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The Blank Page: Effects of Constraint on Creativity

by

Caneel K. Joyce

A dissertation submitted in partial satisfaction of the

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University of California, Berkeley

Committee in charge:

Professor Barry M. Staw, Chair

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Abstract

The Blank Page: Effects of Constraint on Creativity

by Caneel K. Joyce

Doctor of Philosophy in Business Administration

University of California, Berkeley

Professor Barry M. Staw, Chair

This dissertation is about how constraint—restrictions to freedom that limit and direct search—influences creativity. Freedom is often associated with creativity, yet recent work in the decision making literature suggests that too much freedom can be paralyzing when it provides too many choices. This dissertation examines how the extent of constraint imposed on a task, when conceptualized as a continuum, affects creative processes and outcomes. It employs a multi-method, multi-level approach through three studies.

Study 1 was a controlled laboratory experiment centered around a written product design task where constraint was manipulated by varying task instructions. A curvilinear effect of constraint on creativity was identified such that a moderate degree of constraint was more conducive to creativity than either a high or a low degree. These effects were not explained by alternative explanations such as time allocation during the task, or decreased intrinsic motivation.

Studies 2 and 3 examined the role of constraint in 43 new product development teams. Through quantitative analysis, Study 2 found that the degree of constraint that new product development teams voluntarily imposed on their projects at the beginning of the semester predicted the creativity of their product proposals more than ten weeks later. The results held up even when controlling for task conflict.

Study 3 examined the same 43 teams through a series of three multi-method case studies. Grounded-theory analysis gave qualitative support to the theory proposed in Chapter 2 and revealed several emergent themes that were not anticipated, namely: assumption-constrained creativity, uncovering latent conflict, and confirmation-constrained creativity. The study resulted in new predictions about how constraint affects creative teams, and a novel framework for conceptualizing creativity as a hypothesis-testing activity.

These findings suggest that while some amount of choice is important for encouraging creativity, too much can be counterproductive, which runs counter to many popular theories of creativity. This dissertation should provide encouragement to organizations that are institutionally embedded, have scarce resources, or are otherwise restricted.

Dedication

This dissertation is dedicated to:

My mom Cindy, for her open-minded enthusiastic embrace of life, her die-hard positivity and encouragement; her effortlessly natural ability to recognize beauty in all things and situations; her contagious wonder and love of all creations, and for being my teacher and partner in the countless creative projects we've done together that inspired this research

My dad Peter, for his insistence that I stay true to who I am wherever that path may lead; his genuine love of people, community, and fun; his innate curiosity and love all things oceanic or scholarly; and for demonstrating that with integrity, humor, and the persistent pursuit of things one loves, a person can truly have it all

My brother Britt, for his humor, best-friendship, wisdom, improvizational song-writing ability, high ethical standards, and love of business as an intellectual pursuit; his sense of calm and appeciation of theories, food, surfing and kareoke; and for being my sounding board for ideas that are at once ludicrous and possible

&

Roy, my partner, lover, husband, and best friend, who gave me the gift of loving him; for never allowing me to lose faith or give up, for cooking me gourmet meals, nursing my back back to health, maintaining my social life, playing devil's advocate, teaching me to open doors and walk inside, moving to Europe three times, listening to me think out loud, helping me when I lost my keys/erased my hard drive/went down the rabbit hole/was mad as a hatter/forgot to x, y, or z… again, celebrating every gold star, supporting me in every way, wanting the very best for me, and for loving me with all of your heart.

Table of Contents

List of Tables

List of Figures

Acknowledgements

I used to think that being a professor would be pretty easy. I imagined sitting in a cozy café amidst piles of books and handwritten notes, talking for hours about intellectual ideas with my colleagues; me in a corduroy blazer, with suede patches on the elbows. I imagined thinking big thoughts and writing midnight manuscripts in moments of creative brilliance. I imaged leading a revolution of eager minds in a fierce charge up a mountain from curiosity to conviction - all in my blazer, wire-rimmed glasses, and long frizzy grey ringlets (that last part was never realistic).

It turns out that what I imagined of academia was pretty delusional. Professordom is wickedly competitive and tirelessly demanding. The work is often frustrating, at times even wasteful, and tends to tangle my mind into a mess of analytical knots that none of my friends can help me unravel myself. Long days of writing often leave me speechless and antisocial, and after hours of data analysis I can be cynical. And my idea that with so much free time on my hands in academia (!), I would finally be able to express all of my many ideas? Well that was naïve in so many ways. Every idea expressed requires an army of citations to defend it against the attacks of healthy (but brilliant and well-meaning) skeptics. Free time is limited and usually accompanied by a certain degree of guilt (though, happily, it is often spent at cafes, surrounded by books and handwritten notes, and talking about ideas with my colleagues).

But by far the biggest shock that my softy artsy heart experienced when I began my academic career was the environment in which new ideas were "developed." Justly, the creation of knowledge is a lot of work. Sometimes building something new requires destroying something old; strong ideas can be born when weaker ones get out of the way. The pain of learning to select and reject ideas is what gave birth to the ideas that eventually became this dissertation.

A dissertation is a massive project that I could not have achieved without the support and of many friends, collaborators, and healthy skeptics. First I must thank my advisor Barry Staw, for believing (even when I didn't) that if I pushed my weaker ideas out of the way that stronger ones would emerge in their place. For your rigor, ingenuity, and insistence that the only research worth doing is research that's interesting. And for sticking with me when I resolved to do what we both thought would be impossible. You never fail to inspire me to make bigger and more solid contributions by stepping back to see the big picture and keeping faith in science. Thank you for helping me untangle my ideas, and for making me do it on my own.

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many journeys in the years ahead.

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To my lifetime collaborators and members of the Analytic Muse, Jonathan Hey and Kyle Jennings: at this point so many of our ideas were born through synthesis that they are forever inseparable. We've done what we said we would do, haven't we?! Jono, thanks for being my brainstorming partner from the get-go. (We finally found our frames!) Looking forward to many more years of creating with you both.

Thank you to the students of the NPD class. You taught me so much about innovation by letting me observe your teams and ask hundreds of questions, responding only with openness and curiosity. Also thank you to the many faculty members, near and far, that made this work possible: Alice Agogino, Barbara Mellers, Bernard Nijstad, Carsten de Dreu, Charlan Nemeth, Jeffery Grossman, Jennifer Chatman and Thomas Roemer.

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CHAPTER I: OVERVIEW OF THE DISSERTATION

A full understanding of any work means understanding what choices were made and from what range of possibilities they were made, the knowledge I have just suggested is relatively common among practitioners of an art. These choices are made in a complicated social context of artistic activity, which constrains the range of choices and provides motives for making one or another of them. (Becker, Faulkner & Kirshenblatt-Gimblett, 2006, p. 26)

The initial element in solving or limiting certain issues contains an enormous number of built-in decisions that limit the scope of the intellectual or visual problem at hand, thankfully preventing the paralysis that results from the overwhelming unlimited scope of decision contained in a blank page or empty space. (Tufte, 2006)

Constraint has long been considered the enemy of creativity. Historically, creativity researchers have found that too much constraint on freedom may decrease the intrinsic motivation to create (Amabile & Gitomer, 1984; Amabile, 1983). In seeming opposition to these findings, recent decision making research has revealed a "Paradox of Choice" (Schwartz, 2004) in that too much choice can be paralyzing and tends to undermine good judgment, intrinsic motivation (Iyengar & Lepper, 2000), and originality (Chua & Iyengar, 2007). If there are limitations to the benefits of freedom, then constraint may be essential to creativity.

The focus of the present study is on how constraint—any restriction imposed on freedom such as rules, boundaries, and scarcity—influences the creative process. Given that judgment and choice are important, but often-overlooked aspects of creativity, a range of choices available to a creator may have a major impact on the creative process and subsequent outcomes. The present study is a presentation of a set of theoretical hypotheses that apply findings from the decision making literature to the domain of creativity. The hypotheses are then tested in a series of multi-method studies comprised of (1) a laboratory experiment, (2) a quasi-field study using survey, archival, and observer ratings, and (3) a two-year qualitative study of cross-functional product development teams. The research design bridges the creativity and decision making literatures and resolves inconsistent findings in prior research.

Chapter 1 is comprised of sections that are a summarization of (a) the stated research problem, (b) the purpose of the research, and (c) the primary research questions. In addition, the chapter presents an overview of the research design and methodology, and a statement of the significance of the dissertation. Finally, the chapter includes a definition of terms, a statement of ethical assurances, and an overview of subsequent chapters.

Statement of the Problem

While there has been a lot of work done on the effects of the lack of constraint (extensive choice) on decision making quality, purchasing behavior (Chernev, 2003; Iyengar & Lepper, 2000), retirement savings patterns (Huberman, Iyengar & Jiang, 2007; Sethi-Iyengar, Huberman

& Jiang, 2004), post-decisional satisfaction (Botti & Iyengar, 2004), regret, anticipated regret, and psychological well-being (Schwartz, 2004a), there has been very little empirical work on its effects on creative behavior (Chua & Iyengar, 2007 is an exception).

There has been much work done on the effects of different types of constraints on creativity, including surveillance (Amabile, Goldfarb & Brackfield, 1990), external evaluation (Amabile, 1978; Amabile, Goldfarb & Brackfield, 1990), and perceived time pressure (Baer & Oldham, 2006). However, constraint that limits choice with regard to *the creative problem itself* has not been investigated.

Furthermore, most research on the effects of choice on creativity (Chernev, 2003; Chua & Iyengar, 2007), has manipulated the independent variable binarily. Since the effect of unconstrained choice on other dependent variables is thought to be non-monotonic (Schwartz, 2004), it is important to examine the effects of various degrees of constraint along a continuum. The functional form of these effects is as yet unknown because of the methodologies that have been used.

It is also important to investigate how constraint affects creativity in teams. Groups and teams are becoming increasingly important for creative work in organizations (West, 2002). Still, most of the research on the effects of constraint on creativity has focused on the individual level of analysis (Eisenberger & Cameron, 1996; Hennessey & Amabile, 1998). There has recently been a call for research about how individual phenomena occur at the group level (Hinsz, Tindale & Vollrath, 1997). Recent work suggests that factors that influence individual creativity, such as extrinsic rewards, can have can have additional effects in team settings due to social dynamics like obligation (Cooper & Jayatilaka, 2006).

Finally, there is a logical misalignment between the creativity literature and the implementation of creativity in the real world. While the majority of the creativity literature emphasizes freedom over constraint, constraints are widely used to increase the tractability of novel problems and to generate creative solutions in a variety of creative fields including design, engineering, business, theater, writing, photography, and fine art (Stokes, 1999). While this mismatch between theory and observation need not provoke a revision of decades of rigorous research, it suggests that a refinement is necessary.

Research Purpose and Primary Research Question

The purpose of this multi-method research was to refine and expand creativity theory in light of what is known about the effects of choice on decision making. This was done by measuring the effects of constraint on creative outcomes and associated processes. Specifically, the study was designed to both manipulate and measure constraint along a continuum. The primary research question driving the design of the methodology was:

> *Given the importance of decision making in the creative process and the known effects of extensive choice on decision making, how does constraint (limits on freedom and choice placed on the creative project itself) affect creative processes and creative outcomes?*

Research Design and Methodology

This dissertation divides the research attendant to the primary research question into three studies, each using a different methodological approach. Study 1 tested individual level hypotheses in a laboratory setting using 274 undergraduate research participants. The purpose of Study 1 was to test hypotheses about the causal effects of constraint imposed on a creative task in a controlled laboratory setting, where constraint was manipulated along a continuum from low to high. The design was intended to detect any non-monotonic effects of choice on both intrinsic motivation and creative outcomes.

The experiment involved a product design task, which involved researching and writing a creative proposal for a new product that would address a problem given to them in a prompt. Information on participants' search behavior was gathered unobtrusively during the experiment using a computer tracking program. Trained judges rated participants' written product proposals on creativity using the Consensual Assessment Technique (*CAT*, Amabile, 1983).

The following questions and hypotheses were tested in Study 1:

Q1: Does the degree of constraint imposed on a creative task affect individuals' creative outcomes? If so, what functional form do these effects take?

Q2: What mechanisms underlie the effects of constraint on individual creativity?

H1: Constraint has a negative effect on intrinsic motivation.

H2: Constraint has a positive linear effect on individual creativity.

H3: Constraint has a curvilinear (inverted-U) effect on individual creativity.

H4: Time allocation mediates the positive effect of constraint on creativity.

Study 2 was a quantitative study of 43 new product development student teams over the course of a semester-long new product development project. The purpose was to examine the effect of constraint on creativity and associated group outcomes and processes in functionally diverse teams over the full course of a creative project. Constraint was measured by content-coding systematically selected excerpts of the mission statements teams composed at the launch of their projects. Quantitative analyses were used to test the group level hypotheses using archival, survey, and expert ratings of creativity. Constraint measures were used to predict group processes 4 weeks later, and outcomes 10 weeks later.

The creativity of teams' final products was measured using the same method as in Study 1 (*CAT*; Amabile, 1983) and rated by a minimum of seven experts from industry. The research (a) provided a test of the proposed theory that measured the independent variable distantly in time from the dependent variable, (b) measured the degree to which teams in a quasi-natural setting (with higher external-validity than is allowed in a laboratory setting) imposed constraint on their own projects, and (c) tested hypotheses about the relationship between constraint,

creativity, and conflict in teams. This design also allowed for the detection of any non-monotonic effects.

The following questions and hypotheses were tested in Study 2:

Q3:   Does the degree of constraint teams place on their projects affect their creative outcomes? If so, what functional form do these effects take?

Q4:   Does the degree of constraint teams place on their projects affect group conflict and satisfaction?

H5:   Constraint has a linear, positive effect on group creativity.

H6:   Constraint has a negative effect on the overall level of group conflict.

H7:   Constraint has a curvilinear (inverted-U) effect on group creativity.

H8:   Constraint has a negative effect on group member satisfaction.

Study 3 was ethnographic in nature concerning new product development teams. The purpose was three-fold. First, it was designed to qualitatively understand how constraints are used in practice and subjectively experienced by creative teams. Students were interviewed face-to-face, and an interview protocol was used containing a set of predetermined open-ended questions to ensure consistency across all interviews. Combing multiple sources of data (observation, surveys, primary documents, and interviews) enabled a richer understanding of the relationship between constraint and creativity than would have been achieved through quantitative measures alone.

Second, Study 3 followed the same teams participating in Study 2, providing an opportunity to further investigate the processes underlying the quantitative results. By combining quantitative data and emergent insights, this mixed-method approach generated new theory and research questions. The third purpose of Study 3 was to observe how constraints come into play when teams make decisions about the creative direction of a project over time. This refined the general predictions made about the relationship between constraint, choice, and decisions made in the creative process. The analysis was an identification of important themes found across all teams, then an examination of three team cases in greater depth. The result was an expansion of the initial model and a generation of new hypotheses to be tested in future research.

The following research questions were examined in Study 3:

Q5:   How do creative workers subjectively experience constraint in a real-world setting?

Q6:   How does constraint influence decisions groups make about creative work?

Q7:   How does the nature of the constraints teams impose upon their own creative projects influence their approach to the project?

Q8:   What functions of constraint might explain its association with creativity?

Q9:   What is the relationship between conflict, constraint, and creativity in teams?

Significance of the Dissertation

This dissertation attempts to bridge the gap between the creativity and decision making literatures. It explores the adaptive and strategic nature of human creativity in the context of social and task constraints typical of organizations. The model proposed begins to reconcile inconsistent findings in the field of creativity on the cognitive and motivational responses to constraints, such as limited choice and goal-directed tasks. The research explores an intellectually interesting paradox between situational constraint and determinism on the one hand, and individual resourcefulness and ingenuity on the other. This research is intended to contribute important empirical detail to the extant literature on creativity. Functional form is not taken for granted; the research design enables the detection of both linear and curvilinear effects.

The results of the research effort also have practical value. The results can help administrators to better structure organizational challenges and creative opportunities to support creative solutions. The results can also help individual creators of all kinds better understand the nature of their own creative processes, and suggest ways to take concrete action to remedy blocks that they are facing.

Definition of Terms

The terms, "constraint," "creativity," and "problem solving" are presented here for clarification in succeeding chapters:

Constraint

Constraint is defined as any restriction on freedom that limits the number of possible solutions available for solving the problem at hand, including rules, goals, and limitations on choice, norms, boundaries, and scarcity. Constraint is a continuous construct, with the opposite of constraint being absolute freedom of choice. Constraints affect creativity by both limiting and directing the search for new ideas to solve problems (Stokes, 2006). They direct search for solutions to specific problems, and limit the solutions considered appropriate (Newell & Simon, 1972; Reitman, 1965; Stokes, 2001). Thus constraint can be conceptualized as the sum of two dimensions: limiting and directing.

In the present study, the concept of "constraint" is slightly different than in some prior research, so some clarification is needed. Amabile and colleagues used the term "extrinsic constraints" to mean, "any social factors that control, or could be perceived as controlling, task engagement; and are extrinsic to the properties of the task itself" (Amabile & Gitomer, 1984). This conceptualization emphasizes the social aspects of constraint, rather than the limiting and directing aspects that are the focus of this study. For example, Amabile and colleagues' research usually operationalizes constraint in a way that makes social control particularly salient, such as

expecting evaluation by experts (Amabile, 1979), and being allowed to make one's own choices in task materials versus having those choices made for them - quite saliently - by others (Amabile & Gitomer, 1984). This type of constraint is qualitatively different from constraint that limits and directs choice discussed here and in the research related to decision making (Chua, 2008), or from constraint around the specific problem to be solved, which is the focus of this study.

Creativity

Creativity is defined as the production of ideas, solutions, or products that are both novel and useful (Feist, 1998). Amabile points out the need for using both a theoretical and an operational definition of creativity (Amabile, 1983). For an idea to meet the theoretical definition for "creative," it must be both novel (new, unique, unusual, and original) and useful (appropriate, adaptive, effective in solving a problem, or providing value). Novelty can be defined in either statistical (rare in the sample, unlikely to occur) or subjective terms (new to the person judging it). For an idea to meet the operational definition of creativity, it must be judged as creative by others in the domain (Amabile, 1983; Csíkszentmihályi, 1996a; Simonton, 1999).

Creativity is typically measured using the Consensual Assessment Technique (*CAT*; Amabile, 1983), wherein a panel of experts in the field judges each product or idea on three basic dimensions: originality/novelty, appropriateness/usefulness, and creativity, the latter which importantly is defined as "your own subjective definition of creativity." Allowing judges to use individual subjective definitions of creativity has been shown to produce highly reliable ratings. Although simpler measures exist, the externally valid CAT was chosen for the present study over more objective measures such as fluency (Guilford, 1950), which measures the sheer quantity of ideas.

Problem Solving

Many scholars agree that creativity can be thought of as problem solving (Isen, Daubman & Nowicki, 1987; e.g., Osborn, 1953; Treffinger, Isaksen & Dorval, 2000), and the following study includes the language of problems and solutions. A problem is a matter or situation that needs to be resolved or overcome by identifying (through search and/or decision) or inventing (through creation) a solution. Just as creativity can be thought of as problem solving, so can decision making (e.g., "I need to decide what to write about."). In business, creative problems can involve anything from inventing a new product, to meeting a certain consumer need, to crafting a proposal in an integrative negotiation (e.g., Kurtzberg, 1998), to developing a new business strategy (Ford, Sharfman & Dean, 2008; Higgins, 1996). Even the most abstract art is solving a problem (Stokes, 1999), such as evoking an emotional reaction or communicating a political idea. The terms creativity and creative problem solving are used interchangeably in the present study.

<div style="text-align:center;">Ethical Assurances</div>

Procedures for the protection of human participants were followed carefully. All three studies complied with the University of California, Berkeley and Massachusetts Institute of Technology ethical guidelines. It presented minimal risk to participants, as it contained neither

experimental treatment of the participants nor their exposure to physical or psychological harm. Care was taken to ensure that the participants understood the nature of the study and that participation was voluntary. No sanctions were applied if participants declined or withdrew from the study. Confidentiality of data was and has been maintained at all times, and identification of participants was not available during or after the study. These conditions were communicated to all participants at the start of the study.

Summary

Creative behavior is always constrained by the situational context in which it is embedded. Although little is known about the effects of various degrees and types of constraint on creative processes and outcomes, any lack of freedom is often regarded as undesirable by organizational and creativity scholars. Drawing upon findings from the decision making literature, this multi-method dissertation explores the possibility that constraints are not necessarily detrimental to creativity, and can even be beneficial. This work contributes to the creativity literature by helping to unify inconsistent findings with regard to the effects of constraints on creativity, and by acknowledging the context-sensitive, judgmental aspects of creative process.

Chapter 1 provided an overview of the research contained in this dissertation. The purpose of the study and the primary research question were cited, the research methodology was summarized, and the research design was outlined and will be discussed in greater detail in following chapters related to each of the three studies. Chapter 2 reviews the literature on creativity as it relates to constraint, decision making, and teams. Gaps in the knowledge are identified, and hypotheses specified. Chapters 3, 4, and 5 present the methods and results of three studies designed to address these gaps and test the hypotheses. Results from all three studies are summarized and interpreted in the general discussion in Chapter 6.

CHAPTER II: LITERATURE REVIEW AND THEORETICAL DEVELOPMENT

The following chapter provides a conceptual analysis of the literature on creativity, choice, and constraint, and develops a set of theoretical propositions integrating these constructs. The supposition of the study is that while absolute constraint undermines creativity and intrinsic motivation, too little constraint is also counterproductive, resulting in decreased creativity and originality. And although some degree of choice has repeatedly been shown to be essential to creativity, the "freedom" of the blank page can actually stifle creativity.

Overview of the Creative Process

As stated in Chapter 1, creativity is defined as the combination of novelty and usefulness (Amabile, 1983; Feist, 1999; Guilford, 1950). Novelty may apply to the newness of a solution, or to a new application of an existing solution to solve a problem. Usefulness is the degree to which a creative product solves a problem. For the purposes of this dissertation, creativity refers to the process of idea generation or problem solving, and to the novelty and usefulness of the idea or solution produced by this process (Amabile, 1983; Weisberg, 1988). Many factors that facilitate or impede creativity in organizations have been identified by prior research (e.g., Amabile, 1988a; Ford, 1996; Oldham & Cummings, 1996; Woodman, Sawyer & Griffin, 1993).

The creative process has three main stages according to evolutionary theorists (Campbell, 1960; Simonton, 1999): idea generation, idea selection, and idea retention. A problem solving perspective impacts how the creative process is conceived, thus giving more attention to the problem-related stages of the process. The problem-related stages precede the idea generation stage (Amabile, Conti, Coon & Lazenby, 1996), and includes problem identification (Getzels, 1975) and problem definition (Reiter-Palmon, Mumford & Threlfall, 1998). Later stage decision-related processes include and idea evaluation (Dailey & Mumford, 2006a) and idea selection (Rietzschel, Nijstad & Stroebe, 2006). These are judgmental rather than generative tasks (a distinction made by McGrath, 1984). As such, creativity should be examined in light of the literature on judgment and decision making in addition to the literature on idea generation.

Creativity, Freedom, and Intrinsic Motivation

Freedom from constraint has long been considered essential to creativity. This intuition is evident in our cultural archetypes of artists, on our business bestseller lists, even in the classic use of brainstorming rules (Osborn, 1953; Sutton & Hargadon, 1996). The idea that constraint on freedom squelches creativity resonates even at the sociopolitical level, where totalitarian governments are associated with stifled innovation.

The association between freedom and creativity has received empirical support as well (Amabile, 1988). At the individual level, highly creative people have been shown to be unaware of (and/or unmotivated by) social norms (Feist, 1998) and thus are not intrinsically bound by the conformity pressures felt by most. At the situational level, a variety of constraints such as the expectation of evaluation (Amabile, 1979), competition (Amabile, 1982), surveillance (Amabile, Goldfarb & Brackfield, 1990), and contracted reward (McGraw & McCullers, 1979) have been shown to diminish the creativity of output.

The dominant explanation for these effects comes from self-determination theory (Deci & Ryan, 1980), which posits that individuals are intrinsically motivated when they perceive themselves to be acting out of free will, such as in situations providing choice and a sense of personal control. Intrinsic motivation is an essential determinant of creativity (Amabile, 1979; Amabile, 1983; Amabile et al., 1996), and accordingly, creativity is enhanced in situations providing choice and perceived personal control (Deci & Ryan, 1985; Deci, 1981). This literature suggests the following hypothesis:

     H1:   Constraint has a negative effect on intrinsic motivation

    While the implications of this literature are profoundly important and its influence widespread, the empirical results it has generated have not always conformed to predictions. One of Amabile's earliest studies found that while participants in all conditions under the constraint of expecting evaluation were less creative than those not expecting evaluation, participants who were given specific instructions (in how to create art that would be judged as creative) displayed the opposite pattern when constrained via extrinsic evaluation (Amabile, 1979).

    Indeed, a meta-analysis by Eisenberger and Cameron found that when rewards were explicitly dependent upon the fulfillment of a specific performance standard, not only was intrinsic task interest increased, but creativity was protected and in some cases even increased (Eisenberger & Cameron, 1996). Inconsistent findings (e.g., Eisenberger & Cameron, 1996) have prompted the qualification of the original theory by including a host of situational and individual difference moderators (Amabile et al., 1996; Eisenberger & Armeli, 1997). Although these critiques have been rebuffed (Cameron & Pierce, 1996; Hennessey & Amabile, 1998), they suggest that constraints can be beneficial for creativity, yet the pattern has not been parsimoniously integrated into the existing theory.

    In short, the meta-analysis by Eisenberger and Cameron (1996) suggested that the expectation of evaluation by judges had the predicted negative effects on creativity only when task instructions were not given, and the criteria with which products would be evaluated were not defined - in other words, when the task was unconstrained (Eisenberger & Cameron, 1996).

Decision Making Throughout the Creative Process

"Creativity means creative choices of inclusion and exclusion." (McKee, 1997, p. 76)

    The premise underlying this paper is that creativity, like artwork (Becker et al., 2006), is all about choices. These choices take two main forms: Choices about search behavior (whether to search, what to search for, where to search, when to stop) and choices about the selection of alternatives. The creative process is filled with decisions (Mumford, Mobley, Uhlman, Reiter-Paulmon & Doares, 1991), ranging from how to frame problems (Hey, Joyce & Beckman, 2007), to where to search for ideas (March, 1988), to how to select ideas (Cropley 2006; Runco 2003).

    It is likely that these choices determine in large part the degree to which creative ideas are shared, selected, retained and implemented. For instance, Rietzschel and colleagues found that

even though brainstormers were able to generate original ideas, and recognize which of their ideas would be rated as original by others, they were unlikely to select those ideas for implementation - a phenomena the authors coined the "anti-originality bias" (Rietzschel, Nijstad & Stroebe, 2006). In their review of several experiments, Rietzschel, Nijstad and Stroebe argue that creative idea generation itself is not a sufficient condition for selecting good ideas, and emphasized the importance of identifying the right selection criteria (Rietzschel, Nijstad & Stroebe, 2009). The quality and creativity of selected ideas has also been shown to be influenced by factors such as culture and task instructions (Goncalo & Staw, 2006).

At the organizational level, managers and executives make many strategic choices about which new products to invest in (Krishnan & Ulrich, 2001). The screening of ideas for new products has been called the most critical activity in new product development (Lin & Chen, 2004). In their study of 205 U.S. companies, Cooper, Edgett, and Kleinschmidt found that the kind of criteria managers used to select innovative projects predicted the firm's new product performance (Cooper, Edgett & Kleinschmidt, 1999).

Creativity researchers have traditionally focused on idea generation rather than the decision making processes above that contribute to creative end products (Dailey & Mumford, 2006a). However, research has recently begun to examine subsequent stages in the creative process such as idea refinement (Lonergan, Scott & Mumford, 2004)), idea evaluation (Lonergan, 2004; Lubart, 1994, 2001), and idea selection (Rietzschel et al., 2006).

The Paradox of Choice

Given that creativity is about choices, the decision making literature can provide insights into the creative process and resolve findings that have so far been difficult to explain with existing theory. While Amabile's studies emphasize the importance of choice (Amabile & Gitomer, 1984; e.g., Amabile, 1979), recent work in the decision making literature suggests another way to look at choice: Too much choice can be paralyzing, undermining good judgment (Iyengar & Lepper, 2000), intrinsic motivation (Chua, 2006; Higgins, 1999; Mischel, 1970; Shafir, 1993), and originality (Chua & Iyengar, 2008). Furthermore, when given extensive choice, the likelihood of making a decision is decreased, and if a decision is made then satisfaction with one's choice is lower than it would be if fewer options were considered or available (Iyengar & Lepper, 2000). This alternative view of choice is referred to as a "Paradox of Choice" (Schwartz, 2004).

The same logic that revealed these paradoxical effects should also apply to creative decisions. In a series of studies on creative tasks, Chua & Iyengar found that when offered more choices in materials available to wrap a gift (e.g., paper, ribbon, etc.), subjects exhibited more flexibility and novelty than those subjects given fewer choices of materials (Chua & Iyengar, 2008). The same subjects that were given fewer choices of materials experienced more stress and dissatisfaction and less intrinsic motivation. Having more options in terms of resources resulted in *less creative* combinations of available resources and lower use of the unusual resources that were available (Chua & Iyengar, 2008), which runs counter to Amabile's theory. Chua and Iyengar stipulate that people made the mistake of relying upon the large number of available choices to arrive at a creative solution, instead of searching for novel alternatives that are not readily available (Chua & Iyengar, 2008).

Constraint can be used to counteract the negative effect of extensive choice, by both limiting and directing the creative process (Stokes, 1999). Edward Tufte, the cognitive scientist well known for his work in the presentation of visual information, talks about "the power of the initial element in solving or limiting certain issues and thus making the work manageable." He recommends selecting an "initial element"—some small visual building block—to populate the blank page, and then using that as a starting place:

> *That initial element contains an enormous number of built-in decisions that limit the scope of the intellectual or visual problem at hand, thankfully preventing the paralysis that results from the overwhelming unlimited scope of decision contained in a blank page or empty space. The initial element provides a leverage point for expression. Also that starting element helps to find a problem that one can actually make progress on.* (Tufte, 2006)

To the extent that constraints ease the elimination of choices (about where to search, what to search for, and how to evaluate and select ideas that are found), such constraint should prevent this kind of aversive reaction, or "blank page effect" in creative work. Constraints can provide criteria for evaluating an idea's value, usefulness, and creativity (Boden, 1994; Cropley, 2006; Csíkszentmihályi, 1996; Sternberg & Lubart, 1999). Lubart argues that constraints are most important for driving the appropriateness component of creativity judgments: "without constraints, creative work would degenerate into productions that were simply novel" (Lubart, 1994, p. 313). Indeed, constraint is most often associated with appropriateness or usefulness judgments. Constraint may also be used to drive the originality or novelty component of creativity, and exploring this possibility was one of the purposes of the present study. Campbell's evolutionary theory posits that creativity consists of two main processes: idea generation and idea selection (Campbell, 1960). Constraint can increase creativity in both.

Creativity and Search

One of the ways that constraint affects creativity is through idea generation. The process of looking for and generating new ideas is often referred to as "search" (Cyert & March, 1963; March & Olsen, 1979; e.g., March & Simon, 1958; March, 1981; March, 1988). Because time and attention are scarce resources (March & Simon, 1958), decisions about search behavior can have more influence on final outcomes than the set of ideas available in the first place (March, 1988). For instance, unless otherwise compelled, actors tend to prefer searching for new ideas *locally,* or in conceptual spaces that are familiar and closely related to the problem at hand, such as prior solutions (March & Simon, 1958). By definition, ideas encountered in this type of search are less original than those found in *distal* searches.

Another of the purposes of the present paper is to explore the possibility that one can be compelled to search for more distal, novel ideas *if their search is constrained*. "Constraints force the individual to move beyond the early, mundane ideas that readily come to mind" (Lubart, 1994, p. 313). Others have suggested that establishing constraints to structure ideation can produce more innovative breakthroughs than brainstorming alone. For example, Coyne and colleagues recommend a semi-structured approach to generating ideas, wherein the range of acceptable ideas is bounded from the onset using constraints like customer user needs, strategic

imperatives, and data (Coyne, Clifford & Dye, 2007). The ideas are continually narrowed by tailoring specific questions that enable only a few of the most fruitful ideas to be selected for building upon (Coyne et al., 2007). The more constrained the search or idea generation process is, the more quickly novel ideas should emerge. However, novelty is not everything. Creativity also demands usefulness (Amabile, 1983). If search is too constrained, the search can become intractable and many of the most useful ideas may be eliminated. Furthermore, high levels of constraint are likely to have a detrimental effect on intrinsic motivation, which in turn hampers creativity (Amabile, 1983).

Constraint is also expected to affect creativity via idea selection. While idea generation has received more research attention, idea selection can have important effects on the creativity of final products (Rietzschel et al., 2006). For example, Reizschel and colleagues found that even if people are capable of generating and recognizing novel ideas, they are unlikely to select them even if asked to explicitly (Rietzschel, Nijstad & Stroebe, 2006). This pattern is referred to as the "anti-originality bias" (Rietzschel et al., 2006).

Constraint can affect idea selection in two ways. First, the evaluation and selection of ideas is costly and it can result in too many choices (resulting again in the "paradox of choice"). If constraint produces fewer ideas, selection decisions may be more effective.

> *"For all its supposed openness, brainstorming can end up being surprisingly narrow-minded. The first step is to consider all ideas no matter how crazy, but then you have to trim what is sure to be a substantial list of ideas to a manageable number. So what do you do? Apply quick, common sense judgment, which usually eliminates the ideas with the greatest potential novelty." (Goldenberg, Horowitz, Levav & Mazursky, 2003, p. 128)*

Second, constraints serve as selection criteria, which can be used to ease the idea filtering process. Without some criteria, the best way to evaluate ideas is ambiguous. Just as rapidly changing environments prompt organizations to mimic those perceived to be successful (DiMaggio & Powell, 1983), ambiguous situations prompt individuals to infer appropriate courses of action from norms and the behaviors of others (Cialdini, Reno & Kallgren, 1990; Darley & Latane, 1968; Sherif, 1936). Similarly, accountability to constituents with unknown views leads decision-makers to decide upon the most acceptable course of action (Tetlock, 1985). This type of ambiguity increases reliance on norms and averages (Simonson, 1989, 1998), and prevents the selection of risky (Tetlock, 1994), extreme (Simonson 1989, 1998), and ambiguous choices (Curley, 1986). This pattern is especially strong when there is a risk of challenging the status quo (Simonson & Nowlis, 1998).

When applied to idea selection, these decision making heuristics can result in the systematic rejection of original ideas. Relying upon norms and averages to estimate the appropriateness of behavioral options can result in mimicry, homogenization, and conformity (1998; Simonson, 1989), and by definition precludes novelty (a form of deviance). The avoidance of ambiguity (Curley, Yates & Abrams, 1986) and risk (Tetlock & Boettger, 1994) precludes searching for and selecting novel ideas, because such ideas are new by definition and their likely outcomes are unknown. Furthermore, avoiding risks that challenge the status quo

(Simonson & Nowlis, 1998), as creative ideas often do (Pfeffer & Sutton, 2000), is a further strike that ambiguity—or a lack of constraint—makes against creativity.

On the other hand, constraints that are too strictly defined can decrease the quality of the idea selection process. Rules can backfire when they imply a minimum acceptable standard, or discourage the use of individual judgment (Gouldner, 1950). Similarly, accountability to constituents with known views is likely to result in another low-effort tactic—conformity (Cialdini, Levy, Herman & Kozlowski, 1976; Tetlock & Boettger, 1989)—suggesting that high constraint also discourages the selection of original (non-conformist) ideas.

The literature reviewed above suggests competing hypotheses. On the one hand, constraint can encourage original idea generation and selection, because it discourages reliance on either conformity or on rules alone.

H2:   Constraint has a positive linear effect on individual creativity

On the other hand, the effects of constraint on intrinsic motivation cannot be ignored. Although very low constraint should make creative choices overwhelming and difficult to make effectively, very high constraint decreases intrinsic motivation, especially it is perceived as controlling. Constraint was predicted to have a net positive effect on creativity *vis a vis* creative decision making, but a net negative effect on creativity *vis a vis* intrinsic motivation. The interaction of these two effects should be curvilinear, resulting in an inverted-U shaped function.

H3:   Constraint has a curvilinear (inverted-U) effect on individual creativity.

If either of these hypotheses is supported, then two alternative explanations for the effects of constraint on creativity must be examined. The first is suggested by the literature on self-determination (Deci & Ryan, 1985) and its effects on creativity *vis a vis* intrinsic motivation (Amabile, 1990). This line of research, as reviewed above, has shown that situations that decrease an individual's sense of self-determination tend to decrease that individual's level of intrinsic motivation, and in turn decrease their ability to be creative (Amabile, 1983). Because constraint limits freedom, it is expected to decrease self-determination, thus intrinsic motivation. The effect of constraint on creativity therefore could be mediated by intrinsic motivation.

H4:   Intrinsic motivation mediates the effect of constraint on creativity.

Constraint and the Allocation of Time in Creative Tasks

The second potential explanation for any observed effects of constraint on creativity deals with the function that constraint plays in the creative process and how it could affect creativity by saving time. Problem construction has received much attention by creativity researchers, who argue that the time and effort invested in constructing a problem promotes creative outcomes (Mumford, Connelly, Baughman & Marks, 1994). One's definition of a problem has a direct link to one's ability to identify a creative solution to it because the way that one defines a problem determines the set of solutions that will be considered relevant (Getzels, 1975). The design literature describes a nearly identical process(Howard, Culley & Dekoninck, 2008) of need identification (Arkes, 1985; Hales, 1993; Ullman, 1997). It could be argued that constraints

are a short cut to problem construction and that any positive effects of constraint observed could be due to the fact that the time saved on problem construction was invested in other activities such as idea generation and idea development. To test this alternative explanation, I predict that the allocation of time will mediate the effect of constraint on creativity.

H5: Time allocation mediates the positive effect of constraint on creativity.

Constraint in Creative Teams

In addition to the effects of constraint on the creative process reviewed above, the act of setting constraints in teams should have additional positive effects on team outcomes. I will now review the literature on three constraint-related topics that have special relevance for groups and teams: problem construction, mental models, and goals.

Problem Construction

Setting constraints is part of the "analysis phase" of the creative process (Howard, Culley & Dekoninck, 2008), wherein a difficulty is felt (Dewey, 1910), or an opportunity (Basadur, Pringle, Speranzini & Bacot, 2000) or problem is found (Isaksen, Dorval & Treffinger, 1994) or presented (Amabile, 1983). Setting constraints involves opinionated conversation, revealing personal values and preferences, and collaborative iteration. For design teams, the problem construction phase usually involves the setting of constraints in the form of a brief (Hales, 1993) or mission statement (Ulrich, 1995).

Because soliciting the perspectives of team members is a collaborative process, constraint formation prompts each individual to engage in problem construction, which can aid in the formation of a group-level problem construction. Group-level problem construction, however, is not a simple aggregate of the individual level (Reiter-Palmon, Herman & Yammarino, 2007). The content of individuals' pre-inventive structures may differ dramatically, especially in creative tasks. Individuals attend to different aspects of problems, usually focusing on those aspects that are most salient to them based on prior experience with similar problems (Reiter-Palmon, Herman & Yammarino, 2007). Reiter-Palmon and colleagues argue that the more novel a problem is, the more likely that team members will represent the problem in different ways because there is less overlap between their prior experience with similar problems (Reiter-Palmon, 1997). Thus, it may be particularly important to set constraints as a group rather than have them imposed by an outside source.

Mental Models

At the team level, problem construction on creative teams has been theoretically linked to team mental models (Reiter-Palmon et al., 2007). Mental models are knowledge frameworks that indicate which concepts and information are relevant, and specify the relationships between them (Webber, Chen, Payne, Marsh & Zaccaro, 2000). Team mental models are defined as "team members' shared, organized understanding and mental representation of knowledge about key elements of the team's relevant environment" (Mohammed, 2001, p. 90).

Team mental models provide a shared framework for interpreting new information and

prioritizing valued alternatives. For creative tasks, mental models include information about the problem, limitations to solving it, and goals such as a mental vision of the final product. As such, they can be especially helpful in directing creative processes in teams.

When mental models are sufficiently similar across team members, they are referred to as shared. Shared team mental models are associated with various team processes that affect team effectiveness, including by facilitating effective problem solving (Cannon-Bowers & Salas, 2001), a critical aspect of creativity.

Sharedness should be especially important on creative teams, because it supports team coordination and performance on tasks that are unpredictable, complex, or novel (Marks, Zaccaro & Mathieu, 2000), as creative tasks are. Mathieu and colleagues found that the positive effect of team mental model sharedness on team effectiveness was fully mediated by team processes, including strategy formation and coordination, cooperation, and communication (Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000). In a study of product and process innovation teams, Pearce and Ensley found that similar visions of the final product were associated with team innovativeness, as perceived by both the teams' members and external stakeholders such as customers (Pearce & Ensley, 2004).

Goals

Setting constraints elicits members' explicit, public commitment to a shared goal. Goal-setting theory (Locke & Latham, 1990; Locke, Latham & Erez, 1988) argues that the establishment of specific, difficult goals is associated with higher performance than is the establishment of goals to do your best, or with an absence of a specific goal. Constraints contain specific goals that limit the scope and specify the direction of a creative project. Thus, teams that set specific constraints should be more motivated and perform better than teams that either set nonspecific (vague) constraints, or no constraints at all.

Goal commitment is critical to the effectiveness of goal setting in promoting performance (Locke et al., 1988). One thing that improves individuals' commitment to goals is explicitly stating goals in front of important others, and knowing that those individuals will monitor ones behavior toward teaching the goal (Schlenker, Dlugolecki & Doherty, 1994).

For goals to be effective in groups, they must be shared or at least aligned in terms of the actions they promote. However, research has shown that when individual group members have specific goals that align with the group's goal, the whole group performs better (Seijts & Latham, 2000). Both of these conditions are met when teams jointly and explicitly set constraints. Thus, setting explicit constraints in a team should increase each individual's commitment to those constraints, making it more likely that their own behavior will be in line with the goal in subsequent stages of the creative process.

Through the initial process of discussing individual preferences and by negotiating shared goals about how to constrain a creative project, teams should experience higher creativity. Conversely, if they do not initiate the process of sharing individual goals, and coming to an explicit, specific agreement about the limits and direction of their creative project, then performance should suffer.

In sum, the process of setting constraints is expected to positively affect team functioning. This process of setting constraints also supports the formation of a shared mental model, which provides a shared framework for interpreting new information and prioritizing valued alternatives, and it facilitates coordination in novel tasks. Setting constraints also elicits member's public commitment to a shared goal.

The byproducts of negotiating explicit, specific constraints should facilitate group decision making, coordinated action, and the interpretation and integration of new knowledge. It should also positively impact individual contributions to the team project through increased commitment to the team's goals for the project, and increased motivation. Finally, members' experience of witnessing each others' explicit commitment to the team's constraints should increase their own confidence in acting in line with those goals. When team members are confident that they are on the same page as their team members' about the constraints of their team project, they should be willing to work harder and make more confident, bold decisions.

Thus, I predict an overall positive effect of constraint on creative outcomes in teams. I also predict a negative effect of constraint on the overall level of conflict on teams, such that a higher degree of constraint is associated with a lower degree of conflict.

H6:   Constraint has a linear, positive effect on group creativity

H7:   Constraint has a negative effect on the overall level of group conflict.

It is also possible, however, that the negative effects of high constraint will have a greater effect on group creativity than the positive effects suggested by the literature reviewed above. For instance, constraints in the form of rules can backfire when they imply a minimum acceptable standard, or discourage the use of individual judgment (Gouldner, 1950). In group settings, accountability to team members with known views is likely to result in the low-effort tactic of conformity (Cialdini et al., 1976; Tetlock & Boettger, 1989). Because making constraints explicit reveals the views of teammates, high constraint may actually encourage conformity and discourage the selection of original ideas. Thus, the same curvilinear effect predicted at the individual level may also be true for teams.

H8:   Constraint has a curvilinear (inverted-U) effect on group creativity.

Conclusions

This chapter has reviewed theory and research suggesting that the presence of constraints can support various cognitive aspects of the creative process (Stokes, 1999) by limiting and directing search (Reitman, 1965). It has emphasized the importance of constraining (limiting and directing) decisions characterized by extensive choice and ambiguous decision criteria, and it reviewed how decisions are prevalent in the creative process. It has also presented a set of hypotheses predicting that constraint can support creative processes by facilitating these decisions.

A gap in the literature gap exists. While there has been a lot of work done on the effects of the lack of constraint (extensive choice) on decision making (Chernev, 2003; Iyengar &

Lepper, 2000) and psychological well-being (Schwartz, 2004), there has been very little empirical work on its effects on creative behavior. The work that has been done has not examined constraints imposed on the creative problem itself, nor has it been designed to measure non-monotonic effects. The chapters that follow describe three studies that attempt to address this gap. The chapters provide the experienced investigator with enough data to replicate and extend each of the three studies.

CHAPTER III: EXPERIMENT OF AN INDIVIDUAL PRODUCT DESIGN TASK (STUDY 1)

For the convenience of the reader, this chapter begins with an overview of the purpose and nature of Study 1, which was an examination of the link between constraint and creativity at the individual level of analysis. The specific purpose of Study 1 was to test hypotheses about the causal effects of constraint imposed on a creative task in a controlled laboratory setting, where constraint was manipulated along a continuum from low to high. This design aimed to detect any non-monotonic effects of choice on both intrinsic motivation and creative outcomes. The second purpose of Study 1 was to collect data about participants' emotions, information search behavior, and allocation of task time to test hypotheses about the processes potentially underlying the effects of constraint. The "facilitator" identified in the all three studies was the experimenter. In addition to addressing the overall research questions, Study 1 addressed two specific questions:

Q1: Does the degree of constraint imposed on a creative task affect individuals' creative outcomes? If so, what functional form do these effects take?

Q2: What mechanisms underlie the effects of constraint on individual creativity?

Study 1 was a test of the individual level hypotheses in a laboratory setting using 246 undergraduate research participants. In the experiment, participants did a creative task involving research for and writing of a proposal for a new product that would address a problem given to them in a prompt. Information about participants' search behavior was gathered unobtrusively during the experiment using a computer-tracking program, and creativity was assessed using the Consensual Assessment Technique (*CAT*; Amabile, 1983). The hypotheses tested were:

H1: Constraint has a negative effect on intrinsic motivation.

H2: Constraint has a positive linear effect on individual creativity.

H3: Constraint has a curvilinear (inverted-U) effect on individual creativity.

H4: Intrinsic motivation mediates the effect of constraint on creativity.

H5: Time allocation mediates the positive effect of constraint on creativity.

Methods

Participants were randomly assigned one of four prompts introducing a product design task. Prompts included a general topic, and zero to five subtopics depending on condition as explained below. The task had two phases - research and proposal writing. Before writing proposals, all participants researched in a controlled Internet database of articles spanning the five subtopics. Participants had 40 minutes to complete both the research and writing phases of the task. Five trained judges—undergraduate research assistants—rated proposals on the

dependent variables of creativity and originality. Participants completed computerized questionnaires before and after the task, making the total time per experiment one hour.

Participants and Experimental Setting

Participants were 246 undergraduates at the University of California, Berkeley. Of these, seven did not write proposals and were not included in the analysis, leaving 239 total participants (38% men, 61% women). Fifty-four percent received course credit and 46% were recruited from a campus-wide experimental subject pool and paid $15 each. Recruiting notices termed the experiment, "Creative Product Design Study." The average age was 20.87 years (SD = 3.25). Participants had majors spanning 62 departments, with 74 (31%) from Business, 47 (20%) from Economics and related fields, 28 (12%) from Psychology and the Social Sciences, 70 (29%) the Sciences and Engineering, 52 (22%) from the Humanities, and four (2%) undeclared. Percentages totaled over 100 because 38 participants had double majors and 3 had triple majors.

Signs hung on the doors outside and text drafted on a whiteboard inside the lab read: "Assessing Creativity Using a Product Design Task." The lab had 30 laptop computers separated by partitions in 5 rows of desks. Two pencils, a pen, blank paper labeled, "Research Notes and Brainstorming," and an instruction packet were placed on each work station with a cover page that contained only a random four-digit ID number and instructions for participants not to open the packet until asked by the facilitator.

Stimuli

Selection of topics.

Before the study, the subject areas for the product design task were considered carefully. Health was chosen as the general topic for the task because it was a subject that most participants (all undergraduates) were familiar with and were somewhat interested in based on demographic information. The next step was to select five subtopics. Two research assistants scoured *PC Magazine's* list of the top health websites of the year ("Top 100 Classic Websites of 2006," 2006) and identified 95 available subtopics (e.g., mammograms, managing stress, running, gardisil, and food allergy warning labels). Next, four research assistants flagged subtopics that were potentially upsetting, emotionally provocative, or controversial (e.g., teenage pregnancy, suicide); all flagged subtopics were eliminated. The remaining subtopics were rated on familiarity, interest, relevance to undergraduate students, and likelihood of resulting in a creative idea on scales of 1-5, where 5 was "high." Subtopics that averaged above a 3 on every dimension were retained. Finally, five subtopics with the most equal ratings were selected: Drug Abuse, Fitness, Nutrition, Preventing Illness, and Stress.

Construction of article database for research phase.

To construct the article database, articles were downloaded from two of the five websites used above—WebMD and the Mayo Clinic—because they were comparable in length and style and offered a broad variety of subject areas under each subtopic. Fifty articles were chosen for each subtopic, for a total of 250 articles. The text of each article was extracted and stripped of all images and formatting. Six hyperlinks to other articles in the database were added to the

bottom of each article - two from its main topic area, and one from each additional topic area. The database was made searchable using a simple keyword search engine by Google, and was accessible using a web browser. If an article's title did not clearly reflect its content, the article was given an additional title to facilitate searches.

Web browser setup and timer.

Participants were guided through all parts of the study in a custom-built web application that enabled the facilitator to collect responses and track the time participants spent in each part of the task. All instructions, questionnaires, and both parts of the task were accessed using a standard web browser (Mozilla's "Firefox"), and a third-party "kiosk" add-on that disabled user navigation and removed toolbars. The web page window bled to fill the whole screen.

During the product design task, two elements remained on the screen. At the top of the window was a small countdown timer showing time remaining of 40 minutes in MM:SS format; the timer was visible for both research and proposal phases. During the research phase, a search bar remained at the bottom of the browser window for entering new search terms while viewing an article, as well as a button labeled, "finished researching, click to write proposal." If time ran out while the participant was working on either the research or proposal writing phase, a pop-up window appeared asking them to write "time ran out" where they left off, and to continue on to the post-task questionnaire.

Experiment Design

The experiment used a four-level between-subjects design. To enable the detection of non-monotonic effects, constraint was manipulated at four levels - low, moderately low, moderately high, and high. Participants were randomly assigned to receive one of four task prompts that varied on constraint, or the degree to which the prompt restricted participants' freedom and choice in determining how to creatively address the issue presented. The low constraint prompt asked the participant to address any issue related to the general topic of health and the moderately low constraint prompt asked them to solve any one of five subtopics related to health. The number of subtopics listed was reduced to three in the moderately high constraint prompt, and one in the high constraint prompt.

Procedures

Instructions.

Once all participants were seated, the facilitator explained that each participant in the study would engage in a product design task where they would be asked to do research and then write a proposal for a new product that addressed a health-related issue. Participants were encouraged to be creative. Because constraints may help ensure that time and other resources are used in a more focused manner, participants were told to use the timer at the top of their webpage to allocate their time (40 minutes maximum) between research and writing as they preferred. (These instructions also appeared in the written task instructions both on the computer and in the prompt.)

Pre-task questionnaire.

Next, participants completed the pre-task questionnaire containing demographic questions and scales measuring control variables. Participants were asked how much knowledge and experience they had in 20 topics relating to health, research, creativity, and product design to control for participants' level of expertise in the subject. These covariates did not have a significant effect on the results and will not be discussed further.

Task prompts and manipulation of constraint.

When participants finished the questionnaire, the computer program told participants to read their task prompt, which contained the same basic instructions for all conditions:

> *A new product designer's job is to create new products that address specific customer issues. For example, McDonald's addressed its customers' issue of needing to eat in their fast-paced lifestyle, by introducing special packaging for meals-on-the-go. In this study, your job is also to propose a new product that addresses a specific customer issue of your choosing. Before you choose your issue and write your proposal, you will do some research using an online database. Use your paper to take detailed notes in order to substantiate your proposal later on. You will have access to these paper notes but not to the articles in the database, once you begin writing your proposal. When you are ready to finish your research and move on, click the button on the bottom of your screen. You will then be asked to indicate which issue you chose, and write a product proposal to address that issue.*

To ensure that proposals would be comparable (e.g., in terms of the amount of resources it would require to implement them, and their likely impact), all prompts contained the following four rules: (1) the product should cost no more than $10 per unit to produce; (2) the proposal should be creative, convincing, well-researched, and must accurately address the issue at hand; (3) proposals should include a mission statement, product description, and reasons why the product idea was original and useful; and (4) participants were to include specific facts from research to defend their idea and demonstrate that the product would be a good solution to the issue they were trying to solve.

These rules imposed an additional (but equal) level of constraint on all four groups. The purpose of the rules was to limit the between-group variance of factors not directly related to creativity, but which may have compromised the reliability of judges' creativity ratings. They were intended to ensure that judges could evaluate proposals on the basis of their creativity without being distracted by large differences in proposal content, or product scope, scale, and implementation costs.

The next part of the prompt differed by condition:

1. *Low Constraint.* Participants at this level were told to propose a new product that addressed any health-related issue.

2. *Moderate-Low Constraint.* Participants at this level were told to propose a new product that addressed any one of five health-related issues. They were presented with a list of the five issues contained in the health database: drug abuse, fitness, nutrition, preventing illness, and stress.

3. *Moderate-High Constraint.* Similar to the Moderate-Low condition, participants at this level were also given a choice of health-related issues, but instead of five, they were asked to address any of three health-related issues. To ensure that each topic had an equal chance of being chosen across all conditions, there were ten versions of this condition's prompt, distributed equally and randomly, each with a different combination of three of the five possible issues from the database.

4. *High Constraint*: This level continues the same pattern of reducing the number of health-related issues available seen above, this time asking participants to address one specific health-related issue. All five possible variants of this prompt were created to ensure equal spread across the conditions, one for each topic.

Research phase.

After reading their prompts, participants clicked a button that started their 40-minute countdown timer and opened the article database for them to begin research. They could search for articles using keywords, or click on links found at the end of articles. Participants were given paper and pencils and took notes on their research. When they were ready to continue to the proposal-writing stage, participants clicked a button at the bottom of the screen and the article database closed.

Proposal writing phase.

The web-based survey provided a proposal template that was designed to elicit clear, detailed, and thoughtful product idea descriptions from all participants, thereby minimizing time and effort confounds and increasing the reliability of judge ratings. The template contained five questions:

1. *Problem:* Refer to your paper instructions, and type the exact problem you are trying to solve.

2. *Mission:* You will describe your product in more detail later, but for now, imagine that you need to sell your product idea to an executive in 30 seconds or less. In one or two sentences, what is the vision or "mission" for the new product you are proposing? What does it aim to do or achieve? Be compelling.

3. *Description:* In 2-3 paragraphs, please describe your product, including its functions, features, benefits, and appearance. Be concrete and detailed, so that your reader can visualize the product you propose creating. What does it do? How does it work? How is it used? What does it look like? Use references to your research notes to substantiate your and defend proposal as a good solution to the prompt you were given.

4. *How is this idea original?* In 1-2 paragraphs, make a persuasive argument about how your product idea would be novel and unique in terms of addressing the issue you set out to address in this task. Remember, use references to your research notes to substantiate your claims.

5. *How is this idea useful?* In 1-2 paragraphs, make a persuasive argument about how your product idea would be effective and valuable in terms of addressing the issue you set out to address in this task. Again, please use references to your research notes to substantiate your claims.

If the 40-minute time limit ran out and while a participant was still working on either the research or proposal writing phase, a pop-up window appeared asking them to write "time ran out" where they left off, and advised them to continue to the post-task questionnaire.

Post-task questionnaire.

At the conclusion of the experiment, all participants responded to a manipulation check ("While doing this project I had a lot of freedom in deciding exactly what problem I was going to solve"). Several scales were used that were used to inquire about their intrinsic motivation after the task, satisfaction with their own performance, emotions, and other subjective reactions to the task, and gathered demographic information. Participants were excused at the end of the hour.

Measures

Intrinsic motivation.

Intrinsic motivation was calculated as the average of seven items (Cronbach's alpha = 0.89) from the post-task questionnaire, all rated on five-point scales. The following adjectives were rated in terms of how accurately they described the task from 1 (*not at all accurate*) to 5 (*very accurate*): *interesting*, *boring* (reverse-coded), *fun*, *motivating*, and *important*. For the question, *How much did you enjoy this task?,* 1 meant *not at all* and 5 meant *very much*; and for the question *If you were to participate in another experiment, would you be interested in participating in a similar task in the future?*, 1 meant *not at all* and 5 meant *certainly.*

Creativity.

The main dependent variables were measured using a method based on Amabile's Consensual Assessment Technique (*CAT*, Amabile, 1983). Five trained judges, blind to condition and hypotheses, independently rated each proposal on *creativity* (using their own subjective definition), *originality*, *appropriateness*, and *effectiveness*. (This study tested predictions only about creativity. Originality, appropriateness and effectiveness were included to aid the respondent in defining creativity.)

Inter-rater reliability was estimated with a two-way mixed model intra-class correlation (ICC) appropriate for when judge effects are fixed. Initial reliability for the five judges was lower than desirable for creativity (ICC = 0.70). This was likely the large number of ideas rated by each judge (n = 274) and the length of the proposals (roughly two pages each), which could produce inconsistent interpretations across judges and make achieving reliable ratings more

difficult.

In creativity research, discrepancies in judge ratings are often resolved through discussion, a method used in creativity research and Assessment Center contexts (Thornton III & E. Rupp, 2006). Face-to-face discussion is the most common method, but it has been criticized because of the propensity for social pressure to result in judges changing their ratings to achieve consensus even if the revised rating would not reflect their personal views, thus limiting the validity of the multi-judge system.

In this study, a more unbiased approach was used in which a mathematical adjustment to ratings was applied to improve consistency while maintaining independence. For each proposal, the rating with the highest absolute difference from the mean was removed. In cases where there was a tie in absolute differences, one of the tied ratings was randomly selected for removal, alternating between positive and negative differences where ties differed in sign. This process eliminated outliers to increase reliability without substantially changing mean values, resulting in four ratings per proposal. Creativity achieved a good inter-rater reliability estimate (ICC = 0.85) as calculated with the one-way random model appropriate when judge effects are random.

Time allocation.

Based on tracking data collected by the web-based experimental program, three variables reflected participants' allocation of time during the two phases of the product design task: *minutes spent on research, minutes spent on proposal,* and the proportion of *time spent on research / total time*.

Results

The primary goal of the study was to establish whether or not the degree to which a product design task was constrained had an effect on the creativity of the final product. The study was designed to explore both linear and curvilinear effects, thus, there were four conditions, ranging from low to high constraint. The main data used to test the hypotheses were the product proposals participants wrote, as rated by the five independent judges. Examples of products included vitamin-enhanced flour, drug awareness slogans on coffee cups, stress reduction programs on mp3 players, and airborne pollutant detectors in cars.

The primary result was that, as predicted, constraint had a curvilinear effect on creativity, meaning that moderate levels of constraint were associated with higher ratings on these variables than either low or high levels of constraint. Participants given low-constraint ("address any health-related issue") and high-constraint (e.g., "address the health-related issue of stress") prompts wrote proposals rated as more creative than did participants in the two moderate conditions (those who picked either one of five, or one of three health-related issues).

Descriptive Statistics and Correlations

Table 1 shows means, standard deviations, and correlations among the key variables. Scale reliabilities and intra-class correlations are given on the diagonal. As can be seen, judges' ratings of proposals' creativity were reliable (ICC = 0.85). Intrinsic motivation (alpha = 0.89)

was also reliable with good internal consistency.

Table 1: Means, Standard Deviations, Reliabilities, and Correlations Between Study Variables

		M	SD	Correlations			
				1	2	3	4
1	Creativity	3.59	1.07	(.81)			
2	Intrinsic Motivation	1.88	0.88	.08	(.89)		
3	Min. Researching	23.30	6.95	-.20***	-.12*	-	
4	Minutes Writing	23.46	5.62	.09	.22**	-.62***	
5	Minutes Researching/ Total	0.49	0.12	-.14*	-.18**	.93***	-.84***

*p < .10, **p < .05, ***p < .01, two-tailed

Time spent on research was negatively related to creativity (r = -0.20, p < .01) and intrinsic motivation (r = -0.12, p < .05). Time spent on writing was positively related to intrinsic motivation (r = .22, p < .01). The proportional allocation of time these two tasks (calculated as the proportion of time spent on research over the sum of time spent on research and writing) was negatively related to creativity (r = -.14, p < .05) and intrinsic motivation (r = -.18, p < .01). As expected, all of the time-related variables were strongly correlated (all p's < .001).

Manipulation Check

The item "I felt free regarding the problem I was trying to solve" was used as a manipulation check, and confirmed that the manipulation of constraint was effective; the results were negative and linear (F(1, 236) = 3.41, p < .05).

Intrinsic Motivation

Hypothesis 1 predicted a negative linear effect of constraint on intrinsic motivation after the task was complete. A one-way ANOVA showed that the overall effect of constraint on post-task intrinsic motivation was not significant F(3,234) = 2.09, p = .10. Table 2 reports cell means and standard deviations for intrinsic motivation by constraint condition. Figure 1 illustrates a generally negative trend, with a sharp decline between the mid-low and mid-high constraint groups. The low (M = 2.03, SD = 0.85) and mid-low (M = 2.04, SD = 0.81) constraint groups appear almost equally high on intrinsic motivation, while the (M = 1.74, SD = 0.93) and high (M = 1.77, SD = 0.90) constraint groups appear almost equally low. An independent samples t-test supports this account, t(236) = -2.51, p < .05. Hypothesis 1 was partially supported.
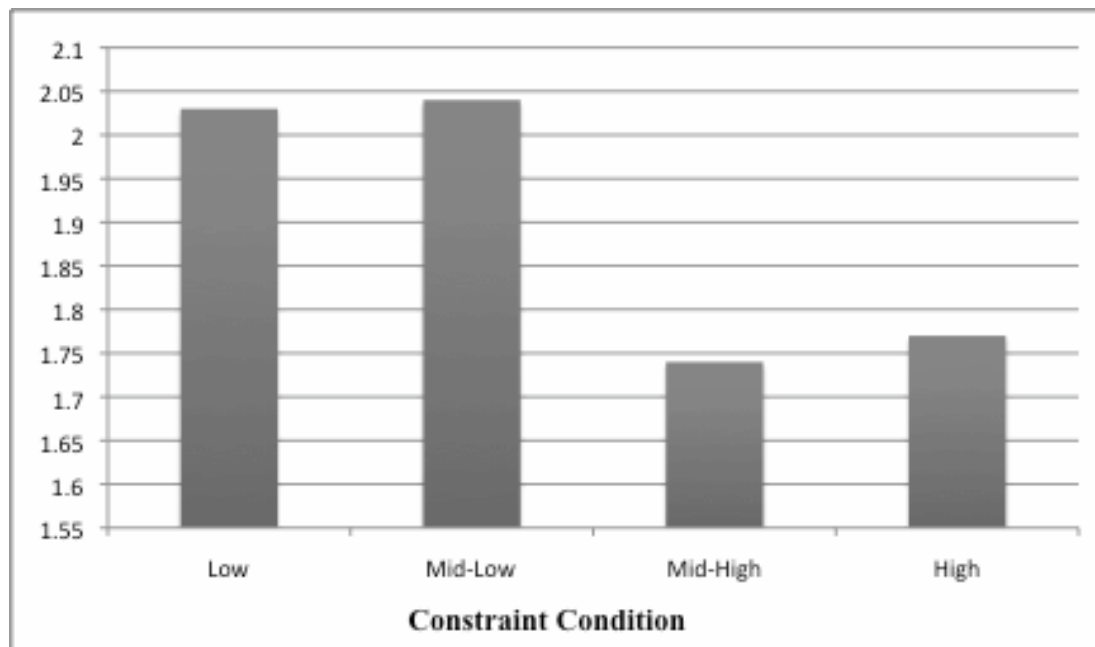
Figure 1. Intrinsic Motivation by Constraint Condition.

Table 2: Intrinsic Motivation Means and Standard Deviations by Constraint Condition

Constraint Level	*N*	*M*	*SD*
Low	58	2.03	.96
Mid-Low	61	2.04	1.16
Mid-High	59	1.74	1.06
High	60		1.05
		1.77	
Total	238	1.9	1.08

Creativity

Hypothesis 2 predicted a positive effect of constraint on creativity. A one-way ANOVA revealed an overall effect of constraint on creativity, $F(3,234) = 3.67$, $p < .05$, thus providing some support for Hypothesis 2. Hypothesis 3 predicted a curvilinear effect, such that the moderate constraint conditions would have higher average creativity ratings than would either the low or high constraint conditions. In a polynomial contrast, only the quadratic term was significant, $F(1,234) = 10.04$, $p < .01$, indicating a curvilinear (inverted-U shaped) effect of constraint on creativity, as predicted. Cell means are reflected in Figure 1. Table 3 reports creativity means and standard deviations for each constraint condition.
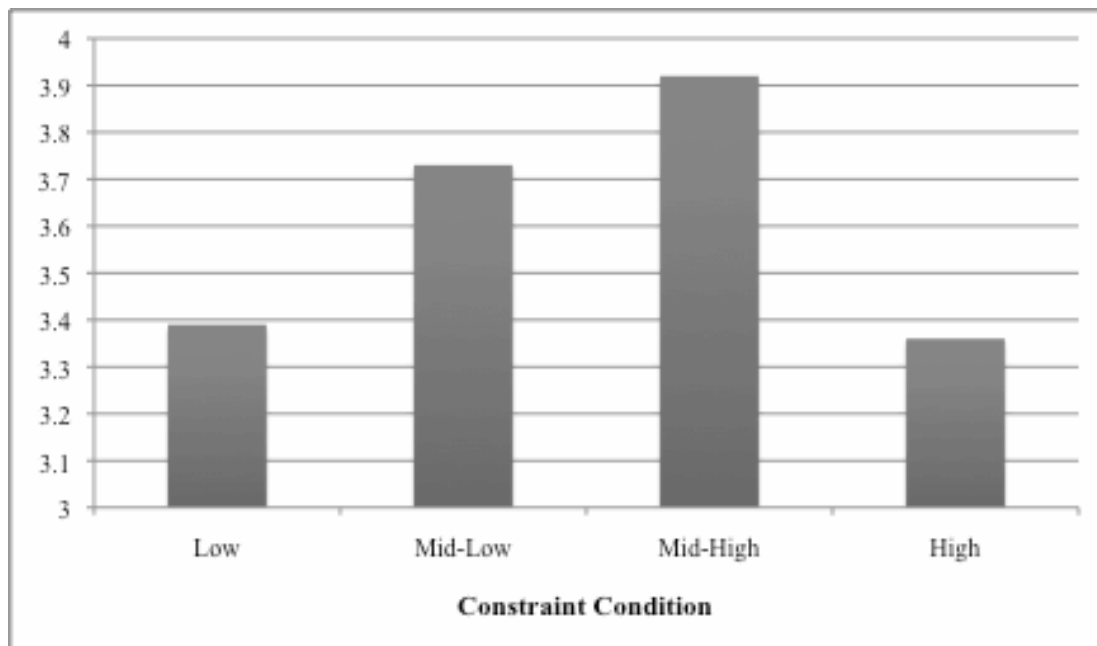
Figure 2: Creativity by Constraint Condition

Table 3: Creativity Means and Standard Deviations by Constraint Condition

Constraint Level	N	M	SD
Low	58	3.39	.96
Mid-Low	61	3.73	1.16
Mid-High	59	3.92	1.06
High	61	3.36	1.05
Total	239	3.60	1.08

To further investigate the nature of the observed curvilinear effect, planned contrasts were conducted for each pair of cells. The low constraint group (M = 3.39, SD = 0.96) scored significantly lower on creativity than the mid-low constraint group (M = 3.73, SD = 1.16; p < .05) and the mid-high constraint group (M = 3.92, SD = 1.06; p < .01), but was not statistically different than the high constraint group (M = 3.39, SD = 1.03). The mid-low constraint group scored was significantly higher on creativity than the high constraint group (p < .05) but was not statistically different than the mid-high constraint group.

Next the two moderate constraint groups were compared combined to the two extreme groups (high and low constraint) combined. As predicted, the mid-low (M = 3.73, SD = 1.16) and mid-high (M = 3.92, SD = 1.06) constraint groups wrote proposals rated as significantly more creative than did the low (M = 3.39, SD = 0.96) and high (M = 3.39, SD = 1.03) constraint groups (F(1, 237) = 10.681, p < .001). There were no significant differences between the two

moderate constraint groups and the two extreme groups, supporting the hypothesis that constraint would have a curvilinear effect on creativity. Hypothesis 3 was supported.

Intrinsic Motivation Mediation

Hypothesis 4 was a prediction that intrinsic motivation would mediate the effect of constraint on creativity. A test for mediation requires four separate regressions. First, the independent variable (constraint) must predict the dependent variable (creativity). Second, the independent variable must predict the mediator (intrinsic motivation). Third, the mediator must predict the dependent variable. Fourth, when the independent variable and mediator are simultaneously entered into the regression predicting the dependent variable, the effect of the mediator must remain significant, while the effect of the independent variable must either fall to non-significance (full mediation) or drop in significance (partial mediation).

In the first regression, creativity was regressed on constraint, where the four levels of constraint in the experiment were collapsed into an interval variable where low constraint $= 1$ and high constraint $= 4$. As expected based on the results of Hypothesis 2 above, constraint had a significant positive effect on creativity ($\beta = -.14, B = -.11, SE = .05, p < .05, R^2 = .02, F(1, 236) = 4.63, p < .05$). In the second regression, intrinsic motivation was regressed on constraint. As expected based on the results of the omnibus ANOVA used to test Hypothesis 1 above, the overall effect of constraint on intrinsic motivation was non-significant. Furthermore, in the third regression, the effect of intrinsic motivation on creativity was also non-significant. These results indicate that intrinsic motivation does not mediate the relationship between constraint and creativity, so Hypothesis 4 was not supported.

Time Allocation Mediation

Hypothesis 5 was a prediction that time allocation would mediate the positive effect of constraint on creativity. The hypothesis was tested using the same four-regression analysis used to test for mediation by intrinsic motivation above. In the first regression, there was no significant effect of constraint on the number of minutes spent writing, number of minutes spent researching, or the proportion of research minutes/ total minutes. Because the first regression in the test for mediation did not demonstrate an effect, the remaining regressions are not conducted. Hypothesis 4 was not supported.

<center>**Discussion**</center>

Without any constraints to limit choices, could freedom actually be stifling? Study 1 looked at individual level creativity in a laboratory experiment to establish the basic phenomenon and assess the functional form of the effect of constraint. Constraint was manipulated by varying instructions in a novel product design task. Random assignment and experimental control emphasized internal validity.

Study 1 found that the degree of constraint imposed on a creative task affects individuals' creative outcomes in a curvilinear fashion, such that a moderate degree of constraint was optimal. Neither time allocation nor intrinsic motivation mediated the effect of constraint on creativity, eliminating two alternative explanations.

Furthermore, although participants who created under very unconstrained conditions enjoyed high levels of intrinsic motivation, their performance was just as poor as those who created under the most constrained conditions. The largest drop in intrinsic motivation happened between the moderate-low (which chose one of five topics) and moderate-high (which chose one of three topics) conditions. This implies that while some degree of choice was essential for maintaining intrinsic motivation, the benefits of choice to creative outcomes quickly drop off as the number of choices becomes overwhelming. This finding supports claims made by Schwartz (Schwartz, 2004; Schwartz, 2004a) about the non-monotonic effects of choice extensiveness on the subjective utility of choice.

The results of Study 1 suggest that a moderate degree of constraint is optimal when creativity is desired. The findings suggest that there are limits to the benefits of freedom and choice, which challenges an assumption underlying psychological theories of creativity - that freedom is the ideal for creativity and intrinsic motivation.

There are several limitations to Study 1 that must be noted. The first is that the manipulation of constraint lacks external validity because it is unlike constraint as it is typically experienced outside of an artificial laboratory environment. Constraint is seldom experienced in as "neutral" a manner as was likely experienced by the subjects in this experiment. Beyond the laboratory, constraint (e.g., a specific restrictions or rule) results from persons or processes, which can imbue the constraint with additional meaning that could alter its effect on the constrained. The effect of the meaning individuals attach to constraints has been the focus of much of the prior research on creativity, constraint, and intrinsic motivation (e.g., Amabile & Gitomer, 1984). Any given constraint can be framed and interpreted differently according to research on cognitive evaluation theory, which, for example, has found differential effects of rewards interpreted as informational versus controlling (Deci & Ryan, 1980; Deci, 1975; Ryan, 1982). Future research must examine how the meaning attached to constraint in various social settings moderates the effects of constraint on creative performance.

An additional limitation is that it is possible that judge's ratings were influenced by unmeasured variables correlated with creativity, rather than creativity itself. Several features of the experimental aimed to prevent this confound. Proposals generated under more constrained conditions were not rated more highly simply because they were more specific. Requiring all participants to back up their proposals with research that they conducted before writing ensures a minimum level of specificity, regardless of condition.

Another feature of the experiment, designed to minimize the effects of proposal content on creativity ratings, was ensuring that all participants had access to relevant information on the topic. Requiring participants to conduct research in the controlled Internet database minimized the potential creativity benefits of knowledge activation (Rietzschel, De Dreu & Nijstad, 2007). Furthermore, because it is thought that prior exposure to subcategories of brainstorming topics is thought to increase creativity within that subcategory by making related knowledge more accessible (Rietzschel, De Dreu & Nijstad, 2007), participants were exposed to specific knowledge from each possibility, regardless of condition. The novel experimental paradigm developed for the study overcame this challenge, manipulating constraint without confounding it with knowledge activation or informational value.

One might be concerned that, by using only four of the five judges, reliability estimates may have been inflated. However, the method used for selecting which four ratings to retain ensured that the measure was not biased, as the mean ratings were not affected and random elimination of the fifth rating was not systematically above or below the mean rating.

Finally, Study 1 was designed to favor internal validity over external validity. Although efforts were made to use a creativity task similar to one found in the real world, the laboratory is never a replacement for the field, and caution must be taken when generalizing from the results of one experiment. Studies 2 and 3 help address this limitation by examining the long-term effects of constraints on creativity in a more realistic setting.

CHAPTER IV: QUANTITATIVE STUDY OF NEW PRODUCT DEVELOPMENT TEAMS (STUDY 2)

For the convenience of the reader, this chapter begins with an overview of the purpose and nature of this study. The specific purpose of Study 2 was to examine the effects of constraint on creativity and associated group outcomes and processes in functionally diverse teams over the full course of a creative project. It also was designed to provide a test of the proposed theory that is in many ways more conservative since the independent variable is measured distantly in time from the dependent variable.

This design also allowed for the detection of any non-monotonic effects by measuring, not manipulating, the degree of constraint teams voluntarily imposed on their own projects. The study setting provided higher external validity than the laboratory exercise allowed in Study 1. In addition to addressing the main research question, Study 2 addressed two specific research questions:

Q3:   Does the degree of constraint teams place on their projects affect their creative outcomes? If so, what functional form do these effects take?

Q4:   Does the degree of constraint teams place on their projects affect group conflict and satisfaction?

Methodologically, Study 2 was a test of the group level hypotheses using archival, survey, and expert ratings of 43 teams over the course of a semester-long new product development (NPD) project. Constraint measures were used to predict group processes 4 weeks later, and outcomes 10 weeks later. The creativity of each teams' final products was measured by a minimum of seven experts from industry using the same method as in Study 1 (*CAT*; Amabile, 1983). The study tested three hypotheses from Chapter 2, which are repeated here for the reader:

H6:   Constraint has a linear, positive effect on group creativity.

H7:   Constraint has a negative effect on the overall level of group conflict.

H8:   Constraint has a curvilinear (inverted-U) effect on group creativity.

Methods

Data and Research Setting

The data were generated by 43 project teams in a graduate NPD class at the University of California, Berkeley, and at MIT. The class was focused on teaching students an innovation process primarily through an intense and realistic new product development project. The range of activities was similar to that used in industry, from (a) writing an original mission statement, (b) conducting ethnographies and interviews of target users, (c) brainstorming product concept ideas, (d) analyzing the competitive marketplace, and (e) developing a prototype.

Data were collected from four different class sections. Three sections were from the Haas School of Business at the University of California, Berkeley (Haas) and one was from Massachusetts Institute of Technology (MIT). Haas partnered with the industrial design program at the California College of the Arts in San Francisco (CCA) in two of the three sections studied, and MIT partnered with the industrial design program at the Rhode Island School of Design (RISD). The course was taught by a team of instructors from three different disciplines – business, engineering, and design -- reflecting both the interdisciplinary nature of NPD work, and the multi-disciplinary Management of Technology certificate program in which the course was housed.

Teams began with an initial project proposal based around a 'bug,' or everyday annoyance, they observed (such as "spreading cream cheese is messy and time consuming"), a valued area of concern ("nutritional school lunches"), or an identified market need (such as a way to estimate manufacturing costs based on early design decisions). Teams then performed "need-finding" through customer and market research, which often resulted in significant changes to the initial direction. Finally, they engaged in concept generation, concept selection, concept prototyping and testing, and financial analysis, closely following the general process in the class textbook, *Product Design and Development* (Ulrich & Eppinger, 2005).

Team Composition

Table 4 describes the four class sections, 43 teams, and 224 students included in the study. Teams contained four to eight members each; the average team size was 5.21, with MIT's teams being largest on average (6.67 members). Thirty-Five of students were female. Academic discipline (based on degree program) was reported by 97% of students, and included business (35%), engineering (26%), a dual business-engineering masters (44% of the MIT section only), and industrial design (14% overall, and 18% of the three sections enrolling them). Other disciplines (9%) included information studies, biology, and education.

Table 4 excludes three cases that had to be dropped from the quantitative analysis. From Haas 2005-1, two teams did not submit sufficient data to be included (explained under *Measures, Constraint* below). From MIT, one team was too different in composition and practice to be considered comparable (they were sponsored by a European corporation and half of the members lived in Europe; teamwork was predominantly virtual).

Assignment of the NPD students to respective teams was based upon common interest and composition requirements. Two weeks into the class, each student shared a one-minute 'pitch' with the class, describing an individual project idea. Students then self-selected into interest-based teams that had to fulfill several requirements. First, teams required a minimum of four members and a maximum of six (at Haas), or seven members (at MIT), and had to contain at least one MBA and one engineer. Second, industrial design students had to be distributed as evenly as possible across all groups. Third, faculty facilitated when necessary to ensure that each student found a suitable team.

Table 4: New Product Development Team Demographics by Class

	Haas 2005-1	Haas 2005-2	Haas 2006	MIT 2006	TOTAL
Number of Teams	8	12	14	9	43
Average Team Size (SD)	5.13 (0.64)	4.83 (0.58)	4.64 (0.75)	6.67 (0.50)	5.21 (0.99)
Number of Students	41	58	65	60	224
Percent Female	24%	34%	38%	34%	34%
Composition by degree program					
MBA	54%	31%	42%	19%	35%
Engineering	30%	29%	29%	16%	26%
Dual MBA/ Engineering	0%	0%	0%	44%	12%
Industrial Design	0%	31%	5%	19%	14%
Information Studies	16%	9%	11%	0%	8%
Other	0%	0%	2%	3%	1%
Unknown	0%	0%	12%	0%	3%

Design Thinking and User-Centered Design

Over the course of the 15-week semester, the syllabus directed teams through the entire new product development process from mission statement to primary research to idea conception to prototype. The class culminated with a presentation and "tradeshow" to a panel of industry experts, who then judged each team's process and product across a variety of dimensions.
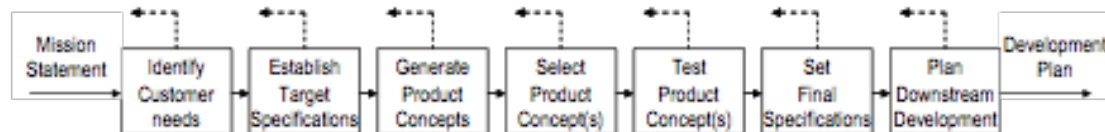
Figure 3. The new product development team process (Source: Ulrich & Eppinger, 1995)

The timeline of the course roughly followed the traditional NPD process illustrated in Figure 3 (Ulrich & Eppinger, 1995), which enabled a linear progression of design stages, starting with a mission statement, moving through the identification of user needs, concept generation and selection, and setting a development plan. This model acknowledges the inherent fuzziness of these stages; the feedback loops in this figure indicate that information gathered at any stage may prompt a team to move backwards to an earlier stage in the process.

While pedagogical demands of course planning resulted in a fairly linear syllabus with stages similar to those found in Figure 3 above (Ulrich & Eppinger, 1995), the philosophy the instructors emphasized was cyclical in nature. The content of the course was based on the "design thinking" model shown in Figure 4. The design thinking model is an iterative process of observation, framing, ideation and solutions/prototyping focused on learning new things about user needs from users themselves, and then basing design decisions on those insights (Beckman & Barry, 2007; Owen, 2001).
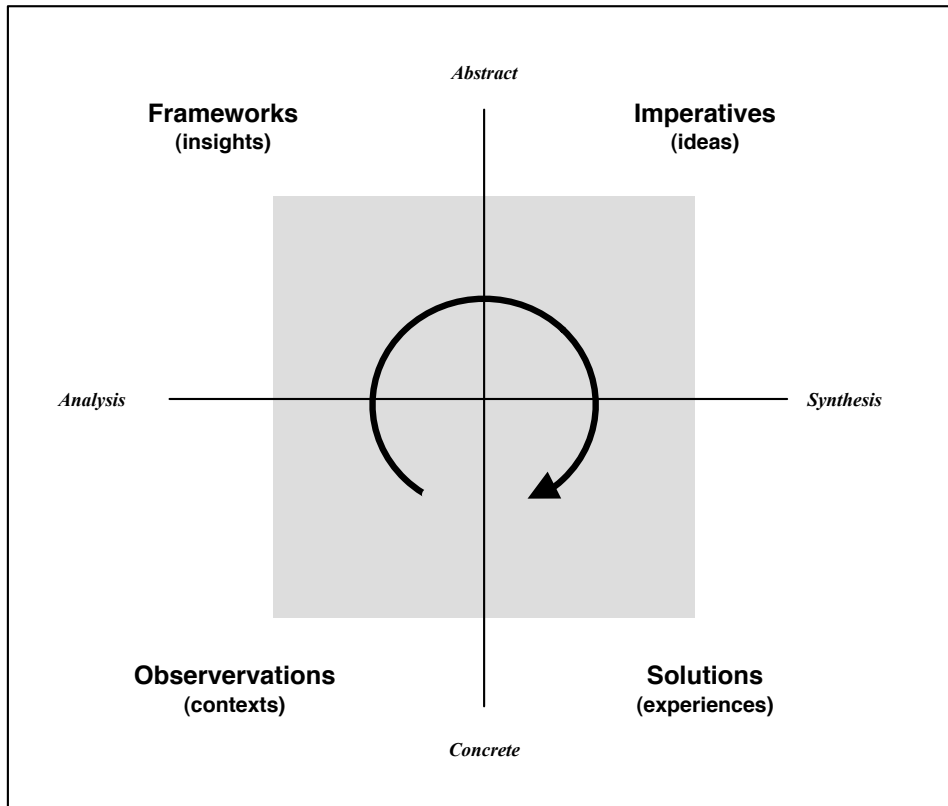
Figure 4: The design thinking model (Source: Beckman & Barry, 2007)

Design thinking is a perspective that views design as a problem formulating (not just problem-solving) process. Ideologically, it emphasizes the need to conduct original analytical work to discover unmet needs or "pain points" before generating solutions. The design thinking process put forth by Owen (2001) was an iterative cycle of observation, framing, generating imperatives, and identifying solutions (Beckman & Barry, 2007). This type of process has been used in many project-based design courses (Dym, 2003, 2005). An important aspect of design thinking is user-centered design. User-centered design is a philosophy and set of practices that prioritize end-user's needs and wants at every stage of the process (Norman, 1990). The philosophy emphasizes discovering, respecting, and attending to user's needs, including emotional and unarticulated or "latent" needs, and often adopts anthropological and psychological research practices such as ethnography and experimentation.

The user-centered design process is a search for novel and appropriate solutions to real but yet-unsolved problems. This is an ideal process for studying constraint and creativity because the emphasis on identifying needs through primary research provides latitude for teams to decide how much or how little to constrain their own projects. They may do this by assuming focus on specific problems, certain solutions, or both. This latitude produces enough variation in

the degree of constraint across team projects to make meaningful comparisons. Finally, user-centered design and design thinking are increasingly considered core skills for a broad range of organizational and business processes beyond new product development, such as strategic thinking, process improvement, and service innovation (Liedtka, 2006), and warrants study from an organizational behavior perspective.

Procedures and Measures

Constraint.

To operationalize the construct of constraint, textual data written by the NPD teams were content-coded using a procedure described in detail below. Content coding is a form of "quantitizing" qualitative data to produce numeric scores that represent abstract constructs (Sandelowski, 2001; Tashakkori & Teddlie, 1998).

Identifying an indicator of team-level constraint. The first task was to develop a unit of textual data that would represent the construct of constraint at the team level, and facilitate between-group comparisons. The source and format of the textual data needed to be fairly standard across teams—meaning that all teams should write it in a similar manner—based on the same instructions, and at the same point of time in the course of the project. The textual data needed to be written early enough in the project lifecycle that they would reveal the teams' initial intent as they began the creative process, but late enough that it could be considered a product of the team, rather than one of the members. The text needed to reflect a shared understanding of the team's agreed-upon constraints as they began the creative search process. Isolated textual data culled from each team's mission statement concretely and consistently satisfied these requirements. All teams were required to agree upon and submit a 1-2 page mission statement - an explicit summary describing the team's goals, intentions, and assumptions (Ulrich & Eppinger, 1995). The teams were taught that the purpose of the mission statement was to "refine the definition of your project and to agree, as a team, about what your objectives are" (document: course syllabus). Mission statements written in the class often included problems the team wanted to solve, potential target markets, and descriptions of the initial vision for the final product or service.

Teams submitted completed mission statements within two weeks of team formation. They were submitted electronically to the class website, which provided a verified date stamp for each submission. Two teams, however, submitted mission statements more than seven days beyond the due date, and were not included in the analysis. The exclusion of these two teams from the analysis helped ensure the mission statements reflected roughly equivalent stages of the creative process.

Rating procedure. Two trained, independent raters evaluated each sentence in two stages. First, to minimize the effect of the mission statement's length, form, and level of detail on constraint ratings, one sentence from each mission statement was extracted for rating. Specifically, raters would read and rate only the one sentence appearing under the heading "Product Description" that summarized the product and project objectives. The majority of mission statements included a clear label for this section, with four exceptions: One team wrote two sentences. In this case, raters jointly selected the one sentence that best summarized the

product. Three teams did not include a heading that labeled the product descriptions. In these cases, research assistants jointly identified the one sentence that best summarized the team's product as described in the mission statement as a whole. Disagreements were resolved through discussion between the facilitator and research assistants.

Constraint items. As described in Chapters 1 and 2, constraints both *limit* the number of ideas available for consideration in a search space, and *direct* search toward certain kinds of ideas. Both of these aspects were rated subjectively for each mission statement "Product Description" sentence.

Raters scored the *limiting* aspect of constraint by responding to the question, "What percentage of possible ideas have been eliminated in solving the problem, or the types of solutions that address the problem" on a scale of 1-100%. Higher scores meant the project was more constrained (a greater percentage of all possible ideas being eliminated *ex-ante*) by virtue of the mission statement sentence. Inter-rater reliability, estimated using a two-way mixed model intra-class correlation (ICC; Shrout & Fleiss, 1979), was high (ICC = .80).

Raters scored the *directing* aspect of constraint by responding to the question, "How constrained is the solution the team is trying to make" (ICC = .75). [1] Higher scores meant the project was more constrained, such that teams moved toward increasingly specific solutions to a specific problem. Responses were on a scale of 1-7, where 1 = not-at-all constrained, and 7 = very constrained.

The constraint measure is the average of each component's standard scores (α = .94). As expected, these two items were significantly correlated (r = .89, p < .001). Table 5 shows means, standard deviations, correlations and reliability estimates for constraint and its component items.

Table 5: Means, Standard Deviations, Reliabilities, and Correlations for Constraint Items

		M	*SD*	1	2	3
1	**Constraint**	0	.97	(α = .94)		
2	**Item 1: Limiting**	54.24	25.16	.97***	(.80)	
3	**Item 2: Directing**	4.15	1.53	.97***	.89***	(.75)

***p < .001, ** p < .01, *p.05, †p < .10 (1-tailed). N = 43. Numbers on diagonal are inter-rater reliability estimates, measured by ICC-1 (one-way random intra-class correlation, Shrout & Fleiss, 1979) unless otherwise indicated.

Word count. Although the number of words in the "Product Description" sentence was not correlated with constraint (r = -.05, n/s) or its component items—limiting (r = -.03, n/s) and directing (r = -.08, n/s)—the number of words was used as a control variable.

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[1] Raters also scored each statement on one additional directing item, "How constrained is problem the team is trying to solve?" (ICC = .82) but this item was not correlated with the other two items in the scale and so it was dropped from the measure.

Creativity.

Creativity was measured using the Consensual Assessment Technique (*CAT*; Amabile, 1982; Amabile, 1983), whereby the creativity of each team's final product was rated by a panel of at least seven expert judges from industry in a presentation at the end of the semester, as described below. The CAT was used because of its reliability and high face validity (Kaufman, Plucker & Baer, 2008). It has been called the "gold standard" of creativity assessment (Carson, 2006), and is the most widely used method of assessing the creativity of products (Kaufman et al., 2008).

Rating procedure. At the end of the semester, each team presented their final product to a panel of at least seven expert judges from industry including technology, consumer goods, service design and consumer and market research. Judges worked in new product development or new product design. Teams presented their final product proposals and prototypes to the panel of judges. Each judge rated between 4 and 12 teams. Judges marked their ratings for each team's product on a separate form for each team as the team presented their product. The audience also included industry experts, peers, faculty and guests.

Products were rated relative to each other on *creativity, novelty, and appropriateness.* These items correspond to the conceptual definition of creativity laid forth by Amabile (1983), wherein creativity is conceptualized as a combination of novelty and appropriateness. As in Study 1, this study tested predictions only about creativity. Novelty and appropriateness were included to aid the respondent in defining creativity. Judges rated each construct on a scale of 1-9, where 1 meant "very low" and 9 meant "very high." Per Amabile's recommendation, judges were allowed to mark the scale in such a way that non-integer scores (e.g., 3 ½) were possible (1982).

Inter-rater reliability. Inter-rater reliability was estimated using a one-way random intra-class correlation (ICC-1; Shrout & Fleiss, 1979). This estimate was appropriate given the nature of the data collected. Furthermore, this methodology is appropriate for estimating the consistency of judges' ratings of a target when there are multiple judges rating multiple targets. There were eight groups of judges spread across four different NPD classes, and each team was rated by at least seven judges on each variable. Not all judges rated all targets; however, judges were treated as a random effect. (This is in line with current practice. Amabile (1996) recommends treating judges as a random effect regardless of the stability of panel membership over time. Calculating ICC-1 requires the same number of ratings for each target (Shrout & Fleiss, 1979). The lowest number of ratings any team had was seven. The measure used was the average of the seven ratings.

Specifically, creativity had an ICC of 0.62, which is considered "good" according to Cicchetti's recommendations for interpreting ICCs (where poor is lower than .40, fair is between .41 and .59, good is between .60 and .74, and excellent is above .75) (Cicchetti, 1994). Table 6 shows means, standard deviations, correlations, and reliabilities of creativity items. As expected, creativity was correlated with both novelty ($r = .67$, $p < .001$) and appropriateness ($r = .62$, $p < .001$).

Table 6: Means, Standard Deviations, Reliabilities and Correlations for Creativity Items

	M	*SD*	1	2	3
1 Creativity	6.76	0.97	(.62)		
2 Novelty	6.61	1.02	.67***	(.66)	
3 Appropriateness	7.03	1.27	.62***	.21	(.78)

***p < .001. N = 43. Numbers on diagonal are intra-class reliability estimates (ICC-1; Shrout & Fleiss, 1979).

Conflict.

Conflict was measured at two points in time during the semester using a web-based survey each student was required to complete for the class. Both the mid-semester (t1) and final (t2) surveys included measures of three types of conflict: relationship conflict, task conflict, and process conflict (Jehn, 1994; Jehn, 1995). Two conflict-related variables are used in Study 2: task conflict at t1, and overall conflict at t2, which is calculated as the average of the three conflict dimensions.

Conflict survey procedure. The first survey was given at mid-semester (t1), about halfway through the project, and roughly 3 weeks after mission statements were collected. Students were asked to respond according to their experience since project launch. At the time the survey was given, teams had just finished conducting user needs research and generating ideas for product concepts and were in the midst of selecting one concept idea to develop. The second survey was given at the end of semester (t2), 2 days before final projects were due. Students were asked to respond according to their experience since the mid-semester survey. At this time, teams were finalizing their prototypes and presentations. Ninety-eight percent of students responded to the t1 survey, and 95% responded to the t2 survey.

Conflict scales used. Due to restrictions on survey length in two of the four classes, two different scales were used. Table 7 shows the means, standard deviations, within-group agreement statistics, and correlations for each factor for each scale.

Conflict Measurement Form 1: Jehn's scale (1995). Two of the four classes completed the 11-item scale developed by Jehn (1994; 1995), which is the most commonly used tool for measuring three types of conflict (De Dreu, 2006). Sample items from each factor included "How much emotional conflict is there in your work group?"(*relationship conflict*), "How often do people in your work group have conflicting opinions about the project you are working on?" (*task conflict*), and "How often are there disagreements about who should do what in your work group?" (*process conflict*). Each item was rated on a scale of 1-7, where 1 meant "not at all" and 7 meant "very much." Items for each factor were averaged resulting in one score for each of the three types. Reliability estimates for each sub-factor were sufficient to high: alpha (relationship conflict) = .93, alpha(task conflict) = .84, and alpha(process conflict) = .71.

Conflict Measurement Form 2: Instructor's scale. The two other classes completed a scale historically used by the instructor. Participants responded to a single item, "Which of the following best describes the level of the conflict at group meetings?" for each conflict type. The three items were (a) "interpersonal / emotional conflict" assessed *relationship conflict*, (b)

"conflict about the direction of the project" assessed *task conflict*, and (c) "conflict about team & task processes" assessed *process conflict*. Each item was rated on a scale of 1-4. Because the Jehn scale ranged from 1 to 7, all conflict scores were standardized before analysis.

Table 7: Means, Standard Deviations, Correlations, and Cross-Factor Correlations for Items in from Both Conflict Scales

			n	M	SD	1	2	3	4	5
								Correlations		
Jehn's scale										
1	t1	Relationship	122	2.32	1.22					
2		Task		2.96	1.15	.80**				
3		Process		2.30	0.87	.67**	.71**			
4	t2	Relationship	115	3.13	1.51	.50**	.39**	.28**		
5		Task		3.42	1.18	.40**	.38**	.35**	.79**	
6		Process		2.60	1.07	.44**	.42**	.47**	.61**	.71**
Instructor's scale										
1	t1	Relationship	98	1.41	0.62					
2		Task		1.90	0.67	.40**				
3		Process		1.72	0.69	.49**	.54**			
4	t2	Relationship	97	1.53	0.63	.23*	.21*	0.15		
5		Task		1.75	0.65	-.08	0.13	0.00	.28**	
6		Process		1.71	0.64	.34**	.24*	0.16	.54**	.27**

* $p < .05$, ** $p < .01$. Total N = 118 for Jehn's scale, 108 for Instructor's scale.

Conflict measurement form equivalence. Prior to treating both scale measurements of conflict as comparable, functional equivalence was assessed by comparing the means and cross-factor correlations. Results are shown in Table 7. Specifically, analysis focused on task conflict (t1), which was the measure of primary concern in the study. In both scales, task conflict (t1) scores were higher than either process conflict (t1) or relationship conflict (t1), and were significantly correlated. The instructor's scale task conflict (t1) measured at mid-semester did not correlate with the same measure taken at the end of the semester, as it did with the Jehn scale. However, it is likely that this inconsistency is due more to the t2 measure than the t1 measure, as conflict (t2) is not correlated with any t1 factors, as would be expected based on the Jehn scale correlations. It was concluded that Task conflict (t1) was sufficiently comparable to the same sub-factor measured using the Jehn scale. The t2 measure was not, and therefore, will not be discussed further.

Conflict within-team agreement and aggregation. To assess whether or not individual team member's responses could be aggregated to the team level of analysis, the item-wise R_{wg} statistic was calculated (James, Demaree & Wolf, 1984; LeBreton & Senter, 2008; LeBreton, James & Lindell, 2005). This statistic estimates within-team agreement and is used to justify aggregation in multi-level research. It is calculated by comparing within-group variance to

expected variance to test the null hypothesis that respondents' ratings of the same target are random.

Table 6 shows the average R_{wg} statistic for each conflict scale used. The Jehn scale had multiple items per sub-factor, so the item-wise $R_{wg(j)}$ statistic was calculated. For each sub-factor, at least 85% of teams that received the Jehn scale had $R_{wg(j)}$ values greater than .70, the traditional cutoff for justifying aggregation (Lance, Butts & Michels, 2006; LeBreton, Burgess, Kaiser, Atchley & James, 2003). The instructor's scale did not have multiple items per sub-factor, so the R_{wg} statistic was sufficient. For each factor, at least 80% of teams had R_{wg} values greater than .71. For both scales, all of the average $R_{wg(j)}$ statistics fell within the .71 - .90 range indicating "strong agreement," according to the revised standards set forth by LeBreton & Senter (2008). Thus, aggregation to the team level was considered appropriate for both conflict scales.

Table 8: Within Team Agreement Estimates (R_{wg} statistics) for Conflict Measures

	Relationship	Task	Process	Average
Jehn's Scale				
M	0.85	0.83	0.85	0.84
N	46	46	46	-
# > .70	41	40	42	41
% > .70	89%	87%	91%	89%
Instructor's Scale				
M	0.78	0.76	0.74	0.76
N	40	40	40	-
# > .70	32	35	33	33.33
% > .70	80%	88%	83%	83%

Control Variables.

In addition to the word count measure described above, a set of control variables was examined that might have affected performance, including team size and dummies for university (Haas vs. MIT), course section, and final presentation room. Of these, only one variable—a dummy for one of the course sections that was held at 8:00 a.m.—had a significant (negative) effect on creativity ratings. This variable is included in all models described below.

Results

Descriptive Statistics and Correlations

Table 9 displays the descriptive statistics and correlations of all main study variables. Creativity was positively correlated with task conflict at t1 ($r = .36$, $p < .05$) and overall conflict at t2 ($r = .34$, $p < .05$), and both of these conflict measures were also correlated ($r = .69$, $p < .05$). The 8am class was correlated negatively with creativity (-.31, $p < .05$) and overall conflict at t2 ($r = -.40$, $p < .01$). All other correlations were low and non-significant.

Table 9: Means, Standard Deviations, and Correlations Between Study 2 Variables

| | *M* | *SD* | Correlations | | | | |
			1	2	3	4	5
1 Creativity	6.76	0.97					
2 Constraint	0.00	0.97	.21				
3 Task conflict t1	2.43	0.81	.36*	-.03			
4 Overall conflict t2	2.47	1.05	.34*	-.10	.69*		
5 Word count	17.65	6.62	.21	-.05	-.14	-.11	
6 8am class (dummy)	0.19	0.39	-.31*	.14	-.25	-.40**	.01

***p < .001, **p < .01 *p < .05 (two-tailed). N = 43.

Effects of Constraint on Creativity

Hypothesis 6 predicted that constraint has a linear positive effect on creativity, while Hypothesis 7 predicted a curvilinear (inverted-U shaped) effect. Table 10 presents the results the stepwise regression analyses used to test these hypotheses. Models I-III regressed the control variables for the 8am class, task conflict at t1, and word count on creativity, adding one more per step. In all models, the control variables t1 task conflict and word count had significant effects on creativity (all p's < .05) with the exception of the 8am class dummy in Model III where it fell to marginal significance (p < .10). (The models were also run without controls for t1 task conflict or word count or both. In all cases, the effects of constraint were the same as reported below.)

Model IV added constraint, which had a significant positive effect on constraint ($\beta = 0.27$, *SE* = 0.14, $p < .05$). Hypothesis 6 was supported. Model V added a squared term to test for curvilinear effects of constraint. The first order term retained significance ($\beta = 0.30$, *SE* = 0.15, $p < .05$) but the squared term was not significant ($\beta = 0.30$, *SE* = 0.15, p = .30). Hypothesis 7 was not supported.

Table 10: Results of Multiple Regression Predicting Creativity

	Model I	Model II	Model III	Model IV	Model V
Controls					
class dummy	-0.31*	-0.23†	-0.23†	-0.26*	-0.27*
(1 = 8am)	(0.37)	(0.36)	(0.35)	(0.35)	(0.35)
t1 task conflict		0.3*	0.34*	0.34*	0.34*
		(0.18)	(0.18)	(0.17)	(0.17)
word count			0.26*	0.27*	0.29*
			(0.02)	(0.02)	(0.02)
Constraint				0.27*	0.3*
				(0.14)	(0.15)
Constraint^2					0.1
					(0.17)
F (df)	4.31* (41,1)	4.39** (40,2)	4.18** (39,3)	4.34** (38,4)	3.51** (37,5)
R^2	0.1	0.18	0.24	0.31	0.32
$R^2\Delta$	0.1	0.09	0.06	0.07	0.01

***.$p < .001$, **.$p < .01$, *$p < .05$, †$p < .10$ (one-tailed). N = 43. Numbers reported are standardized betas. Standard errors reported in parentheses.

To further examine the functional form of the effects of constraint, Figure 5 plots the mean creativity levels of teams in the bottom (*M* = 6.3, SD = 1.1, n = 15), middle (*M = 7.13, SD = .90, n = 14)* and top third (M = 6.85, SD = .72, n = 14) of the teams in the data set, according to constraint score. A one-way ANOVA found a significant overall effect of constraint level on creativity, $F(40,2) = 2.66$, p < .05. A polynomial contrast found the linear term to be marginally significant (F(40,1) = 2.09, p = .08) and the quadratic term to be significant (F(1,40) = 2.71, p < .05), suggesting partial support for Hypothesis 7. *A priori* contrasts examined differences between adjacent levels. The low constraint group of teams were rated significantly lower on creativity than were the middle constraint group of teams (p < .05), and marginally lower than the high constraint group of teams (p = .08). The high constraint teams scored lower on creativity than did the middle constraint teams, but the difference was not statistically significant (p > .20). All tests are one-tailed.
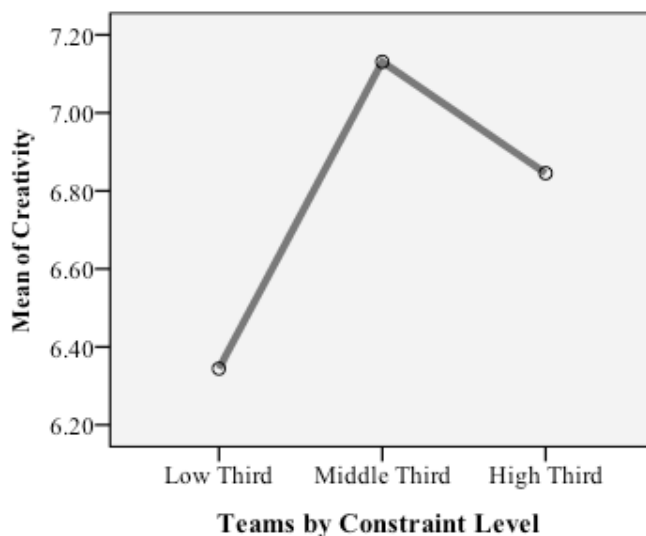
Figure 5: Average Creativity for Low, Medium, and High Constraint Teams

Effect of Constraint on Overall Level of Group Conflict

Hypothesis 8 predicted that constraint would have a negative effect on overall group conflict at t2, such that a high level of constraint would be associated with a low level of conflict at t2. Like the models predicting creativity above, a set of step-wise regressions were run to examine both linear and curvilinear effects of constraint on overall conflict, controlling for the 8am course. The full set of models with additional controls for shared workload and team communication was also tested, each of which might contribute to the level of conflict exhibited in a team. None of the models showed significant results of constraint on conflict (all p-values > .19). Hypothesis 8 was not supported. No hypotheses were posited about the effects of conflict at the project midpoint (t1), but an analysis for exploratory purposes was conducted of the same set of models as above, and no significant effects of constraint on overall conflict were found.

Discussion

Study 2 tested hypotheses regarding the effects of constraint on creativity and conflict in 40 multidisciplinary graduate student teams in a new product development course. Quantitative analyses found that the degree of constraint teams imposed on their own creative projects at team formation linearly predicted their new product's creativity rating over ten weeks later.

While the results of a quadratic regression analysis were non-significant, visually plotting the average creativity scores of teams in the low, middle, and high constraint thirds of the dataset revealed an inverted-U shaped curve similar to the curvilinear effect found in Study 1. This comparison of means showed a drop in creativity for the most highly constrained teams, although future research will need to be conducted in order to assess the statistical significance of this trend in a larger sample with greater statistical power.

The curvilinear trend observed visually must be interpreted with caution, as the statistical results are nonsignificant. The quantitative data in this study support the hypothesis that constraint has a positive linear effect on creativity in teams. The linear positive effect of constraint observed in this study does contrast with the curvilinear effect found in Study 1. These divergent findings warrant further investigation. One possible reconciliation of these discrepant findings is that constraint limits the overall level of group conflict at the end of the project, when cooperation is required to efficiently implement the team's creative idea. Future experimental research is needed, however, to more deeply understand how group settings alter the effect of constraint on creativity.

Much of the empirical research on teams happens either in an experimental laboratory or in the field; each approach has advantages and disadvantages. Lab research offers control over confounds such as group size and team composition (e.g., functional diversity), but can lack the richness of intense group dynamics over time, including the evolution of status hierarchies, group norms, emotional conflicts, and resolution of competing goals. Each of these group dynamics is further influenced by the tight time constraints that characterize teamwork in the real world. In the field, however, difficulty often lies with effectively and reliably comparing performance between teams, and with drawing conclusions about a wide variety of team design parameters given the team's wildly different histories, pressures, incentives, and resources.

The present study, though classified as field research, is unique in that it was designed to reconcile the aforementioned shortcomings of lab research and field study. Specifically, the methodological use of the NPD class format provided a unique opportunity to study a large number of reasonably homogeneous teams working on similar problems with great depth over time, without as many confounds as found in the real world or the artificiality of the lab.

This structure provided many advantages in terms of internal validity. For instance, having a syllabus constructed around a systematic, staged NPD process minimized differences in the timing of different activities and milestones. The syllabus further minimized differences in team performance, incentives, and in the timing of activities and deadlines. For example, the NPD teams in the class were all similar in composition (functionally diverse), size, tenure (all members started at the same time), resource constraints, and timelines. The teams studied were comprised to be very similar in structures (leaderless), makeup (functionally diverse), size, tenure, and resources.

Another advantage that promoted internal validity was the planned and uniform way in which performance metrics were arrived at - that is, using the same panel of judges to evaluate all teams on the same criteria over the course of the semester. All teams were evaluated on the same criteria, at the same time, by the same panel of experts, thus enabling more straightforward comparison across groups than most field studies. This evaluation structure, in turn, overcame another challenge of field studies; many performance metrics are difficult to compare across organizations and departments because researchers must often rely on either self-report measures or supervisor ratings. This further contributed to results that were robust, reliable, and comparable.

There are further limitations specific to the study of student teams. For instance, classroom studies could be been criticized for lacking external validity; stakes are lower and

accountability and social pressures weaker than in full-time jobs in organizations. While this is undeniable, this particular setting offers more external validity than is typical of classroom studies. It is common for teams to end up patenting their products, seeking venture capital funding, and taking them to market; many pursue product development or design as a post-graduation career (Hey, Joyce & Beckman, 2007). The extent of work and high emotional involvement of the projects, and the course's well-known potential for helping graduate students find post-graduation jobs, are also reasons that the phenomena observed in this course is more generalizable than might otherwise be expected.

CHAPTER V: QUALITATIVE CASE STUDIES OF NEW PRODUCT DEVELOPMENT TEAMS (STUDY 3)

For the convenience of the reader, this chapter begins with an overview of the purpose and nature of this study. The specific purpose of Study 3 was three-fold. First, it was designed with a qualitative case study approach to understand the functions and effects of constraint in creative teams. Combing multiple sources of data (observation, surveys, primary documents, and interviews) enabled a richer understanding of the relationship between constraint and creativity than would be achieved through quantitative measures alone. Second, the course of the qualitative study followed the same teams that participated in Study 2, which provided an opportunity to further investigate the processes underlying the quantitative results. By combining quantitative data and emergent insights, this mixed methods approach generated new theory and research questions.

The third purpose of Study 3 was to observe how constraints come into play when teams make decisions about the creative direction of projects over time. This helped to refine the general predictions made about the relationship between constraint, choice, and decisions made during the creative process. Study 3 was designed to answer both a-priori research questions, and to explore questions that emerged over the 2 years of data collection.

Methods

This study includes observation, interviews, and survey data gathered over the course of 2 years from the same 43 teams involved in Study 2. The analysis incorporated identification of important themes found across all teams, and subsequently was an exploration of three team cases in greater depth. The result is an expansion of the initial model and generation of new hypotheses to be tested in future research.

Rationale for Case Study Methodology

Case study research is considered one of the best ways to generate new theoretical insights that are not anticipated by the literature (Eisenhardt & Graebner, 2007). A case study is an in-depth exploration of a particular instance of complex phenomena, embedded in its own real-world context. By focusing on a small sample, researchers can give special attention to cross-level interactions and contextual factors—such as institutionalization, temporal processes, and structural determinants—that large scale deductive studies often must ignore or control (Ross & Staw, 1986).

Achieving this level of depth is not without trade-offs however, and one of the clearest is the sacrifice of generalizability. Case studies do not aim to test hypotheses. Rather, they aim to "develop[] constructs, measures, and testable theoretical propositions" (Eisenhardt & Graebner, 2007, p. 25), by closely examining the interaction of myriad factors – both anticipated and emergent – that are at play in a particular occurrence of the phenomena of interest, maintaining deep connection to the context in which behavior is embedded.

According to McGuire (1983), all knowledge about human behavior is bounded by the

social context surrounding the behavior. Case study research is especially important in organizational research, where many of the most important research questions are concerned with the reciprocal interactions between organizational context and individual and group behavior (Schneider, 1983; Staw & Sutton, 1992). This strategy has been fruitfully employed in the study of a range of complex organizational phenomena, including escalation of commitment (Ross & Staw, 1986), temporal group evolution (Gersick, 1994), and routine innovation (Hargadon & Sutton, 1997).

Multiple case study designs can be used to generate conceptual explanations for complex social phenomena by using insights generated about specific behaviors observed in specific contexts (Yin, 2003) and developing testable theoretical hypotheses (Eisenhardt, 1989). The goal of this research design was to build a conceptual framework that could identify the most important functions of constraint in teams.

Research Setting and Sample

The present study was a multiple case study where the unit of analysis was the team. Qualitative and quantitative data were collected as part of the same New Product Development Team dataset drawn upon by Study 2 in the previous chapter. The reader should refer to the Chapter IV methods sections "Data & Research Setting," "Team Composition," and "Design Thinking and User-Centered Design" for descriptions of the context and study participant demographics.

Meetings with Course Instructors and Collaborators

While planning and conducting the research, I met frequently with the primary course instructor Dr. Beckman, who designed the course and has taught it 14 times. She often coached faculty from other top-tier industrial design, engineering, and business schools interested in teaching similar courses. Dr. Beckman is an expert in the NPD process and a frequent advisor to global product design and technology companies.

I began meeting with Dr. Beckman several months before the semester began, to discuss the research question and plan the approach in relation to the course's typical activities. I worked with her existing syllabus to design the data collection protocol and materials, and consulted her on how best to observe the phenomena under study. I was given permission to distribute my own survey questions in addition to those typically used (Appendix D). In our conversations about tactical plans, Dr. Beckman taught me about the NPD process and the historic evolution of user-centered design, explaining the rationale behind the curriculum. Occasionally, she shared her observations about team dynamics at various stages of the NPD process.

Informed Consent of Participants

At the beginning of the course, the instructor introduced me to the class, told them broadly that my research was about how design teams work, and assured them that all data and findings would not be tied to their personal identities, and that it would have no influence on their grades. I told them that I would not ask for any additional documents to be created as part

of this study, but that they would be asked to voluntarily participate in group interviews, in-class observations, and additional questions on the team feedback surveys that were a typical and required part of the syllabus. They were also asked for their consent (Appendix B) to share their team's documents and other materials. All students signed appropriate informed consent forms and data releases.

Data Collection

Three main types of data were collected over the course of the semester: interviews and observations, surveys, and archival documents. Each is described below.

Observations and interviews.

I conducted observations in three venues: class-time interactions, group interviews, and final presentations. During class time and working sessions, I would make field notes and occasionally ask a question of the team for clarification about current process. I reviewed my field notes on a regular basis and had bi-weekly meetings with my collaborator.

Team meeting observations and interviews were scheduled at mid-semester, roughly during the concept selection stage of the class project. Per the team observation component, either my collaborator or I met with each team to observe and audiotape the meetings, which ranged from 30 to 150 minutes in length. Near the end of each meeting, we engaged the team in a semi-structured interview of approximately 25 minutes. Interview questions are provided in the Appendix D, but the protocol was designed to be flexible so that topics of interest and relevance could be discussed as they emerged. Discussions about the mission statement and user research were given top priority if time was constrained. On a few occasions, both I and the other researcher would attend a team interview. In these cases, one of us would play the role of primary researcher, and the other would observe, only taking a turn to ask follow-up or clarifying questions at the end of the interview so as not to overwhelm the teams. We shared our observation notes, audio recordings, and transcripts with each other for each interview.

(NOTE: As described above, mid-semester surveys were completed around the same time as the interviews. To maintain an unbiased perspective and allow team-level dynamics to be observed without preconceptions based on individuals' private reports, we did not read survey responses until after conducting all of the interviews. However, we reviewed the teams' documents - their user research, their mission statements, their product proposals - to familiarize ourselves with the team, its project, and their evolution, and to give context to the interview before we met.)

Teams presented their final product proposals and prototypes at a presentation to a panel of industry experts and an audience of peers, faculty and guests at the end of the semester. Presentations were approximately ten minutes in length and involved a PowerPoint presentation pitching the idea, explaining the rationale behind their decisions, and demonstrating the design and use of the product through a functional prototype. Data sources collected were videotapes of presentations, electronic slides, and photographs of prototypes and their use.

After formal presentations, all teams participated in a "Trade Show." The trade shows

are well attended by the industry, the school community, other students, and team member friends and families. Team members manned detailed displays explaining their products, shared prototypes for hands-on interaction, and were available to answer questions about their product and process. I walked from booth to booth, chatting with students and judges informally. I asked follow-up questions about team processes and final proposals, moving to the hallway intermittently to take field notes.

Surveys.

Three surveys provided responses to open-ended questions throughout the semester. The first was a short check-in survey. Several weeks into the semester, we asked in a voluntary free-response survey for students to tell us the goals of their projects, the strongest points of consensus on their team about its mission, the most significant issues about which the team members were not in agreement, and how they thought their team's mission statement had changed in the past week.

There were also two major surveys required as part of the course pedagogy; each student completed two Web-based surveys about their project teams. The format of these surveys was introduced in the chapter about Study 2, which used quantitative data from scales included in the survey. Study 3 used responses to open-ended questions.

The first survey ("mid-semester" or "t1") was given about half way through the project, and about 3 weeks after mission statements were due. At this time, teams were more or less finished conducting user needs research and generating product concepts (NPD's "idea generation" phase), and were in the midst of evaluating solution concepts and deciding upon the one concept they would be developing (NPD's "idea selection" phase). Here students were asked to respond to the following questions according to their experience since project launch:

1. Please describe briefly what you learned about the NPD process and working in a cross disciplinary team during this assignment (*t1 learned*)

2. Please write a brief description of any problems or conflicts you encountered in working with your team and how they were resolved. (*t1 conflicts*)

3. Please provide any thoughts on the product development tools provided to you in lectures and how useful / not useful they proved for your project. (*t1 tools*)

4. If there's anything else you would like to communicate to the faculty or anonymously to your team you may write it here (optional). (*t1 other*)

The second survey ("end of semester" or "t2") was emailed to teams three to five days before the final presentations. Teams were asked to complete the survey at least one day before the final presentation, and the majority of respondents completed it by this time. In this survey, respondents were asked to respond only according to the experiences they had in the second half of the course (after the mid-semester team evaluation):

1. Please briefly describe how your team changed throughout the semester. Feel free to touch upon conflicts, changes in project 'frames,' and your personal

changes in thinking, feeling, working with your team, and working with the process. (*t2 change*)

2.   Please write a brief description of any problems or conflicts you encountered in working with your team and how they were resolved. (*t2 conflicts*)

3.   Please describe briefly what you learned about the NPD process and working in a cross disciplinary team during this assignment (*t1 learned*)

4.   If there's anything else you would like to communicate to the faculty or anonymously to your team you may write it here (optional). (*t2 other*)

Archival Documents.

Course documents and assignments came from three main sources, which will be discussed in detail below. The first, project proposals, came from individuals presenting their own ideas to the class before teams formed. The second, team documents, files, and online collaboration records, were generated collaboratively by team members working together. The third, sketchbooks, were created by individuals in private reflection about working with the team.

1. Project proposals: Assignment of the NPD students to their respective teams was based upon common interest, constrained by composition requirements. As described in the previous chapter for Study 2, teams contained four to five members, including at minimum one MBA, one industrial designer (undergraduates from a local prestigious school of art and design), and one engineer. Graduate students from other departments also enrolled in the class and were distributed throughout the teams, depending on their interests.

Two weeks into the class, each student shared a one-minute 'pitch' with the class describing an individual project idea. Then they self-selected into groups based upon similarity of interest. Usually, several project ideas overlapped and students found teammates with a like desire to explore the same things. All teams were constrained by the composition rules and were obliged to sort accordingly. Interest groups larger than five were split up; faculty facilitated when needed to ensure that each student found a suitable team.

I captured both the written project proposal from each student as well as a videotape of his or her one-minute pitch to the class. This provided me with the first description of each project, and a base from which to measure its adaptation over time (usually through mission statements). It also gave insight into the extent of overlap in members' initial interests, and the presence or absence of a strong product champion.

2. Team documents, files and online collaboration records: Each team, as a course requirement, used an online team collaboration space set up by the instructors. This Website included discussion boards for each group and a tool for sharing files with each other and with the instructors. Students were required to use it actively throughout the semester and graded on its completeness, making it an intimate, dated, record documenting the history of each team's process.

The content provided through the space was varied and extensive. All course

assignments were submitted through each team's site, including individual's initial project proposals, team mission statements, research protocols, user needs hierarchies, product use flowcharts, concept selection matrices, competitive analyses, and a final business plan. In addition to formal assignments, teams were required to document all aspects of their process on their teams' site. This included all electronic communication (their discussion boards were used instead of email as a course requirement), ideas, team interview transcripts, field notes, scanned sketches, photographs, videos, secondary research, working drafts, plans, lessons learned, and meeting minutes. It also included the mission statements used for the constraint measure in Study 2.

Most teams used the site heavily. But with archival data sources, one must always be concerned about selection effects that may bias the availability of data for any subject being observed (Heckman, 1979). In this case, it was possible that the most engaged and motivated teams would elect to produce and share the most content. To guard against this possibility, twice in the semester, the head instructor would contact any teams not using their space as actively as others and encouraging them to do so. She would remind them that documenting their internal process as it happened was a required part of the course and would affect their grades, and offered to help if they were having technical issues.

Two teams did report technical difficulties and were assisted; by the end of the semester one of the two had uploaded all early documents and their content was similar to that of their teammates. One team built an external wiki and used it instead of the class Web space to document their internal processes and share non-assignment documents, and they shared this wiki with us. Two other teams shared noticeably less content and did not ask for technical help, nor did they respond to instructor requests to use the site more. These were both low-performing teams (confirmed by performance ratings obtained for the quantitative study in the previous chapter). This suggests that there was, in fact, a selection bias wherein performance and access to data about team histories were related.

The effect of this potential bias on the volume of data available for teams providing moderate volumes of content is not known. However, this concern is eased because there does not appear to be a correlation between performance and volume of data shared—whether measured by number of words (in all messages and in all files), number of megabytes, or number of files—in the teams with complete data. One noticeable trend, however, was that teams sharing fewer total files were less likely to share multiple drafts of class deliverables, the most important example for this study being the mission statement.

3. Sketchbooks: Each student turned in a personal project sketchbook, an ongoing and intimate record of his or her ideas, observations, and experiences. The sketchbook was a requirement contributing to the final grade. Many students planned to continue working on their project after the class and treasured their sketchbooks; for these students, with their consent, I made a photocopy and they retained the original.

There was wide variance in the content, detail, and length of sketchbooks. Many of the industrial designers submitted sketches from computer drawing tablets electronically, and many students supplemented their sketchbooks with photographs of whiteboard drawings. It is certain that much private ideation and reflection was recorded, and that the extent varied greatly across

individuals. Because there was such high variance in the depth and detail of individuals' sketchbooks, I used these data solely to gain additional descriptive insight. I did not use them as inferences about the differences between teams or students.

Case Selection Logic

The advantages of case study methodology described above directly depend upon limiting the sample size to a very small number. This is why the choice of strategy used to select cases is of critical theoretical importance. As stated in Tashakkori and Teddlie, *"in research, sampling is destiny"* (Kemper, Stringfield & Teddlie, 2003, p. 275).

This section describes the process of purposive sampling (Patton, 1990) that was used to select cases for this study. The selection of cases was conducted systematically and strategically, based on theoretical reasons (Glaser & Strauss, 1967), according to the guidelines of Yin (2003), Patton (1990), Miles and Huberman (1994), and Tashakkori and Teddlie (2003). The selected cases are listed in Table 11.

I limited the selection pool to the 20 teams I observed in my first semester of data collection (Haas-1 and Haas-2). The first reason for this rule was proximity: both were at my home institution giving me more complete access to the teams and the context in which they worked. The second reason was primacy: as the first teams observed, my mind was at its most open and questioning state as I saw things for the first time, without the preconceptions that come over time as the theoretical model developed.

I then used *stratified purposive sampling* (Patton, 1990) to select three cases from this pool. Stratified purposive sampling involves dividing the pool into levels, or *strata,* along a theoretically important variable or theme for the purpose of discovering similarities and differences across groups (Kemper, Stringfield & Teddlie, 2003, p. 282). I divided this pool in three equal groups—low, moderate, and high—according to their quantitative constraint score (see Study 2 for a description of this measure).

Finally I applied two criteria to select one case from each level of constraint. The first was representativeness: each case was roughly representative of the other teams at their level of constraint, in both the behaviors observed in the qualitative data, and their creativity outcomes from the quantitative data. The second criterion was information richness (Patton, 1990), which is the degree to which the data can shed light on the research questions and extend and the refine theory. According to Patton,

> *The validity, meaningfulness, and insights generated from qualitative inquiry*
> *have more to do with the information-richness of the cases selected and the*
> *observational/analytical capabilities of the researcher than with sample size.*
> *(Patton, 1990, pp. 184-185)*

Mixed-method sampling strategies (those combining qualitative and quantitative data) like the one used here can "greatly strengthen the research design of most studies in the social and behavioral sciences" by "simultaneously increasing inference quality (internal validity and trustworthiness) and generalizability / transferability" (Patton, 1990, pp. 283-284).

Table 11: Sample of Teams Selected for Case Study

	Blood Donation	**Serving Youth**	**Site For Lonely Minds**
Team Size	5 members	5 members	5 members
Constraint level	Low	Moderate	High
Creativity z-score	-0.43	0.74	-0.26

Case Studies

Data analysis followed the guidelines for grounded theory laid forth in Glaser and Strauss (1967), Strauss and Corbin (1998), and Miles and Huberman (1994) to develop an inductive model grounded in qualitative data. The survey data, interviews, observations, videos, and archival documents were examined and coded in detail within each case.

I used the constant comparison method (Glaser & Strauss, 1967), which involved systematically moving back and forth between field data, my analytical memos, the relevant literature, and my working model. I moved between within-case analysis and across-case analysis to test hunches about differences and similarities between cases that were relevant to the research questions. I added, dropped, and modified elements of the model, refining the nature of their relationships in accordance with the field data until a stable conceptual framework emerged.

Each case is described and analyzed in detail below. Table 12 summarizes essential pieces of the quantitative data used in this mixed method analysis and is referred to throughout. Table 13 summarizes evidence the key theme drawn from each team. The team case studies are followed by an analysis and discussion that unifies the findings across all teams.

Table 12: Mixed-Method Cross-Case Analysis: Summary of Key Measures for Each Team

	Blood Donation	**Serving Youth**	**Site For Lonely Minds**
Task Conflict	Extreme increase: t1: below average (-0.6) t2: very high (1.7)	Extreme decrease: t1: very high (1.5) t2: below average (-0.7)	Decrease: t1: average (-0.2) t2: below average (-0.7)
Satisfaction: *overall*	Decrease: t1: average (0.3) t2: below average (-0.7)	Extreme increase: t1: low (-1.1) t2: above average (0.9)	No change: t1: average (0.3) t2: average (0.3)
by item	t1: 0.0 product / 0.6 team t2: -1.0 product / -0.4 team	t1: -1.0 product / -1.2 team t2: 1.6 product / 0.2 team	t1: 0.8 product / -0.2 team t2: 1.0 product / -0.4 team

Note: All numbers are z-scores.

Table 13: Example Evidence of Team Themes

Strata and Team	Low Constraint: Blood Donation	Moderate Constraint: Serving Youth	High Constraint: Site for Lonely Minds
Theme	**Assumption-Constrained**	**Uncovering Latent Conflict**	**Confirmation-Constrained**
Field notes and interviews	"We all had in mind some kind of solution based around a needle or a chair…. Eventually we learned that our initial assumptions were incorrect – the actual process of giving blood was not what was hindering donors, it was knowing when and scheduling to come back." (team interview transcript)	[Team described how they discovered they weren't on the same page about the mission through conflict.] "We assumed everybody was on board with the mission." [Two different goals, two different stakeholders.] "In the end, [increasing use of] the lunch vouchers was a more defined goal so that's what we went with." (field notes: non-class meeting observation	[Team member seems impatient with user needs matrix process.] "I think it would be more useful to come up with solutions and then classify the solutions" (field notes: non-class meeting observation) "…We found that a website was the best. Well I guess it was a self-fulfilling prophecy." (team interview transcript)
Surveys	"From the beginning we thought the blood donation needed to be a painless hardware, but after research it turned out to be more service oriented. At the beginning, some members of the team felt that 'new product development' needed to be some sort of hardware of tangible things, and that thought kept pulling us away from thinking in terms of the big picture. The idea of having a product (hardware) is still in some teammate's minds, so a chunk of the time we were pushing and pulling between designing a system was designing a product." (survey: t2 learned)	"The main problem was getting everyone going in the same strategic direction, addressing the same problem. It took a couple of rounds of negotiation to get everyone on the same page." (survey: t1 conflicts)	"The team tends to finalize a decision/solution quickly. This may not be good for thinking out of the box." (survey: t1 conflicts) "I think the most serious problem now in our team Is that our [informal] team leader is sometimes too subjective. We haven't really solved this problem yet." (survey: t1 conflicts)
Archival documents	"You are a bit ahead of yourselves in generating concepts at this point. You need more information about your customers... once you are clear about the segment of the market you want to go after, it will be easier for you to brainstorm the many possible solutions you might pursue careful about narrowing so quickly to just three ideas!" (document: peer review from member of another team)	"There are two distinct problems we can try to solve and we have varying opinions as to which one would be more interesting. Therefore, we agreed that we would each conduct our individual interviews and use our data to help us narrow in on a specific need." (individual assignment: interview lessons learned)	"One of our team members also brought up a question I think is very interesting: why don't we have any fights or conflict in our team?" (individual sketchbook: Nov. 4, untitled entry)

Low Constraint: Blood Donation

The Blood Donation team's initial mission was to "create a product, service or product-service combination that increases a blood bank's sustainable blood supply by improving the blood donation process." Theirs was the least constrained of all but one of 20 teams considered for Study 3, according to the quantitative measure of constraint (z = -1.58).

The qualitative data suggest a complex of behavioral patterns expected to be associated with low constraint. A classmate described their mission as "too vague and broad," and their search for new ideas was extensive, unfocused, and chaotic. During brainstorming, the team was "high energy" displaying a "very high level of idea-sharing although they [did] get sidetracked." (field notes: in-class observation). The team "used a lot more paper for brainstorming than the other teams" (field notes: in-class observation). According to one member of the Blood Donation team, "I had to be patient about the idea generation process. Sometimes someone in the room needed to say, 'let's go on' so we wouldn't spend too much time talking." (survey: t1 conflicts). Similarly, another team member noted, "I think [it was] easy for the team to float off into a lot of ideas, but it was hard to see the original project focus of the group." (survey: t1 learned)

The same tendencies characterized the team's search for new information. "We were all over the place on our surveys and questionnaires" (survey: t1 processes and tools). The result of this style of search was too many unrelated ideas and too much disjointed information. Without being able to make sense of the data they had collected from users, and without a clear vision of what they wanted to create or what problem it should solve, the team had a difficult time coming to consensus about how to evaluate and select ideas. "It was hard coming up with the metrics to use in idea selection since our ideas were so different from each other." (survey: t1 processes and tools). The team's difficulties only continued as the project progressed. "As we did more user research, we became more involved in and more connected with the topic. We also got in more disputes over confusing stuff." (survey: t2 how the team changed)

Although this team conformed to expectations, a theme emerged from the qualitative data suggesting an additional pathway by which low constraint can hinder creativity. Low constraint enabled team members to rely on familiar assumptions.

Assumption-constrained creativity.

An unexpected finding was that the team's very unconstrained mission statement perpetuated a highly constrained set of assumptions about what problems they should try to solve, and what a solution would look like.

We all had in mind some kind of solution based around a needle or a chair."
(team interview transcript)

Basing their hypotheses on their own biases, the Blood Donation team went
down the path of making the process of blood extraction more comfortable and
less frightening. (document: first peer review)

These assumptions persisted unchallenged because the data gathered was so extensive and unstructured that making enough sense of it to extract any insights became overwhelming and logistically difficult. They essentially withdrew from the task of making decisions based on data, and relied on what they already believed - familiar, local assumptions that were inherently non-novel.

Unable to defend their chosen path with their data, and struggling to elaborate on their initial ideas, the team eventually realized that they had been basing their decisions on their own assumptions. Ironically these initial implicit assumptions constrained their search for new ideas and information much more than did their explicit constraints in the team mission statement.

> *From the beginning we thought that blood donation needed to be [done with] a*
> *painless hardware, but after research it turned out to be more service oriented.*
> *(survey: t2 change)*

> *Eventually we learned that our initial assumptions were incorrect – the actual*
> *process of giving blood was not what was hindering donors [pain], it was*
> *knowing when [they were able to donate] and scheduling to come back."*
> *(team interview transcript)*

The data suggest that, ultimately, reliance on their unspoken assumptions caused the team to erupt in conflict too late to resolve it, to run out of time, and to finish the project highly dissatisfied with what they produced and with the team as a whole.

> *At the beginning, some members of the team felt that 'new product*
> *development' needed to be some sort of hardware or tangible thing, and that*
> *thought kept pulling us away from thinking in terms of the big picture. The*
> *idea of having a product (hardware) is still in some teammates[sic] minds, so*
> *a chunk of the time we were pushing and pulling between designing a system*
> *and designing a product. (survey: t2 change)*

Aware that they needed to narrow down to a more specific direction in order to meet their deadline, the Blood Donation team sidestepped the challenge of making sense of all of the data they collected. Instead of using the data to constrain their problem enough to be able to think about how to solve it, they "jumped into concepts too soon" and "got too far into concept generation and selection" (document: first peer review). A peer reviewer suggested that they revisit the data before committing to a certain path. For example:

> *You've gotten a bit ahead of yourselves in generating concepts at this point.*
> *You need more information about your customers... once you are clear about*
> *the segment of the market you want to go after, it will be easier for you to*
> *brainstorm the many possible solutions you might pursue careful about*
> *narrowing so quickly to just three ideas! (document: first peer review).*

Another peer reviewer made the same recommendation:

> *From what I see there isn't a lot of clarity about the customers you have interviewed. I'd like to see some information about your market and maybe some more clear statements about what is and isn't working... focusing down so soon on only a few concept directions is dangerous. (document: first peer review).*

The team's experience of identifying more specific constraints is described by this peer reviewer in her post-mortem review:

> *After several brainstorming cycles spent on this idea [for painless hardware], they began speaking to blood donors and found that comfort and fear of needles were not major issues. Simultaneously, discussions with stakeholders like the Red Cross revealed that there were regulations that made it very difficult to change elements of the extraction process.... There was some dissent within the Blood Donation team over whether revisiting the Mission Statement was explicit or simply an implicit process that only a few members used.....*
>
> *The group then revisited the Mission Statement and decided that the goal should be to incent people to give blood, not to fix the donation process.... Once this insight was reached, the rest of the process repeated itself: brainstorming sessions were followed by more stakeholder meetings and consumer research.... This extra information further refined the concept for the group, closing some channels for further exploration and opening others. (post-mortem peer review)*

Low t1 task conflict, increasing over time.

The Blood Donation team had low t1 task conflict ($z = -0.6$). In the first half of the project, they displayed "a high level of agreement" and "little confrontation and no negative energy" (field notes: in class observation). "No problems or conflicts with the team to report!" (survey: t1 conflicts). "We didn't have any problems or conflicts" (survey: t1 conflicts).

Because the team avoided conflict at the early stages, they didn't discover that they had been constraining their search by their own implicit assumptions until it was too late to reorient and still execute well. They similarly avoided conflict until it was too late to avoid a big spike in team conflict late in time. "In the beginning we wasted too much time trying not to offend each other" (survey: t2 learned). Specifically, the team's task conflict score started at a below average $z = 0.6$, but rose sharply to a very high score of $z = 1.7$.

Outcomes.

The quantitative measures show that the Blood Donation team began with low satisfaction and it became even lower over time, possibly because they ran out of time due to their late re-orientation. "It's dangerous to introduce new ideas late in the process" (survey: t2 other). The team was unhappy with both their final product concept and their ability to execute

it.

The experience of this low constraint team provides clues that may explain the negative effect of low constraint on NPD team creativity in Study 2. A paradoxical effect of creating without constraints are that the sprawling mass of possibilities confronted a creator can result in an unconscious reliance on their implicit assumptions. These assumptions can actually constrain them more than explicit constraints would. Furthermore, assumptions constrain search to a zone of ideas and insights that are local, familiar, and unsurprising. The time spent pursuing obvious ideas may have been better spent understanding new information in order to solve a genuine unsolved problem with a useful and novel solution.

Moderate Constraint: Serving Youth

The Serving Youth team's mission was to develop "a solution to increase participation in the Free and Reduced Lunch program for eligible participants during the middle school and high school years." The team began with a very specific problem in mind: the under-utilization of a local program providing vouchers for underprivileged youth to receive lunches at school. Their mission was moderately constrained ($z = -0.63$): to increase utilization of the program by 5%. Their search for ideas and information was limited by a specific focus, directed toward a specific goal, and these constraints provided useful criteria against which to evaluate new ideas.

Uncovering latent conflict.

When the team was first formed, its members shared the impression that they were in agreement about the problem they were trying to solve and the reasons solving it. The team, however, soon encountered difficulties in crafting their mission statement.

"The mission process was difficult," one member reported in a team interview. Within approximately one week of formation, conflict began to erupt. "The team started with conflicts," wrote one member. (survey: t2 change). Similarly, "the major conflict our team encountered was the mission of this project. The goal was not communicated well at first, so some conflicts happened due to misunderstanding and difference in interests." (survey: t1 conflicts). Another team member noted the same concern:

> *That's what made it a problem – we didn't realize there was this problem with the mission. We assumed everybody was on board with the mission… it wasn't until later when I saw some meeting notes that [I realized] we weren't on the same page. (team interview transcript)*

In working through the apparent inconsistencies in their goals, however, the team members began to discover the ultimate cause of their conflicts: they were divided on the reasons they believed the team was trying to solve their specific problem. Two members wanted to increase utilization in order to help the school collect the revenue from the government agency subsidizing the program while another two members' goal was to ensure that the children eligible for the program received proper nutrition (team interview transcript). One member "wasn't sure which she cared about more" (team interview transcript).

The team's initial mission was constrained enough to bring subtle but important differences between its members' perspectives into sharp contrast. These differences became particularly apparent when planning data collection, where each perspective had different implications. The members who were most interested in increasing boosting revenue wanted to interview school administrators and district superintendents, while those interested child nutrition wanted to interview students, teachers, and parents (team interview transcript).

The fact that this team's members favored interviewing different user groups did not make them unique. Many teams interviewed a wide range of people from different groups of potential users, stakeholders, and target markets because they had not yet decided which problem to address of whose problems to resolve. However for this moderately constrained team, this discrepancy was seen as a sharp and meaningful contrast.

Had the team's mission been less constrained, then interviewing all of these groups probably would have made sense - the broad and highly varied search behaviors observed in low constraint teams supports this assumption. However, this team had already agreed upon a moderate level of constraint, so its members recognized this subtle discrepancy as potentially meaningful warning sign.

Uncovering this latent team conflict enabled them to get the team "going in the same strategic direction" (survey: t1 conflicts) through a process akin to integrative complexity (Streufert & Nogami, 1989; Tetlock & Tyler, 1996). Integrative complexity describes an effortful cognitive style, often triggered by value conflict (Kruglanski, 1996; Tetlock, 1986). There are two stages to this style of thinking. The first is differentiation, wherein the focal phenomenon is conceptualized along multiple bipolar dimensions (thesis-antithesis) (Streufert & Nogami, 1989; Tetlock & Tyler, 1996). The second is integration, wherein the dialectical contradictions between the differentiated dimensions of the phenomena are resolved by making interrelations between them. Integration is not possible without first differentiating (Streufert & Nogami, 1989; Tetlock & Tyler, 1996).

First the Serving Youth team explicitly differentiated two interpretations of the team's mission through the process of discussing the merits of interviewing each group. "We realized that half of us had entirely different goals and visions for our project than the other half!" (survey: t1 conflicts). Once this latent source of conflict was explicit, the Serving Youth team went through "a couple rounds of negotiation to get everyone on the same page." (survey: t1 conflicts).

> *In a meeting, this problem was well discussed. Some of the members tried to use voting to resolve this problem, but some of us did not see it as a good way of resolving conflict. So an alternative goal which cover[ed] the interests of all the team members was proposed and agreed by every member of the team. (survey: t1 conflicts)*

Then the team integrated their two different views by abstracting the constraints laid forth in this mission statement to a higher, broader level that could integrate both different perspectives. "We subsumed both goals under the overarching mission to help youth. The

subsuming goal kept us all happy I think" (team interview transcript). Another team member noted, "We redefined the scope of project to address the bigger problem and accommodate interests of members" (survey: t2 change).

High t1 task conflict, decreasing over time.

The Serving Youth team exhibited a very high level of task conflict at t1 ($z = 1.5$), probably reflecting the discovery of latent conflict discussed above. However their level of task conflict fell significantly by t2 ($z = -0.7$) once they had reached consensus. The hypothesis-testing manner in which this team reached consensus (described below) illustrates an unexpected function of constraint that emerged through this research.

Once their mission had been abstracted to a high enough level that it satisfied all members, the team re-approached the task of doing user research to better understand the problems affecting specific groups of users. They began by turning each competing goal into a "hypothesis" to be subjected to empirical testing in their user research. Each distinct hypothesis was constrained (specific and narrow) enough to be falsifiable.

> *The general subject we are addressing is the significant decline in federally funded meal plan enrollees from elementary school to high school… [but] there are two distinct problems we can try to solve and we have varying opinions as to which one would be more interesting. Therefore, we agreed that we would each conduct our individual interviews and use our data to help us narrow in on a specific need. (individual assignment: reflection on conducting user needs research)*

In line with the team's hypothesis testing approach, one team member noted:

> *It seems as though it would often be useful in the design process to develop some hypotheses, which would play an important role in the interview and the ultimate outcome of the user need specifications. However, perhaps this is the point of developing the mission statement beforehand, which will guide the direction of the interview and the assumptions described in the mission's statement may influence the direction of the interview. (individual assignment: reflection on interpreting user needs research).*

The team explicitly used the word "hypothesis" in their concept selection matrix, which was titled "Hypothesized reasons for not enrolling/ participating in program." Several hypotheses were listed including "poor food quality", "social stigma of poverty," and "lack of info/understanding - teachers/principals." (document: concept selection matrix). The pattern of hypothesis testing enabled by this team's high constraint mission statement will be discussed in further detail in the cross-case analysis below.

Outcomes.

This team is an ideal case for presenting the positive role constraint can play in facilitating creativity as a hypothesis testing activity. Once their research began, there was still

conflict within the team about how to interpret their data. But these conflicts were impersonal and problem-solving driven, so they did not escalate and were ultimately productive. The team eventually earned high creativity ratings from the judges as discussed below. Thus, by uncovering their latent conflicts and testing constrained hypotheses, the team did not let their disagreements keep them from successful resolution of problems as they arose.

High Constraint: Site For Lonely Minds

The Site For Lonely Minds team's mission was to develop "an interactive website that connects Berkeley graduate students socially, academically, and culturally." A high constraint team, they were committed to a specific direction from the time their project launched. Specifically, the team limited the problem their project would target to graduate student loneliness, a problem focus likely inspired by the personal experiences of its own members, as described in detail below.

In addition to committing to a specific direction up front, the Site for Lonely Minds team also limited their search for solution ideas. Although lectures discouraged the class from deciding upon a specific solution before fully analyzing their user research, this team had a concrete vision of their final solution before even beginning data collection – a social website for graduate students, with features similar to existing websites popular with that target market at the time (i.e., Facebook, Friendster, Craigslist).

In many ways, the Site for Lonely Minds team behaved in the restricted manner predicted of *individuals* under high constraint in Chapter 2, displaying closed-mindedness, restricted search, and low intrinsic motivation. The team did seem to benefit from the goal sharedness and team problem construction predicted of high constraint teams in Chapter 2 in that they were efficient, cooperative, and their tasks were well coordinated. However, these benefits did not seem to support creative thinking. Rather, the team's highly constrained mission seemed to pre-empt the experimentation, critical thinking, debate, and insights observed in more moderately constrained teams like Serving Youth described in the last case study. The qualitative data suggest that the high level of constraint this team imposed on it's project contributed to a counterproductive pattern of behavior not anticipated by the team-level theoretical model: confirmation-constrained creativity.

Confirmation-constrained creativity.

The team's constraints were based on personal experiences and assumptions and did not evolve based upon user needs research. Although they went through the motions of conducting user needs research before they began brainstorming concept ideas, it was clear that they had settled on a specific problem (graduate student loneliness) and a desired solution (a social website for graduate students) before they even designed their data collection. This was even reflected in the name that the team gave themselves at the very beginning of the project: "Site For Lonely Minds." The course instructor warned,

> *In general, your mission statement looks good. Just make sure you are not*
> *making too many assumptions about the form of your solution too early in the*
> *process. Is the website the very best way to accomplish your goals? Not*

necessarily! (note from class instructor on team webspace, Oct. 7)

The problem the team wanted to solve—graduate student loneliness—was likely based on the experiences of the team members themselves, as suggested by their demographic composition and from inferences drawn through observation (based upon field notes from team interview and in-class observations). All but one team member was a non-native English speaker who had recently moved to the United States to attend graduate school making the majority of team members more likely to experience loneliness and isolation. Perhaps because their personal experience with this problem was so vivid, nothing from the team's interview transcripts suggest that they ever asked whether or not it was also a problem for their target users.

The team constrained its search in a way that precluded team members' initial assumptions from being invalidated. In so doing, the team was also precluded from discovering unexpected problems or generating novel solution ideas through new insights. The team's research design was biased and failed to shed light on their initial assumptions about the needs of users or to test the appropriateness of its hypothesized solution relative to other possible solutions. As illustrated by this excerpt from it's interview script, they asked leading questions that systematically precluded respondents from disconfirming their assumptions:

1. What social networking website do you use now to connect to your friends or to make new friends? Why did you choose it? What do you like about it? What do you dislike about it?

2. What issues do you consider when selecting a networking tool or website?

3. What improvements would you make to the networking tool or website you use now?

(document: user interview protocol)

That these questions focus narrowly on their initial solution concept reinforced their foregone conclusion that the website idea was a good one. As one team member later reflected in an individual written assignment, "We actively tried to consider other media and…found that a website was the best. Well, I guess it was a self-fulfilling prophecy" (document: lessons learned assignment).

Outcomes.

The data the team collected in the course of user research was narrowly focused on the team's initial concept of a social networking website. Team members referred to website features suggested during user interviews as "user needs" even though they were actually solution ideas. Examples of the team's solution-focused ideas (written on post-its and shared during a class exercise focused on *problem definition*) included, "user interface must be clean and straightforward," "calendar of events," and "enable users to interact however often they want" (field notes: team meeting observation). These data helped the team refine and develop its

initial solution idea, but did not test the team's assumptions about the existence of the problem or the validity of a website relative to alternative solutions.

In fact, the team's commitment to its initial assumptions seemed to be reinforced by going through the motions of researching user needs. Members nodded in agreement while another member explained in a team interview how conducting this "user needs research" helped them check their initial assumptions. "Without these techniques, we would have gone straight to the solutions based on assumed needs without thinking too much about the real customer needs" (fieldnotes: team meeting and team interview transcript). In contrast, private documents written by individual members that week demonstrate disagreement with this perspective. One member's sketchbook reports, "We made the mistake that many designers and developers will make as well: we focused on the solution ideas we got from our customers, instead of their desired outcomes" (document: sketchbook entry, October 5, title: "Group meeting in class").

The data that the team collected did not allow for hypothesis testing with regard to the existence of the perceived problem of graduate student loneliness. By systematically omitting disconfirming evidence, the team had difficulty interpreting and managing the data. Frustrated with the process, the team skipped the problem identification stage entirely. One member explained, "We were unable to array our research findings along dimensions using the 2x2 matrix like the other teams did, so we decided to chunk similar features into buckets instead" (team interview transcript).

Even though some members felt it was an error to base project decisions on biased information, none of the qualitative data suggest that this concern was shared in a team setting. As a general rule, the team avoided open discussion of conflicts and disagreements. One student wrote in her sketchbook, "I suddenly realized that the problem is not that we don't have enough communication but that we have never really communicated with each other in a way that can be heard" (document: sketchbook entry, September 21, title: "Class lecture"). Another reflected on his team experience, "Every time we would discuss some issues, we tended to express only part of how we really thought" (survey: t2 conflicts).

The team was heavily dominated by one member who originally proposed the website idea during team formation. Observation fieldnotes describe how this member displayed impatience when the data did not conform to expectations:

> *The tone of the team was generally impatient. They moved quickly through the exercise, focusing on the visible outcome of having all of the post-its put on the board in some matrix form, but quickly became frustrated when a formation was not readily apparent. Two members tried to slow the team down, and offered suggestions of ways to better differentiate between different needs … and were quickly shot down by a particularly inpatient member: "Yeah but then what do we do with something like this need, 'needs to know what's going on'? This is just not going to work." The same member, visibly exasperated, appealed to the rest of the group: "we need to find out what this website will look like, honestly. The professor wants that in two weeks. Can we move on to concept selection?" (fieldnotes: team meeting observation)*

One teammate shared his concern about the leader's biases. "I think the most serious problem now in our team is that our team leader is sometimes too subjective. We haven't really solved this problem yet" (survey: t1 conflicts). Despite the fact that so many members were concerned about the effects of biased decision making on the project, the leader's assumptions persisted relatively unchallenged until the project was completed.

Low task conflict, decreasing over time.

The Site For Lonely Minds team demonstrated conflict avoidance and low task conflict throughout the study. As shown in Table 12, the team experienced below average levels of task conflict at t1 ($z = -0.2$), which decreased over time at t2 ($z = -0.7$). The team also exhibited average levels of creativity, which was lower than predicted. Its norm of conflict avoidance made the team particularly vulnerable to one passionate member's domination.

This conflict scale, however, was only designed to measure overtly expressed conflict and does not tell us anything about the level of unexpressed disagreement between members.

> *One of our team members also brought up a question I think is very interesting: why don't we have any fights or conflict in our team? From what we heard about other teams, it seems like some of them are struggling with flights within their team. I did have some ideas when these questions came to mind: first, the major reason why there are no conflicts or fights in my team is the only one member is really enthusiastic about our product; the rest of us just want to make the work done in an acceptable way... whenever there may be conflicts or fights, most of us will compromise easily. (document: sketchbook entry, November 4, untitled)*

The team's conflict avoidance was probably exacerbated by the fact that every member except the leader was a non-native English speaker, as mentioned above. Two members' mid-semester surveys mentioned that they felt uncomfortable speaking freely in the group, and another wrote about one of his teammates:

> *He is a bit shy, and mentioned to me in private conversation that it is largely because of his accent…. He was bothered about having to repeat himself several times when others couldn't understand, and I completely understand his position as an immigrant myself. (survey: t1 conflicts)*

Cross-Case Analysis and Discussion

The model in Figure 6 summarizes the functions of constraint throughout the creative process. This section discusses the box on the left side of the model, which contains themes that emerged from the case studies above but were not anticipated by the theory in Chapter 2.
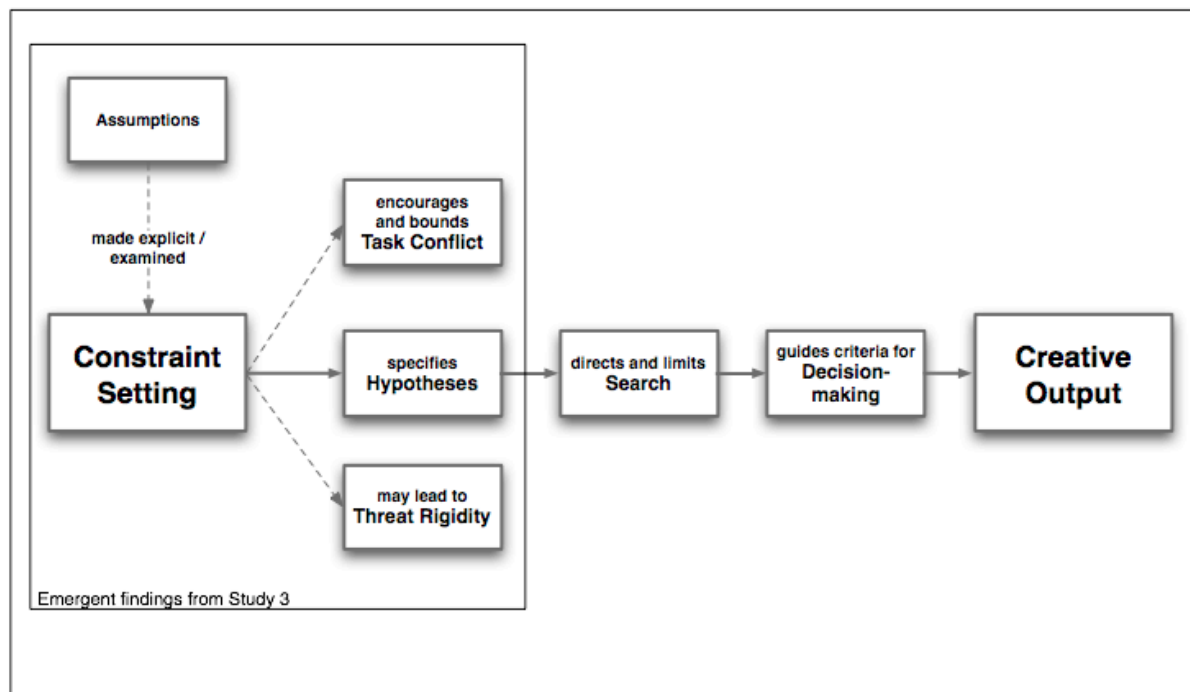
Figure 6: Effects of Constraint Throughout the Creative Process

Assumptions Precede Constraint Setting.

Constraint setting is the act of making implicit ideas and assumptions about a creative project explicit in the form of constraints, which are directional goals and specific limitations that bound what is relevant from what is not. The process of making constraints explicit itself is revealing of one's own assumptions, beliefs, and values.

Explicit constraints, once shared, become the focus of scrutiny. This collaborative scrutiny is very beneficial for teams because it enables team members to discover important differences between their interpretations of the team's chosen path. The degree of precision with which teams approach the constraint setting process (e.g., discussing the meaning of each word used to describe a project's intended direction and scope limits as observed in the Serving Youth team) may have a direct effect on their ability to detect latent sources of conflict early enough to examine and resolve them. The Serving Youth team exemplified this potential benefit of explicit constraint setting.

The conflict this team discovered between members' different interpretations of their explicit constraints may have triggered their hypothesis-testing behavior, described below. In examining the value of multiple competing constraints as a team, this team subjected its ideas to a form of scrutiny similar to accountability. It engaged in an observable pattern of differentiation and integration—the two cognitive processes underlying integrative complexity—shown to result under accountability to diverse constituents (Tetlock, 1985).

Constraint Specifies Hypothesis Testing.

The cross-case analysis introduced above suggests that creativity can be conceived of as a form of hypothesis testing. Constraint setting is akin to hypothesis generation or theory building. Popper (1959) described scientific progress as a series of conjectures and refutations, wherein bad ideas and weak hypotheses are falsified and weeded out, while better ideas (more predictive, "leading hypotheses") remain in the running for consideration and refutation. In many ways, the stages in this process have analogues in Darwinian theories of creativity such as those specified by Campbell (1960) and Simonton (1999), wherein ideas are generated *en masse* but then subjected to some form of selection, which limits the number of ideas retained.

Weick described theory building as a process of "disciplined imagination" and outlined an approach to theorizing supported by imagination, representation, and choice (Weick, 1989). For Weick, problem statements must be the first building block in the conceptual development phase of theory development. Without detailed, clear, and precise problem statements, theoretical predictions about solutions will be misguided and vague. He argued that the problems confronting social scientists are complex and assumption-laden by nature, making the precise specification of problems fundamentally difficult.

> *. . . by their very nature the problems imposed on organizational theorists involve so many assumptions and such a mixture of accuracy and inaccuracy that virtually all conjectures and all selection criteria remain plausible and nothing gets rejected or highlighted. (Weick, 1989, p. 521)*

The same could be said about the problems confronted in creative work, especially those dealing with human behavior and social environments, as most problems in design and business do. Failure to specify a precise problem can result in general and vague hypotheses, enabling the unchallenged persistence of existing assumptions. Alternatively, broadly defined problems can result in excessive and lengthy generation of ideas that are too diverse to evaluate thoughtfully. This mass of ideas itself can result in choice overload, decreasing not only the quality of idea selection, but the intrinsic motivation required to creatively execute an idea once chosen.

Weick suggested that because of the complex nature of the problems they address, social scientists should work toward middle-range theories, which are those predicting "solutions to problems that contain a limited number of assumptions and considerable accuracy and detail in the problem specification" (Weick, 1989, p. 521). Weick argued that "problem statements" to address middle-range theories must be clear and precise, because they must carve out a particular realm in which the problem occurs so that potential solutions are more accurately defined.

It is easier to see when data do not support hypotheses when the hypotheses are defined precisely enough to be falsifiable (Popper, 1959). Like novel and improbable ideas, falsifiable hypotheses can feel more risky to creators, but their benefit is that they can be more quickly and obviously rejected before steering a creator down a wasteful path. The less committed a creator is to an erroneous path, the less dangerous she is to her organizations because she is less likely to chase sunk costs or save face, as described in the work on escalation of commitment (Staw & Ross, 1989).

Weick's recommendation for middle range theory and precise problem statements is applicable to creative work as well. The solutions generated by constrained creativity may be applicable to a smaller number of users in a narrower range of situations, but the precision with which they have been designed means that their effectiveness can be that much more potent. General solutions are unlikely to be as creative as specific, targeted ones. Solutions aimed at mass markets are likely to be less risky, more familiar, and more common than those focused on a small niche.

The findings presented in this study suggest that for businesses and innovators, specifically constraining a creative project can lead to novel, meaningful solutions - thus giving organizations with a clear strategic advantage in the competitive marketplace. The framework provides a useful way of thinking about constraint, unifies the themes observed in each within-case analysis, and helps explain key differences observed across cases with a common set of processes and factors.

Constraints reveal assumptions.

Likewise, avoiding the process of constraint setting can have negative consequences. One such consequence, resulting from a failure to adequately address implicit assumptions, was observed in the Blood Donation team. Like every team in the study, the members of this team began with a set of implicit ideas that restricted the flexibility with which they generated ideas and interpreted new information. However, the team's most basic assumptions went largely unexamined until quite late in the process when it was finally "discovered" and voiced by some of its members. Upon examination, the team revealed a key implicit assumption: The team assumed that the key to increasing blood donation was to improve the donor's experience while giving blood and ignored important factors only observable outside the blood donation center. The team dropped this implicit assumption, but it did so too late in the semester to be meaningful. As a result, the quality of the final project suffered.

Although caution must be taken in entertaining the plausibility of counterfactuals, one might imagine that if the Blood Donation team gone through the process of setting of constraints early on, the ensuing discussion would have prompted the detection, examination, and rejection of the team's key implicit assumption. The team initially concentrated its research on the act of giving blood and people's fear of needles. This led to solutions that were focused entirely on improving donor's experience and alleviating their fears while giving blood. Had the constraint setting process taken place early on, it is quite possible that the team could have been more strategic in planning its data collection, which could have led to a more creative solution.

Assumptions act as interpretive schemes used to filter and interpret information (Weick, 1967). With this in mind, it is likely that the Blood Donation team's unexamined assumptions limited its ability to extract usable knowledge from the extensive amount of data it had collected. The team's implicit assumptions guided them and obscured the meaning of information that was inconsistent with these assumptions. Without making a conscious decision to limit their search, the team unconsciously limited its ability to learn, even though it was mired in data.

Perhaps explicit constraints would have helped the team more clearly distinguish relevant information from irrelevant information, helping the team make sense of its data more effectively

and efficiently, thus reaching its eventual insight more quickly. After the team realized that it held implicit assumptions, it did reach an insight about the problem that was novel and potentially fruitful. Namely, the team determined that many potential donors do not give blood because of schedule-related issues, not fear of needles. Had it occurred earlier, this insight could have guided the development of a novel solution to the blood donation shortage, when more time could be spent developing and refining ideas.

Constraint and threat rigidity.

In addition to the process of setting constraints, a team's attitude toward its constraints has an important influence on its creative outcomes. The Site For Lonely Minds team, for example, explicitly set a high level of constraint very early in the process. As predicted in Chapter 2, the high degree of constraint left little room for new discoveries, refinements, debate, or unexpected ideas. Almost no change to the initial concept was observed between the beginning of the project and the team's final presentation.

But an additional, unanticipated factor emerged through the process of qualitative observation and analysis. This factor was the attitude of rigidity that the Site For Lonely Minds team held toward the constraints that it had set. This team's deeply held personal beliefs about the value of the idea it was pursuing and the veracity of the idea's necessity seemed to make the team unwilling to examine the constraints it had agreed upon. The team treated constraints as if they were etched in stone and suggestions of a change or reinterpretation were perceived as threats.

When change is perceived as threatening, it can provoke a self-reinforcing pattern of behaviors that create rigidity and inhibit creativity. Staw and colleagues brought together disparate literatures to examine the effects of threat rigidity at multiple levels of analysis in organizations (Staw, Sandelands & Dutton, 1981). At the individual level, threat situations tend to provoke well-learned or dominant responses (Zajonc & Sales, 1966). Such familiar pathways are inherently non-novel and, as such, are not expected to be creative. These effects were observed in the Site For Lonely Minds team—specifically, by its dominant and vocal leader, who rigidly defended her idea for a social networking website though it was only a conscious replication of an already familiar model.

Threat rigidity has additional effects at the group level of analysis that can result in biased judgment and decision making. The stress triggered by threat situations may reduce decision making groups' flexibility, provoking the group to seal off new information and control responses that deviate from the status quo in an attempt to maintain congruence with the accepted course of action (Janis, 1972).

The Site for Lonely Minds team's data collection tactics (whether strategically conceived or not) controlled potential users' responses in such a way that they would not cast doubt upon the team's course of action or imply that a reiteration was needed.

The interview questions described above indicate that the team's bias toward confirming their initial views lead them to make a *strategy-based error* (Arkes, 1991) in the design on their user needs research. Specifically, their interview script suggests the use of a *positive test*

strategy heuristic (Klayman & Ha , 1987). In his review on bias in research, MacCoun explains that this strategy-based error produces biased results by leading decision makers to test hypotheses primarily by searching for events that occur when the hypothesis says they should occur (and not searching for the absence of such events at those times, or for the occurrence of the hypothesized events at times other than when the hypothesis says they should occur) (MacCoun, 1998).

By created highly controlled opportunities for their interviewees to validate and expand upon the team's existing idea, but few opportunities to examine alternative ideas or test the validity of their chosen direction, the team severely decreased its likelihood of learning anything from its research. The questions left almost no opportunity to discuss whether or not the idea was a good solution, or at a higher level, whether this solution addressed the problem of genuine import. Without gleaning any new insights from external sources, the team remained unified behind their initial vision and relatively free of task conflict.

As the semester reached it's end, the team exhibited a pattern similar to escalation of commitment (Staw & Fox, 1977; Staw & Ross, 1989; Staw, 1976), the phenomenon of individuals, groups, and organizations increasing their investment to failing courses of action. The further along the team got, the more stringently they needed to defend their earlier commitments in order to keep skepticism from creeping in. The closer the team got to the final deadline, the more necessary it was to stay the course as a re-examination that late in the process had unknown but potentially dramatic implications that could threaten the team's ability to complete the task at hand. This strategy kept conflict at bay even though team member satisfaction dropped. The team did complete its project on time, though the end result was not especially creative ($z = -0.26$).

Conclusion

The analysis above suggests that constraints play a critical role in creative teams by explicitly specifying the project's direction and limits. As predicted by the theory in Chapter 2, constraints aided teams in their search for ideas and information, as well as in making decisions about their project, such as planning their data collection or selecting an idea. However there were findings that emerged from these analyses that provide new insights to our current understanding of the nature of constraint in creative work.

CHAPTER VI: GENERAL DISCUSSION AND CONCLUSIONS

The purpose of this dissertation was to refine and expand creativity theory in light of what is known about the effects of choice on decision making. This was done by measuring the effects of constraint on creative outcomes and associated processes. Specifically, the study was designed to both manipulate and measure constraint along a continuum. The primary research question driving the design of the methodology was, "Given the importance of decision making in the creative process, and the known effects of extensive choice on decision making, how does constraint affect creative processes and outcomes?"

To answer this question, this dissertation employed multiple research methods across three empirical studies. Study 1 looked at individual level creativity in a laboratory experiment to establish the effect of constraint on creativity and assess its functional form. Constraint was manipulated by varying instructions in a novel product design task. Random assignment and experimental control emphasized internal validity.

Studies 2 and 3 used a mixed-method approach to examine the role of constraint in multidisciplinary graduate student teams in a new product development course. Study 2 tested deductive hypotheses using quantitative measures from 43 teams. Study 3 used a mixed-method approach to identify representative teams from each of three levels of constraint—low, middle, and high—and applied grounded theory methodology to identify emergent themes and generate new hypotheses.

Summary of Findings

Study 1 found that the degree of constraint imposed on a creative task affects individuals' creative outcomes in a curvilinear fashion, such that a moderate degree of constraint was optimal. Neither time allocation nor intrinsic motivation mediated the effect of constraint on creativity, thus eliminating two alternative explanations.

Furthermore, although participants who created under very unconstrained conditions enjoyed high levels of intrinsic motivation, their performance was just as poor as those who created under the most constrained conditions. The largest drop in intrinsic motivation happened between the moderate-low (which chose one of five topics) and moderate-high (which chose one of three topics) conditions. This implies that while some degree of choice was essential for maintaining intrinsic motivation, the benefits of choice to creative outcomes quickly drop off as the number of choices becomes overwhelming. This finding supports claims made by Schwartz (2004a) about the non-monotonic effects of choice extensiveness on the subjective utility of choice.

The results of Study 1 suggest that a moderate degree of constraint is optimal when creativity is desired. The findings suggest that there are limits to the benefits of freedom and choice, which challenges an assumption underlying psychological theories of creativity - that freedom is the ideal for creativity and intrinsic motivation.

Study 2 found that the degree of constraint teams imposed on their own creative projects

at team formation linearly predicted their new product's creativity rating over ten weeks later. While the results of a quadratic regression analysis were statistically non-significant, visually plotting the average creativity scores of teams in the low, middle, and high constraint thirds of the dataset revealed an inverted-U shaped curve similar to the curvilinear effect found in Study 1. This comparison of means showed a drop in creativity for the most highly constrained teams, although future research will need to be conducted in order to assess the statistical significance of this trend in a larger sample with greater statistical power.

The curvilinear trend observed visually must be interpreted with caution, as the statistical results are nonsignificant. The quantitative data in this study support the hypothesis that constraint has a positive linear effect on creativity in teams. The linear positive effect of constraint observed in this study does contrast with the curvilinear effect found in Study 1. These divergent findings warrant further investigation. One possible reconciliation of these discrepant findings is that constraint limits the overall level of group conflict at the end of the project, when cooperation is required to efficiently implement the team's creative idea. Future experimental research is needed, however, to more deeply understand how group settings alter the effect of constraint on creativity.

One interesting pattern observed in Study 1 was replicated in Study 2. The creativity ratings in both studies were lower for low constraint groups than any other. Yet in Study 1 the same low constraint group reported the highest level of intrinsic motivation out of all four conditions, and despite the hit to intrinsic motivation observed in Study 1, both studies found a positive effect of moderate constraint on creativity. This pattern contradicts the predictions of self-determination theory (Deci & Ryan, 1980; Deci, 1975; Ryan, 1982). The finding is also inconsistent with prior literature on constraint and creativity, which argues that intrinsic motivation should predict creativity (Amabile & Gitomer, 1984; Amabile, 1983).

A potential explanation for this inconsistency lies in the way in which constraint was manipulated in this study. By operationalizing constraint as a continuum rather a dichotomy, it was possible to detect qualitatively different effects of very low constraint on motivation and creativity compared to moderately low constraint, moderately high constraint, and high constraint. While previous studies have compared the creativity of products created under choice versus no choice conditions (Chua & Iyengar, 2008), all conditions were relatively constrained. This was the first study of its kind to compare creative outcomes from such a wide range of situations ranging from high freedom and to high constraint.

When considered in this light, the findings may suggest that at very low levels of constraint, creativity and intrinsic motivation may become decoupled. The experience of freedom itself may trigger a sense of stimulation, an affective state known to directly enhance people's perceptions of their own creativity (Nemeth & Ormiston, 2007). Perceptions of creativity are inherently unstable, often inconsistent with the quantity and quality of ideas generated (Paulus, Larey & Dzindolet, 2000), and respond to a variety of contextual factors such as management style and corporate culture (Amabile, Schatzel, Moneta & Kramer, 2004; De Dreu & De Vries, 1997; Nemeth, 1997).

These perceptual and emotional factors plausibly influence self-reported intrinsic motivation as well. If the feelings of freedom experienced by the low constraint group enhanced

their intrinsic motivation but not their creativity, then the findings of this study are not conceptually inconsistent with self-determination theory. Instead this illustrates the importance of studies like this one, designed to detect non-monotonic effects along a broad continuum.

Some constraints on freedom may increase the challenge of a task, which can increase one's experience of "flow," until the point that the challenge becomes threatening (Csíkszentmihályi, 1996). The data collected in these studies do not assess how challenging or threatening different levels of constraint felt to participants. Future research should investigate the relationships constraint, perceived challenge, and intrinsic motivation.

Study 3 qualitatively examined a selection of the new product teams included in Study 2. Four teams were studied in detail in a series of mixed method case studies. The findings that emerged suggest pathways by which constraint can affect creativity that were not anticipated by the theory in Chapter 2.

Paradoxically, the freedom of creating with very little constraint can result in a narrow-minded creative process. The logistical overwhelm and confusion resulting from unfocused search can actually restrict teams' open mindedness. In need of a basis for decision making but unable to draw insights from overly extensive and chaotic collections of data, members increase their reliance on their own assumptions. Team members' prior assumptions can restrict the ways in which they think about the problem they are trying to solve, and focus on local, familiar ideas that are inherently non-novel. If left undetected, implicit assumptions can result in solution ideas that are often less creative than would be discovered through more limited, but directed exploration.

Constraints can help bring underlying assumptions and latent conflict into stark contrast. Making constraints explicit provides a forum for discussing them as a team, and subjecting them to empirical testing through focused research. By increasing the level of abstraction of constraints, team members can more easily come to consensus on their goals, without compromising their values or fully confronting task conflict.

While constraint can increase team member coordination and enhance team efficiency, very high constraint can also have negative effects. A team that constrains many aspects of its project before beginning investigation may be threatened by any evidence that disconfirms its preconceptions. Teams can use constraint to direct search in a way that is predisposed to confirm their assumptions. The limitations put on their search processes may mean that misinformed preconceptions go unexamined, leading the project down an increasingly confirmatory and non-novel path.

Limitations

All three studies are limited in generalizability because participants were drawn from a student population. It is possible that the amount of pressure students are under across all of their classes and commitments is quite high as a baseline, and that the moderate challenge presented by the moderate constraint in Studies 2 and 3 proved overwhelming. This may explain why intrinsic motivation was dampened at such modest levels of constraint in Study 1, and why constraint had a net negative effect on teams in Study 2.

Data resulting from the interviews were analyzed using qualitative methods, which may be subject to other interpretations. Researcher biases and perceptual misrepresentations are potential limitations in a qualitative study (Yin, 2003). Finally, how the researcher reacts during the interview may affect the participants' responses (Yin, 2003). It is always difficult to untangle the effects of factors like motivation and effort on performance metrics (like creativity) from other variables of interest. In case studies, this can be particularly problematic.

The case sampling procedure employed by Study 3 was rigorous and systematic, based on a combination of quantitative and qualitative data. The three cases studied were representative of their strata (low, moderate, or high constraint) with regard to both the independent and dependent variables. The cases were also information rich, yielding unique insights that could not have emerged from quantitative analysis alone.

The benefits of this procedure were not without drawbacks however. Creativity is driven in part by intrinsic motivation, which may have contributed in part to the information richness of each case: motivated teams produce thorough documentation and are more deeply engaged in the project. Because they want to do well, they will put more effort into their reflections on the project so their insights will be more revealing and passionate. Therefore it is possible that the three cases examined were systematically more intrinsically motivated, and this may have qualitatively changed the way that constraint influenced their behavior.

One way to address this limitation is to conduct additional case studies using a different set of case selection criteria. For example, to examine boundary conditions on the positive effects of constraint that emerged from the sampling procedure used here, future research should examine disconfirming cases—e.g., what happens when teams fail to be creative under different constraint-related situations?

In Study 2, constraint was predicted to be associated with lower overall conflict, but this hypothesis was not supported. In Study 3, each team was compared on the basis of their experiences with task conflict. The mixed-method analysis suggested that the timing of the task conflict may complicate the relationship between constraint and conflict. Early task conflict played a critical role in teams' ability to reorient their project directions and identify obstacles and sources of confusion. The evidence strongly suggested that open conflict about constraint setting can have a positive effect on teamwork and creative outcomes, provided that it happens early in the creative project's lifecycle.

Under conditions of moderate to high constraint, high and/or early task conflict could be associated with higher creativity than predicted by main effects alone. Constraint keeps task conflict constructive by putting boundaries around the relevant topics of discussion, and creating a shared goal that helps direct the group toward finding a resolution. Similarly, low and/or delayed task conflict may be associated with lower creativity than predicted by main effects alone. Task conflict, debate, and dissent serve as checks against biases and assumptions that could otherwise inhibit the discovery of novel problems, the examination of unfamiliar ideas, and the acquisition of knowledge required to increase an idea's usefulness. Future research should examine how constraint changes the nature of conflict, and how conflict changes the nature of constraint, which in turn affects creativity.

Contributions

This study makes a theoretical contribution by bridging the decision making and creativity literatures to reconcile the inconsistent findings on cognitive and motivational responses to a wide range of constraints. It emphasizes evaluative and strategic aspects of creativity as called for by Dailey and others (Dailey & Mumford, 2006b; Lonergan, Scott & Mumford, 2004). By showing that the cognitive judgments used in the creative process are influenced by the same contextual constraints as other types of decisions, this study helps to unite the creativity and decision making literatures, both of which gain from such an integration. These findings demonstrate the predictive value of this perspective.

This research also contributes important empirical detail to the literature on creativity by attending to non-monotonic effects of constraint on creativity predicted by prior theory about choice (Schwartz, 2004; Schwartz, 2004a). Functional form was not taken for granted; the research design went beyond the choice/no-choice dichotomous variables of previous research and enabled the detection of both linear and curvilinear effects. As such, this paper does not compete with research done by Amabile and colleagues on intrinsic motivation, but rather extends it to resolve a paradox observed in the real world, which was not previously explained by academic theory or popular notions about the benefits of freedom.

Future Research

This dissertation helped to fill several gaps in the literature, but it also identified fruitful paths for future research. One particularly useful line of inquiry is the effect of constraint on biases in the creative process. For example, the "hotness" or "coldness" of biases is a useful distinction drawn by MacCoun in the context of scientific research (MacCoun, 1998). The assumptions driving a low constraint team's cognition may be considered cold in that they have not intentionally favored one direction or outcome over another. The motivated and passionate congruence-seeking behavior of a high constraint team could be considered "hot" bias in that it is not motivated at a conscious level. The notion of bias has been given extensive consideration in a variety of decision making domains, but the highly ambiguous domain of creative work has been relatively ignored and could benefit greatly from a critical examination. This is especially true in industries where creative decisions have potentially costly implications.

Another direction for future research is the role that constraint plays in enabling creative teams to engage in a hypothesis-testing form of creativity. Just as not all ideas can be retained (Campbell, 1960; Simonton, 1999) hypotheses need to be specific enough to be falsifiable (Popper, 1992). Similarly, if the constraints imposed on creativity are not specific, then the ideas that result are difficult to evaluate, refine, or reject on strategic grounds. If unconstrained, creativity cannot benefit from new knowledge or unexpected opportunities, and can generate costly waste from going on creative "fishing expeditions." Furthermore, the glut of information and ideas that are gathered in a sprawling unfocused search can create an overwhelming array of choices and prevent ideas from being implemented altogether.

Conclusion

When constraints are vaguely defined, the quantity, variety, and generality of ideas and issues discussed can obscure even large misalignments. It becomes easy either not to recognize, or not to confront, divergent understandings about the team's purpose. If inconsistencies are recognized, they can either be addressed or ignored. Assuming the team members are motivated to work together as a team, discussion and often task conflict will erupt in attempt to understand and resolve a perceived inconsistency. Thus, recognition, understanding, and resolution of these inconsistencies can lead to hypothesis rejection and revision, and eventually increased convergence between members' conceptions of the projects (or mental models).

When teams have adequately constrained their project up front—meaning they have defined its boundaries and intended direction—there is less ground to cover for each individual, and fewer possible ways to interpret vague language. Members can more easily recognize and reconcile inconsistencies between their hypothesis and a peer's. By aligning rival hypotheses they can subject each to testing, interpreting data on the same basis. Creativity is an iterative process, which like scientific inquiry, continually destroys old and familiar notions and produces new ways of interpreting, understanding, and interacting with the world.

These findings provide encouragement to organizations that are institutionally embedded, resource-scarce, or otherwise restricted. From a managerial perspective, these findings suggest that while some amount of choice is important for encouraging creativity, it is important for creators to have some boundaries to structure problems and limit the endless options available to them. Paradoxically, by making boundaries and limits explicit, managers can enable their employees to fully exploit a search space, exploring it in more original and creative ways.

As author Bob Garfield put it, "The lack of boundaries does not liberate, it enslaves" (Garfield, 2004, p. 4). This dissertation suggests that in many situations, a moderate degree of constraint could help turn the blank page into a tractable creative challenge that is directed, limited, and meaningful, and thus, solvable. Creativity is resilient, and in fact performs best when given some challenge to overcome.

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APPENDIX A: Study 1 Participant Consent Forms

UNIVERSITY OF CALIFORNIA, BERKELEY

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Experimental Social Sciences Laboratory
CONSENT FORM

August 15, 2007

My name is **Caneel Joyce**. I am a researcher professor/graduate student in the **Haas School of Business Department of Organizational Behavior**. My advisor is Professor **Barry Staw** in the **Haas School of Business Department of Organizational Behavior**. I am using the Experimental Social Science Lab at the University of California, Berkeley to conduct my research. I would like to invite you to take part in my study which examines **how people create new products to address important issues.**

If you agree to take part, you will be asked **to do computer research about an important issue and propose an idea for a product addressing that issue.** The experiment will last **about 1 hour** and will be conducted at a time that is mutually agreeable. During the study, we will **ask some questions about your experience doing the task**.

There are minimal risks to you from taking part in this research. There are no direct benefits to you from this research.

Payment to you for participation in this experiment will be by **a check for $15.** It is our hope that the research will benefit the scientific community and lead to a greater understanding of **how people create new products.**

All of the information that I obtain from you during the research will be kept confidential. The data will be stored in **a secure computer.** Each person will have his/her own code number. Only the Xlab staff will have the list of codes (*numbers*) and names; that list will not be available to me. Your name and other identifying information about you will not be used in the research. After the research is completed, we may save data for use in future research.

Please understand that your participation in the research is voluntary and that you are free to withdraw your consent and discontinue participation in the research at any time. However, you will not receive **payment** if you do not complete the study. We understand that if you participate in the study, you may refuse to answer a question(s) that might make you feel uncomfortable and still receive full credit.

If you have any questions about the research, you may telephone me, **Caneel Joyce** at **(415) 939-7308** or contact me by e-mail at **joyce@haas.berkeley.edu**. If you agree to take part in the research, please sign the form below, and keep the other copy of this agreement for your future reference. If you have any question regarding your treatment or rights as a participant in this research project, please contact the University of California at Berkeley's, Committee for Protection of Human Subjects at 510/642-7461, subjects@ berkeley.edu.
****

I have read this consent form and I agree to take part in this research.

_____ _____
Signature   Date

CPHS# 2007-9-8
APPROVED 10/5/07
EXPIRES 10/4/08

Committee for Protection of Human Subjects   University of California, Berkeley

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Haas School of Business   BERKELEY, CALIFORNIA
94720

PARTICIPANT CONSENT FORM

My name is Caneel Joyce. I am a graduate student at the Haas School of Business (Organizational Behavior and Industrial Relations group), University of California at Berkeley. I would like to invite you to take part in my research study, which looks at how people create new products to address important issues..

If you agree to take part in my research, you will be asked to do computer research about an important issue, and propose an idea for a product addressing that issue. You will then be asked to complete an additional confidential questionnaire regarding your experience. Your participation in this study will last for no more than one hour. The session today will take place entirely at Haas School of Business. If you choose to participate, you will receive course credit in partial fulfillment of the OB requirement for research participation. You will be awarded the credit regardless of whether or not you complete the tasks.

All of the information that I obtain from you during the research will be kept confidential. Each person I interview will have their own code number so that no one other than I will know who you are in my notes. The key to the code of names will be kept in a separate locked file. Your name and other identifying information about you will not be used in any reports of the research. Participation in research may involve a loss of privacy, but your information will be handled as confidentially as possible. If information from this study is published or presented at scientific meetings, your name and other personal information will not be used.

There are minimal risks to you from taking part in this research. There are no foreseeable direct benefits to you from this research. However, it is hoped that the research will benefit others (or science) who wish to understand and improve creativity and decision-making.

Your participation in this research is voluntary. You are free to refuse to take part. You may refuse to answer any questions and may stop taking part in the study at any time.

If you have any questions about the research, you may telephone me, Caneel Joyce, at (415) 939-7308 or contact me by email: joyce@haas.berkeley.edu. If you agree to take part in the research, please sign the form below. Please keep the other copy of this agreement for your future reference.

If you have any questions regarding your treatment or rights as a participant in this research project, please contact the University of California at Berkeley's, Committee for Protection of Human Subjects at 510/642-7461, subjects@berkeley.edu.

****

I have read this consent form and I agree to take part in this research.

CPHS# 2007-9-8
APPROVED 10/5/07
EXPIRES 10/4/08

_____   _____
Signature   Date

Protocol Narrative Form   Page 17 of 28   March 2007

APPENDIX B: Study 1 Example Health Articles for Experiment's Internet Database

Article Title	Source URL*	Topic				
		Drug Abuse	Nutri-tion	Fitness	Stress	Pre-venting illness
10 Perks for Teens Who Exercise	http://www.webmd.com/fitness-exercise/guide/no-time-work-out			f		
10 Questions About the Common Cold	http://www.webmd.com/cold-and-flu/cold-guide/top-10-questions-cold					p
4 Stress Busting Moves You Can do Anytime	http://www.webmd.com/balance/guide/4-holiday-stress-busting-moves				s	
5 Strategies for Keeping Pounds Off	http://www.webmd.com/diet/features/5-strategies-keeping-pounds-off		n			
Aerobic Exercise: What 30 min a day can do	http://www.mayoclinic.com/health/vitamin-e/NS_patient-vitamin-e			f		
Alcohol Abuse Health Center	http://www.webmd.com/mental-health/Alcohol-Abuse/Teen-Alcohol-and-Drug-Abuse-Prevention-Strategies	d				
Alcohol Poisoning	http://www.mayoclinic.com/print/alcohol-poisoning/DS00861/DSECTION=all&METHOD=print	d				
All Stressed Out: How to take care of Stress	http://www.webmd.com/balance/Stress-Management/all-stressed-out				s	
Anabolic Steroid (Oral route, Parenteral Route)	http://www.mayoclinic.com/health/drug-information/DR602077	d				
Antibiotics: Too Much of a Good Thing	http://www.mayoclinic.com/health/antibiotics/FL00075					p
Are Infectious Diseases on the Rise?	http://www.mayoclinic.com/health/infectious-disease/ID00015					p
Artificial Sweeteners: A Safe Alternative to sugar	http://www.mayoclinic.com/health/diabetes-diet/NU00592		n			

*All articles retrieved in September 2007

APPENDIX C: Study 1 Laboratory Signage

EXPERIMENT HERE TODAY

Assessing creative aptitude using a product design task

APPENDIX D: Study 1 Screenshots from Internet Database

Example of Article with Timer, Article Hyperlinks, Search Bar, and Ready to Write Proposal Button

Example of Search Results with Timer, Search Bar, and Ready to Write Proposal Button

APPENDIX E: Study 1 Pre-Task Questionnaire

Pre-Task Questionnaire

Please fill out the following Preliminary Questionnaire.
Refer to the handout you received for your Participant Number.

Before you begin, we want to find out about you.

The following is a list of words that describes different feelings and emotions. Please read each item and indicate to what extent you **generally feel this way**; that is have felt this way during the year.

	very slightly or not at all	a little	moderately	quite a bit	extremely
sad	○	○	○	○	○
active	○	○	○	○	○
inspired	○	○	○	○	○
pessimistic	○	○	○	○	○
attentive	○	○	○	○	○
ashamed	○	○	○	○	○
nervous	○	○	○	○	○
optimistic	○	○	○	○	○
determined	○	○	○	○	○
hostile	○	○	○	○	○
upset	○	○	○	○	○
afraid	○	○	○	○	○
pleased	○	○	○	○	○
unhappy	○	○	○	○	○
alert	○	○	○	○	○
alarmed	○	○	○	○	○
happy	○	○	○	○	○

What are you interested in?

The following is a list of possible interests that you might spend your time thinking and learning about or doing. Indicate how interested you are in each.

	very slightly or not at all interested	a little interested	moderately interested	quite a bit interested	extremely interested

puzzles & games	○	○	○	○	○
advertising and marketing	○	○	○	○	○
the newest products and gadgets	○	○	○	○	○
music	○	○	○	○	○
research	○	○	○	○	○
staying healthy / avoiding illness	○	○	○	○	○
art	○	○	○	○	○
writing	○	○	○	○	○
film & theater	○	○	○	○	○
health	○	○	○	○	○
entrepreneurship	○	○	○	○	○
science	○	○	○	○	○
exercise	○	○	○	○	○
literature	○	○	○	○	○
nutrition	○	○	○	○	○
design	○	○	○	○	○
web surfing	○	○	○	○	○
creative problem solving	○	○	○	○	○
managing stress	○	○	○	○	○
physical fitness	○	○	○	○	○

Please fill in the following information:

Computer number

Participant number (from handout)

As a reminder, your task is to propose a creative idea for a new product costing no more than $10 per unit, which addresses a health-related issue.

Your task will consist of two components:

1. Researching in an online database
2. Creating a proposal for a new product to address the issue you've been asked to address

Your proposal will include a mission statement and a description. Your proposal should be convincing, creative, and well-researched, and must accurately address the prompt you were given.

This is why you must take detailed research notes. You will also be asked to use specific facts from your research to defend the originality and usefulness of your idea, and demonstrate that your product will be a good solution to the problem you have been asked to solve.

Budget your time:

Please note that you will have 40 minutes total to complete both tasks before answering some final questions. Use the timer that appears on your screen. It is your job to budget your time as you see fit between research and proposal.

No point in rushing:

When you are finished with your proposal, please wait quietly and patiently until the experimenter tells you to continue to the next step.

APPENDIX F: Study 1 Post-Task Questionnaire

You are now ready to write your product proposal.
Please refer to your notes to answer the following questions.

What is your participant number?

What is your computer number?

Refer to your paper instructions, and type the exact problem you are trying to solve.

Mission: You will describe your product in more detail later, but for now, imagine that you need to sell your product idea to an executive in 30 seconds or less. In one or two sentences, what is the vision or "mission" for the new product you are proposing? What does it aim to do or achieve? Be compelling.

Description
In 2-3 paragraphs, please describe your product, including its functions, features, benefits, and appearance. Be concrete and detailed, so that your reader can visualize the product you propose creating. What does it do? How does it work? How is it used? What does it look like? Use references to your research notes to substantiate your and defend proposal as a good solution to the prompt you were given.

Congratulations! You have now completed your product proposal.

Before we conclude, you will need to answer a few more
questions about your experience and personality.

How do you feel right now?					
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
alert	○	○	○	○	○
attentive	○	○	○	○	○
hostile	○	○	○	○	○
pleased	○	○	○	○	○
inspired	○	○	○	○	○
optimistic	○	○	○	○	○
pessimistic	○	○	○	○	○
happy	○	○	○	○	○
afraid	○	○	○	○	○
unhappy	○	○	○	○	○
upset	○	○	○	○	○
sad	○	○	○	○	○
determined	○	○	○	○	○
ashamed	○	○	○	○	○
nervous	○	○	○	○	○
active	○	○	○	○	○

Please rate the following adjectives in terms of how accurately they describe <u>this task</u>, on this scale of 1-5.					
	1 Not at all accurate	2	3	4	5 Very accurate
Interesting	○	○	○	○	○
Boring	○	○	○	○	○
Fun	○	○	○	○	○

Creative	○	○	○	○	○
Difficult	○	○	○	○	○
Freeing	○	○	○	○	○
Limiting	○	○	○	○	○
Motivating	○	○	○	○	○
Important	○	○	○	○	○
Constrained	○	○	○	○	○
Broad	○	○	○	○	○
Narrow	○	○	○	○	○
Abstract	○	○	○	○	○
Specific	○	○	○	○	○
Vague	○	○	○	○	○
Well-defined	○	○	○	○	○

How much did you enjoy this task?
1 being **not at all** and **5** being **very much**

Not at all	Slightly	Somewhat	Quite a bit	Very much
○	○	○	○	○

How easy or difficult was each of these parts of the task you just completed?

	Very difficult	Somewhat difficult	Slightly difficult	Neither easy nor difficult	Slightly easy	Somewhat easy	Very easy
Coming up with good ideas	○	○	○	○	○	○	○
Deciding what problem / issue I wanted to solve	○	○	○	○	○	○	○
Wondering if I was doing a good job	○	○	○	○	○	○	○
Staying focused on the task	○	○	○	○	○	○	○
Using this website / survey	○	○	○	○	○	○	○
Staying within the rules (e.g. cost no more than $10, solved the particular problem)	○	○	○	○	○	○	○
Solving a problem that was so broad	○	○	○	○	○	○	○
Specifically defining the problem / issue I was trying to solve	○	○	○	○	○	○	○
Finishing in time	○	○	○	○	○	○	○
Being unmotivated	○	○	○	○	○	○	○
Writing up my proposal	○	○	○	○	○	○	○
Describing my idea in words	○	○	○	○	○	○	○
Doing research	○	○	○	○	○	○	○
Not having enough freedom in the task	○	○	○	○	○	○	○

Staying focused on one topic ○ ○ ○ ○ ○ ○ ○

Please rate the following adjectives in terms of how accurately they would describe your proposed product idea, if it were to be implemented or built.

	1 Not at all accurate	2	3	4	5 Very accurate
Creative	○	○	○	○	○
Useful	○	○	○	○	○
Novel	○	○	○	○	○
Effective	○	○	○	○	○
Innovative	○	○	○	○	○
Original	○	○	○	○	○
Clever	○	○	○	○	○
Thoughtful	○	○	○	○	○
Marketable	○	○	○	○	○
Needed	○	○	○	○	○
Feasible	○	○	○	○	○
Costly	○	○	○	○	○
Impossible	○	○	○	○	○

How satisfied are you with your performance on this task?

Not at all	Slightly	Somewhat	Quite a bit	Very much
○	○	○	○	○

While doing this project I had a lot of freedom in deciding exactly what problem I was going to solve.

○ not at all

○

○ moderately

○

○ very much

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please indicate the extent to which you agree or disagree with that statement.

I see myself as someone who...

	Disagree strongly	Disagree a little	Neither agree nor disagree	Agree a little	Agree strongly
Does a thorough job	○	○	○	○	○

	strongly disagree	mostly disagree	slightly disagree	neither agree nor disagree	slightly agree
Is original, comes up with new ideas	○	○	○	○	○
Can be somewhat careless	○	○	○	○	○
Is curious about many different things	○	○	○	○	○
Is a reliable worker	○	○	○	○	○
Is ingenious, a deep thinker	○	○	○	○	○
Tends to be disorganized	○	○	○	○	○
Has an active imagination	○	○	○	○	○
Is inventive	○	○	○	○	○
Perseveres until the task is finished	○	○	○	○	○
Values artistic, aesthetic experiences	○	○	○	○	○
Does things efficiently	○	○	○	○	○
Prefers work that is routine	○	○	○	○	○
Makes plans and follows through with them	○	○	○	○	○
Likes to reflect, play with ideas	○	○	○	○	○
Has few artistic interests	○	○	○	○	○
Is easily distracted	○	○	○	○	○
Is sophisticated in art, music, or literature	○	○	○	○	○

If you were to participate in another experiment, would you be interested in participating in a similar task in the future?

Not at all	Probably Not	Maybe	Probably	Certainly
○	○	○	○	○

How much do you agree with these statements??

	strongly disagree	mostly disagree	slightly disagree	neither agree nor disagree	slightly agree	mostly agree	strongly agree
It's annoying to listen to someone who cannot seem to make up his or her mind	○	○	○	○	○	○	○
My personal space is usually messy and disorganized	○	○	○	○	○	○	○
I like to have a place for everything and everything in its place	○	○	○	○	○	○	○
I tend to struggle with most decisions	○	○	○	○	○	○	○
I dislike it when a person's statement could mean many different things	○	○	○	○	○	○	○
I don't like to go into a situation without knowing what I can expect from it	○	○	○	○	○	○	○
I dislike unpredictable situations	○	○	○	○	○	○	○
I dislike the routine aspects of my work studies	○	○	○	○	○	○	○
I enjoy the uncertainty of going into a new situation without knowing what might happen	○	○	○	○	○	○	○

Statement	○	○	○	○	○	○	○
I hate to change my plans at the last minute	○	○	○	○	○	○	○
I dislike questions which could be answered in many different ways	○	○	○	○	○	○	○
I tend to put off making important decisions until the last possible moment	○	○	○	○	○	○	○
I enjoy having a clear and structured mode of life	○	○	○	○	○	○	○
I'd rather know bad news than stay in a state of uncertainty	○	○	○	○	○	○	○
I would describe myself as indecisive	○	○	○	○	○	○	○
When thinking about a problem, I consider as many different opinions on the issue as possible	○	○	○	○	○	○	○
In most social conflicts, I can easily see which side is right and which is wrong	○	○	○	○	○	○	○
I think that I would learn best in a class that lacks clearly stated objectives and requirements	○	○	○	○	○	○	○
I believe that orderliness and organization are among the most important characteristics of a good student	○	○	○	○	○	○	○
When faced with a problem I usually see the one best solution very quickly	○	○	○	○	○	○	○
I do not usually consult many different opinions before forming my own view	○	○	○	○	○	○	○
I think it is fun to change my plans at the last minute	○	○	○	○	○	○	○
When considering most conflict situations, I can usually see how both sides could be right	○	○	○	○	○	○	○
I think that having clear rules and order at work is essential for success	○	○	○	○	○	○	○
I usually make important decisions quickly and confidently	○	○	○	○	○	○	○
I feel uncomfortable when I don't understand why an event occurred in my life	○	○	○	○	○	○	○
I find that establishing a consistent routine enables me to enjoy life more	○	○	○	○	○	○	○
Even after I've made up my mind about something, I am always eager to consider a different opinion	○	○	○	○	○	○	○
I feel irritated when one person disagrees with what everyone else in a group believes	○	○	○	○	○	○	○
I don't like situations that are uncertain	○	○	○	○	○	○	○
When trying to solve a problem I often see so many possible options that it's confusing	○	○	○	○	○	○	○
When dining out, I like to go to places where I have been before so that I know what to expect	○	○	○	○	○	○	○
I prefer interacting with people whose opinions are very different from my own	○	○	○	○	○	○	○
When I go shopping, I have difficulty deciding exactly what it is that I want	○	○	○	○	○	○	○
When I am confused about an important issue, I feel very upset	○	○	○	○	○	○	○
I don't like to be with people who are capable of unexpected actions	○	○	○	○	○	○	○
I feel uncomfortable when someone's meaning or intention is unclear to me	○	○	○	○	○	○	○
I always see so many possible solutions to problems I face	○	○	○	○	○	○	○
I like to have friends who are unpredictable	○	○	○	○	○	○	○
I find that a well-ordered life with regular hours suits my temperament	○	○	○	○	○	○	○
I like to know what people are thinking all the time	○	○	○	○	○	○	○
I prefer to socialize with familiar friends because I know what to expect from them	○	○	○	○	○	○	○

APPENDIX G: Studies 2 and 3 Participant Consent Forms for Berkeley and MIT Classes

UNIVERSITY OF CALIFORNIA, BERKELEY

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Consent Form for "Framing in Design and Innovation" Study

We are Jonathan Hey and Caneel Joyce. We are researchers in the Department of Mechanical Engineering and the Haas School of Business at the University of California at Berkeley. We would like to invite you to take part in our research study, which is looking at how teams and individuals engage in new product development and innovation processes. We very much appreciate your participation in this project.

If you agree to take part in the research, you will be asked to participate in two interviews with your team members, lasting about 1 hour each, at a time and place convenient to you. With your and your fellow team members' permission, the interview will be audio taped. The first interview will take place in the first half of the product development cycle and the second towards the end of the product development cycle. We also ask permission to collect your responses to two main surveys and two short forms administered during your project activities. Finally, as part of the project we would like to supplement our understanding with your team's design project deliverables, which may include presentations and design journals, as data for analysis.

There are minimal risks to you from taking part in this research, and no direct benefit to you either. Your decision to participate will not affect your grade in this class, nor will the results of this research. It is hoped that the research will benefit others through an enhanced understanding of the product development and innovation activities of design teams.

While there is a small chance that the confidentiality of information collected could be compromised we will take great care to prevent this from happening. We will store the audio recording and notes about it in a locked file and on a password protected computer. Each team interviewed will have their own code number that we will use as reference. The key to the code of names will be kept in a separate file in a password protected location. Your name and other identifying information about you will not be used in any reports of the research. After this research is completed, we may save the audio recordings and notes for use in future research by other researchers or ourselves. The same confidentiality guarantees given here will apply to future storage and use of the materials.

Your participation in this research is voluntary. You are free to refuse to take part. You may refuse to answer any questions and may stop taking part in the study at any time. If you have any questions about the research, you may telephone or e-mail us using the following information: Jonathan Hey, 510 499 2628, jono@berkeley.edu; Caneel Joyce, 415 939 7308, joyce@haas.berkeley.edu.

If you agree to take part in the research, please sign the form below.   Please keep the other copy of this agreement for your future reference.

If you have any question regarding your treatment or rights as a participant in this research project, please contact the University of California at Berkeley's, Committee for Protection of Human Subjects at 510/642-7461, subjects@berkeley.edu.

I have read this consent form and I agree to take part in this research.

Name _____

Signature _____   Date _____

UNIVERSITY OF CALIFORNIA, BERKELEY

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PHOTOGRAPHIC, AUDIO, AND/OR VIDEO RECORDS RELEASE FORM

As part of this project we may make a photographic, audio, and/or video recording during interviews or team activities. We would like you to indicate below what uses of these records you are willing to consent to. This is completely up to you. We will only use the records in ways that you agree to. In any use of these records, your name will not be identified.

Please write your initials next to any use you consent to.

1. The records can be studied by the research team for use in the research project.

Photo _____ Audio _____ Video _____

2. The records can be shown to other participants in our studies

Photo _____ Audio _____ Video _____

3. The records can be used for scientific publications.

Photo _____ Audio _____ Video _____

4. The records can be shown at meetings of researchers interested in the study of design and innovation

Photo _____ Audio _____ Video _____

5. The records can be shown in public presentations to interested parties

Photo _____ Audio _____ Video _____

I have read the above description and give my consent for the use of the records as indicated above.

Name _____

Date _____

Jonathan Hey - jono@berkeley.edu :: Caneel Joyce - joyce@haas.berkeley.edu

CONSENT TO PARTICIPATE IN NON-BIOMEDICAL RESEARCH

Framing in Design and Innovation

You are asked to participate in a research study conducted by Assistant Professor Thomas Roemer, at the Sloan School of Management at the Massachusetts Institute of Technology (M.I.T.). The study is being performed with Professor Sara Beckman at the Operations and Information Technology Management Group, Jonathan Hey, from the Department of Mechanical Engineering, and Caneel Joyce from the department of Organizational Behavior at the University of California, Berkeley. The results of this study may be included in the PhD theses of Jonathan Hey and Caneel Joyce. You were selected as a possible participant in this study because you are participating in the product design and development class. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

- **PARTICIPATION AND WITHDRAWAL**

Your participation in this study is completely voluntary and you are free to choose whether to be in it or not. If you choose to be in this study, you may subsequently withdraw from it at any time without penalty or consequences of any kind. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

- **PURPOSE OF THE STUDY**

The purpose of the study is to understand how teams and individuals engage in new product development and innovation processes.

- **PROCEDURES**

If you volunteer to participate in this study, we would ask you to do the following things:
If you agree to take part in the research, you will be asked to participate in two interviews with your team members, lasting about 30 minutes each, at a time and place convenient to you. With your and your fellow team members' permission, the interview will be video or audio taped. The first interview will take place in the first half of the product development cycle and the second towards the end of the product development cycle.

We also ask permission to collect your responses to two main surveys, in the middle and end of the product development class, and two short forms near the beginning of the class. Finally, as part of the project we would like to supplement our understanding with your team's design project deliverables, which may include presentations and design journals, as data for analysis.

- **POTENTIAL RISKS AND DISCOMFORTS**

There are no risks or discomforts to you from taking part in this research. Your decision to participate will not affect your grade in this class, nor will the results of this research. It is hoped that the research will benefit others through an enhanced understanding of the product development and innovation activities of design teams.

- **POTENTIAL BENEFITS**

There are no direct benefits to you from taking part in this research. It is hoped that the research will benefit others through an enhanced understanding of the product development and innovation activities of design teams.

- **PAYMENT FOR PARTICIPATION**

Participation in this research is voluntary and you will not be compensated for taking part in this research.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law.

We may take some audio or video records of team interviews and presentations. You may specify whether you consent to capture and use of this information in different contexts on the attached records release form.

While there is a small chance that the confidentiality of information collected could be compromised we will take care to prevent this from happening. We will store photo, audio and video recordings and notes about them in a locked file and on a password protected computer. Each team interviewed will have their own code number that we will use as reference. The key to the code of names will be kept in a separate file in a password-protected location. Your name and other identifying information about you will not be used in any reports of the research. After this research is completed, we may save the photos, audio and video recordings and notes for use in future research by other researchers or ourselves. However, the same confidentiality guarantees given here will apply to future storage and use of the materials.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about the research, please feel free to contact:

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- **EMERGENCY CARE AND COMPENSATION FOR INJURY**

In the unlikely event of physical injury resulting from participation in this research you may receive medical treatment from the M.I.T. Medical Department, including emergency treatment and follow-up care as needed. Your insurance carrier may be billed for the cost of such treatment. M.I.T. does not provide any other form of compensation for injury. Moreover, in

either providing or making such medical care available it does not imply the injury is the fault of the investigator. Further information may be obtained by calling the MIT Insurance and Legal Affairs Office at 1-617-253 2822.

- **RIGHTS OF RESEARCH SUBJECTS**

You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you feel you have been treated unfairly, or you have questions regarding your rights as a research subject, you may contact the Chairman of the Committee on the Use of Humans as Experimental Subjects, M.I.T., Room E32-335, 77 Massachusetts Ave, Cambridge, MA 02139, phone 1-617-253 6787.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Subject

_____   _____
Signature of Subject   Date

SIGNATURE OF INVESTIGATOR

In my judgment the subject is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this research study.

_____   _____
Signature of Investigator   Date

APPENDIX H: Study 2 Mid-Semester Survey (t1)

(Mid-semester) Team and Peer Feedback Survey

Introduction

This Mid-semester Team and Peer Feedback Survey is intended to give you an opportunity to reflect on your team & how your project has been going, and give anonymous, honest feedback to both your team as a whole, and your teammates as individuals. It is based on a survey instrument Jane Creech used at Quantum with her development teams.   With reflection the survey should require about 45 minutes to complete, so please leave yourself adequate time to get all the way through without rushing.   This feedback has proven extremely valuable to NPD teams in the past, and is a unique opportunity to see how you are evaluated by others in a team project setting. Thus, be honest, straightforward, and thorough.

Confidentiality: Feedback will be presented in the form of a group averages and no names will be revealed. Responses will be sanitized before they are delivered when appropriate or if you request for something to be communicated to faculty only. So feel free to communicate anything you wish to the faculty or your team.

Your responses need to be submitted by Friday, Oct. 28th at 5pm. This will allow you & each of your teammates to receive an individual report and a team report on Wednesday of next week.

* 1. Your Full Name   _____
* 2. Your Team Name   _____
* 3. Your Section   _____

Your Team

This section allows you to provide your thoughts on your team as a whole. This feedback will be averaged with your teammates' anonymously, and returned to your team. Be thorough, straightforward, and honest.

* 4. Did all members of the group share in the team's responsibilities?
- □ Some members did not work at all
- □ A few members did most of the work
- □ The work was generally shared by all members
- □ Everyone did an equal share of the work

* 5. Which of the following best describes the level of the conflict at group meetings?

	No conflict, everyone seemed to agree on what to do	There were disagreements, but we resolved them easily	Disagreements were resolved with considerable difficulty	Open warfare: still unresolved
Conflict about team & task processes	□	□	□	□
Conflict about the direction of the project	□	□	□	□
Interpersonal / emotional conflict	□	□	□	□

* 6. Think about your satisfaction with your TEAM and with the PRODUCT/SERVICE you're developing. If you had a chance to change either or both, how would you feel?

Product/Service	Team
□ Would want very much to change	□ Would want very much to change
□ May want to change but not sure	□ May want to change but not sure
□ Would rather change than stick with the same...	□ Would rather change than stick with the same...
□ Would make no difference to me	□ Would make no difference to me
□ May want to stay but not sure	□ May want to stay but not sure
□ Would rather stick with the same...	□ Would rather stick with the same...
□ Would want very much to stick with the same...	□ Would want very much to stick with the same...

* 7. Team Communication

1. **DISAGREE** strongly - 2. moderately - 3. slightly - 4. **neither -** 5. slightly - 6. moderately - 7. strongly **AGREE**	1	2	3	4	5	6	7
We felt comfortable making decisions and openly sharing our honest opinions in a constructive way.	□	□	□	□	□	□	□
We felt comfortable openly sharing our creative ideas.	□	□	□	□	□	□	□
We felt safe investing time in exploring risky & unusual ideas.	□	□	□	□	□	□	□
We were effective at sharing individuals' information with the team (e.g. things learned during research, ideas & thoughts on the project).	□	□	□	□	□	□	□
Occasional mistakes were expected & not punished.	□	□	□	□	□	□	□
Our team was productive - accomplishing not only course requirements but our own goals as well.	□	□	□	□	□	□	□
As a team, we were all clear about & agreed upon what the important goals for our project and team were.	□	□	□	□	□	□	□
New ideas & direction changes were implemented quickly.	□	□	□	□	□	□	□
The team gave due consideration to ideas / thoughts put forth by me.	□	□	□	□	□	□	□
I felt comfortable sharing my own thoughts/ideas.	□	□	□	□	□	□	□
I really felt like I was a part of my team - I worked with others, was included in most ways, and felt like I belonged.	□	□	□	□	□	□	□

* 8. Communications outside of class: To help us understand how team communicate, how many HOURS PER WEEK (on average) did your team spend interacting in…

Face-to-face meetings	_____
Email (not basecamp)	_____
Telephone	_____
Basecamp	_____
Another website or system	_____
Other (give hours & describe)?	_____

9. Ideals, Values & Goals: Below you will rate a number of values & goals in terms of their importance when you evaluate new ideas and make decisions about the direction of your project. Pick the most and least important for both YOU and YOUR TEAM.

PICK 3 of each:	least important to me personally	most important to me personally	least important to my team	most important to my team
building a profitable, self-sustaining business	□	□	□	□
being evaluated positively in the class	□	□	□	□
working in a way that supports group cohesion & morale	□	□	□	□
taking all business partners, supply chain, and institutions into account	□	□	□	□
keeping costs of the product/service low	□	□	□	□
creating a final project that reflects my/our unique personalities & values	□	□	□	□
satisfying users' emotional & social needs	□	□	□	□
learning about the process of NPD & teamwork	□	□	□	□
developing an exciting new technology	□	□	□	□
developing a creative, unique & innovative product/service	□	□	□	□
completing project deliverables on time & with efficient use of resources	□	□	□	□
benefiting a specific group or society without regard for profit	□	□	□	□
satisfying users' functional & technical needs	□	□	□	□
strategically identifying a promising niche in the competitive marketplace	□	□	□	□

10. Is there anything else that was important to you & your team in terms of evaluating new ideas and making decisions about the direction of your project? _____

Ways of Thinking & Feeling
The report that you will receive about your results on this section will give you insight into your own "cognitive style," or your way of thinking & feeling.   As with the MBTI there are no right or wrong answers - it's a matter of style! The more you learn about yourself the better able you will be to discover opportunities for you to build upon your unique strengths.

* 11. Based on your own attitudes and experiences, please rate each item below.

1. **DISAGREE** strongly - 2. moderately disagree - 3. slightly disagree - 4. slightly agree - 5. moderately agree - 6. strongly **AGREE**						
	1	2	3	4	5	6
What one is used to is always preferable to what is unfamiliar.	□	□	□	□	□	□
When considering most conflicts, I can usually see how both sides could be right.	□	□	□	□	□	□
I tend to put off making important decisions until the last possible moment	□	□	□	□	□	□
In the long run it is possible to get more done by tackling small simple problems rather than larger and complicated ones.	□	□	□	□	□	□
When trying to solve a problem I often see so many possible options that it's confusing.	□	□	□	□	□	□
I find it annoying to listen to people who cannot make up their minds.	□	□	□	□	□	□
I prefer to interact with people whose opinions are very different from my own.	□	□	□	□	□	□
I usually make important decisions quickly and confidently.	□	□	□	□	□	□
When faced with a problem I usually see the one best solution very quickly.	□	□	□	□	□	□
NPD is more cloud-like than clock-like.	□	□	□	□	□	□
The sooner we all acquire similar values and ideas the better.	□	□	□	□	□	□
Many of the most important decisions are based upon insufficient information.	□	□	□	□	□	□
It is more fun to tackle a complicated problem than to solve a simple one.	□	□	□	□	□	□
Often the most interesting and stimulating people are those who don't mind being different and original.	□	□	□	□	□	□
People who fit their lives to schedules probably miss most of the joy of living.	□	□	□	□	□	□
Even after making up my mind, I am eager to consider a different opinion.	□	□	□	□	□	□
Having clear rules and order is essential for success.	□	□	□	□	□	□
A more common error is exaggerating the complexity of the world as opposed relying too heavily on simple rules of thumb.	□	□	□	□	□	□
I dislike questions that can be answered in many ways.	□	□	□	□	□	□
A more common error is abandoning good ideas too quickly as opposed to persevering too long with a bad idea.	□	□	□	□	□	□
A good job is one where what is to be done and how it is to be done are always clear.	□	□	□	□	□	□

* 12. Teams have sometimes been said to have "personalities" of their own. For this section, think about your group - how it behaves, it's attitudes and norms, and the behaviors and thinking styles it tries to encourage & discourage. Then mark how you'd imagine your TEAM AS A WHOLE would respond, if it were a person with its own attitudes and personality. Then rate each item below.

1. **DISAGREE** strongly - 2. moderately disagree - 3. slightly disagree - 4. slightly agree - 5. moderately agree - 6. strongly **AGREE**						
	1	2	3	4	5	6
When faced with a problem my team usually sees the one best solution very quickly.	□	□	□	□	□	□
My team thinks that often the most interesting and stimulating people are those who don't mind being different and original.	□	□	□	□	□	□
My team tends to put off making important decisions until the last possible moment	□	□	□	□	□	□
My team's attitude is probably that people who fit their lives to schedules probably miss most of the joy of living.	□	□	□	□	□	□
My team feels that the sooner we all acquire similar values and ideas the better.	□	□	□	□	□	□

My team thinks NPD is more cloud-like than clock-like.	□	□	□	□	□	□
My team thinks having clear rules and order is essential for success.	□	□	□	□	□	□
My team thinks a good job is one where what is to be done and how it is to be done are always clear.	□	□	□	□	□	□
My team usually makes important decisions quickly and confidently.	□	□	□	□	□	□
My team thinks in the long run it is possible to get more done by tackling small simple problems rather than larger and complicated ones.	□	□	□	□	□	□
My team probably has more fun to tackle a complicated problem than to solve a simple one.	□	□	□	□	□	□
My team probably feels many of the most important decisions are based upon insufficient information.	□	□	□	□	□	□
What we are used to is always preferable to what is unfamiliar.	□	□	□	□	□	□
My team thinks a more common error is abandoning good ideas too quickly as opposed to persevering too long with a bad idea.	□	□	□	□	□	□
My team prefers to interact with people whose opinions are very different from its own.	□	□	□	□	□	□
Even after making up its mind, my team is eager to consider a different opinion.	□	□	□	□	□	□
My team finds it annoying to listen to people who cannot make up their minds.	□	□	□	□	□	□
When considering most conflicts, my team can usually see how both sides could be right.	□	□	□	□	□	□
My team dislikes questions that can be answered in many ways.	□	□	□	□	□	□
When trying to solve a problem my team often sees so many possible options that it's confusing.	□	□	□	□	□	□
My team thinks a more common error is exaggerating the complexity of the world as opposed relying too heavily on simple rules of thumb.	□	□	□	□	□	□

Roles and responsibilities
13. Please provide the full name of each of your teammates, NOT INCLUDING YOURSELF. You may want to WRITE DOWN the order in which you provide them below on a piece of paper for use later in the survey.

Name 1 _____
Name 2 _____
Name 3 _____
Name 4 _____ (n/a if none)
Name 5 _____ (n/a if none)

14. Please rate YOURSELF and YOUR TEAMMATES on the following. Scroll across to rate each teammate, and refer to the order of names in the list you jotted down above. YOU MUST rate your teammates in the same order as above!!!

YOURSELF *************** (Repeat this table for each Teammate - Name 1, 2, 3, etc.) *********************							
1. **DISAGREE** strongly - 2. moderately - 3. slightly - 4. **neither -** 5. slightly - 6. moderately - 7. strongly **AGREE**							
	1	2	3	4	5	6	7
Kept an open mind/ was willing to consider other's ideas:	□	□	□	□	□	□	□
Was fully engaged in discussions during meetings:	□	□	□	□	□	□	□
Took a leadership role in some aspects of the project:	□	□	□	□	□	□	□
Does more than their fair share of work:	□	□	□	□	□	□	□
Helps group overcome differences to reach effective solutions:	□	□	□	□	□	□	□
Tries to excessively dominate group discussions:	□	□	□	□	□	□	□
Contributes useful ideas that help the group succeed:	□	□	□	□	□	□	□
Encourages team to complete the project on a timely basis:	□	□	□	□	□	□	□
Has strong preconceived ideas about what we're going to develop:	□	□	□	□	□	□	□
Delivers work when promised/needed:	□	□	□	□	□	□	□

Easily negotiates issues with members of the group:	☐	☐	☐	☐	☐	☐	☐
Communicates ideas clearly/effectively:	☐	☐	☐	☐	☐	☐	☐
Is willing to change his or her mind based on what was learned:	☐	☐	☐	☐	☐	☐	☐
Has the respect of the group:	☐	☐	☐	☐	☐	☐	☐
Has influence within the group:	☐	☐	☐	☐	☐	☐	☐
Focuses on the problem as opposed to solutions:	☐	☐	☐	☐	☐	☐	☐
Tends to broaden/diverge as opposed to narrow/converge:	☐	☐	☐	☐	☐	☐	☐

Use this table to answer the three questions below:

	Points	Title	Reason
Yourself			
Name 1			
Name 2			
Name 3			
Name 4			
Name 5			

15. Please distribute 100 pts. among the members for their overall contribution to the team's efforts (including work, communication, problem solving, etc.). The total points should add up to 100. (Again please use the same order as above!)

16. Assign a job title that best describes the role each member assumed in the group. You can be creative! - some past examples include reality checker, counterbalance, idea person, artsy gal, technician, pessimist, listener, troubleshooter, visionary…

17. Please provide one reason why you assigned each role.

18. Please write the name of the member who you think provided the most leadership. _____

Design Coaches

19. Design coach: firm/company name   _____

20. Design Coach: Individual's Names & Titles   _____

21. On average, how many hours per week did your team spend interacting with your design coaches in…
   Face-to-face meetings   _____
   Email (not basecamp)   _____
   Telephone   _____
   Basecamp   _____
   Another website or system _____
   Other?   _____

22. Please rate each item below.

	Not at all	A little	Quite a bit	A lot
How involved was your coach in your project?	☐	☐	☐	☐

Did your coaches' involvement meaningfully change the direction of your team or your project?	☐	☐	☐	☐
Overall, how helpful have your coaches been to the team?	☐	☐	☐	☐

<u>Reflection</u>

23. Please describe briefly what you learned about the NPD process and working on a cross-disciplinary team during this assignment.

24. Please write a brief description of any problems or conflicts you encountered in working with your team and how they were resolved.

25. Please provide any thoughts on the product development tools provided to you in lectures and how useful/not useful they proved for your project.

26. If there's anything else you would like to communicate to the faculty or anonymously to your team you may write it here. (optional)

APPENDIX I: Study 2 End of Semester Survey (t2)

Semester End Reflection (Final Survey)

Your Team
This section repeats many of the questions that you answered in the mid-semester survey. As before, this feedback will be averaged with your teammates' anonymously, and returned to your team. Be thorough, straightforward, and honest. PLEASE RESPOND ACCORDING TO YOUR EXPERIENCE OVER THE LAST SEVERAL WEEKS OF THE COURSE, SINCE YOU COMPLETED THE LAST SURVEY.

* 1. Your Name _____

* 2. Which of the following best describes the level of the conflict at group meetings since you completed the last survey?

	No conflict, everyone seemed to agree on what to do	There were disagreements, but we resolved them easily	Disagreements were resolved with considerable difficulty	Open warfare: still unresolved
Conflict about team & task processes	□	□	□	□
Conflict about the direction of the project	□	□	□	□
Interpersonal / emotional conflict	□	□	□	□

* 3. Now that you have reached the end of your group project, think about your satisfaction with your TEAM and with the PRODUCT/SERVICE you developed. If you were given the opportunity to continue the work you began this semester, what would you want to?

Product/Service	Team
□ Would want very much to change	□ Would want very much to change
□ May want to change but not sure	□ May want to change but not sure
□ Would rather change than stick with the same...	□ Would rather change than stick with the same...
□ Would make no difference to me	□ Would make no difference to me
□ May want to stay but not sure	□ May want to stay but not sure
□ Would rather stick with the same...	□ Would rather stick with the same...
□ Would want very much to stick with the same...	□ Would want very much to stick with the same...

* 4. Team Communication

1. DISAGREE strongly - 2. moderately - 3. slightly - 4. neither - 5. slightly - 6. moderately - 7. strongly AGREE							
	1	2	3	4	5	6	7
We felt comfortable making decisions and openly sharing our honest opinions in a constructive way.	□	□	□	□	□	□	□
We felt comfortable openly sharing our creative ideas.	□	□	□	□	□	□	□
We felt safe investing time in exploring risky & unusual ideas.	□	□	□	□	□	□	□
We were effective at sharing individuals' information with the team (e.g. things learned during research, ideas & thoughts on the project).	□	□	□	□	□	□	□
Occasional mistakes were expected & not punished.	□	□	□	□	□	□	□
Our team was productive - accomplishing not only course requirements but our own goals as well.	□	□	□	□	□	□	□
As a team, we were all clear about & agreed upon what the important goals for our project and team were.	□	□	□	□	□	□	□
New ideas & direction changes were implemented quickly.	□	□	□	□	□	□	□
The team gave due consideration to ideas / thoughts put forth by me.	□	□	□	□	□	□	□
I felt comfortable sharing my own thoughts/ideas.	□	□	□	□	□	□	□
I really felt like I was a part of my team - I worked with others, was included in most ways, and felt like I belonged.	□	□	□	□	□	□	□

5. Communications outside of class: Over the past several weeks of the course (SINCE THE LAST SURVEY), how many HOURS PER WEEK (on average) did YOU PERSONALLY spend interacting in…

Face-to-face meetings	_____	Doing user research	_____
Email (not basecamp)	_____	Interacting with your coach	_____
Telephone	_____	Working on your own	_____
Basecamp	_____	Other (give hours & describe)?	_____
Another website or system	_____		

6. Ideals, Values & Goals: As you did in the first survey, below you will rate a number of values & goals in terms of their importance when you evaluated new ideas and make decisions about the direction of your project. Pick the MOST and LEAST important for YOU, and the MOST and LEAST important for YOUR TEAM, leaving the rest unchecked. This time, consider only the last several weeks of the course, SINCE YOU TOOK THE LAST SURVEY.

PICK 3 of each:	least important to me personally	most important to me personally	least important to my team	most important to my team
building a profitable, self-sustaining business	□	□	□	□
being evaluated positively in the class	□	□	□	□
working in a way that supports group cohesion & morale	□	□	□	□
taking all business partners, supply chain, and institutions into account	□	□	□	□
keeping costs of the product/service low	□	□	□	□
creating a final project that reflects my/our unique personalities & values	□	□	□	□
satisfying users' emotional & social needs	□	□	□	□
learning about the process of NPD & teamwork	□	□	□	□
developing an exciting new technology	□	□	□	□
developing a creative, unique & innovative product/service	□	□	□	□
completing project deliverables on time & with efficient use of resources	□	□	□	□
benefiting a specific group or society without regard for profit	□	□	□	□
satisfying users' functional & technical needs	□	□	□	□
strategically identifying a promising niche in the competitive marketplace	□	□	□	□

7. Is there anything else that was important to you & your team in terms of evaluating new ideas and making decisions about the direction of your project?

Ways of Thinking & Feeling
This section assesses your cognitive style and the cognitive style of your team. Your responses from the Midsemester Survey will be analyzed in combination with your answers today to give you a detailed feedback report about your ways of thinking and feeling as they evolved over the course of the semester.

* 8. Based on your own attitudes and experiences, please rate each item below.

1. **DISAGREE** strongly - 2. moderately disagree - 3. slightly disagree - 4. slightly agree - 5. moderately agree - 6. strongly **AGREE**						
	1	2	3	4	5	6
What one is used to is always preferable to what is unfamiliar.	□	□	□	□	□	□
When considering most conflicts, I can usually see how both sides could be right.	□	□	□	□	□	□
I tend to put off making important decisions until the last possible moment	□	□	□	□	□	□
In the long run it is possible to get more done by tackling small simple problems rather than larger and complicated ones.	□	□	□	□	□	□
When trying to solve a problem I often see so many possible options that it's confusing.	□	□	□	□	□	□
I find it annoying to listen to people who cannot make up their minds.	□	□	□	□	□	□
I prefer to interact with people whose opinions are very different from my own.	□	□	□	□	□	□
I usually make important decisions quickly and confidently.	□	□	□	□	□	□
When faced with a problem I usually see the one best solution very quickly.	□	□	□	□	□	□
NPD is more cloud-like than clock-like.	□	□	□	□	□	□
The sooner we all acquire similar values and ideas the better.	□	□	□	□	□	□
Many of the most important decisions are based upon insufficient information.	□	□	□	□	□	□
It is more fun to tackle a complicated problem than to solve a simple one.	□	□	□	□	□	□
Often the most interesting and stimulating people are those who don't mind being different and original.	□	□	□	□	□	□
People who fit their lives to schedules probably miss most of the joy of living.	□	□	□	□	□	□
Even after making up my mind, I am eager to consider a different opinion.	□	□	□	□	□	□

	1	2	3	4	5	6
Having clear rules and order is essential for success.	□	□	□	□	□	□
A more common error is exaggerating the complexity of the world as opposed relying too heavily on simple rules of thumb.	□	□	□	□	□	□
I dislike questions that can be answered in many ways.	□	□	□	□	□	□
A more common error is abandoning good ideas too quickly as opposed to persevering too long with a bad idea.	□	□	□	□	□	□
A good job is one where what is to be done and how it is to be done are always clear.	□	□	□	□	□	□

* 9. Teams have sometimes been said to have "personalities" of their own. For this section, think about your group - how it behaves, it's attitudes and norms, and the behaviors and thinking styles it tries to encourage & discourage. Then mark how you'd imagine your TEAM AS A WHOLE would respond, if it were a person with its own attitudes and personality. Then rate each item below.

1. **DISAGREE** strongly - 2. moderately disagree - 3. slightly disagree - 4. slightly agree - 5. moderately agree - 6. strongly **AGREE**

	1	2	3	4	5	6
When faced with a problem my team usually sees the one best solution very quickly.	□	□	□	□	□	□
My team thinks that often the most interesting and stimulating people are those who don't mind being different and original.	□	□	□	□	□	□
My team tends to put off making important decisions until the last possible moment	□	□	□	□	□	□
My team's attitude is probably that people who fit their lives to schedules probably miss most of the joy of living.	□	□	□	□	□	□
My team feels that the sooner we all acquire similar values and ideas the better.	□	□	□	□	□	□
My team thinks NPD is more cloud-like than clock-like.	□	□	□	□	□	□
My team thinks having clear rules and order is essential for success.	□	□	□	□	□	□
My team thinks a good job is one where what is to be done and how it is to be done are always clear.	□	□	□	□	□	□
My team usually makes important decisions quickly and confidently.	□	□	□	□	□	□
My team thinks in the long run it is possible to get more done by tackling small simple problems rather than larger and complicated ones.	□	□	□	□	□	□
My team probably has more fun to tackle a complicated problem than to solve a simple one.	□	□	□	□	□	□
My team probably feels many of the most important decisions are based upon insufficient information.	□	□	□	□	□	□
What we are used to is always preferable to what is unfamiliar.	□	□	□	□	□	□
My team thinks a more common error is abandoning good ideas too quickly as opposed to persevering too long with a bad idea.	□	□	□	□	□	□
My team prefers to interact with people whose opinions are very different from its own.	□	□	□	□	□	□
Even after making up its mind, my team is eager to consider a different opinion.	□	□	□	□	□	□
My team finds it annoying to listen to people who cannot make up their minds.	□	□	□	□	□	□
When considering most conflicts, my team can usually see how both sides could be right.	□	□	□	□	□	□
My team dislikes questions that can be answered in many ways.	□	□	□	□	□	□
When trying to solve a problem my team often sees so many possible options that it's confusing.	□	□	□	□	□	□
My team thinks a more common error is exaggerating the complexity of the world as opposed relying too heavily on simple rules of thumb.	□	□	□	□	□	□

User Research

10. Please describe your experience with user research.

1. **DISAGREE** strongly - 2. moderately - 3. slightly - 4. **neither -** 5. slightly - 6. moderately - 7. strongly **AGREE**

	1	2	3	4	5	6	7
User research was an important part of our project.	□	□	□	□	□	□	□
We were surprised by what we learned from users.	□	□	□	□	□	□	□
We significantly changed the direction of our project based on what we learned	□	□	□	□	□	□	□

from users.							
Users tended to confirm our thinking about the project.	□	□	□	□	□	□	□
I really enjoyed interacting with users.	□	□	□	□	□	□	□
User research was important in facilitating my team's discussions.	□	□	□	□	□	□	□
User research tended to slow us down.	□	□	□	□	□	□	□
User research was not useful enough to our team to be worth the time and effort.	□	□	□	□	□	□	□
If I were to do the semester over again, I would have done more user research.	□	□	□	□	□	□	□
User research was more helpful for fine tuning of features than for establishing needs.	□	□	□	□	□	□	□
What we learned from users was more about their "pain points" and needs rather than what kinds of solutions they wanted.	□	□	□	□	□	□	□
I felt unsure that we knew what questions to ask users.	□	□	□	□	□	□	□
We ended up spending a lot of time interviewing users who did not end up being our target market.	□	□	□	□	□	□	□
User research helped us to establish who our target market should be.	□	□	□	□	□	□	□
Talking to users helped us to broaden our project.	□	□	□	□	□	□	□
Talking to users helped us to narrrow our project.	□	□	□	□	□	□	□
The changes we made to our mission statement accurately reflected our learning from users.	□	□	□	□	□	□	□
User research tended to create conflict within our team in terms of the direction of the project.	□	□	□	□	□	□	□
User research tended to create conflict within our team in terms of task processes.	□	□	□	□	□	□	□
My team resisted changing when learnings from users challenged their frames for thinking about the project.	□	□	□	□	□	□	□
I think that our project fully satisfies user needs.	□	□	□	□	□	□	□
I feel that our project will disappoint some users.	□	□	□	□	□	□	□
When it came down to it, what we thought was more important than what users told us when making decisions about the project direction.	□	□	□	□	□	□	□

Roles and responsibilities

Use this table to answer the three questions below:

	Points	Title	Reason
Yourself			
Name 1			
Name 2			
Name 3			
Name 4			
Name 5			

* 11. Please distribute 100 pts. among the members for their overall contribution to the team's efforts (including work, communication, problem solving, etc.). The total points should add up to 100.
* 12. Assign a job title that best describes the role each member assumed in the group. You can be creative! - some past examples include reality checker, counterbalance, idea person, artsy gal, technician, pessimist, listener, troubleshooter, visionary…
* 13. Please provide one reason why you assigned each role.
* 14. Please write the name of the member who you think provided the most leadership since the last survey. _____

Reflection
You're almost there! Thanks for taking the time to reflect on your and your team's experience in the design process. This final section leaves you space to consider what you have experienced and learned about the methods used, conflict and teamwork.

* 15. Please briefly describe how your team changed throughout the semester. Feel free to touch upon conflicts, changes in project "frames," and your personal changes in thinking, feeling, working with your team, and working with the process.
* 16. Is there anything you'd like to communicate to Caneel & Jono about their interviews & observation of the class for their research?
* 17. If there's anything else you would like to add write it here.

APPENDIX J: Studies 2 and 3 Items from Conflict Scale by Jehn (1995)

These items used in Mid-semester and Final Surveys for MIT (Spring 2006) and Haas (Fall 2006) (replacing previous items from instructor's scale)

Which of the following best describes the level of the conflict at group meetings?

1. How much conflict about the work you do is there in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

2. How much tension is there among members in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

3. To what extent are there differences of opinion in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

4. How much are personality conflicts evident in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

5. How much friction is there among members in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

6. How much emotional conflict is there among members in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

7. How often do people in your team disagree about opinions regarding the work being done?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

8. How frequently do members of your team disagree about the way to complete a task?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

9. How frequently are there conflicts about ideas in your team?
   1 (None)2   3   4   5   6   7 (A lot)
   or [ ] I prefer not to respond

10. How much conflict is there about delegation of tasks within your team?
    1 (None)2   3   4   5   6   7 (A lot)
    or [ ] I prefer not to respond

11. How often do members of your team disagree about who should do what?
    1 (None)2   3   4   5   6   7 (A lot)
    or [ ] I prefer not to respond

APPENDIX K: Study 3 Quick Check-in Survey

QUICK CHECK-IN SURVEY

It is understandable that all projects evolve over time. However there is significant value in putting into words where you currently stand in the NPD process, and reflecting on where you've been.

Your answers are completely confidential. They will not be shared with your teammates or have any impact on your grade.

1. Full Name

2. In one sentence, describe the goals of your project.

3. What are the strongest points of consensus on your team right now about your team's mission? (1-2 sentences would be fine.)

4. What are the most significant issues upon which your team members are currently not in agreement? (1-2 sentences would be fine.)

5. How have your ideas regarding your team's mission changed over the past week?

APPENDIX L: Study 3 Team Interview Protocol

This portion of the study involves interviews with design teams with one or two researchers present. It is expected that the interviews will follow more or less the themes outlined below but allow for exploration of additional topics that seem relevant to both the interviewee and the interviewer. This is not an exhaustive list of questions; instead, it highlights main themes and key questions for this part of the study.

MISSION STATEMENTS (mandatory)
  Tell me about your mission statement. Have you used it? If so, how? How was it developed? Has it changed?

USER RESEARCH: (mandatory)
  Tell me about your research process so far.
  Who have you studied and what methods did you use?
  What have you discovered? How has your team dealt with your findings?

PRODUCT FRAMING:
  What do you see your project/product as?
  Tell me how your understanding of your project developed as a story.
  How would you describe your project using "can be seen as" or "as if"?

CONSTRAINT:
  What did you consciously choose not to consider?
  What did you choose as the boundaries of the situation?
  What is the benefit you see for the customer?

CRITERIA:
  What does the team think is important?
  How will you select the evaluation criteria? (if haven't been set yet) / What are your evaluation criteria? (if have been set)

IDEA GENERATION
  How did you decide 'where' to look for new concepts?
  How do you determine which concepts are better than others?

CHANGE:
  How have your criteria changed over the course of the product?
  Were there intermediate changes?
  What triggered your change of what you see as important?

CONFLICT:
  How has your project been going so far?
  Have you had any conflicts? How have you managed them?

OTHER:
  What do you think is important in your product for the user?
  Who do you consider your stakeholders?
  How long are you considering the effect of your product?
  What are you trying to minimize/maximize?
  What products do you see as your competitors? Why?