the more salient the expertise identity in the group, the stronger the positive effect of expertise diversity on task conflict.*

Hypothesis 1b: *As expertise diversity varies from moderate to high, the more salient the expertise identity in the group, the stronger the negative effect of expertise diversity on task conflict.*

The Effect of Task Conflict and Group Work Design on Idea sharing: The Role of Expertise Diversity Salience

We distinguish between two components of task discussions: *problem identification*, where exchange of information for the purposes of position expression, argumentation and disagreements occur, and *problem solution*, where attempts to solve problems through creative solutions lead to exchange of the ideas of group members. In our model, the first component is captured by the construct of *task conflict* while the second component is captured by the construct of *idea sharing*. Task conflict is about disagreements, debates, and arguments about opinions and perspectives, while idea sharing is about providing of new solutions. Idea sharing captures new problem solutions that members of diverse teams receive as the result of the discussion of different opinions and perspective and the applying of these perspectives to

creatively solve the problem. We focus on how problem identification through task conflict affects problem solution through idea sharing recognizing in some cases idea sharing may in turn lead to new problem identification and new task conflict. To investigate the first type of relationship, we exclude from the task conflict measure items that capture conflict over ideas and develop a measure of idea sharing that focuses only on receiving of novel problem solutions.

We argue that in academic research groups, task conflict can stimulate *idea sharing* when the context is supportive. Task conflict stimulates idea sharing via two mechanisms: problem identification and deeper information processing. First, task conflict stimulates idea sharing because it allows for the identification of differences in task representations across perspectives (Cronin & Weingart, 2007). Task disagreements allow groups to identify more task-related problems and as a result develop (and share) more ideas to solve those problems. Second, task conflict enables not only problem identification but also the deeper processing of problem-related information which leads to deeper processing of ideas and the generation of more novel solutions to problems. Prior research shows that task conflict stimulates deeper *information* processing (Phillips, Mannix, Neale, & Gruenfeld, 2004, Tjosvold & Poon, 1998) and problem solving (Tjosvold & Poon, 1998). When group members cognitively process the information and ideas of other group members they generate more ideas (Dugosh, Paulus, Roland, & Yang, 2000) and therefore are likely to share more ideas.

For these positive effects to be realized both the group's identity and the design of the work itself need to be supportive. As discussed earlier, groups with salient expertise identity distinctions are more likely to experience social categorization processes such as subgroup formation, stereotyping and intergroup biases (Williams & O'Reilly, 1998). These processes can stifle idea sharing within the group. An important contextual feature is the design of the group

work itself. Although researchers acknowledge the importance of well designed group work, current research on diversity, conflict, and group performance tend not to consider it.

Numerous studies investigating work design in terms of task characteristics at both the individual and group level have found that they can influence motivation as well as performance, turnover and absenteeism (Adler, Skov, & Salvemini, 1985; Campion et al., 1993; 1996; Hackman & Oldham, 1975; Liden, Wayne, & Sparrowe, 2000). Recent studies investigating the effects of work design on group processes and outcomes have supported the view that the characteristics of a group's work such as self-management and decision-making participation can also affect individual's motivation and group interactions and result in satisfaction, organizational commitment, and better performance (Campion et al., 1993; 1996; Liden, Wayne, & Sparrowe, 2000; Parker, 2003; Sprigg, Jackson, & Parker, 2000).

Campion, Medsker, and Higgs (1993) identified five work design characteristics that were relevant to group work. They found that self-management, participation, task variety, task identity, and task significance were related to various measures of group performance and manager judgments of group effectiveness. In academic research groups, this translates to situations where group members have some say over the assignment of tasks to individuals and the coordination of the work; where group members actively participate in decision-making; and where the group as a whole is given research activities that allows them to identify with the group, to perform a variety of tasks, and is perceived to be important to the field and to the advisor.

We argue that enriched task characteristics (task variety, identity, and significance), decision-making participation, and self-management will increase the motivation of group

members to work with other group members, i.e., to cooperate, towards completing the task. In addition, participation in decision making and self-management within a group should provide a work design and stimulate work interactions that promote idea sharing. Willingness to cooperate will affect the way diversity influences idea sharing through the processes of information processing and social categorization.

Group members who are motivated to work together are more likely to share what they know (Quigley, Tesluk, Locke, & Bartol, 2007; Zander and Wolfe, 1964), pay more attention to the ideas expressed by others (Slavin, Hopkins, Hurley, and Chamberlain, 2003) and experience fewer communication difficulties (Deutsch, 1973). This suggests that group work design should strengthen the positive effects of information processing (i.e., task conflict) on idea sharing in diverse groups because group members will be more motivated to engage in cooperative information sharing and to pay attention to ideas.

We argue, however, that the joint effects of group work enrichment and task conflict on idea sharing will be positive only in groups with low expertise diversity salience. Groups in which members are acutely aware of expertise differences (i.e., expertise diversity salience is high) are likely to interpret task conflict to be a result of those differences, reinforcing the distinctions and the ingroup/outgroup divides. The conflict in the interactions between groups will make the differences between groups appear more negative (Gaertner & Dovidio, 2000; Pettigrew, 1998) and thus increase the negative effects of salience of subgroup identity. Group members engaged in more conflict will therefore choose to share fewer ideas, even in the context of enriched work design. Therefore, we hypothesize a three-way interaction between task conflict, group work enrichment, and expertise diversity salience.

Hypothesis 2: *Idea sharing will be highest in groups with high task conflict, more enriched group work design, and low expertise diversity salience.*

The Effects of Idea sharing on Group Outcomes

According to the combination of contributions perspectives on group creativity, a group is creative only if its members share their ideas effectively (Nijstad et al., 2006). In the previous sections we elaborated on why group members may often fail to share ideas and what contextual factors may facilitate idea sharing. In this section, we argue that idea sharing is important because it influences group outcomes in innovation tasks.

The combination of contribution theory on group creativity predicts that the creative potential of a group cannot be realized without the effective exchange of ideas (Nijstad et al., 2006). The value of expertise diversity lies in its broad knowledge base, but the diverse inputs may not improve performance and the potential of diversity may fail to be realized (van Knippenberg & Schippers, 2007). Work in groups can lead to higher creativity than individual work only when groups are able *to share* and then *combine* their diverse inputs (Dugosh, Paulus, Roland, & Yang, 2000; Nijstad et al., 2006).

Furthermore, idea sharing leads to cognitive stimulation (Nijstad & Stroebe, 2006) and to the *generation* of more original ideas. Idea sharing stimulates additional idea generation in groups because new ideas from other group members provide access to cognitive categories that otherwise are not accessible, a process called cognitive stimulation (Diehl, Munkes, & Ziegler, 2002). Examples of this can be found in brainstorming groups where idea sharing leads to producing more ideas and ideas with higher originality (Paulus et al., 2002). Thus, groups with high idea sharing will both have more ideas to *combine*, and will *generate* more original

individual ideas which will in turn lead to better group ideas and higher group performance on innovation tasks such as research projects. The performance on innovation tasks depends on the novelty and usefulness of the ideas generated by the group (Amabile, 1983). Therefore, we hypothesize:

Hypothesis 3: Idea sharing will have a positive effect on group performance on innovation tasks.

We do not develop hypothesis on the direct effect of task conflict on group outcomes because a recent meta-analysis shows that on average there is no effect of task conflict on innovation outcomes (Huelsheger, Anderson, & Salgado, 2009).

METHOD

Setting

We collected survey data from 148 individuals in 29 academic research labs. We chose the setting of academic research labs because the task of doing research involves creativity and innovation. Furthermore, the lab research groups varied in their expertise diversity and work structure since there is very little consensus on how to structure an academic research lab. Thus, we had data on idea sharing in expertise-diverse groups with different work structures working on an innovation task.

Data Collection

We administered paper and pencil and web-based questionnaires to lab groups in two universities. Lab groups consisted of 3 to 11 members including graduate students, post-docs, and one advisor. Lab members and advisors received different questionnaires.

Measures

All predictors and moderators were measured using self-report Likert-type scales ranging from 1 = “strongly agree” to 7 = “strongly disagree”. Expertise diversity was measured using Blau’s (1977) index. Group performance was assessed by each group’s advisor.

Expertise diversity. Expertise diversity was measured in terms of lab members’ major area of study associated with their most recent educational degree because post-doctoral and graduate students’ expertise is typically derived from other educational programs. Similar to expertise diversity, educational diversity results in differences in perspectives, languages, and values of the group members. In the sample, lab group members had 24 unique majors. The most common majors were biology, chemistry, and engineering. Since the data was categorical, we calculated diversity using Blau’s (1977) index $(1 - \sum p_i^2)$ where p_i is the fraction of group members with major i .

Expertise diversity salience. We measured expertise diversity salience using a single item indicator based on work by Randel (2002). “When people ask me who is in my lab group, I initially think of describing group members in terms of what fields they worked in prior to coming.”

Task conflict. We measured task conflict using 3 items from Jehn’s (1995) 4-item scale (see Appendix A). We did not include the item “How frequently are there conflicts about ideas in your lab group?” because it overlaps with the construct space of idea sharing, a separate construct in this study. The scale assesses the amount of disagreements around how to perform the task at hand ($\alpha = .73$). We averaged responses to the group level (average $r_{wg} = .93$, ranging from .70 to .99 across groups).

Idea sharing. Each lab member reported on the level of idea sharing and receiving within the group using four items (see Appendix A). The reliability of the 4-item measure was satisfactory ($\alpha = .70$).¹ We chose an individual level referent instead of a group level referent to assess idea sharing during lab meetings (i.e., how “I” receive ideas by idea sharing within my lab group) because of the difficulties and biases that individuals might have in evaluating what constitutes idea sharing for other people.

Group work design. Group members assessed the group work design in terms of task significance, task variety, task identity, self-management, and participation (Campion et al. 1993). We measured the five theoretical dimensions using scales developed and validated by Campion and colleagues (1993, 1996). We conducted confirmatory factor analysis (CFA) to assess validity of the measure. We tested whether the group work design measure represent a second-order factor that consisted of five first order factors. The CFA results showed a good model fit ($\chi^2[29] = 49.93$, CFI=. 91; RMSEA=.07, RMSEA confidence interval = .35, .10). The factor loadings all but two of the items were statistically significant and greater than the accepted cut-off criterion of .4. Only the factor loadings of two of the items on the task identity factor were lower than .4 (equal to .33 and .32 respectively). We averaged all 10 items to form a group work design scale ($\alpha = .76$). We averaged responses to the group level (average $r_{wg} = .93$, ranging from .72 to .98 across groups).

Group performance. We measured lab performance based on advisor evaluations. Using different respondents for evaluating the group processes and group outcomes allowed us to reduce the potential for common method bias in our findings related to the effects of idea sharing and task conflict on group performance. The advisor of each lab group assessed their lab’s

¹ The scale was pretested in another sample of 67 master students working in new product development groups. The scale reliability in the pre-test sample was $\alpha = .90$.

performance using four Likert-type items (see Appendix A). The items were based on the group performance measure developed by Edmondson (1999). The group performance scale exhibited high reliability ($\alpha = .85$).

Control variable: Intrinsic satisfaction. Intrinsic satisfaction was used as a control variable because both idea sharing and group performance may be related to intrinsic satisfaction. Idea sharing may be higher when group members are more satisfied because they may be more creative (Amabile, 1983). Furthermore, group performance may be higher in teams with more intrinsically satisfied members because they will be more intrinsically motivated to invest effort in accomplishing the task (Tett & Burnett, 2003). To measure intrinsic satisfaction we used a 3-item scale ($\alpha = .83$) developed and validated in prior research (Camman, Fichman, Jenkins, & Klesh, 1979) (see Appendix A).

Divergent validity. In addition to assessing scale reliabilities, we tested the divergent validity of the self-reported group-level measures (i.e., task conflict, idea sharing, intrinsic satisfaction, and group work design) using confirmatory factor analysis (CFA). Following the recommendations of Anderson and Gerbing (1988), we first conducted a CFA specifying a 5 factor solution. The 5-factor solution displayed a good fit with the data based on the accepted goodness of fit criteria in the literature (Hu & Bentler, 1999) ($\chi^2[193] = 306.52$, CFI = .91, RMSEA = .06, RMSEA confidence interval = .05, .08). A single-factor model did not fit the data well. To test whether there is not a more parsimonious solution, we estimated four 4-factor models. Each of the models combined two of variables with high correlations ($r > .60$) while the other three factors remained separate. The alternative measurement models where group work design and idea sharing (χ^2 difference [9] = 74.72, $p < .001$), group work design and learning (χ^2 difference [9] = 80.2, $p < .001$) or learning and intrinsic satisfaction (χ^2 difference [5] = 113.28,

$p < .001$) were estimated as one factor and the three other factors were held the same had significantly worse fit compared to that of the 5-factor model. The findings from the CFA supported the theoretical distinctiveness between the concepts of task conflict, idea sharing, intrinsic motivation, and group work design.

Data Analysis

We first analyzed the effects of diversity-related processes and context on idea sharing. We used Hierarchical Linear Modeling (HLM) to test for these effects. Idea sharing was the dependent variable and the effects of the corresponding predictors were modeled at individual and group level simultaneously. On level 1, expertise diversity salience and individual intrinsic satisfaction were the individual level predictors of the variation in the level of idea sharing. On level 2, expertise diversity, task conflict, and group work design were the group level predictors of the variation in idea sharing. The group level predictors of expertise diversity, task conflict, and group work design were also modeled to have cross-level effects on the relationship between expertise diversity salience and idea sharing.

We chose to model the hierarchical structure of the data and use HLM for three reasons. First, idea sharing was evaluated by individuals within groups and we wanted to control for individual level differences in their perception of group processes. Even when intra-class correlations (ICCs) and within group agreement (rwg) show satisfactory agreement among group members in their evaluation of group processes, the agreement is always lower than 100% and thus there is always measurement error in group level regression equations. The HLM approach to modeling group level phenomenon allows us to account for measurement error in measures that aggregate individual responses to measure group phenomena and thus to avoid a bias in the regression coefficients on the group level due to measurement error (Raudenbush & Bryk, 2002).

Second, we considered expertise diversity salience as a predictor that varies between individuals within group. Individuals with different expertise backgrounds and different traits may have different levels of expertise diversity salience. Thus, we chose to model the impact of expertise diversity salience on idea sharing as an individual level relationship. Third, we wanted to control for individual level predictors of idea sharing such as individual intrinsic satisfaction. We wanted to reduce the probability that the relationships on the group level of analysis capture the effects of individual level omitted variables.

We analyzed the effects of expertise diversity and expertise diversity salience on task conflict using hierarchical Ordinary Least Squares (OLS) regression because the dependent variable (task conflict) is at the group level. We tested for interaction effects of both the linear and the non-linear components of expertise diversity and diversity salience because of the nature of the hypothesis on the moderating effects of expertise diversity salience.²

After we tested the effects of expertise diversity, diversity-related processes and group work design on idea sharing, we proceeded to analyze the effects of idea sharing on group outcomes. We analyzed the effects of idea sharing on lab group performance using OLS regression. We controlled for the direct effects of expertise diversity, diversity salience, and task conflict.

RESULTS

Table 1 presents the descriptive statistics and the correlation between variables. To test for the effects of expertise diversity on task conflict, we use hierarchical OLS regression (see Table 2).

² Prior research provides evidence that task conflict can serve to mediate the relationship between diversity and group outcomes (e.g., Jehn et al., 2009). We did not test a mediation model because our theory focuses on the moderating role of expertise diversity salience and group work design and we did not have a large enough sample to test both models simultaneously.

All variables in the regression were on the group level. Hypothesis 1 predicted an inverted-U relationship between expertise diversity and task conflict that would become stronger with higher levels of expertise diversity salience. Results showed a significant interactive effect between the squared value of expertise diversity and expertise diversity salience ($b = -.63$, $p < .05$). The addition of this interaction significantly improved the model fit (R^2 change = .15, F change (1, 23) = 4.55, $p < .05$). Thus, Hypothesis 1 was supported.

To facilitate the interpretation of the results, we plotted the interaction effect following Aiken and West (1991) (see Figure 3). The interaction plot shows an inverted U relationship between expertise diversity and task conflict only for groups with high expertise diversity salience. That is, for groups with high expertise diversity salience, expertise diversity had a positive effect on task conflict as diversity ranged from low (mean low expertise diversity = .23) to moderate (mean medium expertise diversity = .57), and had a negative effect on task conflict as diversity ranged from moderate to high (mean high expertise diversity = .91). As predicted, reductions in levels of expertise diversity salience made the relationship between expertise diversity and task conflict less curvilinear. At moderate levels of expertise diversity salience, the relationship between expertise diversity and task conflict was linear and essentially zero. Interestingly, further reductions in expertise diversity salience (from moderate to low) led to a reversal of the curvilinear expertise diversity – task conflict relationship. In groups with low expertise diversity salience, increases in expertise diversity from low to medium resulted in a slight drop in task conflict and increases in expertise diversity from medium to high resulted in an increase in task conflict.

Hypothesis 2 posits a 3-way interaction between task conflict, group work design, and expertise diversity salience on idea sharing such that idea sharing will be highest in groups that

have high task conflict, enriched work, and low expertise diversity salience. To test Hypothesis 2, we used a multilevel approach because the dependent variable reflected how much ideas individuals received during group discussions and was, therefore, on the individual level. Table 3 summarizes the HLM results. First, we tested a null model where no predictors were entered. The null model allowed us to test the significance of the between-group variance in idea sharing by examining the level-2 residual variance and ICC(1). The level 2 residual variance was significantly different from zero ($\tau_{00} = .12, p < .05$) and 34% of variance resided between groups ($ICC(1) = .34$). Thus, we had statistical evidence that idea sharing could be modeled a group level variable. We estimated slopes- as- outcomes models in HLM to assess the cross-level effects of expertise diversity, task conflict and group work design on idea sharing in Hypotheses 2.³

Results showed that the three-way interaction between expertise diversity salience, enriched group design, and task conflict was negative and significant ($b = -.71, p < .05$) (see Table 3). Following Aiken and West (1991) we plotted the interaction effects (see Figure 4). As predicted, idea sharing was highest in groups with high group work enrichment and high task conflict and low expertise diversity salience. However, idea sharing was similarly high in groups with enriched work, high expertise diversity salience, and low task conflict. Thus, Hypothesis 2 was partially supported.

Hypothesis 3 predicted that idea sharing would positively influence performance in academic research lab groups. To test for the effects, we used an OLS regression analysis (see

³ First, we tested whether the relationship between identity salience and idea sharing varies between groups (the level-1 slope of identity salience). This is a necessary precondition for testing cross-level interactions. The results showed a significant between group variation in the level 1- slope of identity salience (U1 variance = .23, Chi-squared (26) = 47.47, $p < .01$).

Table 4)⁴. We controlled for task conflict and expertise diversity salience to remove variance associated with information processing and social categorization processes that prior research had shown to affect group outcomes. Idea sharing predicted group performance over and above task conflict and expertise diversity salience. The coefficient of the effect was statistically significant and positive ($b = .44, p = .05$). Thus, Hypothesis 3 was supported. Interestingly, when controlling for the effect of idea sharing on group performance, task conflict had a negative and significant direct effect on lab group performance ($b = -.45, p < .05$). Thus, task conflict influenced group performance in two ways: it had a negative direct effect on performance and a positive indirect effect through its positive main effect on idea sharing.⁵

DISCUSSION

Although innovation has been defined as the generation of creative ideas and their implementation into valuable products (Nijstad & De Dreu, 2002), prior research on group innovation has not considered when individual expertise-based ideas are shared in order to be combined into group cross-expertise ideas. Moreover, members of creative groups (such as brainstorming groups) are often discouraged from expressing disagreements because conflict is expected to reduce idea sharing (Osborn, 1957). In this paper, we provided evidence on the how teams with task conflict share ideas in creative groups who work on research task and who are endowed with diverse expertise. We showed that idea sharing in diverse groups can be stimulated by task conflict, but only if work design is appropriately enriched and expertise diversity salience is low.

⁴ Since the analysis was performed on the group level, we aggregated the idea sharing items to the group level. The within group agreement was satisfactory (average $r_{wg} = .76$).

⁵ We tested whether there was a three way interaction effect of task conflict, work design, and diversity salience on group performance similar to the three way interaction effect on idea sharing. The three way interaction effect of task conflict, work design, and diversity salience was not statistically significant.

Social categorization states such as diversity salience have been related primarily to demographic diversity characteristics such as age, race, and gender (Joshi & Roh, 2009; van Knippenberg et al., 2004). In contrast, we showed that social categorization states play an important role in explaining the effects of *expertise diversity* on group processes and outcomes. We argued that social categorization would be evidenced by higher expertise diversity salience in the group and found that the relationships between expertise diversity, task conflict, group work design and idea sharing all depended on the salience of group members' fields of expertise. This is especially interesting in light of the fact that expertise differences in the lab groups are not reinforced by functional distinctions, as they are in organizations. In multi-functional groups in organizations, group members' functional affiliation is front and center, and therefore can easily be used to form a social category. However, in academic lab groups, group members do not usually affiliate with an external group. Their expertise diversity is based on their past education and affiliations, not current. In spite of this, the salience of expertise social categories proved to be very important in understanding the effects of expertise diversity on idea sharing and group performance.

Perhaps the most intriguing finding is how expertise diversity salience influenced the relationship between diversity and task conflict. Prior research on diversity and conflict suggests that more (expertise) diversity should lead to more (task) conflict (Jehn et al., 1999). However we did not see a main effect of diversity on conflict in our study. Instead, expertise diversity salience mattered, especially when expertise diversity was moderate and subgroups could occur. Groups whose members thought more about one another in terms of their background expertise experienced more task conflict, and that effect was strongest at moderate levels of diversity when subgrouping could occur. This is evidenced by the bowing out of the regression lines at

moderate levels of expertise diversity. This finding speaks to the need to consider both psychological social categorization processes along with objective levels of diversity and the potential for subgroup formation simultaneously. It also reiterates the need to consider curvilinear effects of diversity on group processes (Dahlin et al., 2005), as moderate levels of diversity introduce unique configurations that invite subgroup formation (Earley & Mozaowski, 2000). Measures of diversity should not be considered independent of their structural implications.

Expertise diversity salience also played an important role in determining how enriched work and task conflict combined to influence idea sharing. In groups with low expertise diversity salience (and thus less social categorization), task conflict increased idea sharing in highly enriched work groups and decreased idea sharing in less enriched work groups. This finding was in line with our prediction that low expertise diversity salience and enriched work are necessary for task conflict to stimulate the positive process of idea sharing. We predicted and found that enriched work, consisting of task identity, decision-making participation, and self-management (which increase outcome interdependence and facilitate the contact between the expertise-diverse group members) and task significance and variety (which increase the motivation to work towards the common group goal) positively affects the relationship between task conflict and idea sharing when social categorization is not prevalent. This finding is in line with predictions from social categorization theory that outcome interdependence and motivation to reach group goals are conducive to reducing categorization-based processes in groups (Gaertner & Dovidio, 2000; Pettigrew, 1998), making it easier to transfer knowledge and engage in cooperative discussions.

The conditions conducive to idea sharing in groups with high expertise diversity salience appear to be somewhat different. Amongst groups with high expertise diversity salience (and thus more social categorization), those with high group work enrichment and low task conflict shared the most ideas, followed by groups that had high conflict (regardless of level of enrichment), followed by groups with low enrichment and low conflict. In groups where members define themselves in terms of their different expertise, idea sharing is easiest when work is enriched, but task conflict is low. It appears that the enrichment is enough to bridge the gaps across the differentiated expertise, but that bridge is fragile – high levels of disagreement about the task undermines that connection and inhibits the idea sharing benefit of the enrichment.

When the work is not enriched for groups with high expertise diversity salience, idea sharing suffers. In the absence of enrichment, task conflict can generate a moderate amount of idea sharing in these groups. But in the absence of group work enrichment and task conflict, idea sharing is almost non-existent. The social categorization that exists in these groups suppresses idea sharing and there is no mechanism available to overcome it.

These results again point to the centrality of social categorization processes as a determinant of how group processes influence one another. They also highlight the importance of considering the nature of the work being performed. Group work design should not be left to chance. Our results show that the work itself does matter, as it motivates group members and provides them with opportunities to interact and collaborate.

The creative process of idea sharing has received little attention in studies of group diversity do far. We provide evidence that *idea sharing* is critical to groups working on innovation tasks and distinguishable both theoretically and empirically from task conflict.

Hence, the study of task conflict should be complemented by the study of the *idea* sharing in groups working on creative tasks.

An important finding from our research is that task conflict had a direct negative and indirect positive effect (via idea sharing) on group performance. This finding has implications for the literature on task conflict in teams, which finds predominantly negative effects of task conflict on performance, but positive effects on the performance of some innovation tasks (De Dreu & Weingart, 2003). Our results show that task conflict stimulates idea sharing which in turn improves group performance. After accounting for idea sharing, the remaining effects of task conflict on group performance are negative. Thus, without considering the idea sharing in groups the effects of task conflict on group outcomes may not be fully captured.

Both social categorization and information processing influenced idea sharing in our study of diverse groups. Expertise diversity had no direct effect on idea sharing and affected idea sharing only through its effect on the information process of task conflict. Idea sharing in turn predicted group performance. Thus, we provide initial evidence in support of the effective idea sharing principle underlying the combination of contribution theory on group creativity proposed by Nijstad and his colleagues (2006). Furthermore, we extend theories on diversity (van Knippenberg et al., 2004) through investigating contextual moderators of the effects of diversity processes and through examining the effects of diversity processes on creativity processes in groups with innovation tasks. Future research could consider the mechanisms through which idea sharing influences group performance as well as distinguish between generative and implementation idea sharing. For example, future research could address how the shared ideas in expertly diverse groups are integrated into a group idea (i.e., generative idea sharing) and then incorporated into a new product (i.e., implementation idea sharing).

Limitations and Future Research

Because of our choice of research method, i.e. field survey research, our analysis cannot prove causation. The internal validity depends on the strength of the theory and on controls through either the design of the empirical context or statistical analyses. We encourage future research on the relationships between task conflict and idea sharing over time and on potential feedback loops.

As a measure of group performance, we used the performance evaluation of the lab group advisor. While this allowed us to avoid mono-method biases associated with using lab member self-reports of performance, it still represents a subjective assessment of performance. We encourage future research with different outcome measures to test the effects of expertise diversity, group processes, and idea sharing on performance in interdisciplinary research labs.

Our findings also have important implications for managing interdisciplinary research groups and expertise-diverse innovation groups. Engaging in task conflict can actually promote creativity and idea sharing but only if team members do not perceive each other as members of different subgroups and if their work design are managed appropriately. Perceiving others as members of a different subgroup of experts may hinder the realization of the expected benefits of interdisciplinary research or other innovation tasks. We suggest that managers use diversity management tools (e.g., by creating group norms and a group culture that values diversity) also in groups of expertise-diverse group members (Homan, van Knippenberg, van Kleef, & De Dreu, 2007). Furthermore, while enriching the group work design can on average stimulate idea sharing, it fails to stimulate idea sharing if team members both perceive others as members of different subgroup of experts and engage in high task conflict. This finding speaks to the

importance of directly managing diversity salience as a prerequisite for the effectiveness of work design intervention such as changes in work design through group work enrichment. Based on our results, enriched group work design in terms of designing tasks with high significance, variety, and identity as well as promoting self-management and participation seems to be an especially important tool for stimulating creativity in research groups. However, our findings also suggest that managers should consider the salience of the differences between experts and the level of task conflict in the team before deciding how to design the work. Furthermore, conflict management tools may help counteract the negative effects of task conflict on idea sharing in interdisciplinary research groups with high diversity salience and enriched group design.

The results of the study contribute to understanding the effects of expertise diversity on task conflict and idea sharing in terms of the driving diversity processes and the group work design moderators. Goldenberg, Lehmann, & Mazursky (2001) show that how new ideas emerge in groups can explain variation of innovation outcomes. Furthermore, recent meta-analysis shows that, on average, task conflict does not affect innovation (Huelshegger, Anderson, & Salgado, 2009). We provide evidence regarding the role that both task conflict and idea sharing play in diverse groups engaged in research and encourage further research on conflict, idea sharing and other group processes through which new ideas emerge in diverse groups.

CHAPTER 3 (Paper 2)

Creativity and conflict in cross-functional innovation teams: What facilitates or inhibits idea building across functions over time

Abstract

In cross-functional innovation teams functionally diverse team members are expected, but often fail, to generate more innovative products through integrating their creative inputs. Group creativity research points to the importance of idea building – that is, combining and improving on one another’s ideas. We examined whether conflict and changes in experience and trust between functions facilitate or impede team member’s idea building across functions and over time. Cross-functional longitudinal data from student teams engaged in integrated product development projects shows that members from different functional backgrounds had more difficulty building on one another’s ideas than team members from the same functional background. Building on cross-functional ideas became even more difficult as cross-functional experience increased. Cross-functional idea building, however, became easier as cross-functional trust increased. Furthermore, we disentangled task conflict from idea building and found that only when team members trusted functionally different others, task conflict facilitated idea building. Results showed that cross-functional idea building but not task conflict directly enhanced product innovation in cross-functional teams.

Keywords: group creativity/innovation, diversity, task conflict, trust, group processes, multilevel model, latent growth curve

Creativity and conflict in cross-functional innovation teams: What facilitates or inhibits idea building across functions over time

Organizations increasingly rely on new product development projects where functionally diverse team members are expected to combine their distinct knowledge, skills, and ideas to develop a new product. Sutton and Hargadon (1996) show that it is important to understand group creativity and ideation not only in standalone brainstorming groups but also in the context of new product development teams. When teams engage in creative tasks such as new product development, members' creative inputs, i.e., their ideas, must be combined to realize the potential of their diverse knowledge base (Nijstad, Rietzschel, & Stroebe, 2006). Building on the ideas of others represents one of the four original rules of effective group creativity in the brainstorming research tradition (Osborn, 1957). Osborn's fourth rule states, "*Combination and improvement are sought*. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea" (pp. 301). However, most research on group creativity and ideation often presumes but does not investigate idea building in tasks that require creativity (e.g., Diehl & Stroebe, 1987; Paulus, Dugosh, Dzindolet, Putnam, & Coskun, 2002; Paulus & Yang 2000).

A recent simulation of brainstorming suggests that idea building can result in more creativity and better solutions in cross-functional teams (as compared to nominal groups) when they are working on problems that are cross-functional in nature (Kavadias & Sommer, 2009). Theoretically, this occurs because the diversity of perspectives results in the building of ideas along novel paths. Studies of idea building, however, tend to focus on homogeneous groups and mono-functional tasks (e.g., Girotra, Terwiesch, & Ulrich, 2010). In homogeneous situations, research shows that ideas that build on others are not better than the original ideas generated

(Girotra et al., 2010). We know little about how idea building occurs in heterogeneous teams and whether it affects innovation. Furthermore, there is ample evidence on the important role of conflict in heterogeneous teams (Jehn, 1995; Jehn, Northcraft, & Neale, 1999; De Dreu, 2006), but we do not know how conflict affects idea building in heterogeneous teams such as cross-functional teams.

Our research seeks to fill these gaps and examines conflict and idea building over time in the setting of cross-functional new product development teams. Sutton and Hargadon (1996) show that it is important to understand group creative processes not only in standalone brainstorming groups but also in the context of new product development teams. Furthermore, recent research on product development suggests that the circumstances around the emergence of new ideas predict new product success (Goldenberg, Lehmann, & Mazursky, 2001). Drawing on brainstorming research and research on cross-functional teams, we define idea building as the process through which a team member understands, builds upon, and integrates his/her ideas with ideas of team members. Integrating theories on learning, creativity, and conflict, we investigate the processes and states that drive idea building in cross-functional new product development teams over time. To investigate the dynamics of team members' idea building in cross-functional innovation teams, we capture and examine experience, trust, team conflict, and satisfaction across functional divides in new product development teams over a period of 4 months (see Figure 1). Disentangling the effects of task conflict and idea building on innovation, we also examine the relationship between conflict and idea building and their separate roles in cross-functional new product development teams.

In cross-functional new product development teams, the very diversity of functional perspectives that provides high creative potential can impede the realization of the creative

potential. Functional diversity can result in inconsistent understandings of the task and hinders the optimal combination of diverse novel inputs (Cronin & Weingart, 2007). Cross-functional innovation is characterized by a tension that our current understanding of team work cannot yet fully resolve: although cross-functional teams are put together because of the differences in perspective that increase the creative potential, the difficulty of combination of new inputs stemming from different cross-functional perspectives often hinders the realization of the creative potential in integrated product development teams (Dearborn & Simon, 1958; Dougherty, 1992; Weingart, Cronin, Houser, Cagan, & Vogel, 2005). The interpersonal creative processes of combination of creative inputs such as idea building often result in process losses in cross-functional teams (Steiner, 1972).

There is scarce research on the interpersonal creative processes (George, 2007) and they have rarely been investigated in the setting of new product development (Huelsheger, Anderson, & Salgado, 2009) in spite of our common understanding that creativity is an integral part of innovation (Amabile, 1996; West & Farr, 1990). Building off results of a recent meta-analysis showing that team processes are stronger predictors of product innovation than is team composition (Huelsheger et al., 2009), we examine the team and temporal dynamics of a key interpersonal creative processes, i.e., idea building, in the setting of cross-functional teams to better understand what processes and states facilitate innovation in cross-functional new product development teams.

This study extends previous research in several ways. First, we contribute to advancing research on innovation and new product development by examining idea building over time and demonstrating how its development helps teams create more innovative products in the setting of cross-functional teams. We show that cross-functional idea building is more difficult than

within-function idea building and identify team dynamics factors that facilitate or hinder cross-functional idea building. Second, we integrate theories on conflict and group creativity to contribute to the research on functional diversity and innovation. Recent studies have started to address the relationship between task conflict and creative outcomes with a focus on homogeneous teams (Farh, Lee, & Farh, 2010). We know little, however, about the relationship between task conflict and creative processes as well as between task conflict, creative processes, and innovation outcomes in heterogeneous teams. Finally, we investigate interpersonal creative processes across functions and over time and add a learning perspective to better understand creativity over time. We use dyad-level cross-functional data over time and a multi-level Latent Growth Curve model to examine the interactions and attitudes of each team member with team members with different functional backgrounds. Our approach recognizes the fact that team members will not interact with different functions in the same way over the lifespan of a project. We provide both new insights on the dynamics of the interplay of learning, conflict, and creativity processes such as idea building in cross-functional teams and an example of the use of dynamic multilevel models for gaining new insights on how team member vary in the way they interact with functionally different others over time (Chen, Bliese, & Mathieu, 2005).

THEORY AND HYPOTHESES

Idea Building and Team Creativity

The combination of novel solutions based on different problem frames via idea building is central to group creativity on tasks that require creative inputs from multiple functional domains (Osborn 1957). In their combination of contribution perspective on group creativity, Nijstad, Rietzschel, & Stroebe (2006) specifically suggest that group creativity *requires* the combination of team members' inputs, such as ideas (p. 164). Further, when group members have diverse

task-relevant perspectives and are working on a cross-functional problem, computer simulation results suggest that collocated brainstorming groups should outperform nominal brainstorming groups because collocated groups can build on ideas across functions (Kavadias & Sommer, 2009).

We focus on the ease with which cross-functional idea building occurs because cross-functional idea building is integral to effective innovation in cross-functional teams. Prior research suggests that ease of knowledge transfer is a main factor that explains whether individuals engage in knowledge transfer (Reagans & McEvily, 2003). Similarly, we argue that ease of idea building predicts whether ideas get combined and integrated in innovative products in functionally diverse teams. Since the ease of engaging in processes may change over time as the processes themselves change, we study the dynamics of the ease of cross-functional idea building during integrated product development projects.

The Dynamics of Idea Building

Idea building is a dynamic process that is facilitated by learning that occurs as a result of experience working together and the emergence of attitudes in the team. In the setting of functionally diverse teams, we capture cross-functional learning by examining the effects of cross-functional experience and cross-functional trust over time and distinguishing them from the effects of time spent on the project. Learning involves *changes* in knowledge, skills and behavior and is therefore best studied over time (Argote, 1999; Wilson, Goodman, & Cronin, 2007). Over time a team member can acquire knowledge about different aspects of the functionally different team members. Team members can learn about one another's knowledge and task approaches developing overlapping functional knowledge (Bunderson & Suttcliffe, 2002). Team members can also learn about one another's competence, integrity, and

benevolence, developing feelings of trust (Gulati, 1995; Shoorman, Mayer, & Davis, 2007). To understand the temporal effects of team work on idea building we capture the effects of both experience and trust across functional divides and over time.

Research on the temporal aspects of work in diverse teams as well as temporal aspects of group creativity is scarce (Van Knippenberg & Schippers, 2007). A dynamic learning approach to idea building allows us to examine changes in the ease of idea building activities within individuals over time and better understand cross-functional innovation teams. This approach is in contrast to the more traditional approach of static models which examine variance across individuals.

Team member experience working with functionally different team members.

Theories and prior research on learning suggest that experience working together improves team performance (Goodman & Leyden, 1991; Reagans, Argote, & Brooks, 2005). Experience working together has been shown to improve information sharing (Wittenbaum, 1996), knowledge of who knows what (Liang, Moreland, & Argote, 1995), and idea generation (Paulus & Dzindolet, 1993).

Although most prior research on idea building focuses on creativity at a single point of time, idea building across functions can change over time as team members interact on the projects. While working together, team members learn about the functional perspectives of others and about ways to deal with incompatible ideas. Two types of learning can occur as a result of experience. First, team members learn the knowledge and perspectives of other functions. For example, an engineer can learn something about industrial design after working with an industrial designer. This type of learning leads to similarities in the mental models of the team members and the development of shared mental models (Klimoski & Mohammed, 1994;

Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Wilson et al., 2007). It promotes the development of overlapping functional knowledge which has been shown to promote innovation in functionally diverse teams (Bunderson & Suttcliffe, 2002). Second, from experience working together, team members learn skills for building on the ideas that are based on other functional perspectives. For example, the engineer can develop techniques for integrating design and engineering solutions into the product. In this case, team members are learning how to connect incompatible ideas and representations. This type of learning reflects the development of team members' skills to build on novel inputs from dissimilar perspectives. The more team members work together the more they learn by doing and the better they become at connecting incompatible ideas and perspective. We argue that the development of overlapping functional knowledge as well as the development of skills to integrate dissimilar knowledge between the representations of two functionally diverse members that can be learned through experience can facilitate idea building in functionally diverse teams over time. Therefore, we hypothesize:

Hypothesis 1: As team members gain more experience working with members from different functions over time, they will have less difficulty engaging in idea building with those members.

Team member trust towards functionally diverse others. While a team member's experience working with others influences her knowledge about deep level differences, a team member's cross-functional trust influences whether she is *willing* to work with functionally different team members in spite of these differences (Weingart et al., 2005). Trust is often defined as the willingness to make oneself vulnerable to another based on the expectation that the person will perform a particular action (in the absence of being able to control or monitor that

person) (Mayer, Davis, & Shoorman, 1995). People who *trust* diverse teammates will be more willing to rely on the information they provide because the teammate is believed to be honest, competent, and benevolent (Mayer et al., 1995). People build judgments about the integrity, abilities, and benevolence of others over time as they work together (Gulati, 1995; Gulati & Sytch, 2008). As trust develops, team members should more carefully consider and value what cross-functional teammates have to say (Hansen, 1999; McAllister, 1995; Weingart et al. 2005). Trust should provide the impetus for team members to attempt to integrate new solutions based on different functional perspectives with their own (Cronin & Weingart, 2007; Weingart et al., 2005). As such a team member's trust toward members of other functions should aid in the development of cross-functional idea building.

Hypothesis 2: As team members gain more trust for members of different functions over time, it will be easier for them to engage in cross-functional idea building.

Idea Building and Team Task Conflict

Research on creativity and conflict often assumes that task conflict leads to idea building and fails to distinguish both theoretically and empirically between idea building and task conflict. We first capture the effects of task conflict on the idea building and then in the next section the effects of both processes on innovation. Furthermore, we theorize that task conflict will not always facilitate idea building in cross-functional setting. The effects will depend on the development of trust across functional divides.

Theories and research on team conflict suggest that teams that afford opportunities for members of diverse teams to explore their alternative perspectives provide a rich context wherein members improve their ability to understand and integrate those perspectives (Cronin & Weingart, 2007; Jehn et al., 1999; Weingart et al., 2005). We believe that the opportunities for

learning about other perspectives and thus improving cross-functional idea building will be generated when team members both trust one another across functions and surface disagreements via task conflict.

Prior research shows that task conflict mediates the positive relationship between information diversity and group performance (Jehn et al., 1999). However, recent meta-analysis of innovation in teams shows that task conflict has no effect on innovation on average. Our theorizing responds to the call for the identification of mediators and moderators of the task conflict – team performance effect (De Dreu & Weingart, 2003a, 2003b; Jehn & Bendersky 2003). Our model suggests that task conflict will have a positive effect on product innovation (our performance outcome) via its impact on the creative process of cross-functional idea building when there are high levels of trust within the team. Thus, we extend research on the relationship between conflict, trust, and performance outcomes (Simons & Peterson, 2000).

In line with prior theory on team diversity, we believe that this occurs because the voicing of disagreements about the team task allows team members who trust each other to identify incompatible assumptions, goals, and elements of their thought worlds. Task disagreement often engenders more careful consideration of the task representations, opinions, and ideas of other team members (Jehn et al., 1999; Cronin & Weingart, 2007). People who trust diverse teammates are more likely to be willing to rely on the information provided during task disagreements. As such, cross-functional trust provides motivation for better information and idea processing through carefully considering and valuing what other team members said (Hansen, 1999; McAllister, 1995; Reagans & McEvily, 2003; Uzzi, 1997; Weingart et al., 2005), increasing idea building across functional divides. This suggests that team members who trust others on their team and are embedded in teams with high task conflict will be able to identify,

understand, and examine implicit assumptions, taken for granted values, and other differences in perspectives that affect the content of their ideas because these differences are surfaced via task disagreement (De Dreu, Van Dierendonck, & Dijkstra, 2004; De Dreu & Weingart, 2003a, Cronin & Weingart, 2007). Thus, cross-functional idea building will be easier in teams with high cross-functional trust and high task conflict.

Hypothesis 3: Task conflict will have a positive effect on idea building in teams with high cross-functional trust and no effect on idea building in teams with low cross-functional trust.

Idea Building and Product Innovativeness

We have already made the case that idea building is important to creativity, drawing from work on group creativity (Nijstad et al., 2006), brainstorming (Kavadias & Sommer 2009; Paulus and Yang, 2000; Sutton & Hargadon, 1996) and team cognition and diversity (Weingart et al., 2005; Weingart & Cronin, 2007). Given that creativity is an integral part of innovation processes, it follows that teams whose members find it easier to build on ideas across functional divides will develop more innovative products. Members of new product development teams engage in group ideation, the collective generation and selection of new solutions, throughout the product innovation process (Hargadon & Bechky, 2006; Sutton & Hargadon, 1996). Sutton and Hargadon (1996) show that it is important to understand group creativity and ideation not only in standalone brainstorming groups but also in the context of new product development teams.

The ease of cross-functional idea building captures team members' ability to understand and incorporate inputs coming from different perspectives. In new product development teams, less difficulties with cross-functional idea building should result in more innovative products

because the blending of perspectives is necessary for teams to be able to find creative solutions that meet multiple functional goals (Cronin & Weingart, 2007; Sutton & Hargadon, 1996). As such, cross-functional idea building allows for the effective blending and use of the creative outputs of the diverse perspectives, knowledge, and skills of functionally diverse teams engaged in integrated product development projects and should lead to higher team innovation. Therefore, we hypothesize:

Hypothesis 4: Teams whose members find it easier to build on the ideas of cross-functional teammates will produce more innovative products.

Team satisfaction represents another important team outcome. Team effectiveness consists not only of team performance but also of the ability of the team to satisfy team members' needs (Hackman & Morris, 1975). Integration of the cross-functional inputs through idea building represents one of the main goals of cross-functional teams. Research on satisfaction shows that goal success leads to satisfaction (Locke & Latham, 1990). Therefore, team members who build on and integrate their ideas with the ideas of cross-functional others will find their cross-functional interactions and teamwork more satisfying. Therefore, we hypothesize:

Hypothesis 5: Team members who find it easier to build on the ideas of cross-functional team mates will have higher satisfaction working with cross-functional others.

METHODS

Sample

Engineering, industrial design, and MBA students enrolled in a multi-disciplinary integrated product development course participated in this study. Data were collected at 4 time periods from 121 participants who worked in 21 integrated product development teams. Teams consisted

of 5-6 students. The sample consisted of 62 graduate and 59 undergraduate students, 33% of the students were female. Both undergraduate and graduate students were enrolled in the course, which was sponsored by a company. Data were collected from the course across 4 years.⁶ The course was taught by the same faculty using the same team selection criteria and same course requirements across all four years. There were no statistically significant differences in the variables we studied between the 4 years. The teams did not vary with respect to team tenure, functional composition, context, and type of task. This allowed us to control for the effects of these variables on team processes through the research design.

Students were assigned to teams at the beginning of the 15-week semester based on their functional experience with the goal of forming teams composed of at least 2 engineers, 2 designers, and 1 MBA student.⁷ Other criteria for the assignment of students to teams were gender diversity, national diversity, and age diversity. The choice of setting allowed us to build cross-functional teams and develop a realistic task with high ecological validity, while holding constant the task environment. Thus, we were able to provide some level of experimental control while allowing for task realism.

Task

Teams worked through a four-phase product development process over 15 weeks to develop a product within a pre-determined market domain set by a corporate sponsor. For example, one year, teams were tasked with developing aftermarket products that could be integrated into the bed of a pickup truck. The product development process focused on early stages, or the “fuzzy front end” of product development, including Phase I: identifying an opportunity, Phase 2:

⁶ The year of data collection did not predict outcomes, nor did it affect other results, so were not included in the analyses.

⁷ The teams with 6 students had either an extra engineer, designer, or MBA student depending on course enrollment.

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 4th phase for the final presentation, students also fabricated a prototype of their product. The task could not be effectively completed without the concurrent consideration of design, engineering, and marketing perspectives.

Data for the test of the hypotheses was collected using surveys completed at four points of time (Phase 0: beginning of the semester, Phase 1: 4 weeks elapsed, Phase 2: 7 weeks elapsed, Phase 3: 12 weeks elapsed).⁸ Cross-functional experience working together, cross-functional trust, and the ease of cross-functional idea building were measured at all 4 time periods. All these variables were assessed by the team member with regard to teammates with different functional backgrounds. Thus, we collected a unique set of dyad-level data across functions over time. Task conflict was collected after Phases 1-3.

Measures

Ease of cross-functional idea building. Ease of cross-functional idea building was measured using 4 items that assessed the ease with which team members understood and integrated their own ideas with the ideas of team members from the other functional backgrounds. Respondents were asked to think about a specific member of their team from another functional area and indicate their level of agreement (on a 5-point scale ranging from *strongly disagree to strongly agree*) with the following items, “His/her ideas are difficult to build

⁸ We were unable to collect sufficient data at the end of the semester (phase 4), because students were graduating and too busy to complete the survey.

on” (reverse-scored), “It is hard to incorporate his/her ideas in with my own” (reverse-scored), “I understand his/her ideas,” and “I tend to dismiss what s/he says” (reverse-scored). The scale includes two items on ease of idea building, one item on understanding of ideas, and one item on the acceptance of ideas. We included the latter two items to capture the concept space of cross-functional idea building. First, we included an item on understanding because it is a necessary precondition of idea building between team members coming from functional backgrounds, i.e., from different thought worlds. Second, we included dismissal of an idea because it provides information about whether ideas tended to be considered and thus perceived at all. We pre-tested the scale in a sample of 70 master students in cross-functional teams who were also engaged in cross-functional product development projects in another graduate program. The pre-test of the scale using principal component analysis with varimax rotation showed that all four items loaded on one factor with factor loadings above .65. In the sample for the pre-test the scale reliability was Cronbach alpha of .84.

For the current sample, all 4 items loaded on one factor when analyzed using principal component analysis with varimax rotation (all factor loadings > .70). Scale reliabilities were calculated for each pair of functional areas (e.g., engineers rating designers, designers rating engineers, MBAs rating engineers, etc.) and ranged between .73 and .81 (Cronbach Alpha). The variable “ease of cross-functional idea building” was averaged within individuals to reflect the ease with which a team member integrates ideas with members from the different functional areas. For example, if a team member was an engineer, “ease of cross-functional idea building” reflected her ease of idea building with MBA and design students on her team.

Time. We included time to capture the effects of project stage and to differentiate it from the effects of experience working together. Since we collected data over 4 periods of time we

included a time variable that ranged from 1 to 4. The four data collection points coincided with the beginning of the four project phases. Thus we controlled for the effects of project phase on the interpersonal creative processes and disentangled it from the effects of experience working with members of different function.

Cross-functional experience. The amount of work experience with members with different functional backgrounds was measured by asking respondents their level of agreement (5-point scale) with the following question, “I have a lot of experience working with [Engineer 1].” The variable was averaged across ratings of teammates to assess the amount of experience of a team member towards team members with different functional background on her team. Although we used one item to evaluate the amount of experience with a team member, we asked team members to evaluate the amount of experience with four other team members from different functions. Then we averaged the four assessments of the cross-functional experience item. Thus, the measure of cross-functional experience represented a summary index measure comprised of four ratings made by each team member.

Cross-functional trust. Trust was measured using 4 items that reflected a team member’s trust for team members with different functional backgrounds from his/her own. We adapted scales developed by Gillespie (2003) and Tyler (2003) to evaluate trust towards members with different functional background. We shortened the scales because team members had to report on their trust towards each of the other four team members. This approach is common for survey research where individuals assess the same item towards multiple others such as in networks research. In adapting the scales, we selected items that captured all of the three components of trustworthiness: competence, integrity, and benevolence (Mayer et al. 1995).

We asked the team member to evaluate his/her trust for each of the other team members using the following items, “I am willing to rely on his/her work related judgments,” (competence component), “I am willing to depend on him/her to support me in difficult situations,” (benevolence) “I have little faith in the things s/he says” (integrity). We also included an item that captured the overall level of trust “I trust him/her”. Scale reliabilities were calculated for each pair of functional areas (e.g., engineers rating designers, MBAs rating engineers, etc.) and ranged between .89 and .94 (Cronbach’s Alpha). The variable cross-functional trust was averaged to reflect the trust of a team member towards members with different functional backgrounds on her team.

Team task conflict. Task conflict was measured using four items (Behfar, Mannix, Peterson, & Trochim, 2008) “To what extent does your team debate different ideas when solving a problem?” “To what extent does your team argue the pros and cons of different opinions?” “How often do your team members discuss evidence for alternative viewpoints?” “How frequently do members of your team engage in debate about different opinions or ideas?” (Cronbach alpha = .83). Participants responded using a 5- point scale where high scores indicated more task conflict. 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).

Cross-functional satisfaction. Satisfaction working with functionally different team members was measured by asking team members how satisfied they were working with each of the team members with different functional backgrounds, “Overall, how satisfied are you working with [Engineer 1]?” The variables were averaged across ratings of teammates to assess the amount of satisfaction team members had working with members from different functional backgrounds. The level of cross-functional satisfaction of each team member represents an

average of four items: his or her evaluations of cross-functional satisfaction with each of the team members with a different functional background.

Product innovativeness. After the course was completed, we asked two experts with engineering, design, and business backgrounds to assess the final products. The experts, former students of the course 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.

The experts evaluated the products with regard to two dimensions of innovativeness of the final product: product novelty and product usefulness. The choice of the two dimensions was based on prior theories and research on product innovation and creativity (e.g., Amabile, 1983). To better fit our cross-functional context and task, we adapted the product novelty items to capture the characteristics of the product with regard to business (e.g., novel functionality) and to engineering and design (e.g., novel construction). The first two items on usefulness assessed the usefulness for the customer and were based on evaluating the product. The items were derived from the work of Cagan and Vogel (2002) and Sanders (1992, 2006). The other two items on usefulness were used to evaluate the product usefulness for the company and were based on evaluating the business plan. Therefore, these two items were synthesized from criteria used in business plan analysis (e.g., Timmons & Spinelli, 2007) (see Appendix A).

Product innovativeness was assessed using the 6 items discussed above. (1 = strongly disagree to 7 = strongly agree) (see Appendix A for the set of items). ICC(2)'s for each item were acceptable (ranging from .47 - .67, $M = .56$). We averaged the items within and across dimensions to create a composite measure of product innovation. The measure exhibited high

reliability (Cronbach Alpha = .84).

Data Analysis

To analyze longitudinal multilevel data we used Hierarchical Linear Modeling (HLM) that incorporated Latent Growth Curve modeling (Raudenbush & Bryk, 2002). The approach allowed simultaneous investigation of the patterns of team member's change of idea building over time and of time-varying predictors of team member's change on both team member and team level of analysis. Another advantage of HLM is that it solves estimation problems and reduces potential biases resulting from missing data (Raudenbush & Bryk, 2002). We had missing observation on individuals in 6 teams for amount of experience for time period 1.

Our data had a three level hierarchical structure: a level 1 unit was repeated observations of a team member over time, which were nested within the level 2 units of a team member, who was in turn nested within a level 3 unit of a team. The HLM estimated simultaneously three regression equations for each level of analysis: on level 1 the dependent variable was the variation of cross-functional idea building within a team member over time (the growth trajectory of team member's idea building), on level 2 the dependent variable was the variation of ease of cross-functional idea building between team members within a team (team member's ease of cross-functional idea building), and on level 3 the dependent variable was the variation of ease of cross-functional idea building between teams. Thus, the three-level HLM allowed us to investigate the individual growth trajectories (state and growth rate) (regression equation on level 1), the impact of individual characteristics on the state and growth rate of the individual growth trajectories (regression equation on level 1 if they vary and regression equation on level 2 if they do not vary), and the impact of team characteristics on the

individual states (regression equation on level 3). The impact of the team characteristics on the individual states constitutes a context or cross-level (top-down) effect (Chen et al., 2005).

As a first stage of the model specification we performed preliminary analysis of the data. In this preliminary analysis, we examined the distribution of the variables, how they change over time, as well as some bivariate relationships using the appropriate graphs. We began by examining the development of the ease of cross-functional idea building over time, using graphs to explore whether there are differences amongst the initial status and growth rates of team members' ease of cross-functional idea building. The graphs showed that team members' growth curves differed in their shape, intercept, and slope. The graphs and OLS regressions of how individuals change over time⁹ suggest that there is variation in how easy it is for individuals in teams to engage in cross-functional idea building over time. Therefore, we chose to use a random coefficients model (Latent Growth Curve Modeling) instead of OLS regression, which assumes that all team members in a team change their idea building activities over time in the same way.

Next, we examined which team member level variables (i.e., cross-functional trust and cross-functional experience) vary over time and which are time-invariant using graphs of change of the independent variables over time. As expected the graphs of individual level predictors and tests of random growth curve models showed different trajectories and variation in the intercepts and slopes for all team member level variables. Therefore, we entered the amount of cross-functional experience and cross-functional trust variables as time varying predictors in the model. This analytical approach allowed us to examine the dynamics of idea building in terms of how the growth of the cross-functional experience and trust affect the growth of the ease of cross-functional idea building over time.

⁹ Graphs and OLS regression results can be obtained from the first author.

We then used HLM to establish that there is within-team member (over time), between-team member, and between-team variance of the growth curves and examined how ease of cross-functional idea building evolves over time. There was statistically significant variation in the ease of cross-functional idea building between team members (variance of level 2 intercept = .08, $p < .001$) and between teams (variance of level 3 intercept = .02, $p < .01$). Furthermore, time had significant effects on the ease of cross-functional idea building ($b = .08$, $p < .001$). These results demonstrated that longitudinal multilevel analysis was the correct approach to analyzing and detecting patterns in the data. Furthermore, the results show that cross-functional idea building becomes easier over time. Next, following a *forward steps strategy*, we tested models that allowed us to better understand the change of cross-functional idea building over time.

In model 2 we added all individual level predictors, i.e., cross-functional experience and cross-functional trust, as time-varying predictors and tested for the significance of the coefficients. Working upward from level 1, we first modeled the variability within team members: the team member growth trajectories in model 2. After we selected the predictors on level-1 (within-individual) we tested whether there were random effects of the individual level predictors and whether individual level predictors had both individual level and context level components. Based on the significance of the random effects and residuals, we chose to model the slope of cross-functional trust as varying between individuals and teams.

We then proceeded to estimate models with a context (team level) predictor for the variation of the ease of cross-functional idea building. Model 3a adds team task conflict as a main effect and Model 3b adds the interaction effect of team task conflict and cross-functional trust. In model 3b, we tested whether team task conflict predicts the variance of the slope of cross-functional trust. Thus, we tested whether the relationship between cross-functional trust

of a team member and idea building of a team member changes depending on the amount of task conflict in the team where she works. We also compared the fit of the models using deviance. Models 3b had the best goodness of fit based on the deviance fit index.

We used OLS regression to test Hypothesis 4. Since team innovation is a team level variable, we first averaged the ease of cross-functional idea building, cross-functional satisfaction, cross-functional trust, and cross-functional experience to the team level.

RESULTS

Table 1a and 1b provide descriptive statistics and bivariate correlations for the two levels of analysis in our sample. The correlations on team level (Table 1b) differ from the correlations on the team member level (Table 1a). Both types of correlations are calculated at midpoint, i.e., at the end of phase 2.

Preliminary analyses. Since we assumed that functional differences make idea building more difficult, we first tested whether idea building was easier within functions than between functions. The paired sample t-test of ease of between-function idea building versus within-function idea building showed that within-function idea building was significantly easier for designers (Mean [between-function] = 3.30, Mean [within-function] = 4.24), $t = 4.68$, $p < .001$, MBA students (Mean [between-function] = 4.01, Mean [within function] = 4.28), $t = 2.96$, $p = .001$, and for engineers (Mean [between-function] = 3.85, Mean [within-function] = 4.23), $t = 5.44$, $p < .001$. Thus, results suggest functional differences made idea building more difficult.

Model 1 in Table 2 shows that time has a significant impact on the ease of cross-functional idea building of a team member. Individual ease of cross-functional idea building increases with time ($b = .08$, $p < .001$). Time captured the effects of the phase of the project

while experience captured how much team members actually worked together across functional divides. With time spent working on the project, team members had less difficulty integrating their own ideas with the ideas of members from different functions. Since time was centered at the midpoint of the project to reduce the effects of missing data at time 1, the team member intercept in Model 1 (4.02) reflects the average ease of cross-functional idea building at end of the second phase (time 2) . To determine the level of ease of cross-functional idea building at the beginning of the project, we also analyzed a model where time was not centered. In that model, the intercept of the model (i.e. the average team member's idea building at time 1) was equal to 3.80, ($p < .001$). Thus, team members started their work on the project with moderate ease at cross-functional idea building (ease of idea building was measured on a 5-point scale). Model 1 also shows that the ease of cross-functional idea building varied between team members within a team (variance of individual level intercept = .08, $p < .001$) and the ease of cross-functional idea building varied between teams (variance of team level intercept = .02, $p < .01$).

Hypotheses tests. Model 2 tests the mechanisms underlying the growth in ease of cross-functional idea building over time. The results show that changes in the amount of cross-functional experience, and cross-functional trust over time had statistically significant effects on changes in cross-functional idea building. Furthermore, the changes in these variables explained the effects of time on idea building. When we added these time-varying member-level predictors, the effect of time on the ease of cross-functional idea building became non-significant. Thus, the time-varying level 1 predictors explained the effect of time spent on the project on ease of cross-functional idea building. Increases in cross-functional trust were positively associated with an increase of the ease of team member cross-functional idea building ($b = .66$, $p < .001$), supporting Hypotheses 2. Increases in the amount of cross-functional experience had a

significant effect on the cross-functional idea building. However, the effect was negative ($b = -.05, p < .01$). Thus, Hypothesis 1, which predicted a positive effect, was not supported. Together the results show that holding constant changes in the amount of individuals' cross-functional experience, increases in cross-functional trust were associated with increases in ease of cross-functional idea building over time. In contrast, holding cross-functional trust constant, increases in the amount of experience with cross-functional teammates over time were associated with decreases in the ease of cross-functional idea building over time.

Testing Hypothesis 3 required the addition of a context (team-level) predictor to our model. Before adding this predictor, there must be evidence that there is significant between-team variance to be explained. Model 2 shows that the ease of cross-functional idea building varies between teams when controlling for variation in individual ease of cross-functional idea building and individual-level predictors (between team variance = .01, $p < .05$). Therefore, we were justified in adding team task conflict to our model. Hypothesis 3 predicted that task conflict will positively influence idea building only when team members developed high trust for functionally different others. Task conflict had no significant main effect on ease of cross-functional idea building amongst team members (Model 3a) but had a significant interaction effect with cross-functional trust (Model 3b) ($b = .14, p < .05$) as predicted. Thus, we found support for Hypothesis 3. We plotted the interaction following Aiken and West (1991). As predicted, there was a positive effect of task conflict on idea building only when team members developed high cross-functional trust (see Figure 2).

As mentioned above, we used OLS regression to test Hypothesis 4, which predicted that teams whose team members found it easier to engage in cross-functional idea building would develop more innovative products (see Table 3). We controlled for the effects of task conflict

and team members' satisfaction. We controlled for task conflict because prior research has shown that it predicts innovation in diverse teams (Jehn, 1995) and our results show that it also affects cross-functional idea building. As mentioned earlier, we controlled for satisfaction because, as a positive emergent state, it represents an alternative explanation for the effects of team processes such as cross-functional idea building and task conflict on team outcomes (Marks, Mathieu, & Zaccaro, 2001; Jehn et al., 2008). The results from the analysis showed that cross-functional idea building had a positive and statistically significant effect on product innovation when controlling for team members' satisfaction and task conflict ($b = .77, p < .05$). Thus, we found support for Hypothesis 4. The effects of cross-functional satisfaction and task conflict were not statistically significant.

To test Hypotheses 5, we used Latent Growth Curve Model (HLM). We modeled the variation of team member's cross-functional satisfaction over time in the same way as we modeled the variation of team member's ease of cross-functional idea building over time. We tested the effect of team member's cross-functional idea building on team member's cross-functional satisfaction over time. We found that cross-functional idea building had a significant and positive effect on cross-functional satisfaction ($b = .78, p < .001$). Thus, hypothesis 5 was supported.

DISCUSSION

Idea building has long been assumed to be an important underlying mechanism of creativity and innovation (Osborn, 1957), however there is little research examining idea building in cross-functional new product development teams or over time. We provide empirical evidence that idea building improves the product innovation in functionally diverse teams. We also identify

factors that influence the ease of cross-functional idea building over time – cross-functional experience, cross-functional trust, and team task conflict all influence the ease of cross-functional idea building over time. Thus, we extend our understanding of innovation processes.

Our study of idea building extends the current understanding of product innovation and the creative processes in functionally diverse teams in several ways. First, we provide evidence that idea building is more difficult between than within functions. As such, our results address the specific phenomenon of cross-functional idea building, rather than idea-building more generally. Second, we demonstrate that the ease of cross-functional idea building enhances new product development. Many have suggested this to be the case, but few have empirically examined it. Girotra and colleagues examined homogeneous brainstorming groups and found that the outcome of idea building, i.e., idea buildup, was not associated with better ideas. This interesting finding contradicts the brainstorming rules widely adopted in research and practice and suggests that idea building may not be beneficial for group creativity in homogenous groups (Girotra et al., 2010). In contrast, we examined heterogeneous, cross-functional groups and found that idea building enhances the novelty and usefulness of new products. This contradictory finding suggests that creativity in cross-functional groups is different from creativity in homogenous groups and further supports the importance of study of cross-functional work. Our finding supports the results of a computer simulation which demonstrated that idea building can result in more creativity in teams working on tasks that require the integration of the creative inputs of functionally diverse team members (Kavadias & Sommer, 2009). Future research on idea building needs to consider other task requirements and team composition.

Third, the study extends our understanding of how working in a functionally diverse team may change over time (Harrison et al., 1998, 2002; van Knippenberg & Schippers 2007;

Williams & O'Reilly, 1998). Early in a team's history, members feel it is moderately easy to build on the ideas of cross-functional teammates. Interestingly, idea-building became more difficult the more experience diverse team members accumulate working together. However, as trust builds along with debate and discussion, cross-functional idea building again becomes easier to do. Future research should continue to consider the dynamic aspects of cross-functional integration of ideas and other types of knowledge inputs in organizations. Collecting data over time and using statistical models such as Latent Growth Curve HLM can advance our understanding of temporal processes in work teams (Mitchell & James, 2001).

Prior research on learning from experience suggested positive effects of learning from experience on team outcomes. However, most of this research has been done on relatively homogeneous teams. The role of experience working together in functionally diverse teams is not clear. Recent advances in learning theories predict that different types of experience have different effects on team outcomes (Argote & Todorova, 2007). We found that cross-functional experience can actually make cross-functional idea building more difficult in functionally diverse teams. This finding speaks to the importance of integrating learning theories with theories and research on deep level diversity (Harrison et al., 1998, 2002): gaining experience working together resulted in team members experiencing more difficulty building on the ideas of cross-functional teammates. That is, team members who reported more interaction with diverse team members over time also found it more difficult to understand, accept, build on, and incorporate those members' ideas. We believe the increased interaction surfaced the more hidden differences associated with functional membership (Harrison et al., 1998, 2002). The negative correlation between experience and trust between functionally different team members as well as the negative effect of experience on cross-functional satisfaction also suggested that

gaining cross-functional experience lead to less social integration and worse cross-functional attitudes as research on deep level diversity shows.

Learning more about how different the functionally different team members actually are, activated stereotypes and the division of team members into subgroups. Social-categorization mechanisms may have hindered the willingness of team members to integrate the ideas of different others and interfered with their idea integration processes (Harrison et al., 1998, 2002). Additional research is needed to examine the mechanisms through which cross-functional experience affects interpersonal creative processes and innovation.

Our results also show that the growth in trust that a team member has for functionally diverse others facilitates cross-functional idea building. We show that as trust in other functions grows, team members find it easier to understand and build on their ideas. The positive effect of trust on idea building was stronger than the negative effect of experience, as evidenced by the overall positive trend in idea building over time and the stronger effect size for trust. Furthermore, task conflict interacted with trust. That is, team members who trusted those from other functions and were part of a team that debated and discussed their disagreements found it easier to engage in idea building across functions. Thus we show that team task conflict may facilitate interpersonal creative processes and can positively impact team innovation through this mechanism.

The study extends research on task conflict and trust. Simons and Peterson (2000) provide evidence on how trust makes task conflict more beneficial because team members who engage in task conflict but trust each other engage less in relationship conflict. We show that trust can help reap the benefits of task conflict for yet another reason. In functionally diverse teams, team members who engage in task conflict and trust each other will understand and build

on each other ideas and thus be more innovative. Our results provide a picture of team members who develop trust across functions and work in a team that engages in open discussion and debate and thus overcome that difficulty to build on ideas of functionally different others.

The interaction between trust and task conflict also has implications for the research on team conflict. In response to the 2003 meta-analysis showing that, on average, task conflict has negative effect on team performance (De Dreu & Weingart, 2003a), several contingency models of conflict have been developed to help identify moderators of the task conflict – team performance effect. Our results suggest that one must consider the task type (here a complex, multi-functional task) and the interpersonal attitudes (in our study, trust) within the group. In our multi-functional integrated product development teams working on an innovation task, trust was necessary for task conflict to positively influence the ease of cross –functional idea building – a key process underlying innovation. Based on an interpretation of the main effect of task conflict, task conflict did not affect cross-functional idea building and innovation. Only when cross-functional trust was high, task conflict made it easier to build on ideas and thus to innovate in functionally diverse teams.

Our findings on what predicts idea building over time can also contribute to research on the relationships between creativity and learning in teams (e.g., Hirst, van Knippenberg, & Zhou, 2009). Learning from experience can help cross-functional team members to innovate and be creative, if they learn about the competence, integrity, and benevolence of functionally different others and thus develop cross-functional trust. Learning from experience can however interfere with interpersonal creative processes if the experiences lead only to surfacing of deep level differences. We suggest that future research investigates the interplay of creative and learning processes in teams.

Managerial Implications

Our results also have important implications for managers. First, although an emphasis on integrated product development and the use of cross-functional teams can enhance product innovation, simply putting together a cross-functional new product development team is not enough. Functionally different team members can actually have more difficulty integrating their creative inputs and building on each other's ideas as they interact over time as the more deep level differences surface and pull them apart. Since the surfacing of deep-level differences is inevitable, managers should provide a counterbalance by designing contexts that encourage the development of cross-functional trust over time. Research on diversity suggests that instilling and maintaining appropriate diversity norms (Homan, van Knippenberg, van Kleef, & De Dreu, 2007) and stimulating interdependent work (Joshi & Roh, 2009) may help achieve these goals. Finally, to reap the benefits of high cross-functional trust, managers should stimulate task discussion, disagreement, and conflict in new product development teams. Task conflict alone is not sufficient – cross-functional team members need to engage in conflict with people that they trust for cross-functional idea building to improve. Conflict management tools and norms that rely on addressing conflicts and problem solving may enhance the willingness of functionally different team members to actively engage in task disagreements and conflict as other studies on team conflict suggest (Kuhn & Poole, 2000). Our research suggests that integration in functionally diverse new product development teams should be actively managed and fostered over time.

Methodological Limitations and Further Directions for Future Research

Our sample consisted of students involved in a new product development project working over at

15 week semester. Although this approach allowed us to avoid variation in the external context and team inputs (e.g., differences across organizational settings, team tenure, team diversity, etc.) and to control the team selection process, it may raise questions about the generalizability of our findings to organizational settings. Despite these differences in context, many proxies for organizational realities were in place. Students came from diverse educational backgrounds (majors), were accountable to multiple constituents (professors and sponsors), worked under time pressure with no possibility of deadline slippage, and were working on other projects (courses) simultaneously. To increase the external validity of the findings, future research should test the model in an organizational context.

Our choice of research design did not allow us to directly test for causality. It allowed us, however, to keep characteristics of the context constant, to use statistical controls, and to assign individuals to teams in order to increase the internal validity of the results. Furthermore, it allowed us to study teams that interact over a long period of time, work on a realistic complex creativity task, and have different functional background. Subsequent research could sharpen the internal validity of our findings by further examining the relationship between experience, trust, and idea building using experimental methods.

Research on individual creativity-related cognitive processes investigates stable differences in the way individuals approach creative tasks, such as flexibility, openness to new experience, and divergent thinking. These creativity styles may act as antecedents of idea building. Our analytical approach allowed us to control for these potential individual differences. More specifically, the addition of the between-individual effects (second level) in the three level Latent Growth curve (HLM) model statistically controls for the stable difference in idea building between individuals. Thus, our findings are not confounded by stable differences in the creative

thinking of individuals. Future research will show which of individual creativity-related traits predict the differences in idea building between individuals.

Conclusion

To better manage new product development, we need a better understanding of the innovation processes. In the setting of cross-functional teams, innovation processes incorporate both task conflict and creative processes such as idea building. Members of integrated cross-functional product development teams must be able to understand, accept, and build on the ideas of functionally different team members. However, this is difficult to do because individual's ideas are often functionally constrained by differences in expertise, thinking styles, and value systems and these constraints often lead to conflict (Cronin & Mueller, 2009; Cronin & Weingart, 2007; Dougherty 1992). By providing empirical evidence on how idea building between functions evolves over time as well as on the relationship between task conflict, idea building, and innovation, this research provides a richer understanding of what can make functionally diverse teams engaged in new product development more innovative.

CHAPTER 4 (Paper 3)

The conflict-creativity relationship in functionally diverse innovation teams: The tension between team cognition and emotion

Abstract

The cognitive differences of functionally diverse team members can stimulate creativity that spurs innovation but they can also lead to misunderstandings, tensions, and conflict that harm innovation. To provide insights for understanding and managing the seemingly opposing creativity and conflict forces, the study examines the relationship between conflict and creativity in diverse innovation teams. Integrating group conflict, creativity, and team cognition theories, I predict that two types of team cognition as well as conflict negative emotions represent the mechanisms through which conflict affects interpersonal creative processes and innovation in functionally diverse teams. Using data from 180 master students in 41 new product development teams, the study shows that task conflict reduces the harmful cognitive differences, i.e., the deep level value diversity, and increases the beneficial cognitive differences, i.e., the cognitive division of labor within transactive memory systems. Furthermore, the study provides evidence that although negative emotions of fear engendered by task conflict interfere with idea sharing, task conflict spurs the group creative processes and innovation through its effects on team cognition, i.e., value diversity and transactive memory systems. Thus, in contrast to prior research on creativity and conflict that assumed only negative effects of conflict on creativity, this research provides evidence on both the positive and negative effects of task conflict on group creativity and innovation in functionally diverse teams.

The conflict-creativity relationship in functionally diverse innovation teams:

The tension between team cognition and emotions

In organizations, functionally diverse innovation teams are increasingly used to tap into broad expertise resources to teams and to reduce glitches between functional areas. Functionally diverse team members, however, come from different “thought worlds” (Dougherty, 1992). Therefore, functionally diverse teams may fail to innovate. Some research points to the importance of cognitive differences in general for stimulating group creativity and team performance during innovation tasks (Nijstad & Stroebe, 2006; Sutton & Hargadon, 1996). Other researchers have shown that cognitive differences lead to misunderstandings, tensions, and conflict that harm team performance and innovation (Cronin & Weingart, 2007; Dearborn & Simon, 1958; Dougherty, 1992). Thus, paradoxically, cognitive diversity both benefits and harms innovation teams. To reconcile the conflicting predictions, we examine both creativity processes and conflict processes and their relationship to deep level diversity and other types of cognitive differences in functionally diverse innovation teams.

In innovation team projects, creativity represents an integral part of the innovation process (West, 2002). Members of creative groups (such as brainstorming groups), however, are often discouraged from expressing disagreements while generating ideas based on the belief that it will generate fear of negative evaluations and thus interfere with members’ willingness to take risks and “think outside the box”(Osborn, 1957; Paulus, Dugosh, Dzindolet, Putman, & Coskun, 2002). In the paper, I investigate whether and why team members with different functional backgrounds can be more creative not in spite, but because, of engaging in disagreements and conflict. To better understand the relationship between conflict and creativity, I integrate both

cognitive and emotion-related predictions on the relationships between these two seemingly conflicting forces.

In this paper, I attempt to disentangle the effects of conflict on creativity and examine the tension between the cognitive and emotion-based mechanisms of the relationship. I examine this tension between team cognition and emotion by investigating how task conflict, negative conflict emotions of fear, cognitive diversity, and creative processes affect new product development success. I focus on two types of emergent structures of cognitive diversity: deep level cognitive differences in terms of diversity in functional values and transactive memory systems. Integrating theories on work diversity, conflict, creativity, and innovation, I propose that deep level cognitive diversity harms the interpersonal creative processes of idea sharing and cross-functional idea building in functionally diverse teams and thus inhibits innovation. I develop a model in which task conflict can be a positive force that solves this problem in two ways (see Figure 1). First, task conflict can reduce deep level cognitive differences by enabling team members to realize, to elaborate on, and to reconcile the existing differences between functional areas and thus improve the interpersonal creative processes. Second, task conflict can strengthen the cognitive division of labor in terms of transactive memory systems and thus improve the interpersonal creative processes and innovation. Furthermore, to capture the emotion-related aspects of the relationship between conflict and creativity, I propose that the effects of task conflict on creativity may not always be positive and consider the effects of negative conflict emotions of fear during innovation. I test the theoretical model using a unique data set of functionally diverse student teams engaged in new product development projects.

Cognitive diversity based on different functional training and experience is particularly interesting because it comprises differences in perspectives, goals, approaches, and language that

are often hard to reconcile. 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 value sets (i.e., functionality versus aesthetics values). These differences are hard to reconcile: the engineer will want to change product attributes, and the designer will not.

To better understand the effects of functional diversity on innovation and the driving processes of conflict and creativity, I disentangle the stable more surface level functional differences such as educational diversity from the evolving deeper level functional differences such as values diversity. Surface level differences are more stable than deep level differences. The deep level differences in values may be initially based on functional training. However, they evolve and change as team members interact and work together as research on deep level diversity shows (Harrison et al., 1999, 2002). Thus, at any point in time after the beginning of the project, the differences in values represent emergent, i.e., resulting from the team members' interactions, structures of deep level diversity. I treat value diversity as an emergent form of cognitive diversity or an emergent team cognitive state (Marks, Mathieu, & Zaccaro, 2001). Furthermore, I argue that emergent cognitive differences can be based not only on the deep level components of functional diversity but also on the cognitive division of labor in terms of transactive memory systems. Research on transactive memory systems provides scarce evidence on how functionally diverse teams develop and use transactive memory systems. It is not clear how the initial cognitive differences of team members based on functional training affect the cognitive division of labor within transactive memory systems. In this paper, I investigate how task conflict affects both emergent deep-level cognitive diversity and transactive memory

systems in functionally diverse teams and their role in predicting the interpersonal creative processes in new product development teams.

Sutton and Hargadon (1996) show that it is important to understand group creative processes not only in standalone brainstorming groups but also in the context of new product development teams. Furthermore, recent research on new product development suggests that the circumstances around the emergence of new ideas predict new product success (Goldenberg, Lehmann, & Mazursky, 2001). This paper examines the interpersonal creative processes that underlie innovation in functionally diverse teams that develop new products and how they are affected by group conflict.

The paper extends current theory and research in three important ways. First, the findings challenge the current understanding of the role of task conflict in creative groups. The study shows that functionally diverse teams can be more creative not in spite but because of task conflict. Second, the research provides evidence on the mechanisms through which task conflict affects innovation. Although some studies find that task conflict stimulates innovation, a recent meta-analysis finds that task conflict on average does not affect innovation (Huelshegger, Anderson, & Salgado, 2009). Encompassing team cognitive states, conflict emotions, and creative processes, the study shows why task can both stimulate or harm innovation and therefore have no effect on average. Finally, I investigate the role of conflict negative emotions in innovation teams and distinguish them from conflict frequency. Creativity researchers prohibit conflict in creative groups because they assume that disagreements and arguments engender negative emotions such as fear of negative evaluations and thus harm group creativity. This understanding is correct but incomplete because it omits task conflict not always engenders

negative emotions and there is a positive role of team cognitive states that emerge as a function of task conflict.

THEORETICAL BACKGROUND AND HYPOTHESES

The Effects of Task Conflict on Interpersonal Creative Processes and Innovation

Task conflict comprises disagreements, arguments, and debates about what the team must do to perform the task (Jehn, 1995). Members of creative groups (such as brainstorming groups) are often discouraged from disagreeing and arguing based on the belief that it will interfere with members' willingness to take risks and "think outside the box". In fact, Osborn (1957) introduces the rule not to disagree and criticize the ideas of others as one of the four basic rules for effective group creativity. I argue that this rule may be dysfunctional in some types of groups and that disagreements in teams with deep level differences are likely to be beneficial. I next theorize on the relationship between task conflict and interpersonal creative processes in functionally diverse innovation teams to provide a deeper understanding of the effects of task disagreements on group creativity.

Although some prior research on task conflict, creativity, and innovation provides evidence that teams with more task conflict produce more original and divergent work (Jehn, Northcraft, & Neale, 1999; Nemeth & Nemeth-Brown, 2003; Van Dyne & Saavedra, 1996), a meta-analysis of the effects of task conflict on team innovation shows that task conflict on average has no effect on team innovation (Huelshegger et al., 2009). To extend the understanding of the effects of task conflict on innovation, I next examine the mechanisms of the relationship between task conflict and group creative processes.

Understanding group, i.e., interpersonal, creative processes will help researchers and managers understand the process gains and losses during team work on creative tasks such as new product development (Steiner, 1972). The research on group creative processes such as idea sharing and idea building is scarce (George, 2007). Group creativity research suggests that team members must follow the brainstorming rules of idea sharing, building on each other ideas, and not engaging in conflict in order to be successful (Osborn, 1957). However, it is unclear why and when the group creative processes of idea sharing and idea building will be most effective and how they are affected by conflict in the setting of functionally diverse teams.

Drawing on theories of conflict, creativity, and team cognition, I propose that there are two pathways through which task conflict stimulates idea sharing and thus cross-functional idea building in functionally diverse innovation teams. First, task conflict can directly resolve the problems of the negative effects of deep level diversity on team creativity through reducing the deep level differences. Task conflict can stimulate interpersonal creative processes through surfacing and elaborating of deep level differences such as differences in the values about what a successful team must do. Second, task conflict can promote the emergence of team cognitive states such as transactive memory systems that foster creativity and innovation. Task conflict can be beneficial for interpersonal creative processes through strengthening the transactive memory systems of the team, i.e., the cognitive division of labor based on specialization and knowledge of who knows what (Liang, Moreland, & Argote, 1995; Wegner, 1987).

The mediating role of value diversity. As theories on work diversity and innovation predict, task conflict in terms of disagreements and arguments in functional diverse teams allows for deep level differences to surface (Cronin & Weingart, 2007). The positive effect of information-related diversity results from processes of use of diverse information. Task conflict represents

one of the core processes through which this surfacing and use of diverse information takes place (Cronin and Weingart, 2007; Jehn et al., 1999; van Knippenberg and Schippers, 2007).

Team members who are exposed to the different approaches, values, and perspectives and elaborate on them are more likely to expand their own system of approaches, values, and perspectives. Weingart and colleagues (2010) provide evidence that task conflict changes the deep level differences in problem representations as team members engage in disagreements, elaborate, and accommodate the differences (Weingart, Todorova, & Cronin, 2010). They suggest that task conflict increases the overlap between functional mental models because it enlarges functional perspective through the cognitive process of accommodation (Fiske & Linville, 1980; Piaget, 1952). Similarly, task conflict will increase the overlap in functional values as team members from different functional backgrounds who work interdependently adopt some of the new values in order to solve the conflicts and jointly develop new products. Thus, task conflict will reduce deep level diversity in terms of value diversity.

Deep level cognitive diversity such as value diversity may impede group creative processes through interfering with elaboration, i.e., with information and idea processing. Paulus and Yang (2000) investigated problems with idea sharing in brainstorming groups and showed that idea sharing can be stimulated if individuals are instructed to pay more attention to the ideas of others. In functionally diverse teams, however, differences in schemas and systems of meaning between functions make it harder for team members to notice and perceive ideas of functionally different others even if people attempt to pay attention to what the others contribute (Dougherty, 1992). The representational gaps perspective on work diversity also proposes that differences in functional perspectives will deteriorate the information sharing in innovation teams (Cronin & Weingart, 2007; Weingart, Cronin, Hauser, Cagan, & Vogel, 2005). Deep level differences

related to the differences in functional systems of meaning represent a barrier to idea sharing because ideas are not perceived and thus not received by functionally different others. Deep level difference of this type can hinder also the cross-functional idea building, because the team members with different system of meanings will not be able to understand and integrate the ideas of functionally different others. Thus, deep level diversity may hinder the interpersonal creative processes through interfering with information processing.

In addition to the information processing mechanism, a social categorization mechanism may be at play when team members with deep level differences interact and develop new products. Deep level differences including value diversity reduce group cohesion and social integration through social-categorization processes of stereotyping and ingroup biases (Harrison et al., 1999, 2002). In groups with less smooth interactions between functional subgroups, both idea sharing and cross-functional idea building will deteriorate. When teams members think about functionally diverse others in terms of outgroup members, they do not share ideas with them even if the work is designed to motivate idea sharing. Furthermore, Todorova and Weingart (2009) provided evidence that gaining experience working together hindered cross-functional idea building and theorized that surfacing of more deep level differences and the social categorization based on those differences explains the negative effects. In sum, both social categorization processes and errors in information processing triggered by deep level differences may lead to lower idea sharing and cross-functional idea building in teams with deep level differences. Integrating the arguments on the effects of task conflict on deep level diversity and of deep level diversity on interpersonal creative processes, I propose that task conflict will increase idea sharing through its negative effects on value diversity. Therefore, I hypothesize:

Hypothesis 1: *Value diversity will mediate the positive relationship between task conflict and idea sharing. Specifically, task conflict will decrease the deep level diversity which decreases idea sharing.*

The mediating role of transactive memory systems. Teams with transactive memory systems have systems for distributing and retrieving knowledge based on team members' specific areas of expertise (Hollingshead, 1998; Lewis, 2004; Liang et al., 1995; Wegner, 1987). Furthermore, transactive memory systems are based on both cognitive specialization and knowledge of who knows what. I contend that task conflict will facilitate the development of such systems. Engaging in disagreements will help team members learn about the differences in their knowledge domains and systems of meaning and thus acquire knowledge about who knows what. Disagreements will further promote specialization as team members become aware of the differences between functional areas, develop credibility and trust in their expertise, and learn to coordinate the effort to combine the functional inputs. Within a transactive memory system, specialization is related to credibility and smooth coordination in combining the specialized inputs (Lewis, 2003; Liang et al., 1995). Task conflict will stimulate the development of specialization that is based on the functional expertise, credibility of functional experts, and smooth coordination of functional inputs. Thus, functionally diverse teams where team members engage in task conflict will develop more accurate and thus stronger transactive memory systems.

Task conflict can promote creativity and innovation through strengthening the transactive memory system of the team. Transactive memory systems render new product development teams more creative (Gino, Argote, Miron-Spektor, & Todorova, 2010). The components of transactive memory systems, i.e., specialization, credibility, and coordination (Liang et al., 1995;

Lewis, 2003) will be especially important for innovation in functionally diverse teams.

Specialization based on functional expertise will allow team members to act based on their own shared systems of meaning within their knowledge roles on the team. Identification of who knows what on the team represents an important prerequisite for the development of transactive memory system development (Austin, 2003; Liang et al., 1995; Pearsal, Ellis, & Bell, 2009). Identification of who knows what within the transactive memory system will present the opportunity to act based on one owns knowledge and system of meaning within the bounds of their specialized knowledge domain and thus without interfering with other team members' activities. Therefore, specialization based on functional expertise will enhance also coordination.

Task conflict will affect the *coordination* component of transactive memory system. Difference in functional perspectives may inhibit coordination through engendering conflicting behaviors if team members do not surface these differences through task conflict (Cronin & Weingart, 2007). Team members in functionally diverse teams who engage in task conflict will learn more about their differences and will be more able to predict the subsequent behaviors of other team members. Predicting the behaviors of other team members represents an important determinant of effective coordination in teams (Wittenbaum, Vaughan, & Stasser, 1998). Thus, team members in teams with task conflict will develop the ability to effectively combine the activities of team members will allow for smooth retrieval, storage, and exchange of both old and new knowledge related to idea sharing

The *credibility* in the opinions and ideas of functionally diverse team members participating in a transactive memory system will also be enhanced by task conflict because task conflict and the related identification of expertise domain will encourage team members to pay attention to and accept the ideas of functionally different others. Identification of expertise

enhances credibility and trust in functionally diverse teams (Bunderson, 2003). Thus, even if the values, approaches, and language are different, team members will accept, trust, and value these ideas because of the credibility in the opinions and ideas of functional experts within the team's transactive memory system.

Consequently, transactive memory systems in functionally diverse teams will promote idea sharing and cross-functional idea building through enabling more knowledge specialization, credibility, and coordination based on the team members' functional expertise. Even in the presence of deep level diversity, functionally diverse teams will be more innovative when they engage in task conflict and develop a cognitive division of labor in terms of transactive memory systems. Therefore, I hypothesize:

Hypothesis 2: Task conflict will increase idea sharing through its positive effect on transactive memory systems.

The mediating role of negative emotions of fear during task conflict. Task conflict may also hinder idea sharing. Brainstorming research suggests that disagreements and arguments about ideas may actually generate negative emotions such as fear of negative evaluations (Osborn, 1957; Paulus et al., 2002). The negative emotions that disagreements with ideas may engender represent the rationale for the brainstorming rule that forbids disagreements and arguments during group creative tasks. Consequently, to understand the relationship between conflict and creativity in teams, it is important to include not only the cognitive effects of task conflict such as change in deep level diversity but also the emotion-related effects of task conflict, i.e., task conflict emotions. We build on the brainstorming research and suggest that negative emotions during task conflict hinder the idea sharing.

Negative emotions of fear such as fear of negative evaluations may reduce the willingness to be vulnerable to others and thus to trust them. Credibility, a type of trust, represents an integral part of TMS. Thus, fear engendered during task conflict may weaken TMS through its negative effects on trust. Negative emotions during task conflict are likely to inhibit the use of transactive memory systems. They may disrupt the transactive memory system for retrieval, storing, and use of information because they disrupt interpersonal communication, decrease trust, and reduce the sharing of information within teams (Ellis, 2006; Jehn, 1995, 1997; Rau, 2005;).

Negative emotions during task conflict may be harmful for the relationships within the team. Prior research shows that task conflict often leads to conflict about the relationships (De Dreu and Weingart, 2003; Simons & Peterson, 2000) and explains this relationship through the negative emotions that task conflict may generate (Greer, Jehn, & Mannix, 2008). Negative emotions during task conflict help transform task conflict into conflict about the relationship because task conflict will be more easily misinterpreted as personal attacks (Greer et al., 2008; Jehn & Mannix, 2001; Simons & Peterson, 2000).

In a study of top management teams, Rau shows that the knowledge of who knows what within a transactive memory system has no effects on team performance for teams with high relationship conflict (Rau, 2005). Fear during task conflict and the resulting tension about the relationship decreases the credibility component of TMS because team members become less willing to rely on other team members (Jehn, Greer, Levine, & Szulanski, 2008). Recent research shows that negative emotions such as stress disrupt the functioning of transactive memory systems (Ellis, 2006). Therefore, we expect that fear during task conflict will reduce the use of transactive memory systems. Thus, negative emotions of fear during task conflict represent the

path of the negative effects of task conflict on idea sharing. Fear harms the relationships within the team and destroys the credibility component of TMS. Therefore, we predict:

Hypothesis 3: Negative emotions of fear during task conflict will decrease idea sharing through their negative effect on transactive memory systems.

Research on relationship between task conflict frequency and task conflict negative emotions is scarce. Although disagreements may lead to negative emotions of fear of negative evaluations as brainstorming research predicts (Paulus et al., 2002), conflict research shows that disagreements and conflict do not always lead to negative emotions (Weingart, Bear, & Todorova, 2009). Since the relationship between task conflict frequency and task conflict negative emotions may depend on characteristics of the individual, i.e., tolerance for disagreement, the team, i.e., conflict management approaches, or the context, i.e., work design, I do not develop a hypothesis on the direct effect of task conflict frequency on task conflict emotions.

The Effects of Interpersonal Creative Processes on Innovation

Group creativity research is grounded in the brainstorming tradition. Most research on group creativity in the brainstorming tradition focuses on brainstorming groups and investigates why the group is more creative than the individual and how the group affects the individual (Diehl & Stroebe, 1987; Paulus et al., 2002). The creativity processes such as production blocking and cognitive stimulation that this research stream uncovers are related mainly to intrapersonal creativity. The brainstorming research provides some insight into which interpersonal creative processes are important as a part of the brainstorming rules. However, even when interpersonal

processes such as idea sharing are investigated, the focus is on individual level predictors such as individual's attention to ideas (Paulus et al., 2002).

Interpersonal creative processes such as idea sharing and idea building are likely to predict the success of innovation teams. Group creativity represents an integral part of innovation; innovation has been defined as idea generation and implementation of the ideas (West, 2002). Drawing on the combination of contribution perspective on group creativity, I argue that interpersonal creative processes enable functionally diverse team members to capitalize on their expertise and information differences, because they allow them to combine the creative inputs (Nijstad et al., 2006). Teams where team members share and build on each other's ideas will effectively use their different novel inputs to generate more innovative products. A field study in one of the most innovative companies, IDEO, shows that access to diverse expertise represents an important source of advantage of creative groups (Sutton & Hargadon, 1996) but additional group processes are needed to transform the creative individual into a creative group (Hargadon & Bechky, 2006). Furthermore, as a meta-analysis on innovation in teams shows, team processes have stronger impact on team innovation than team composition and input (Huelshegger et al., 2009). In line with these arguments, I argue that the team processes related to group creativity represent an important factor in predicting the success of new product development teams. Furthermore, I propose that idea sharing represents an antecedent of cross-functional idea building. Group creativity scholars theorize that effective sharing of ideas is the necessary first step of group creative processes. Only if effective idea sharing takes place, cross-functional idea building and combination of novel contribution will occur (Baruah & Paulus, 2009; Paulus & Brown, 2003; Nijstad et al, 2006). If team members do not receive ideas from other team members they cannot build on them. Therefore, I hypothesize:

Hypothesis 4a: *Teams with more idea sharing will develop more innovative products.*

Hypothesis 4b: *Teams with more cross-functional idea building will develop more innovative products.*

Hypothesis 4c: *Teams with more idea sharing will have more cross-functional idea building.*

RESEARCH METHOD

Sample

Data was collected as part of a larger project on innovation in functionally diverse teams.

Participants included teams of graduate students who developed new entertainment and technology products as part of their master program. The goal of these new product development projects was to have technologists and fine artists work together on projects that produce artifacts intended to entertain, inform, inspire, or otherwise affect the customers. The program focus was on interdisciplinary work and innovation. The teams presented their work in front of the faculty and the other students at four points of time. The survey data was collected before the presentations in order to avoid the effects of feedback on the respondents. Each team had two faculty advisors but received feedback from all faculty members.

Data was collected from 222 students in 49 teams. The teams consisted of 2 to 11 team members and developed new products together over the period of 4 months. Team members with following educational backgrounds are included in the sample: computer science, engineering, business administration, cognitive science, sociology and history, art (film, theater, literature, music), and design.

This research setting was appropriate because the conditions were similar to those experienced by real-world new product development teams. When students were informally asked how their project team experience compared with their internship experiences, the general consensus was that they were very similar. This view was affirmed by faculty members who indicated that the team project experience was designed to replicate the dynamics and pressures of working in an interactive media team in an organizational setting. Furthermore, the research settings was appropriate for the study of conflict and creativity in diverse innovation teams. Each team project involved producing high technology new products for various applications such as entertainment (e.g., videogames), education (e.g., interactive museum exhibits), military (e.g., new applications for control) and aesthetic appeal (e.g., interactive art). Observations of the team interactions revealed that teams varied in their conflict level as well as in their creativity processes. For example, while members of team A engaged in heated conflict about the design of the product, members of team B avoided conflict. Often members of team B would choose not to voice their opinions or even leave the meeting during conflict episodes. Interestingly, team A developed more novel and useful product than team B. Interviews with team members on the idea building process revealed the problems that team B had with cross-functional idea building while conversations with the faculty revealed an overall low evaluation of the product that stemmed from a low evaluations of the product on one of the functional disciplines, namely design. Faculty agreed that the technological features of the product of team B were outstanding but commented that the product is “user unfriendly and even ugly”. Thus team B seemed not to have been able to succeed in cross-functional creativity.

Team members had to complete a web-based survey at four points of time. The survey was administered approximately every 3 weeks with each survey taking between 10-20 minutes

to complete. The fourth survey was collected before the final presentation and the final grading took place. In this paper, I used the final grades of the teams as product innovation measures in order to avoid common method bias and increase the internal validity of the study. A group of 13 faculty members evaluated together the final product and presentation of the teams.

To increase the response rate, participants received a \$5 Amazon gift and pizza was provided to each team in which all members completed the survey. Eight teams were removed because their response rate was lower than 50%. Thus, the current sample used in this paper consists of 180 students in 41 teams. Data were collected from the masters program across 2 years. The masters program was taught by the same faculty using the same team selection criteria and same course requirements across both years.¹⁰ To gain a better understanding of the context I observed the team meetings of two teams and the presentations of all teams. In addition, I interviewed team members informally or with a semi-structured questionnaire. I also attended several faculty meetings where the grades were discussed and determined.

Measures

Educational background was collected at the beginning of the project. Measures of task conflict and task conflict emotions were collected 9 weeks after the beginning of the project work, at the end of Phase 3. The measures of deep level diversity, transactive memory systems, idea sharing, and cross-functional idea building were collected 12 weeks after the beginning of the course. They were collected at the end of the project but before the final presentation and the faculty evaluations of the teams. The self-report scales consisted of 5-point Likert-type scales ranging

¹⁰ Data is currently being collected for one more academic year. These data will be then added to the current sample to increase the validity of the results through increasing the sample size.

from strongly disagree to strongly agree. We chose to collect the first measures of team processes and states after 9 and 12 weeks of team interactions in order to capture the emergent team properties that need time to develop. The effects on emergent deep level cognitive structures are latent and need time to emerge. Furthermore, we collected the task conflict measure before the other measure because task conflict was theorized to be the emergent process through which the states of deep level diversity and TMS emerge. Thus, we could be more confident in the temporal precedence of the processes that theoretically lead to emergence of the cognitive states of deep level diversity and TMS. We captured the interpersonal creative processes during the final stage of the product development because interpersonal creative processes vary over time and we wanted to make sure that we capture the creative processes that are most proximal to the creative outcomes, i.e., to the final new product.

Product innovation was assessed by all 13 faculty members of the program at a meeting at the end of the semester. Faculty members assessed both the final product and the presentation. Independent ratings of product innovation were used to avoid problems of common method bias.

Deep level diversity: values diversity. I chose four aspects of values related to functional training as measures of values diversity. The four aspects of values were related to functional training as the basis for values diversity because I wanted to incorporate the effects of functional diversity on team cognition. Value diversity levels changed over time as values changed. I studied the effects of task conflict as the process which facilitated the change of value diversity states and emergence of new states of value diversity different from the initial functional diversity. The choice of the value aspects was based on the functional composition of our sample and prior research on functional diversity, functional work styles, and design thinking (Dougherty, 1992; Sanders, 1996, 2002; Weingart et al., 2005). I asked team members to indicate

whether they agree or disagree that the following words describe what a team ought to be in order to be successful: analytical, logical, intuitive, and informal. I used a 5-point Likert-type scale (ranging from Strongly disagree=1 to Strongly agree =5).

Two of the words, i.e., analytical and logical, reflected the more mechanistic understanding of what is valuable that is related to the engineering and computer science functional backgrounds. The other two words, i.e., intuitive and informal, captured the more organic understanding of what work approaches are valuable that is more typical of designers and artists. I compared the means of the four items for team members with computer and engineering major versus team members with design, art, business, and humanities majors. The mean differences were in the predicted directions: members with computer science and engineering background had higher means on analytical and logical values and lower means on intuitive and informal values compared to team members with the design, art, and humanities backgrounds. Paired sample t-tests showed that team members differed significantly in their valuing of the analytic versus informal task approach ($t=5.83$, $p<.0001$) as well as in their valuing of the logical versus intuitive task approach ($t=5.01$, $p<.0001$). Therefore, for the calculation of the measure of deep level diversity I used these four items to reflect the different functional values about task approaches. Drawing on the approach to measuring deep level diversity used by Harrison and colleagues (1998), I used within-group coefficient of variation to index functional value diversity. I first calculated the coefficient of variation for each item. I then proceeded to sum the coefficients of variation for the four items.

Idea sharing. Each team member reported on the level of idea sharing, i.e., whether they received ideas during discussions with other team members (see Appendix A). I used a measure developed and validated in prior research (Todorova, Brake, & Weingart, 2010). The reliability

of the 5-item measure was high ($\alpha = .93$). I chose an individual level referent instead of a group level referent to assess idea sharing during team meeting (i.e., how “I” receive ideas by idea sharing within my lab group) because of the difficulties and biases that individuals might have in evaluating what constitutes ideas for other people. I then aggregated the responses to the group level using a consensus composition model to measure group level properties (Chen, Bliese, & Mathieu, 2005). The estimated values of the inter-member reliability statistics supported the aggregation to the team level (ICC(1)=.17, significant F test; ICC (2)=.45). I had missing data for 6 teams. The data for these teams was imputed using the imputation techniques in for SEM in AMOS. In the next drafts of the paper, these teams will be removed and new teams with complete data on idea sharing will be added.

Cross-functional idea building. Idea building was assessed using a measure of ease of cross-functional idea building developed and validated in prior research (Todorova & Weingart, 2009). The scale assessed the ease with which team members understood and integrated their own ideas with the ideas of team members from the other functional backgrounds. Since the task of team members was to engage in cross-functional creative work, the ease of idea building represented an indicator of how much team members will engage in idea building. This approach has been used in prior research where researchers assessed knowledge transfer using scales of ease of knowledge transfer (Reagans and McEvily, 2003).

Respondents were asked to think about a specific member of their team and indicate their level of agreement (on a 5-point scale ranging from *strongly disagree* to *strongly agree*) with the following items, “His/her ideas are difficult to build on” (reverse-scored), “It is hard to incorporate his/her ideas in with my own” (reverse-scored), “I understand his/her ideas,” and “I tend to dismiss what s/he says” (reverse-scored). The scale includes two items on ease of idea

building, one item on understanding of ideas, and one item on the acceptance of ideas. I included the latter two items to fully capture the construct space of cross-functional idea building. First, I included an item on understanding because it is a necessary precondition of idea building between team members coming from functional backgrounds, i.e., from different thought worlds. Second, I included dismissal of an idea because it provides information about whether ideas tended to be considered at all. Only the responses to items on “cross-functional idea building” which referred to team members with different functional background were averaged within individuals to reflect how a team member integrates ideas with members from the different functional areas. For example, if a team member was an engineer, “cross-functional idea building” reflected her idea building with art, business, humanities, and design students on her team. The reliability was satisfactory (Cronbach alpha =.89). The results from the tests for group level aggregation supported the aggregation of the items to the team level (ICC(1)=.20, significant F test; ICC(2)=.45).

Task conflict: frequency. To assess the amount of disagreements, arguments, and debates over differing opinions and ideas, I used a scale adapted from Behfar, Mannix, Peterson, and Trochim (2008) (see Appendix A). Since I hypothesized that task conflict predicts emergent team cognition and group creative processes, the measure of task conflict was collected three weeks before the measures of deep level diversity, transactive memory systems, and group creative processes, i.e., idea sharing and cross-functional idea building.

The test the reliability of the scale was satisfactory (Cronbach alpha =.88). Following the accepted approach to measuring task conflict, I aggregated the scale of task conflict to the team level after testing for homogeneity of responses in the groups (ICC(1)=.15, significant F-test; ICC(2)=.43). I tested for the discriminant validity of task conflict and idea sharing. Based on the

results of principle component analysis with promax rotation ($Kappa=4$), a two factor solution fitted the data best. Thus, task conflict and idea sharing represented two different constructs. The correlation between the two constructs was statistically significant but low ($r=.38$, $p<.05$).

Task conflict: negative emotions of fear. I used a self-report measure of fear as a main task conflict negative emotion. The two items were selected from a fear scale developed and validated in PANAS X. Team members were presented with two adjectives for fear emotions, i.e., afraid and distressed. They were asked whether they feel these emotions when their team engages in task conflict using self-report scale ranging from strongly disagree to strongly agree. The reliability indices were satisfactory (Cronbach Alpha =.67). I conceptualized task conflict emotions as a summary index measure (Chen et al., 2005) and averaged them within team before including the variable in the hypotheses tests.

Transactive memory systems. I measured the extent to which team members developed a transactive memory system using the scale developed and validated by Lewis (2003) (see Appendix A). The TMS scale consists of three subscales: specialization, coordination, and credibility. Following research on trust where items are adapted to reflect the characteristics of the referent, I adapted the credibility measure to the context of functionally diverse teams where the level of credibility within and between functions may be different. I asked each member to report on the credibility of the knowledge of each of the other team members instead of asking to assess the credibility for the team as a whole. In order to reduce the length of the survey, I used only two items from the original 4 item subscale. I aggregated the responses of the credibility items for all team members. The results from second-order confirmatory factor analysis (CFA) showed that the three subscales, i.e., specialization, coordination, and credibility, represented components of a higher order factor ($Chi\text{-squared} = .97$, $p=.32$; $GFI=.99$; $RMSEA=.001$; factor

loadings: $f=.57$ for specialization, $f=.58$ for coordination, and $f=1$ for credibility). Therefore, TMS was measured using the three subscales. Consistent with the CFA results and prior research, the subscales were aggregated into a single construct of TMS.

The reliability of the TMS scale was satisfactory (Cronbach alpha = .73). Before aggregating the items of the specialization, credibility, and coordination subscales to the team level, I tested statistically whether the team member responses were similar enough to be aggregated into a team score. Checks of ICC(1) and ICC (2) yielded acceptable values for each of the TMS subscales and for the overall TMS (ICC(1) = .44, significant F-test; ICC(2) = .76).

Product innovation. I used the faculty evaluations of the final product and presentation to measure product innovation. The final product and presentation of the teams were evaluated by all members of the faculty at a meeting at the end of the semester and after the final survey was administered. The evaluation criteria were based on the novelty and usefulness of the new product that the team had developed. The temporal precedence of the self report measures with regard to the product innovation measure increased the validity of our results. The evaluation criteria used by the faculty were related to both novelty and usefulness. Therefore, they reflected the criteria for assessing the creativity and innovation levels of new products established by prior research (Amabile, 1983; Gino et al., 2010). The products and presentation were assessed on a 5-point scale. Because of the high correlation between the two evaluations ($r=.82$), I used them as dimensions of a latent variable of product innovation.

Control variable 1: Functional diversity. I controlled functional diversity to rule out alternative explanations that the association between team processes and team outcomes was caused by team composition. According to the IPO framework of teamwork, team composition causes team processes which in turn predict team outcomes. The effects of team composition on

team outcomes, however, may be only partially mediated by the processes included in the study. Therefore, I included functional diversity as a control variable in the models.

Functional diversity was measured in terms of team members' major area of study associated with their most recent educational degree because post-doctoral and graduate students' expertise is typically derived from other educational programs. Similar to functional diversity, educational diversity results in differences in perspectives, languages, and values of the team members. In the sample, team members had 12 unique majors. The most common majors were computer science, design, and engineering. Since the data was categorical, I calculated diversity using Blau's (1977) index $(1 - \sum p_i^2)$ where p_i is the fraction of group members with major i .

Control variable 2: Team size. To capture the possibility that large teams may have different task conflict, emergent cognitive states, and creativity processes and that size may be driving the team process effects, I controlled for team size.

RESULTS

I analyzed the data with structural equation modeling (SEM) using AMOS software (version 19) with maximum likelihood estimation procedures. SEM provides the opportunity to test for complex theoretical relationships in order to disentangle the mechanisms through which the relationships between variables occur (Bagozzi & Phillips, 1982; Hedstroem & Swedberg, 1998).

I tested the full theoretical model with a structural model where I controlled for the effects of functional diversity, and size. First, I evaluated the overall model fit with the data

using the overall fit indices. The overall fit of the final model was very good ($\chi^2(29) = 31.78$, CFI=.98, IFI=.98, RMSEA=.05, RMSEA confidence interval = .00, .13). After establishing the overall goodness of fit, I considered the paths in the model.

Figure 2 depicts the path coefficients for the hypothesized relationships. The coefficient sizes and significance are summarized in table 2. As hypothesized, task conflict had a statistically significant negative effect on deep level diversity ($b = -.34$, $p < .05$). Furthermore, deep level diversity had a statistically significant effect on idea sharing ($b = -.24$, $p < .05$). Therefore, the results showed that deep level diversity mediates the effect of task conflict on idea sharing, supporting hypothesis 1. The results of the bootstrap mediation analysis of indirect effects showed that task conflict had a statistically significant positive indirect effect on idea sharing (indirect effect = .27, $p < .05$). Task conflict in the new product development teams stimulated creative processes because it reduced the deep level diversity and thus facilitated the interpersonal creative processes and innovation.

Hypothesis 2 predicted that task conflict will affect another type of emergent team cognitive structure, namely the transactive memory systems. The effect of task conflict on transactive memory systems was positive and statistically significant ($b = .26$, $p < .05$). The effect of transactive memory system on idea sharing was positive and statistically significant ($b = .75$, $p < .001$). Therefore, I found support that task conflict will increase idea sharing through its positive effect on TMS (hypothesis 2). Teams with task conflict developed more their transactive memory systems and their transactive memory systems enabled them to engage more in idea sharing.

In Hypothesis 3, I predicted that task conflict negative emotions of fear will negatively affect idea sharing and that the effect will be mediated through transactive memory systems. The task conflict negative emotions of fear had statistically significant effects on transactive memory systems ($b = -.54$, $p < .001$, respectively) and no statistically significant direct effects on idea sharing. The bootstrap mediation analysis provided further evidence that the effect of task conflict negative emotions on intergroup creative processes of idea sharing was indirect, i.e., through the effects of task conflict negative emotions on the development and use of the transactive memory systems (indirect effect of task conflict negative emotions of fear $= -.41$, $p < .01$). Thus, we found support for hypothesis 3. Teams with negative emotions during task conflict used less their transactive memory systems and therefore engaged less in idea sharing.

Idea sharing and cross-functional idea building were expected to predict product innovation (hypothesis 4a and 4b). The effect of cross-functional idea building on product innovation was positive and statistically significant ($b = .25$, $p < .05$) while the effect of idea sharing on product innovation was not statistically significant. Therefore, hypothesis 4b was supported but hypothesis 4a was not supported. Furthermore, I predicted and found that idea sharing had a positive effect on cross-functional idea building ($b = .22$, $p < .05$). Thus, hypothesis 4c was supported. Idea sharing increased the opportunities for innovation-enhancing cross-functional idea building but did not have a direct effect on product innovation.

The control variable of size had no statistically significant effect on team processes and a statistically significant positive effect on product innovation ($b = .47$, $p < .001$). Teams with more resources in terms of number of team members developed more innovative products. The other control variable, functional diversity, had a statistically significant effect on cross-functional idea building ($b = .81$, $p < .001$) and no statistically significant effect on the other team processes or

product innovation. Higher functional diversity provided more opportunities for cross-functional idea building in the teams.

DISCUSSION

Team members with different functional backgrounds can be more creative not in spite, but because of engaging in disagreements and conflict. Although task conflict negative emotions of fear may interfere with the positive effects of task conflict, task conflict does not always lead to negative emotions. Furthermore, task conflict stimulates creativity through its effects on emergent cognitive structures. Prior research suggests that group creativity in functionally diverse teams can be problematic because of the inherent differences in cognition: the ideas coming from team members with different functional values, approaches, and language are not in harmony with the individual's system of meaning and are therefore dismissed (Dougherty, 1992). The study shows that task conflict solves this problem in two ways: it reduces the functional differences in individuals' systems of meanings and strengthens the cognitive division of labor underlying a team's TMS thus fostering group creativity and new product development.

Empirical evidence on individual creative processes in groups that are requested to follow these rules abounds. However, the empirical evidence on the group creative processes of idea sharing and idea building as well as on their relationship to disagreements and conflict is scarce (George, 2007). Researchers and practitioners often assume that group members follow the brainstorming rules of idea sharing, idea building, and not disagreeing and that those rules are productive. Questioning this assumption, I showed that team members who engage more frequently in task conflict engage in more idea sharing and idea building and thus develop more novel and useful products. If task conflict engendered negative emotions of fear, it actually hindered idea sharing through weakening the transactive system of the team.

In order to understand the relationship between the conflict and creativity processes in functionally diverse innovation teams, it is important to capture and study the emergent group cognitive states through which conflict processes affect the group creative processes. Some emergent differences in group cognition can be complementary, i.e., transactive memory systems (TMS). Other differences in emergent team cognition can be incongruent such as the incongruent differences in the values based on different functional training and approaches. The research showed that task conflict affected the emergence and effects of both types of differences in group cognitive structures. Task conflict was the emergent processes that affected both cognitive differences that are difficult to reconcile, such as emergent functional value diversity, as well as cognitive differences that are complimentary, such as transactive memory systems.

The results of the study generalize to groups involved in complex and highly novel projects characterized by high ambiguity of both the end states and means to reach the end states, i.e., to groups in the situation of wicked problems (Rittel & Webber, 1973). For wicked problems the goal is not clear and it is not clear whether and how they can be resolved. Groups that work on such problems need to engage in both deep level thinking and deploy broad expertise resources. In such groups, task conflict both stimulates the deep level thinking that is necessary for change of deep level cognitive differences and helps the deployment of an existing broad base of resources through the change of deep level cognitive differences. Future research should investigate the relationship between conflict and creativity in other types of teams facing “wicked problems” such as entrepreneurial teams and emergency teams.

The effects of task conflict on deep level diversity may differ for teams that work in situations with lower process and outcome interdependence. In such situations, task conflict may lead to polarization and enlarging of the initial differences instead of accommodation and

shrinking of the initial differences. Recent research provides evidence that task conflict may have both enlarging and shrinking effects on cognitive diversity (Weingart et al., 2010). Future research should investigate interdependence, collaboration, and other boundary conditions that may predict the effects of task conflict on emergent structures of cognitive diversity.

We know little about the emergence of TMS in innovation tasks and its effects on innovation outcomes. While most research on TMS has focused on structured tasks, our research shows what fosters the emergence of TMS and how TMS renders teams more creative in ill-structured innovation tasks. Gino and colleagues provide evidence that learning from direct experience fosters the emergence of TMS in new product development tasks and that TMS in turn predicts novelty and usefulness of new products (Gino et al., 2010). I extend the understanding of TMS in innovation teams by examining the mechanisms through which TMS affects creative outcomes. I show that team with TMS share more ideas and thus innovate more. Furthermore, I examine the relationship between TMS and task conflict and show that engaging in disagreements fosters the development of TMS.

Engaging in task conflict may engender negative emotions such as fear of negative evaluations (Paulus & Yang, 2002). The study provides evidence that although task conflict does engender negative emotions, it enhances the emergence of appropriate group cognitive states that stimulate the interpersonal creative processes. Thus, task conflict affects not only individual emotions but group cognition in creative groups. Moreover, task conflict does not always engender negative emotions. There was no significant effect of task conflict frequency on task conflict emotions. Other factors such as tolerance for disagreement, conflict intensity, transformation of task conflict in relationship conflict and conflict management style may represent boundary conditions that determine when task conflict will generate negative emotions.

I provide initial evidence that the relationships between task conflict, conflict emotions, and creativity are more complex than predicted based on prior research. I identify a gap in prior research, i.e., the negative emotions related to task conflict may depend on characteristics of the individual and the team. I encourage future research on the conflict, conflict emotionality, and group creativity.

Why are some diverse teams more innovative than others? In the quest for sustainable competitive advantage, organizations increasingly rely on teams to develop innovative new products. Yet managers often intentionally or unintentionally thwart creativity processes and mismanage conflict in cognitively diverse innovation teams. Integrating the team cognition, transactive memory systems, conflict, and creativity research streams, I showed why conflict can be beneficial for creativity in spite of the negative emotions that it generates. To understand and manage the conflict-creativity relationship, it is important to understand the mechanisms of the relationship between team conflict and creativity in terms of the tension between team cognition and emotions. Different dimensions of conflict, conflict emotions, and emergent team cognition can enhance or inhibit innovation. The more we learn about the interplay of these factors, the more we will know about managing successful new product development teams.

CHAPTER 5

General discussion

My dissertation focuses on the effects of functional expertise diversity on conflict and creativity in innovation teams. Members of creative groups (such as brainstorming groups) are often discouraged from expressing disagreements while generating ideas based on the belief that it will interfere with members' willingness to take risks and "think outside the box". In three studies, I investigate whether and when team members with different functional backgrounds can be more creative not in spite, but because of engaging in disagreements and conflict. The first study shows that task conflict may also stimulate the group creative processes of *idea sharing* if work design and diversity salience are managed appropriately. The second study provides insights on how conflicts in teams where functionally different team members trust each other can stimulate the group creative processes of *idea building* and thus make teams more innovative. The third study extends our understanding of the cognitive and affective mechanisms through which conflict affects the interpersonal creative processes of *idea sharing* and *idea building* in innovation teams.

Taken together the dissertation studies provide evidence about when and why teams who engage in task conflict will be not less but more creative and thus succeed in innovation projects. By studying conflict and creativity processes together, I show when conflict can stimulate interpersonal creative processes: when the direct negative effects of conflict on innovation can be counteracted by the indirect positive effects of conflict on innovation through its effects on interpersonal creative processes. The studies identify and show how to use *two approaches for understanding and managing the relationship between conflict, creativity, and innovation and*

thus how to resolve the tensions between conflict and creativity: first, they identify the moderators or boundary conditions that influence the effects of conflict and creative processes on innovation, and second, they identify the mechanisms of the relationships between conflict and creative processes in innovation teams that can be used for identifying further moderators and conditions that switch on the positive forces of conflict in functionally diverse innovation teams.

The dissertation research suggests that conflict can be a positive force that enhances interpersonal creative processes in functionally diverse innovation teams. In my future research, I want to extend my research on conflict and interpersonal creative processes in innovation teams by investigating the role of conflict emotions and divergent versus convergent task conflict. Task conflict may generate different emotions, i.e., positive or negative, and conflict emotions may have different effects on creativity depending on the individuals, teams, and context characteristics. Furthermore, I want to understand the role of organizational context in terms of ambiguity and uncertainty and how it affects the relationship between conflict and creative processes. For example, more ambiguous context may increase the negative emotions related to conflict and decrease the power of conflict to reduce harmful deep level value diversity and improve transactive memory systems. In this context, conflict may have more negative effects on the interpersonal creative processes and thus on innovation because the negative mechanisms will be amplified while the positive mechanisms will be suppressed.

The empirical evidence on the group creative processes of idea sharing and idea building is scarce (George, 2007). Osborn's (1957) rules on group creativity encompassing the need for sharing of ideas and building on ideas are used as the starting point for much of the current creativity research and practice. Empirical evidence on individual creative processes in groups that are requested to follow these rules abounds. Researchers and practitioners often assume that

group members follow the brainstorming rules of idea sharing and idea building, and therefore do not examine the *antecedents* and *boundary conditions* for these interpersonal creative processes. To question the assumption and extend the understanding of interpersonal creative processes, I build on the combination of contribution framework and develop an idea processing framework (see figure A). Then, I empirically study whether and when team members engage in idea sharing and idea building and how it affects the success of new product development teams. In my future research, I will investigate also the interpersonal creative processes through which ideas are stored or embedded in new products, i.e., idea encoding, and what facilitates or impedes this process. Furthermore, I want to study how different characteristics of the context such as ambiguity and uncertainty, as well as other team processes such as learning processes affect the interpersonal creative processes in diverse teams.

The results of the dissertation studies have also important implications for managing work diversity and new product development. First, although an emphasis on integrated product development and the use of cross-functional teams can enhance product innovation, simply putting together a cross-functional new product development team is not enough. Instead of learning and improving their creative interactions over time, functionally different team members can actually have more difficulty integrating their creative inputs and building on each other's ideas as they work together over time as the more deep level differences surface and pull them apart. Since the surfacing of deep-level differences is inevitable, managers should provide a counterbalance by designing contexts that encourage the development of cross-functional trust over time. Research on diversity suggests that instilling and maintaining appropriate diversity norms (Homan, van Knippenberg, van Kleef, & De Dreu, 2007) and stimulating interdependent work (Joshi & Roh, 2009) may help achieve these goals.

To reap the benefits of functionally diversity, managers should also stimulate task discussion, disagreement, and conflict in new product development teams. Task conflict alone is not sufficient – cross-functional team members need to engage in conflict with people that they trust for cross-functional idea building to improve or in context with enriched work design and low diversity salience. Conflict management tools and norms that rely on addressing conflicts and problem solving may enhance the willingness of functionally different team members to actively engage in task disagreements and conflict as other studies on team conflict suggest (Kuhn & Poole, 2000).

The dissertation research suggests that conflict and creativity processes in functionally diverse new product development teams should be actively managed and fostered over time. In my future research, I want to better understand the dynamics of emergence of team cognitive states as a result of interactions during innovation tasks and how they are related to creative processes of idea sharing and cross-functional idea building. Are emergent cognitive differences better during the opportunity identification and ideation phases or during the implementation phases of a new product development project? How do they affect conflict and creativity processes in innovation project characterized by fast iterations and overlap between these three innovation phases? Are shared mental models or cognitive states with high diversity better during the beginning, the midpoint, and the end of the project? I also plan to study the value of initial and emergent cognitive diversity in different types of environment and organizational contexts.

Why are some teams more innovative than others? In the quest for sustainable competitive advantage, organizations increasingly rely on teams to develop innovative new products. Universities and companies compete on the basis of their innovativeness. Yet

managers often intentionally or unintentionally thwart creativity processes and mismanage conflict in cognitively diverse innovation teams. Using both longitudinal and multilevel approaches and integrating the team cognition, conflict, and creativity research streams, I investigate how the interplay between diversity, conflict, and interpersonal creative processes can enhance or inhibit innovation.

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TABLES

CHAPTER 2 (Paper 1)

TABLE 1: Descriptive statistics and correlations at group level of analysis

	Mean	Std. Dev.	1	2	3	4	5	6	7
1. Expertise diversity	.57	.34	1						
2. Expertise diversity salience	5.44	.87	-.15	1					
3. Task conflict	5.07	.46	.13	.24	1				
4. Idea sharing	2.86	.58	.16	-.49**	.19	1			
5. Group work design	2.79	.38	.29	-.37	.06	.69**	1		
6. Intrinsic satisfaction	2.04	.55	.24	-.23	-.05	.51**	.64**	1	.
7. Group performance	2.46	.87	.01	.05	-.24	.18	.36	.39*	1

Note: * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). All correlations are calculated at the group level of analysis (N=29).

CHAPTER 2 (Paper 1)

TABLE 2: Hierarchical OLS regression analysis: Task conflict as dependent variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std.E.	Beta		
1	Intercept	5.87	.14		43.95	.00
	Expertise diversity salience	.43	.17	.82	2.56	.01
	Expertise diversity	.26	.35	.19	.73	.48
	Expertise diversity squared	.05	.98	.02	.06	.96
	Expertise diversity X Expertise diversity salience	-.31	.35	-.19	-.86	.39
	Expertise diversity squared X Expertise diversity salience	-2.39	1.12	-.63	-2.13	.05

Note: N= 29. Dependent variable is task conflict.

CHAPTER 2 (Paper 1)

TABLE 3: HLM analysis: Idea sharing as dependent variable

Fixed Effect	Coefficient	Std. Error	T-ratio	P-value
<i>Group member effects</i>				
Intrinsic satisfaction	.38	.12	3.17	.01
Expertise diversity salience	-.13	.06	-2.23	.04
<i>Context effects</i>				
Intercept	2.84	.08	35.20	.00
Expertise diversity	-.25	.21	-1.22	.24
Group work design	.73	.26	2.87	.01
Task conflict	.36	.16	2.23	.04
Task conflict X Group work design	-.20	.46	-.44	.66
<i>Cross-level effects</i>				
Expertise diversity salience X Expertise diversity	-.10	.14	-.70	.49
Expertise diversity salience X Group work design	.24	.15	1.58	.13

Expertise diversity				
saliency X				
Task conflict	.13	.13	1.05	.31

Expertise diversity				
saliency X				
Task conflict X				
Group work design	-.71	.28	-2.59	.02

Statistics for current covariance components model

Deviance = 405.14

Number of estimated parameters = 7

Note: n= 148 individuals, N= 29 groups

CHAPTER 2 (Paper 1)

TABLE 4: OLS regression analysis: Group performance as dependent variable

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	Intercept	5.18	2.18		2.38	.03
	Task conflict	-.58	.37	-.301	-1.55	.14
	Expertise diversity salience	.13	.20	.125	.65	.53
3	Intercept	3.55	2.21		1.61	.12
	Task conflict	-.86	.38	-.45	-2.27	.03
	Expertise diversity salience	.38	.22	.38	1.71	.10
	Idea sharing	.67	.33	.44	2.04	.05

Note: N=29

CHAPTER 3 (Paper 2)

TABLE 1: Descriptive statistics and correlations

Table 1a: Descriptive statistics and correlation on the team member level (n = 121) (at midpoint: at the end of phase 2)

Variables	Mean	Std. Dev.	1	2	3	4
1. Cross-functional experience	2.99	.89	1			
2. Cross-functional trust	4.08	.42	.07	1		
3. Ease of cross-functional idea building	4.05	.40	-.02	.70**	1	
4. Cross-functional satisfaction	4.19	.53	.11	.60**	.49**	1

CHAPTER 3 (Paper 2)

Table 1b: Descriptive statistics and correlations on the team level (N = 21) (at midpoint: at the end of phase 2)

Variables	Mean	Std. Dev.	1	2	3	4	5	6
Team cross-functional experience	2.32	.34	1					
2. Team cross-functional trust	3.79	.18	.07	1				
3. Task conflict	4.06	.34	.39	.37	1			
4. Team ease of cross-functional idea building	3.73	.16	-.26	.65**	.04	1		
5. Team cross-functional satisfaction	3.80	.21	.02	.29	.18	.13	1	
6. Product innovativeness	6.06	.85	-.29	.33	-.18	.31	-.09	1

Note: *** p < .001; ** p < .01; * p < .05.

CHAPTER 3 (Paper 2)

TABLE 2: HLM results: Latent Growth Curve models of team member’s ease of cross-functional idea building

Variables	Model 1	Model 2	Model 3a	Model 3b
<i>Level 1 variables</i>				
Intercept	4.02 (.04)***	4.02 (.05)***	4.19 (.06)***	4.19 (.06) ***
Time	.08 (.02)***	.01 (.02)	.01 (.02)	.01 (.02)
Cross-functional experience		-.05 (.02)**	-.05 (.01)**	-.05 (.02)**
Cross-functional trust		.66 (.04)***	.63 (.05)***	.63 (.05)***
<i>Level 3 variables¹¹</i>				
Team task conflict			.06 (.13)	.03 (.13)
<i>Cross-level interactions</i>				
Cross-functional trust X team task conflict				.14 (.07)*
Model Deviance	474.71	161.23	161.38	160.86
Variance components				
<i>Level 1</i>	.09***	.04***	.03***	.03***
<i>Level 2</i> Intercept	.08***	.04***	.12***	.12***
Cross-functional trust slope		.04***	.08***	.07**
<i>Level 3</i> Intercept	.02**	.01*	.01*	.01*

Note: Team members: n = 121; Teams: N = 21. The table shows standardized coefficients (the fixed effects) and variances (the random effects). Coefficients and variances are significant at ***p<.001; **p<.01; *p<.05. Standard errors are shown in parentheses. We centered the time variable using the mid time point (grand mean of time).

¹¹ Level 2 does not include any variables because we did not hypothesize or collect data on any time invariant predictors of team member idea building (i.e., no stable individual differences). Our research question focuses on the dynamics of interactions in teams. The inclusion of level 2 in the model (in the variance components) however allowed to statistically control for the variance of cross-functional idea building due to time invariant predictors (i.e., to stable individual differences). This variance is largely accounted for when cross-functional trust is added into the model.

CHAPTER 3 (Paper 2)

TABLE 3: OLS regression results: The effect of ease of cross-functional idea building on product innovativeness

	Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	Intercept	3.48	3.25		1.07	.30
	Team cross-functional satisfaction	-1.67	.97	-.53	-1.73	.11
	Team task conflict	-.32	.55	-.13	-.59	.57
	Team ease of cross-functional idea building	2.67	.99	.77	2.70	.02

Note: Dependent variable is product innovativeness. Teams N= 21

CHAPTER 3 (Paper 2)

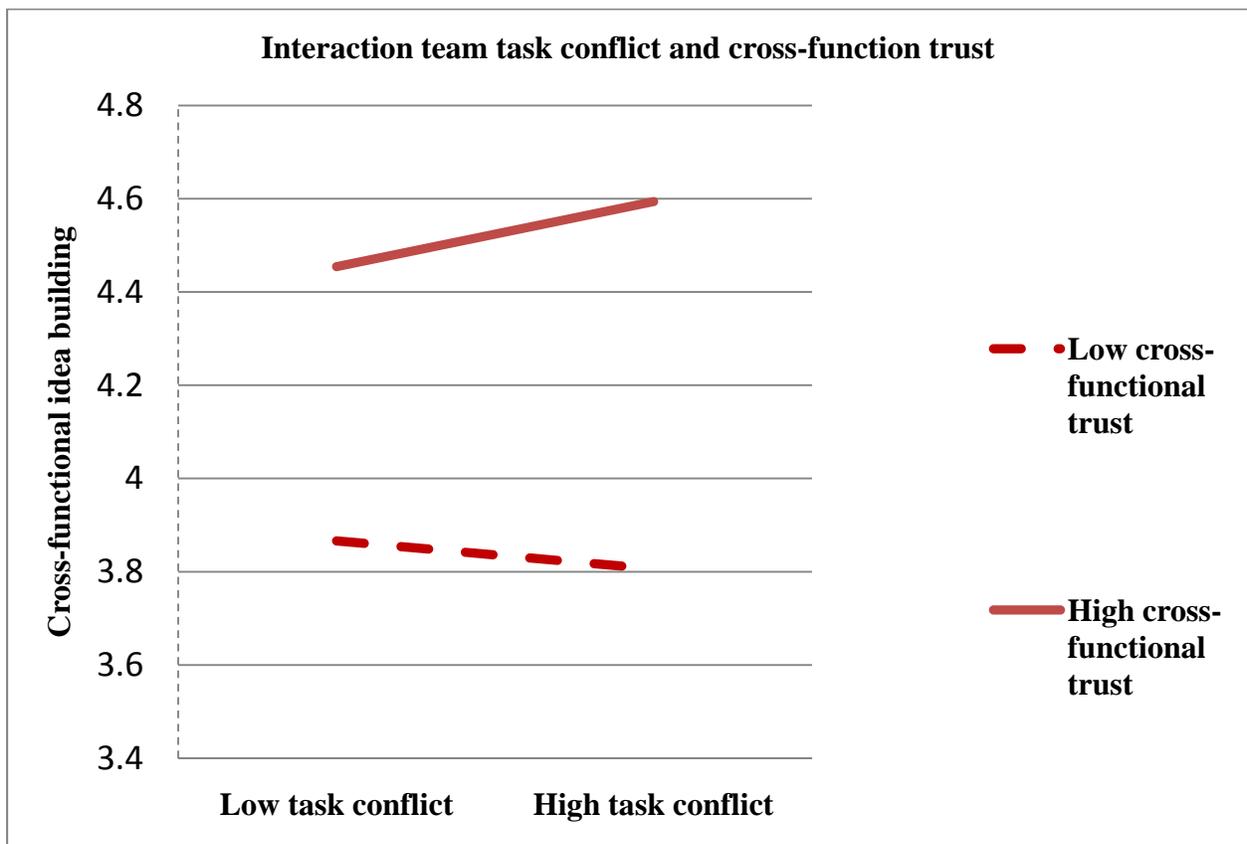
TABLE 4: HLM results: The effects of cross-functional idea building on cross-functional satisfaction over time

Variables	Model
	<i>Level 1 variables</i>
Intercept	4.14 (.03)***
Time	.03 (.02)
Cross-functional idea building	.78 (.05)***
Model Deviance	547.08
Variance components	
<i>Level 1</i>	.16
<i>Level 2</i> Intercept	.05**
<i>Level 3</i> Intercept	.01

Note: Dependent variable is cross-functional satisfaction. Team members: n = 121; Teams: N = 21

CHAPTER 3 (Paper 2)

FIGURE 2: Interaction plot of team task conflict and cross-functional trust predicting ease of cross-functional idea building



CHAPTER 4 (Paper 3)

TABLE 1: Descriptive statistics and correlations at group level of analysis

	Mean	Std.	1	2	3	4	5	6	7	8	9	10
1. Size	4.93	1.77	1									
2. Functional diversity	.78	.23	.22	1								
3. Idea sharing	3.72	.62	-.13	-.04	1							
4. Cross-functional idea building	3.65	.92	.21	.79**	.19	1						
5. Deep level diversity	.24	.15	.16	-.07	-.37*	-.04	1					
6. Transactive memory system	3.88	.40	.08	-.08	.74**	.22	-.18	1				
7. Task conflict: frequency	3.74	.48	.14	.27	.38*	.41**	-.34*	.22	1			
8. Task conflict: negative emotions of fear	3.26	.72	.02	.05	-.27	-.10	-.03	-.54**	.02	1		
9. Presentation grade	3.68	1.27	.51**	.31	.25	.42**	-.02	.40**	.22	-.36*	1	
10. Product grade	4.00	1.34	.46**	.19	.23	.33*	-.02	.48**	.19	-.43**	.82**	1

Note: * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). All correlations are calculated at the group level of analysis (N=41).

CHAPTER 4 (Paper 3)

TABLE 2: Structural equation modeling (SEM) analysis: Results

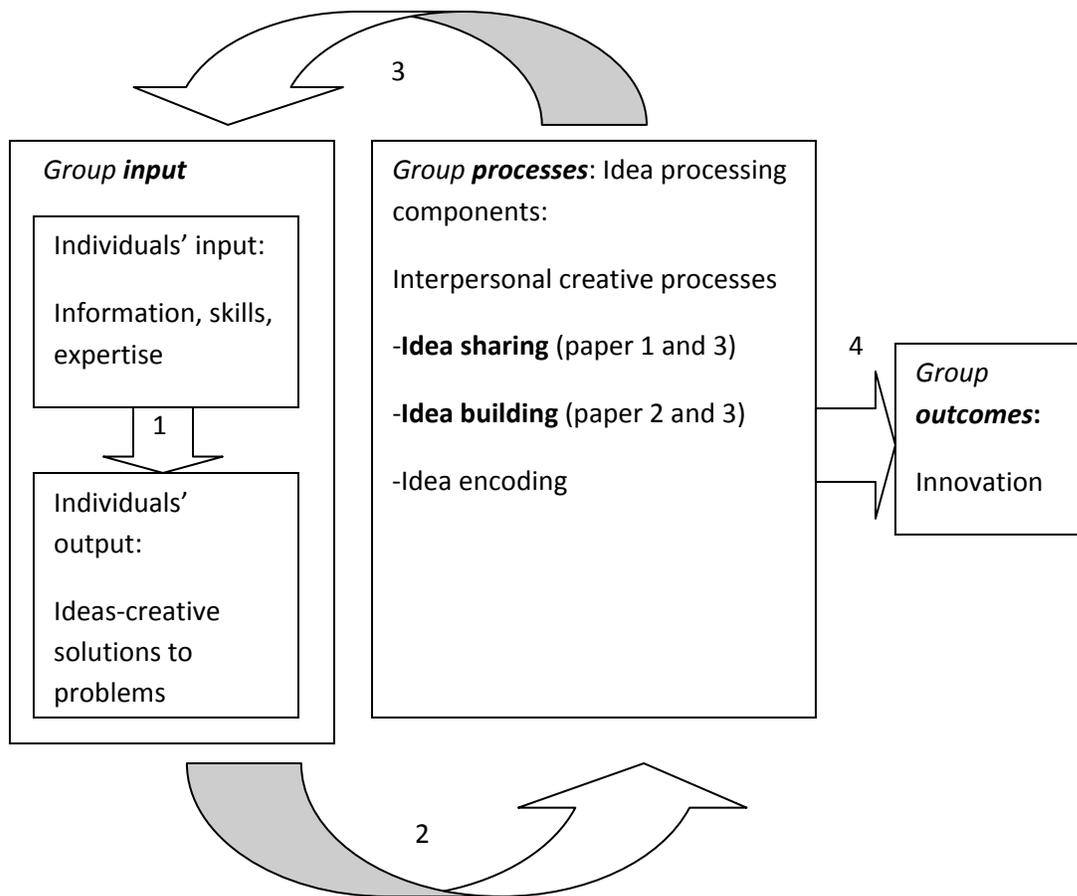
Predicted variable	Predictor variable	Path coefficient	S.E.	P-value
Deep level diversity	<--- Task conflict frequency	-.34	.02	.03
Transactive memory	<--- Task conflict frequency	.26	.11	.04
Task conflict: Negative emotion of fear	<--- Task conflict frequency	.02	.24	.89
Transactive memory	<--- Task conflict: Negative emotions of fear	-.54	.07	.00
Transactive memory	<--- Functional diversity	-.13	.23	.32
Idea sharing	<--- Deep level diversity	-.24	1.20	.02
Idea sharing	<--- Transactive memory	.75	.17	.00
Idea sharing	<--- Task conflict: Negative emotions of fear	.12	.10	.32
Cross-functional idea building	<--- Idea sharing	.22	.15	.02
Cross-functional idea building	<--- Functional diversity	.81	.38	.00
Innovation	<--- Transactive memory	.47	.51	.01
Innovation	<--- Cross-functional idea building	.25	.16	.05
Innovation	<--- Idea sharing	-.07	.36	.71
Innovation	<--- Size	.47	.08	.00
Presentation grade	<--- Innovation	.91		.00
Product grade	<--- Innovation	.88	.17	.00

Note: N=41. Path coefficients are standardized.

FIGURES

CHAPTER 1

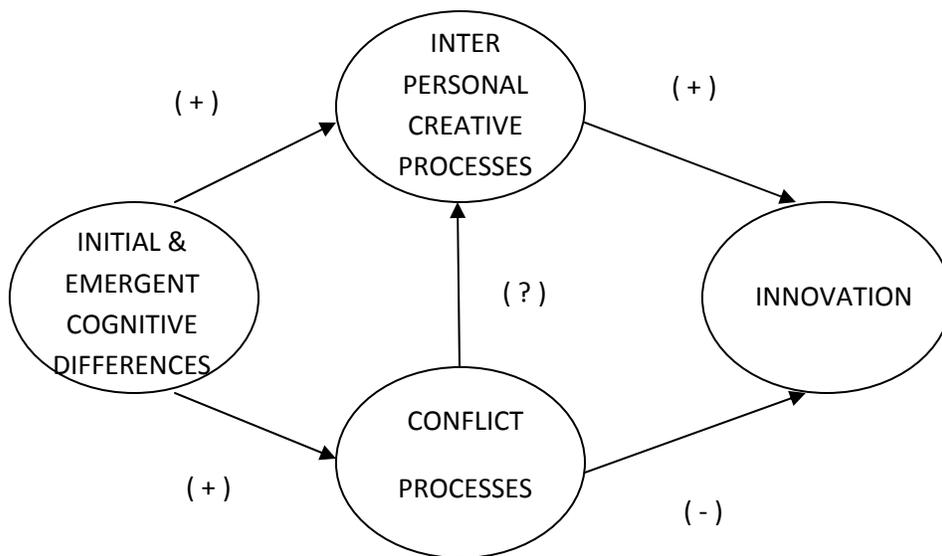
Figure A: Group idea processing framework: The antecedents and outcomes of interpersonal creative processes



Group idea processing **antecedents** and **moderators**: paper 1, 2, and 3

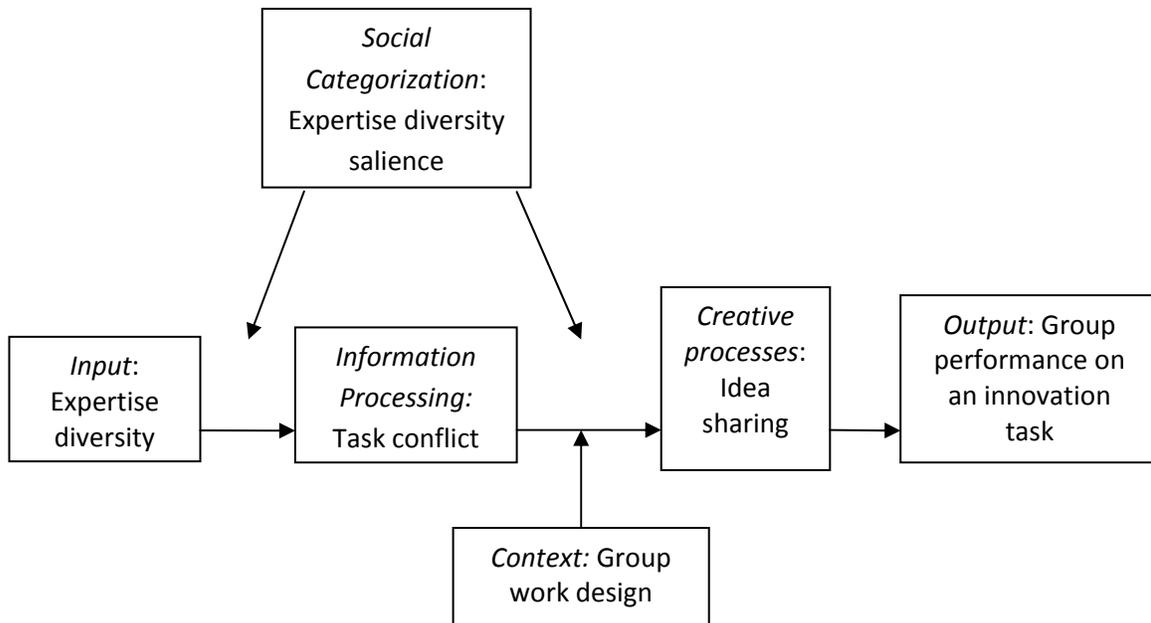
CHAPTER 1

FIGURE B: The conflict-creativity tension in diverse innovation teams



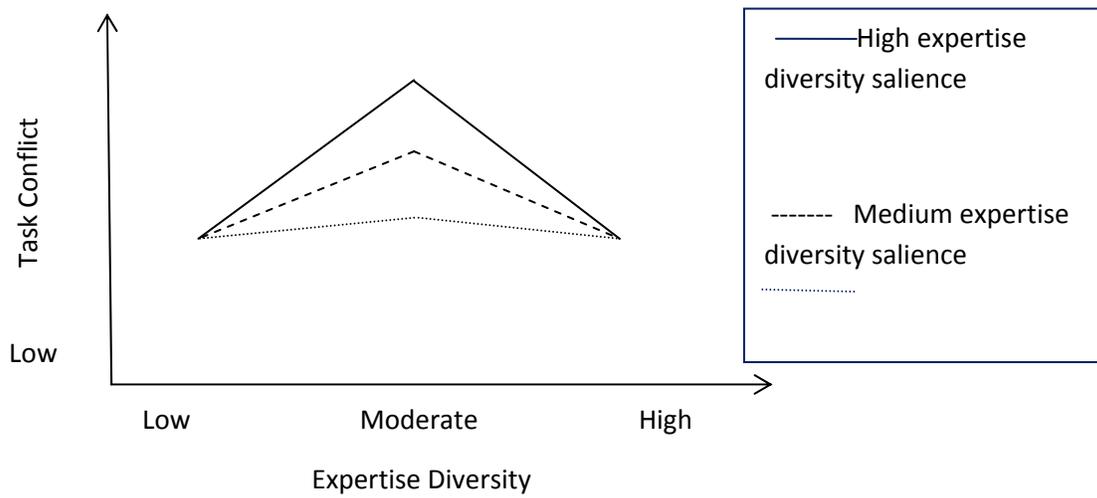
CHAPTER 2 (Paper 1)

FIGURE 1: Theoretical model of idea sharing in diverse groups



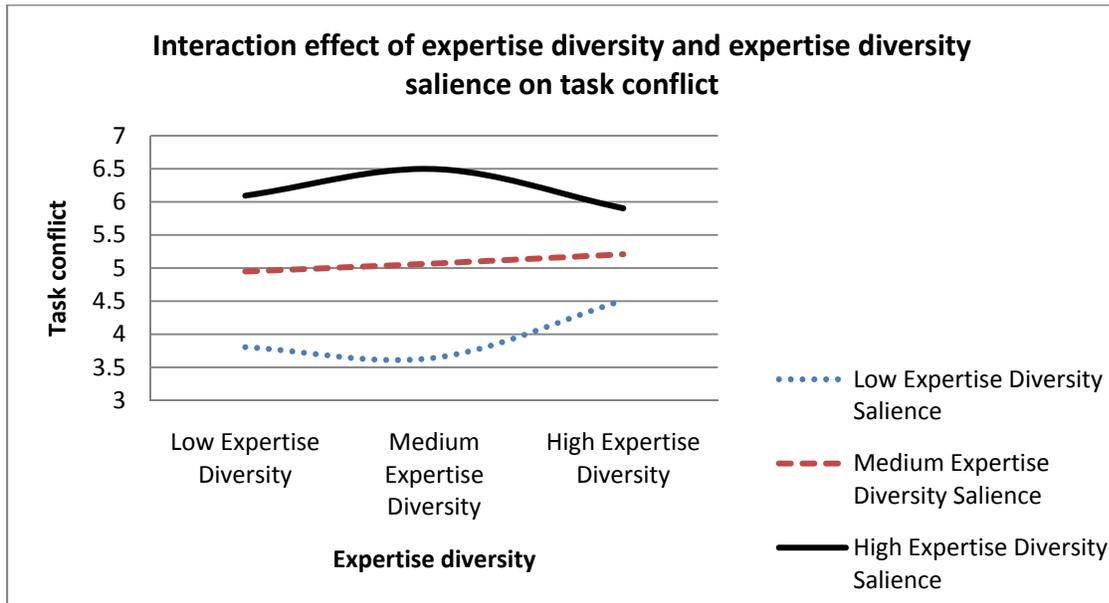
CHAPTER 2 (Paper 1)

FIGURE 2: Hypothesized relationship between expertise diversity, expertise diversity salience, and task conflict.



CHAPTER 2 (Paper 1)

FIGURE 3: Interaction plot: interactive effect of expertise diversity salience and expertise diversity on task conflict



CHAPTER 2 (Paper 1)

FIGURE 4: Interaction plot: Interactive effect of task conflict, expertise diversity salience, and group work design on idea sharing

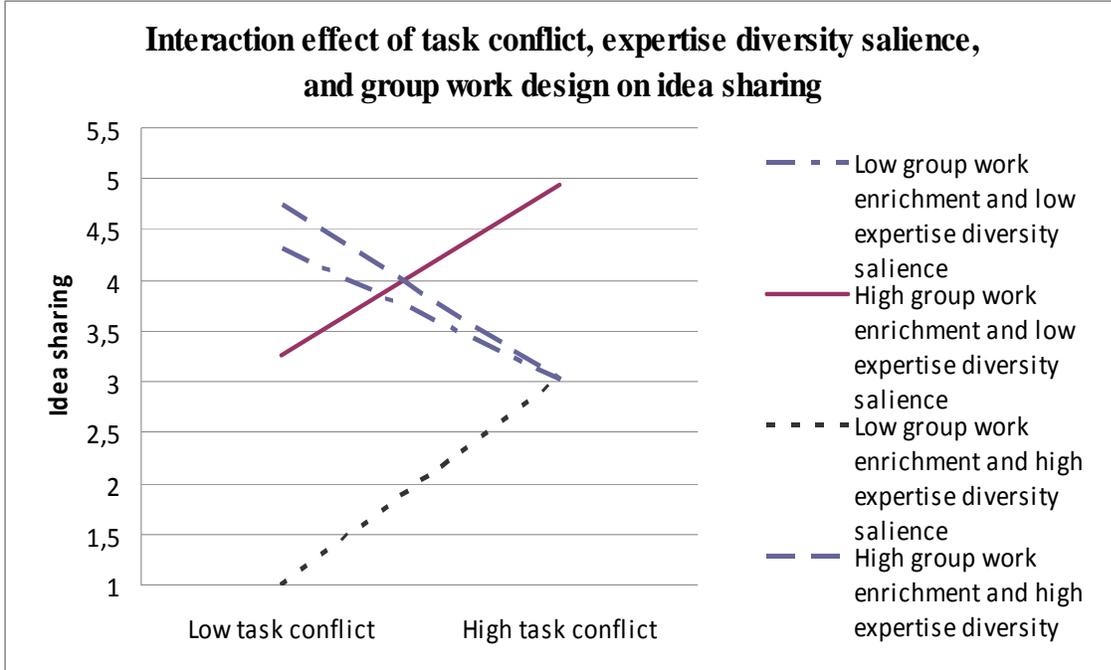


FIGURE 1: Hypothesized Model

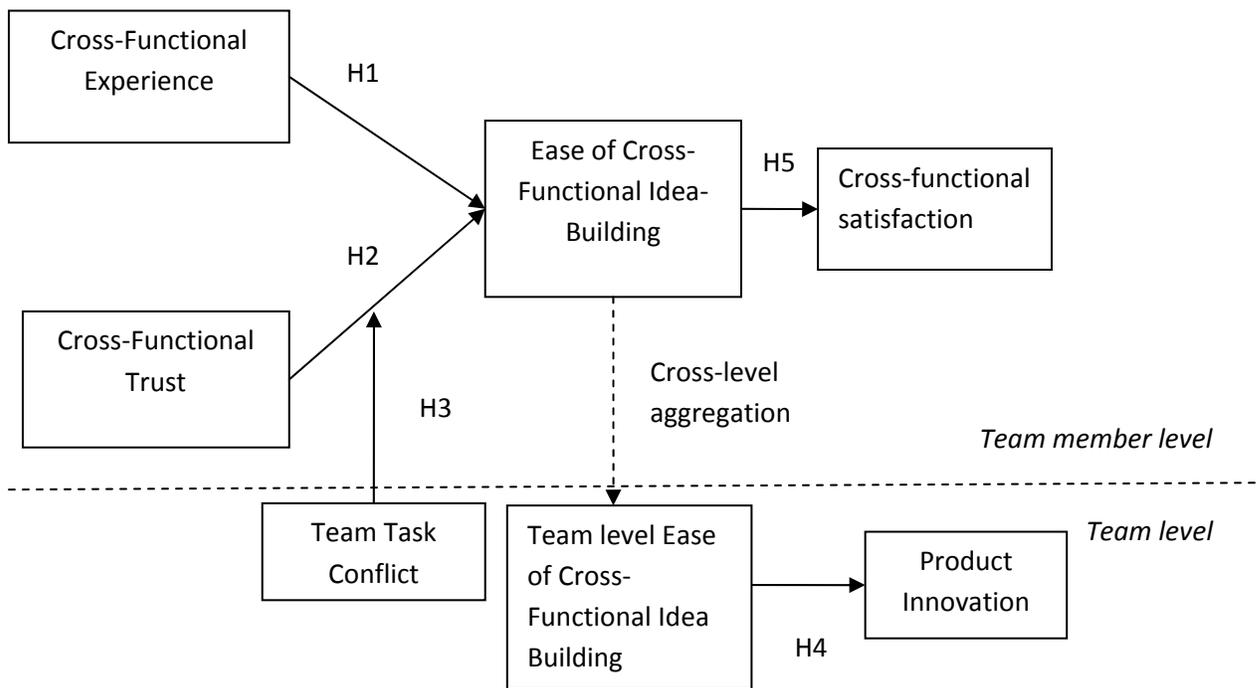


FIGURE 1: Theoretical model

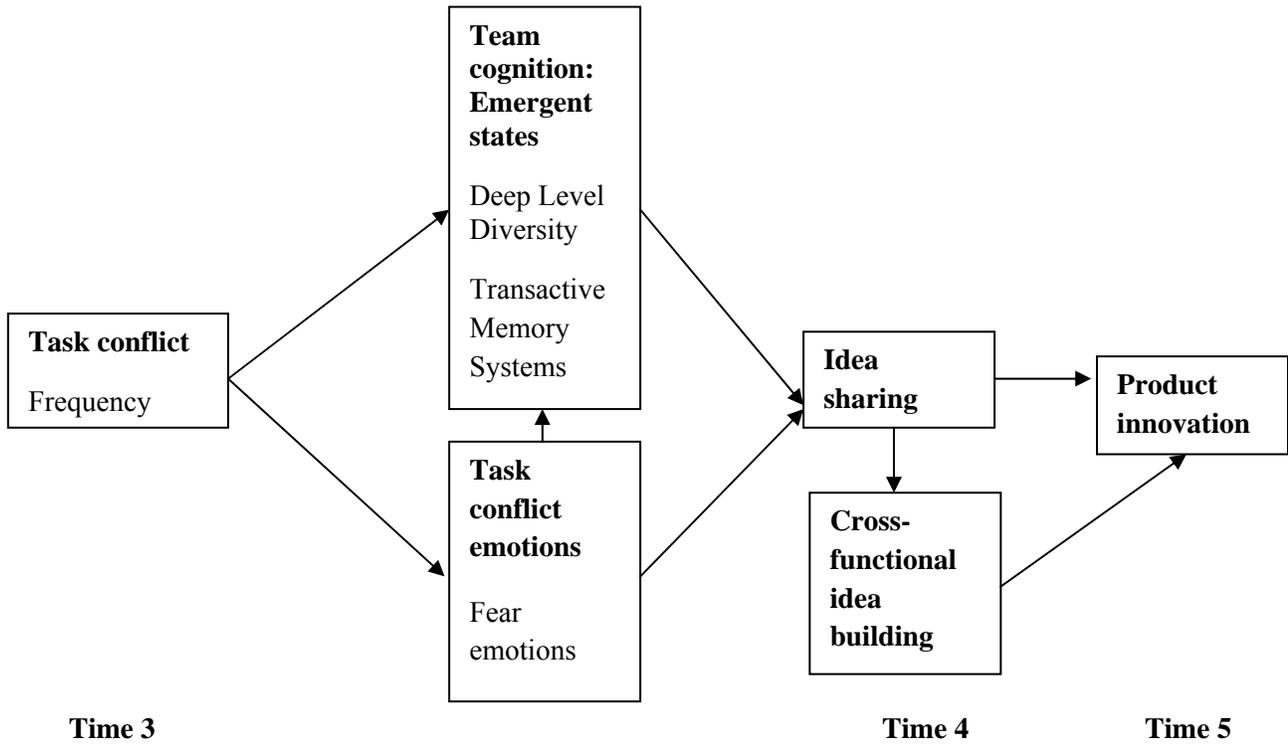
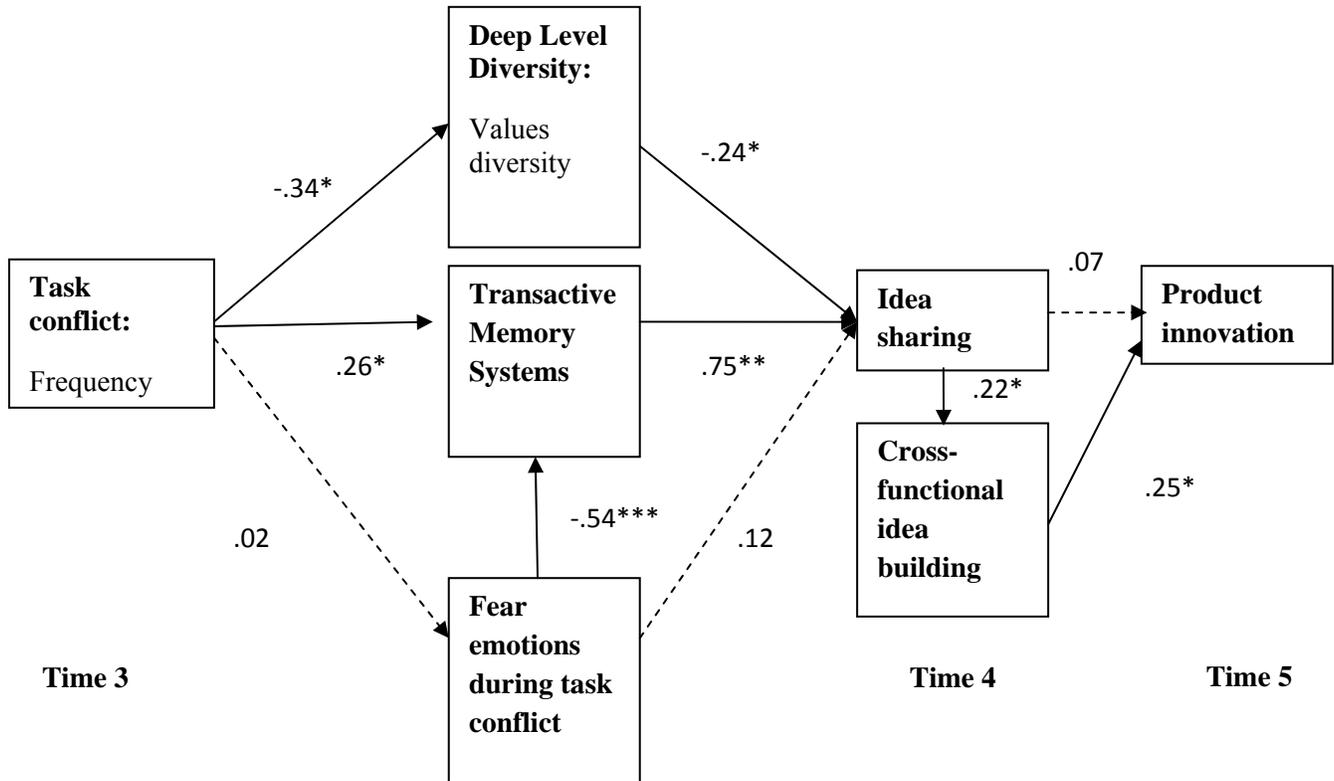


FIGURE 2: Summary of SEM results



Note: N= 41. Path coefficients are standardized. * Coefficient is statistically significant at the 0.05 level (2-tailed). ** Coefficient is statistically significant at the 0.01 level (2-tailed). Control variables are not included in the figure but they are included in table 2.

APPENDICES

CHAPTER 2 (Paper 1)

APPENDIX A: Scales

Task conflict

1. How often do people in your lab group disagree about opinions regarding the work being done?
2. How much conflict about the work you do is there in your lab group?
3. To what extent are there differences of opinion in your lab group?

Idea sharing

1. Members of my lab group offer novel approaches to address the problems I encounter.
2. I rarely come away from meetings and talks with my lab group members with new ideas of how to approach my research. (R)
3. Conversations with members of my lab group provide me with creative, viable approaches to solving the problems my research poses.
4. Innovative solutions to problems often arise out of discussions with my lab group.

Group work design

1. The work performed by my lab group is important to the field. (task significance)
2. My lab group helps me feel that my work is important to the field. (task significance)
3. Most members of my lab group get a chance to learn the different tasks the lab performs. (task variety)
4. Most everyone in my lab group gets a chance to do the more interesting tasks. (task variety)
5. The work on a given project is generally completed by the same person/set of people that began it. (task identity)
6. The members of my lab are responsible for all aspects of the projects undertaken within the lab. (task identity)
7. The members of my lab group are responsible for determining the methods, procedures, and schedules with which the work gets done. (self-management)
8. Most work-related decisions are made by the members of my lab group rather than by my advisor. (self-management)
9. Most members of my lab group get a chance to participate in decision making. (participation)
10. My lab group is designed to let everyone participate in decision making. (participation)

Group performance

1. This lab group meets or exceeds my expectations.
2. Our lab group does superb work.

3. Critical quality errors occur frequently in this lab group.
4. This lab group keeps getting better and better.

Intrinsic satisfaction

1. How satisfied are you with the chances you have to learn new things?
2. How satisfied are you with the chances you have to accomplish something worthwhile?
3. How satisfied are you with the chances you have to do something that makes you feel good about yourself as a person?

CHAPTER 3 (Paper 2)

APPENDIX A: Product innovativeness scale

PRODUCT INNOVATIVENESS

Novelty:

The product is innovative in its construction.

The product is innovative in its functioning.

Usefulness:

The product performs a useful task.

The product fulfills a need.

Intellectual property protection potential is well explored.

The cost of production analysis is of high quality.

CHAPTER 4 (Paper 3)

APPENDIX A: Survey items

Task conflict

To what extent does your team argue the pros and cons of different opinions?

How often do your team members discuss evidence for alternative viewpoints?

To what extent does your team debate different ideas when solving a problem?

How frequently do members of your team engage in debate about different opinions or ideas?

Transactive memory systems: Specialization

Each team member has specialized knowledge of some aspect of our project

Different team members are responsible for expertise in different areas

I have knowledge about an aspect of the project that no other team member has

I know which team members have expertise in specific areas

The specialized knowledge of several team members is needed to complete the project deliverables

Transactive memory systems: Credibility

I am willing to rely on his/her work related judgments

I have little faith in the things s/he says

Transactive memory systems: Coordination

Our team works together in a well-coordinated fashion

Our team needs to backtrack and start over a lot

We accomplish the task smoothly and efficiently

There is much confusion about how we will accomplish the task

Our team has very few misunderstandings about what to do

Idea sharing

Conversations with members of team provide me with creative, viable approaches to solving the problems my research poses.

Members of my team provide me with new ideas on how to solve problems I encounter.

Innovative solutions to problems often arise out of discussions with my team.

Members of my team offer novel approaches to address the problems I encounter.

I receive new ideas about my work during discussions with the team members.