HOW MULTI-TEAMING AFFECTS INDIVIDUALS AND TEAMS

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HOW MULTI-TEAMING AFFECTS INDIVIDUALS AND TEAMS

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SUMMARY

Teamwork is a cornerstone of many facets of society, and as such, organizations continue to increase the use of teams as a vehicle through which organizational goals are accomplished. As the prevalence of teams continues to grow, individuals are working as a part of more than one team at any given time. This dissertation explores the phenomenon of multi-teaming, defined as an individual's membership in multiple work teams. Participation in multiple teams gives individuals the opportunity to gain access to the knowledge of others through their own connections, and the indirect connections of their teammates. Therefore, there are incentives for individuals to be part of not just one team, but to participate in multiple teams. However, participation in multiple teams can also be ill advised as individuals have limited resources to devote across various team tasks. While multi-teaming is an unavoidable fact for contemporary teamwork, there is not yet enough empirical evidence to fully comprehend its effects on individuals and teams.

This dissertation takes a multi-method approach to examine how multi-teaming impacts individuals and teams. The research is divided into two parts: 1) a quantitative study, and 2) a qualitative study. Study 1 establishes how individuals' participation in multiple teams has an impact on the performance of individuals and teams. Study 2 takes a deeper dive into the experience of multi-teaming from the perspective of multi-teamers and people who work with multi-teamers. This study is intended to uncover the perceptions surrounding multi-teaming, and generate theory on how engaging in multi-teaming, or working with others that do, influences both individuals and teams.

Study 1. Study 1 is an investigation of the effects of multi-teaming on individual productivity and team performance in a sample of 224, 2-13 person teams (Median = 3). Teams were comprised of individuals registered on an online community of nanotechnology researchers, nanoHUB.org. Teams included in the study created tools for the nanotechnology community from 2006-2012. Measures of multi-teaming were derived from the data on the nanoHUB servers. Findings reveal that the number of teams to which an individual belongs benefits their productivity. However, having high variety in one's teammates, harms productivity. At the team level, the effects of multi-teaming on team performance are not always straightforward. Having connections to other teams is good to a point, but too many connections begin to harm the team's performance. Additionally, having access to unique contacts outside the team harms performance.

Study 2. Study 2 is an investigation of the experience of multi-teaming in a sample of 18 researchers working within five different university research labs. The sample includes three lab directors and 15 graduate students. Participants were interviewed either face-to-face or via Skype using a semi-structured interview format. Using a grounded theory approach (Glaser & Strauss, 1967), I generated themes from the interview data and developed a narrative of the experience of multi-teaming based on the perceptions of multi-teamers and their teammates. Results suggest that working within an environment that requires multi-teaming is complex, and full of paradox, trade-offs and inconsistencies. I describe how participants navigate and manage their multi-teaming through the lens of paradox theory (Lewis, 2000) and incorporate how participants' descriptions of their experience relate to the extant literature.

CHAPTER 1

INTRODUCTION

Teamwork is a cornerstone of science, technology, business, healthcare, military operations, and education. Organizations continue to increase the use of teams as a vehicle through which organizational goals are accomplished (Devine, Clayton, Philips, Dunford, & Melner, 1999). Research in the organizational sciences has demonstrated the ability of teams to achieve goals. Teams are creative (Paulus, 2000), innovative (Hülsheger, Anderson, & Salgado, 2009), and productive (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008). Additionally, individuals can also reap multiple benefits from working in teams. Team members have the opportunity to learn from one another (van der Vegt & Bunderson, 2005), form meaningful social and instrumental task relationships (Uzzi, 1997), and gain access to their teammates knowledge and expertise (Coleman, 1988).

As the prevalence of teams continues to grow, individuals are working as a part of more than one team at any given time (Mortensen, Woolley, & O'Leary, 2007). Consider this:

> *"A worker today might start the morning by collaborating with a team of engineers, then send emails to colleagues marketing a new brand, then jump on a conference call planning an entirely different product line, while also juggling team meetings with accounting and the party-planning committee (Duhigg, 2016)."*

This vignette illustrates the phenomenon of *multi-teaming*, defined as *an individual's participation in multiple work teams* (O'Leary, Mortensen, & Woolley, 2011). This

dissertation explores the consequences of multi-teaming in organizations. First, I explore how multi-teaming affects the productivity of individuals. Multi-teaming behavior affords individuals the advantage of access to different ideas and resources beyond the boundary of a single team. However, an excess of multi-teaming may drain individuals of their limited attentional resources resulting in diminished productivity. Second, I explore the effects of multi-teaming on team performance. At the team level, multi-teaming affects the unique advantage of a team within an organizational ecosystem of teams. By virtue of the fact that individuals are participating in multiple teams concurrently, team boundaries become permeable to ideas and information that resides across the border. Returning to Duhigg's vignette, ideas from the engineering team rapidly spread to the team planning the new product line by virtue of individual multi-teaming. Third, I qualitatively explore the experience of multi-teaming from the perspective of multi-teamers and their teammates. In all, this dissertation seeks to advance a foundational understanding of multi-teaming and its effects on individuals and teams.

Participation in multiple teams gives individuals the opportunity to gain access to the knowledge of others through their own connections, and the indirect connections of their teammates (Burt, 2000). Therefore, there are incentives for individuals to be part of not just one team, but to participate in multiple teams. However, participation in multiple teams can also be ill advised as individuals have limited resources to devote across various team tasks (Zika-Viktorsson, Sundström, & Engwall, 2006). While membership in multiple teams is an unavoidable fact for contemporary teamwork, there is not yet enough empirical evidence to fully respond to the question: *How does participation in multiple teams impact individuals and teams?*

Multi-teaming originates at the individual level, and ultimately gives rise to patterns evident at the team ecosystem level. Thus, individual multi-teaming behavior has consequences at two levels of analysis. Multi-teaming behavior has implications at the individual level, as individuals apply their efforts across various teams, and it also has implications for the team as members, as the pattern of multi-teaming across team members pulls attention to or away from the team's task.

This dissertation advances the literature on multiple team membership through a multi-method investigation of multi-teaming. In an empirical study, I use a large dataset consisting of individuals in a virtual community that captures an ecosystem of nanotechnology researchers and the interlocks of these individuals on other teams. In a follow-up qualitative study, I will interview members of these teams to ask about their overall experience while working on these teams, including perceptions of their learning, information sharing, and team functioning, in an attempt to provide insights into the experience of multi-teaming. I explore multi-teaming through objective metrics of effectiveness, and from the perspective of the multi-teamer and their teammates. In doing so, I will build a foundational understanding of how multi-teaming affects individuals and teams.

CHAPTER 2

LITERATURE REVIEW

Defining Multi-Teaming

An individual's membership in multiple teams is an important reality that is under-studied in the literature, despite its prevalence. Research has reported that most individuals are part of multiple teams, with people engaging in anywhere from 6 to 12 teams (Anavi-Isakow & Golany, 2003; Martin & Bal, 2006; Mohrman, Cohen, Mohrman, 1995), and the prevalence of multi-teaming continues to grow. For example, in a recent interview, Mark Mortensen commented:

> *"What we see in particularly in professional service firms but across the board whether it's R&D, whether it's product design teams, or whatever is people aren't working on one team" (Mortensen, 2016).*

While multi-teaming is a common reality for most workplaces, it is at the core of intellectual work. Research, innovation, and the like are activities that are so often carried out in teams, and benefit from teamwork (Wuchty, Jones & Uzzi, 2007). Individuals are encouraged to seek out collaborations and have multiple collaborations that combine several perspectives. For example, the typical research laboratory in one of the Sciences is an environment in which there are likely multiple projects going on at the same time. Members of a research lab will participate in various teams in pursuit of publications, grant funding, or both (Golde, 2005). Research labs are designed for multi-teaming as members fulfill their roles as faculty, graduates student, or lab employee, to produce scholarly works. Multi-teaming is a common and encouraged practice in collaborative

intellectual work general, as the goal is to promote continued collaboration and knowledge sharing across disciplines and institutions.

Collaborative intellectual work has also facilitated the creation of networked organizational communities through the reliance on computers and the internet (Wellman, 2001). Virtual communities are created for the purpose of bringing people together to collaborate on projects online (e.g., nanoHUB, GitHub, HUBzero, Wikipedia). In online communities such as nanoHUB or GitHUB, people have the opportunity to build teams from a community of researchers with common interests that together develop new knowledge, software, and innovations in a particular area of interest (e.g., nanotechnology). Community building websites allow users to share documents, pictures, and videos, and have the built-in capacity for connecting with others. Thus, online communities facilitate multi-teaming as participants become more embedded and accessible within the community.

Multi-teaming refers to participation in multiple work teams. It is important to differentiate the phenomenon of multi-teaming described in this study, from other types of "teaming". It is certainly the case that individuals have multi-faceted lives, and participate in many different teams at any given time. For example, a person may have many teams of which they are a part including a work team, community service team, and a sports team. These different types of teams can be very central to a person's daily life and make-up a large part of their personal sense of identity (Brewer, 2001). However, while the many facets of an individual's daily life may bear influence on their work (e.g., embeddedness negatively predicts turnover; Mitchell, Holtom, Lee, Sablynski, & Erez,

2001), it is not the topic of discussion in this dissertation. The focus of multi-teaming is on the *work* teams of which an individual is a part.

Consider for example, the following illustration. Oscar is an engineer at Google. Google is heavily reliant on teamwork for the advancement of their different product lines, so teams are assembled to work on particular issues. Oscar is a software engineer working with a team to develop a new Chrome application, he is working with a team to implement new functions on YouTube, and he recently joined an employee volunteer team to resolve a pressing issue with Android. These three teams each require Oscar's time and effort, deal with different problems, have their own timeframes, and are comprised of different leaders and teammates, each with their own set of team memberships. The different teams in which Oscar participates are both opportunities and challenges for Oscar and his teams. The exploration of multi-teaming in this dissertation is aimed at understanding how an individual's engagement in multiple work teams, like those Oscar is involved in, have personal and team-wide implications.

Research Relevant to the Multi-Teaming Concept

While multi-teaming is a common reality of modern work, research in this area is scant. Research on multi-project environments has examined the negative, individual-level implications of working on several projects at one time (Engwall & Jerbrant, 2003; Zika-Viktorsson et al., 2006). This research finds that there is a problem of resource allocation when individuals work on multiple project teams (Engwall & Jerbrant, 2003). Individuals have limited attentional resources available for the accomplishment of tasks (Wickens, 1991). Engaging in multiple tasks at once triggers self-regulatory processes (e.g., self-evaluation and self-monitoring), which are beneficial for performance

(DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004), but these self-regulatory activities also absorb attentional resources, which can hinder performance (Kanfer & Ackerman, 1989). When engaged in multiple projects at once, individuals must divide a limited pool of resources among multiple projects, which can lead to overload and stress (Zika-Viktorrson et al., 2006).

Qualitative work on project teams has identified factors in multi-project success (Fricke & Shenhar, 2000; Watson-Manheim & Belanger, 2002). Some of the success factors in single project teams, such as leader support (Amabile, Schatzel, Moneta & Kramer, 2004), personnel (Pinto & Slevin, 1989), communication (LePine et al., 2008), and clear goals (Locke & Latham, 2002) are also applicable to multi-project environments (Fricke and Shenhar, 2000). However, Fricke and Shenhar (2000) also find that there are success factors that while somewhat less relevant for single-project teams are critical in multi-project environments. These include prioritization of different projects, division and assignment of resources across projects, and customized management styles across projects. Qualitative research by Mortensen and colleagues highlights some of the challenges and benefits associated with multiple team membership for individuals, teams, and organizations (Mortensen et al., 2007). For example, while individuals are challenged by multi-tasking and allocating time across projects, benefits include cross-project learning, and skill building.

Finally, research in social networks has focused on the team- and organizational-level consequences of team interlocks (Grewal, Lilien, & Mallapragada, 2006; Gulati & Westphal, 1999; Kang, 2008). Much research on team interlocks has focused on the organizational level implications of interlocks between company boards. Research

suggests that interlocks between firms open up opportunities for collaboration and advancement. For example, board interlocks can promote strategic alliances between firms when there is a trusting relationship between the board and the outside director (Gulati & Westphal, 1999). Alternatively, interlocks may expose firms to negative spillover effects from another firm. Kang (2008), for example, found that over 18% of firms with director interlocks to a firm accused of fraud experienced a decline in market value. Thus, in a multi-teaming environment, interlocks between teams can expose teams to new opportunities (e.g., perhaps to share resources or ideas), but may also expose the team to negative spillover effects emanating from a connecting team.

CHAPTER 3

PROGRAM OF RESEARCH SUMMARY

Multi-teaming is so common a practice in modern work, that it has become too narrow a scope to consider one team in isolation. The key assertion of this dissertation is that individuals participate in, and contribute to multiple teams at once. This participation in multiple teams is captured by the construct of *multi-teaming*. This dissertation aims to elucidate the impact of multi-teaming on individuals and teams, which has long been understudied in the teamwork literature. Understanding and investigating how individuals' participation in multiple teams impacts individual and teams will help to better understand the process of multi-teaming and how it functions in modern work.

To accomplish this aim, this dissertation takes a multi-method approach. The first is a quantitative study that examines the effects of multi-teaming on individual productivity and team performance. This study uses archival data on a sample of researchers working within an online community. The second study is a qualitative study that takes a deep dive into the experience of multi-teaming. This study uses interview data from a sample of faculty and graduate students working within university research labs. The subsequent sections describe and present each study independently. The dissertation closes with an overall discussion that summarizes the major contributions of this research overall, and ties together the findings from both studies to create a synthesized work.

CHAPTER 4

STUDY 1 – EFFECTS OF MULTI-TEAMING ON INDIVIDUAL PRODUCTIVITY AND TEAM PERFORMANCE

Multi-teaming has important consequences for outcomes at the individual and team levels. While there is some literature available to inform the ideas surrounding the phenomenon of multi-teaming, there is limited research available on the individual and team consequences of multi-teaming. Multi-project research is certainly relevant in this context, but tends to focus mostly on the individual level implications of resource allocation across teams. Furthermore, this research may often assume that team membership does not change, but simply that a single team takes on multiple projects. Thus, practical implications of research in this vein are to develop technological infrastructures that help teams manage multiple projects (e.g., Adler, Mandelbaum, Nguyen, & Schwerer, 1996; Anavi-Isakow & Golany, 2003). While multi-teaming involves taking on multiple projects, of substantive interest is whether the multiple projects involve the same or different teammates.

Research on team interlocks is also applicable to multi-teaming contexts, but has mainly focused on the interlock of organizations by virtue of board memberships. There is a gap in the literature regarding the impact of multi-teaming on the individual *and* the team. In Study 1, I fill this gap by considering various patterns of multi-teaming in virtual communities, and how these different patterns may affect individual and team effectiveness. I propose that at individual level patterns of multi-teaming affect individual productivity, while at team level patterns of multi-teaming influence team performance.

Individual Productivity

Productivity refers to the amount of outputs produced. In scientific fields the productivity of a researcher is measured by their contributions to the field. Scientists in virtual communities have an obligation to contribute to their team, but are marked by their success in their respective field through the publication of their research. In virtual communities that develop tools and products, researchers have the opportunity to publish their work, but also have access to resources that may inform their work outside of the community.

Team Performance

Team performance can be assessed through the end user's approval of the final product. Simply put, if those intended to use the product consider it useful, the team has been successful (Thompson, 2011). Team performance is no doubt a central construct, because teams are assembled for the purpose of goal attainment. Multi-teaming requires members manage several team goals at once, and exposes members to different people, tasks, and information, suggesting that the success of the teams may be highly influenced by multi-teaming behavior.

There is limited research that sheds light on the individual- and team-level consequences of multi-teaming. However, there are several literatures that are relevant for developing theory in this area. In generating specific predictions for the impact of multi-teaming on the individual and team, I synthesize arguments from previous work on multiple team membership with related literatures on individual multitasking, team effectiveness, boundary management, and social capital.

Patterns of Multi-Teaming

Stemming from an initial framework of multiple team membership (O'Leary et al., 2011), the concept of multi-teaming encapsulates five patterns of multi-teaming: individual multi-teaming degree, teammate variety, team interlocks, team external range, and multi-teaming disparity. I consider multi-teaming as an individual level behavior that has individual level consequences, but that can also scale up to have team-level implications.

At the individual level, I consider *individual multi-teaming degree* as the total number of teams to which an individual belongs. An individual may only belong to one team or many teams. Online communities are built for creating social ties among members, and therefore, are prime with opportunities for multi-teaming. *Teammate variety* represents the lack of overlap in an individual's teammates across the different teams in which an individual participates. In online communities, it is possible to engage in multiple projects with the same individuals or find new members with which to collaborate. The concept of teammate variety implies diversity in one's teammates, but as described here, is slightly different from other measures of diversity found in the literature (e.g., Perry-Smith & Shalley, 2014; Somech & Drach-Zahavy, 2013; van der Vegt & Janssen, 2003). Van Knippenberg, De Dreu, and Homan (2004) refer to diversity as "differences between individuals on any attribute that may lead to the perception that another person is different from self" (p. 1008). At a low level of teammate variety, an individual's teammates may still be diverse, while at high levels of variety, an individual's teammates may be more similar. What teammate variety captures are how many different relationships an individual is managing across multiple projects. While

this does not capture the differences among teammates, it does capture the number of different connections with others.

Individual multi-teaming behavior generates three team level properties. Individual multi-teaming behavior gives rise to *team interlocks*. *Team interlocks are links between teams that result by virtue of one or more shared members* (Mizruchi, 1996). Similar to individual multi-teaming degree, a team may be connected to no other teams, or may be connected to many other teams by virtue of the members' multi-teaming behavior. *Team external range* captures the extent to which a team has access to unique sources of ideas and perspectives. If members are embedded in a fully dense network, there is little access to new ideas that may benefit the team, and thus low external range because teammates have too many common ties. However, in teams with high external range, members foster connections (i.e., teammate ties) with others that are not in common with their teammates. Finally, individual multi-teaming behavior gives rise to a structure of multi-teaming at the team-level. *Multi-teaming disparity* captures how many people on a team possess multiple team memberships. A team in which all members are engaged in multi-teaming has low multi-teaming disparity, whereas a team in which only one member is engage in multi-teaming has high multi-teaming disparity.

In Study 1 I explore the effects of individual level patterns of multi-teaming (i.e., individual multi-teaming degree and teammate variety) on individual productivity. Additionally, in Study 1 I explore the effects of team level patterns of multi-teaming (i.e., team interlocks, team external range, and multi-teaming disparity) on team performance.

Effects of Multi-Teaming on Individual Productivity

Individual multi-teaming degree. Individuals are interdependent with their teammates in pursuit of team goals, and are therefore the very elements of the teams they comprise; the cogs in the "team machine", so to speak. Additionally, individuals possess personal goals, which they pursue alongside their team duties (DeShon et al., 2004). The team context, and further, the multi-teaming context may impact how productive individuals are not only in pursuit of the team goals, but also in the pursuit of individual goals.

The impact of individual multi-teaming degree on productivity may not be linear. On the one hand, the number of teams an individual is a part of may improve productivity. The work on any one team ebbs and flows during the life cycle of the team (Gersick, 1988). Being on multiple project teams allows for individuals to fill down-time with work that contributes to overall productivity (Fricke & Shenhar, 2000). Therefore, it may be inefficient for individuals to only belong to a single team, as there may be underutilized gaps in time as individuals wait for work to progress in a project (Milgrom & Roberts, 1992). These periods of inertia and action in teams allow for individuals to oscillate between the workload of multiple teams (O'Leary et al., 2011), and stimulate energy by creating interruptions that gives individuals a break from the work of a single team (Jett & George, 2003).

In the pursuit of personal goals, such as publications in the field, belonging to multiple teams offers more opportunities to contribute to scientific work. Quite simply, researchers that are involved in multiple project teams, are more likely to produce publications of their work, because they have more studies, patents, programs, etc. on which to publish. That is not to say that individuals cannot produce work independent of

their work teams, but scientific fields are moving away from this trend (Wuchty et al., 2007). Therefore, belong to multiple teams individual both contributions to the team and to the field.

On the other hand, being a part of too many teams may impede productivity. While having multiple projects encourages the efficient management of multiple work flows (i.e., through the exploitation of existing knowledge) and opportunities for research contributions, continuing to add projects reduces the amount of time individuals have to devote to any one project (Wheelwright & Clark, 1992). The diminished time allotted to working on a project lengthens the time it takes to complete any one project (Anavi-Isakow & Golany, 2003). At a more micro level, research on multitasking suggests that individuals are challenged to accomplish two tasks simultaneously (e.g., listening and typing notes, Hembrooke & Gay, 2003; driving while distracted, Strayer & Johnston, 2001). Multi-tasking problems may be augmented in multi-project environments (Goldratt, 1997), in which individuals are not only switching between small tasks, but switching between a different set of task requirements and different time-frames. Fricke and Shenhar (2000) report that managers agree that two or three projects are the ideal number to maximize productivity without overburdening employees with competing responsibilities. However, at a high numbers of team memberships, a person's attention may become too fragmented, switching costs become too high, and output is decreased. Therefore, while a moderate number of multiple memberships promotes individual productivity, a high number of memberships over-burdens individuals and results in performance decrements.

Hypothesis 1: An individual's multi-teaming degree has a curvilinear relationship with productivity, such that productivity is maximized at a moderate level of individual multi-teaming degree.

Teammate variety. Alternatively, teammate variety does not support individual productivity. Individuals incur a cost when switching between tasks (Allport & Wylie, 2000; Altmann & Trafton, 2002; Jarmasz, Herdman, & Johannsdottir, 2005; Trafton & Monk, 2007). Research on task-switching takes an individual cognition perspective to multitasking to investigate the "speed and fluency with which people switch between two different tasks" (Wickens, Santamaria, & Sebok, 2013).

When switching between teams, members are not only switching tasks, but they are also switching to a different team environment with different expectations, norms, and constraints. When members have high variety teammates, switch costs also include having to re-orient oneself to different mental models, and managing different social relationships, and types of information. Research on multiple projects environments finds that one of the success factors for multiple projects is the establishment of somewhat stable work structures across the different team contexts (Adler et al., 1996; Brown & Eisenhardt, 1997; Zika-Viktorsson et al., 2006). When individuals have high variety in their teammates across multiple teams, it is less likely that the teams will have similar work structures, norms, and cognitive architectures. These dissimilarities across teams increase the costs associated with switching between different teams.

However, when there is more overlap in the teammates across team membership, individuals are not required to acclimate to new team norms, relationships, or cognitive architectures. Individuals only have to reorient themselves to a new team task. The

familiarity of the team members reduces uncertainty of team performance (Hinds, Carley, Krackhardt, & Wholey, 2000), and allows individuals to focus on both team task accomplishment and personal goal accomplishment. Therefore, due to the added cognitive load of having teammate variety when engaging in multi-teaming, I predict:

Hypothesis 2: Teammate variety negatively predicts individual productivity.

The Effects of Multi-Teaming on Team Performance

Team interlocks. Having a moderate number of team interlocks can benefit team performance. When a team has access to other teams, the team collectively has access to social capital. This means that members' other team memberships serve as access points for the team and have the potential to influence their performance. When individuals create bridges between teams there is an opportunity share resources across teams. Having other groups from which to draw information and resources increases a team's access to knowledge that can inform the development of a useful product (Burt 1997; 2000; Marrone, 2010; Oh, Chung, & Labianca, 2004). In online communities that develop software tools, the end-user is typically also a member of the community. When a team has connections to other teams within the community, they have an "in" to understanding what the community members want and need. Through team interlocks, teams can transfer information and ideas to different people in the community, thereby increasing the likelihood that a final tool or product meets the needs of users in the community.

On the other hand, while multi-teaming increases the access to resources, it also activates an increasing number of responsibilities that members must manage. For individuals, the increasing number of projects burdens their limited pool of attentional

resources (March & Simon, 1958; Simon, 1947). As the members' attention is divided across an increasing number of projects, the amount of time they can devote to any one project is limited (Cummings & Haas, 2012). In online communities, the number of projects that the members of a team must produce may hinder the development of a quality product that members of the community will find useful. This suggests that up to a certain point multi-teaming is helpful to team performance. Members gain access to new and helpful information with some team interlocks, but after a certain point, team performance may start to decline as members struggle to divide their effort and attention across multiple projects.

Hypothesis 3: The number of team interlocks has a curvilinear relationship with team performance, such that team performance is maximized at a moderate number of team interlocks.

Team external range. A team's external range has the potential to offer better access to social capital. When members are tied to unique contacts (i.e., contacts to which their teammates do not have a connection), members can each access diverse pools of information that collectively benefit the team. Research on social capital suggests that unique external connections are critical for obtaining useful resources (Burt, 2000; Reagans & Zuckerman, 2001). For example, Reagans and Zuckerman (2001) found that in R&D teams were more productive when members had more heterogeneity in their external ties.

However, a team may have a large number of brokers that bridge structural holes and provide access to new ideas, but having access to new ideas is not the same as implementing those ideas (Obstfeld, 2005). Individuals need a "common base" for

integrating knowledge obtained from different sources (Ahuja, 2000; Tortoriello & Krackhardt, 2010). This can be achieved through establishing common connections outside of the team. For example, Tortoriello & Krackhardt (2010) found that strong Simmelian bridging ties, in which two individuals are connected to the same third party, resulted in a higher number of patent applications, compared to non-Simmelian ties (bridging relationships in which individuals have non-redundant external connections). Embedded relationships are characterized by higher information exchange and trust among parties (Uzzi, 1997), which can help teams to achieve better performance (Costa, 2003; Mesmer-Magnus & DeChurch, 2009).

In a multi-teaming context, sharing *some* contacts with teammates (i.e., through common membership), allows for some degree of embeddedeness and access to social capital that comes from having close knit ties (Coleman, 1988). In contrast, having high external range creates too many structural holes, which may negatively affect performance as members struggle to see the common core in their unique sets of ideas (Ahuja, 2000; Tortoriello & Krackhardt, 2010). Therefore, I posit:

> *Hypothesis 4: Team external range has a curvilinear relationship with team performance, such that team performance is maximized at a moderate level of team external range.*

Multi-teaming disparity. As described above, the number of team interlocks may be an important factor that impacts team performance. However, equally important to consider is the pattern of multi-teaming. As the social capital literature suggests connections to multiple groups can benefit the team (Oh et al., 2004; Reagans et al., 2004), but these benefits can be limited when all of the bridging conduits flow through a

single member, or select few members on the team. Figure 1 illustrates the idea of *distributed and concentrated multi-teaming*. In Figure 1, the team with high disparity has four interlocks that bridge the team to external groups. These ties are all bridged by the same member. Thus, this team demonstrates *concentrated multi-teaming* in that there is high multi-teaming disparity. In contrast, the team on the left in Figure 1 also has four ties that bridge the team to external groups, but those ties are bridged by four different members. Thus, the team on the right demonstrates *distributed multi-teaming* in that there is low multi-teaming disparity.

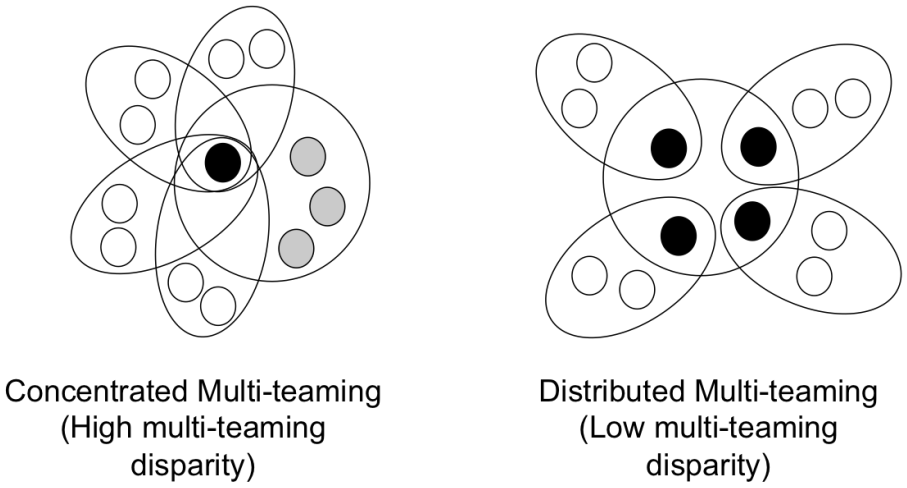

Figure 1. Illustration of concentrated and distributed multi-teaming.

Constricting the flow of external information through a single member creates a bottleneck, which limits the amount of external resources that the team can access. Groups are notorious for engaging in biased information sampling in which individuals on the team tend to focus on the information that is already shared among members rather than new information that can benefit the team (Stasser & Titus, 1985). When one

member on the team is the single conduit to external sources, it is less likely that the team will receive an influx of unique information to maximize their performance (Hinsz et al., 1997). Further, when one member holds most of the puzzle pieces, it is incumbent on them to translate the resources into useful knowledge and resources for the team, and therefore, the team's ability to integrate information is crippled. Alternatively, when teams engage in distributed multi-teaming, multiple members have access to external social capital. Each person's external contacts have the potential to shape ideas and provide new perspectives that benefit the team (Perry-Smith & Shalley, 2014).

However, it may not benefit the team that everyone be engaged in multi-teaming. The achievement of team goals requires effective coordination processes among team members (Marks, Mathieu, & Zaccaro, 2001). As the number of people engaged in multi-teaming increases, so does the number of people with fragmented attention. If all members' attention is divided up among multiple teams, the team may not be able to effectively execute coordinated action (Davison, Hollenbeck, Barnes, Sleesman, & Ilgen, 2012). This may be due to the fact that members engaged in multi-teaming are placed in a boundary spanning role, in that they connect their team to other teams in the broader network (Grewal et al., 2006). Boundary spanning activities require effortful communication (Ancona & Caldwell, 1992; Marrone, 2010), which can drive the focus away from the team (Yan & Louis, 1999). Therefore, I posit:

> *Hypothesis 5: Multi-teaming disparity has a curvilinear relationship with team performance, such that team performance is maximized at moderate levels of multi-teaming disparity.*

Method

In Study 1, I investigate the impact of multi-teaming within a large virtual community known as nanoHUB. nanHUB is an online community for nanotechnology researchers. The nanoHUB community consists of researchers from various fields including Engineering, Chemistry, Material Sciences, and Biology. The community is open to anyone who is interested in nanotechnology research. For this study, I employ the use of the nanoHUB user database to explore the effects of multi-teaming on individual productivity and team performance. This database includes information regarding each user including their registration date, affiliation, title, degree, nanoHUB activity, and team memberships. As part of a larger research project with the nanoHUB data, the database was augmented by filling in missing data that could be found online through user-provided URLs, institutional websites, and Linkedin.

Participants

Participants are tool developers registered in nanoHUB.org. The tool developers on nanoHUB are individuals and teams that develop simulation tools for public and restricted use. nanoHUB provides the collaboration platform for teams to come together and develop these tools. A total of 339 participants assembled into 224 teams from 2006-2012. Teams ranged in size from 2 – 13 persons with a median and modal size of 3 people.

Measures

Individual multi-teaming degree. Individual multi-teaming degree is a simple count of the number of teams of which each person is a part each year.

Teammate variety. Teammate variety is a measure of diversity (Harrison & Klein, 2007) that captures the extent to which an individual's teammates overlap across that individual's multiple team memberships. A tie between an individual and a teammate is considered unique when it only exists within a single team (i.e., people are on only one team together). The measure of teammate variety is the proportion of an individual's unique ties, or ties with others that that do not exist across multiple teams.

Team interlocks. Team interlocks represents the number of teams to which a team is connected in each year. A team is connected to another team by virtue of shared members.

Team external range. Team external range captures the extent to which a team's set of external ties overlaps across teammates. An overlapping tie exists when two members on the same team have the same external contact (i.e., two people in one team are also on another team with the same third party). Team external range is the proportion of ties to others outside of the team that do not overlap across teammates.

Multi-teaming disparity. Multi-teaming disparity is another measure of diversity that captures the unevenness of multiple team membership in a team (Harrison & Klein, 2007), or the proportion of people on the team with multiple memberships. If the team has fully concentrated multi-teaming, only one member on the team has multiple memberships, and thus high multi-teaming disparity. However, if a team has fully distributed multi-teaming, everyone on the team has multiple memberships, and thus low multi-teaming disparity. The calculation involves identifying the number of people on the team who have other team memberships and dividing by the total number of people on

the focal team. I use the inverse of this measure in so that the range of low to high disparity is 0-1.

Individual productivity. Individual productivity is a measure is of the number of publications each individual has obtained each year since joining the nanoHUB community.

Team performance. The simulation tool each team develops is available for use within the nanoHUB community. Team performance is a measure that captures the number of users for each tool. This metric is first weighted by the number of days that the tool has been online in a given year, and then it is weighted by the number of users on the nanoHUB website.

$$\frac{\text{Number of tool users in the year / Number of days online (ratio value)}}{\text{Total number of nanoHUB users}} * 100$$

The team performance measure accounts for how long a tool has been online in a given year, and the flux in the number of users available on the nanoHUB website, then computes a weighted measure of performance per 100 website users (i.e., a value of 1 indicates that 1 in 100 users have used the tool). This is important because the nanoHUB website was launched in 2002, and it is expected that the number of users has increased as the community has gained popularity. Therefore, teams that launched their tools in 2006 may have fewer users compared to those that launched in 2012 based on the size of the nanoHUB community at the time.

Covariates. Figure 2 is a depiction of the distribution for team sizes in the sample. Teams ranged from 2 to 13 persons per team. This difference in team sizes may impact the observed the relationships (e.g. larger teams may have more team interlocks).

Therefore, to account for any differences in the observed relationships due to the number of people on the team, I include team size in the subsequent analyses where appropriate. Additionally, because I obtained measures in each year from 2006-2012, I account for the role of time in each of the analyses.

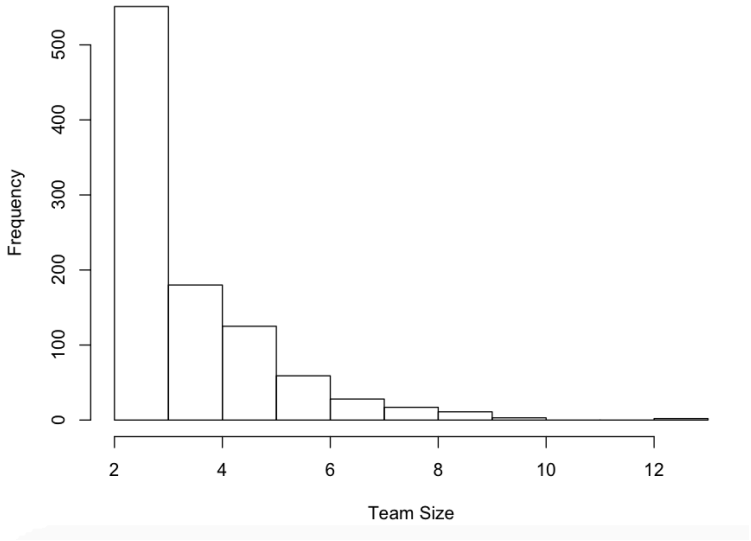

Figure 2. Team size distribution

Analytic Approach

Study 1 is an empirical test of the relationship between multi-teaming with individual productivity (Hypotheses 1-2) and team performance (Hypotheses 3-5). I have generated measures in each year from 2006-2012, and thus have longitudinal data involving a cross-section of subjects (i.e. individuals or teams) over time. Longitudinal data is essentially multi-level in which Level 1 consists of the observations for each construct over time, and level 2 consists of either individuals or teams. The datasets were

constructed such that the first time period for each individual or team is coded as 0, the second is coded as 1, etc.

I use a stepwise procedure to test the hypotheses (Bliese & Ployhart, 2002). For each dependent variable, I start with an empty model (no predictors). In subsequent analyses I add the covariates and focal predictors. In addition, I include tests of alternative models and conduct model comparisons to assess the fit of these alternatives to the data. Finally, the individual productivity outcome is a simple count of the number of publications each individual has in a given year. I test Hypotheses 1 and 2 using Poisson models. Poisson models are part of the family of generalized linear models (Nelder & Wedderburn, 1972; McCullagh & Nelder, 1989), and are appropriate for the analysis of count data (Gardner, Mulvey, & Shaw, 1995). These models can be applied in the multi-level context.

Results

Descriptives and Correlations

Table 1 provides the descriptive information for each of the variables over time. Most of the values are stable over time. However, there are a couple of patterns in the data worth noting. First, the number of teams and individuals decreases over time. This decrease may be because individuals are only active in the community for several years, and teams may launch a tool, but stop maintaining it after several years. The attrition of subjects is a common and unavoidable occurrence in longitudinal data (Frees, 2004). The second trend to note is that while most patterns are stable over time, the number of team interlocks seems to steadily rise over time, suggesting that as the community developed, the ecosystem of teams became denser with interlocks.

Table 1.

Means and standard deviation for study variables over time.

	Time 0		Time 1		Time 2		Time 3		Time 4		Time 5		Time 6	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Individual Level														
Individual Multi-Teaming Degree	1.56	1.41	1.92	1.77	2.41	3.05	2.71	3.48	3.08	3.91	3.50	4.72	3.88	5.43
Teammate Variety	0.87	0.28	0.81	0.32	0.78	0.32	0.77	0.33	0.76	0.33	0.77	0.31	0.78	0.29
Individual Productivity	3.38	6.83	3.74	7.44	4.57	8.29	4.45	8.07	6.32	11.44	6.20	10.98	5.60	9.27
N	339		322		269		220		179		123		86	
Team Level														
Team Size	3.26	1.30	3.41	1.34	3.56	1.41	3.83	1.77	4.06	1.98	4.33	2.03	4.76	2.27
Team Interlocks	9.66	9.92	11.47	11.09	14.19	13.60	16.34	15.15	18.20	15.74	17.59	16.89	19.63	19.04
Team External Range	0.53	0.41	0.55	0.37	0.58	0.35	0.56	0.34	0.56	0.34	0.54	0.35	0.42	0.32
Multi-Teaming Disparity	0.28	0.33	0.26	0.31	0.24	0.31	0.22	0.30	0.21	0.30	0.25	0.31	0.26	0.29
N	221		205		170		151		122		66		41	

Note: Values outside of parentheses indicate the mean, while values within the parentheses indicate the standard deviation.

Table 2 provides the correlations among the focal study variables. Correlations are low to moderate in strength. Individual multi-teaming degree and teammate variety are negatively correlated (r = -.35, p < .001), indicating that as individuals join more teams, they do so with familiar teammates. There is also a positive correlation between individual multi-teaming degree and individual productivity (r = .26, p < .001), suggesting that belonging to multiple teams benefits individuals' productivity. At the team level, team interlocks is positively correlated with team external range (r = .24, p < .001), suggesting that being tied to more teams also provides more unique contacts across teammates. Team external range is negatively related to multi-teaming disparity (r = -.36, p < .001), indicating that there are less unique contacts when fewer people on the team are multi-teaming. To assess the relationship between individual productivity and team performance, I aggregated individual productivity to the team level by taking the average number of publications for each team. Mean productivity and team performance are moderately correlated (r = .20, p < .001).

Table 2.

Correlation among study variables

Individual Level (N = 1538)	1	2	3			
1. Time						
2. Individual Multi-Teaming Degree	.22***					
3. Teammate Variety	-.11***	-.35***				
4. Productivity	.11***	.26***	.02			
Team Level (N = 976)	5	6	7	8	9	10
5. Team Size						
6. Time	.24***					
7. Team Interlocks	.48***	.23***				
8. Team External Range	-.01	-.02	.24***			
9. Multi-Teaming Disparity	.00	-.05	-.36***	-.03		
10. Performance	.35***	-.05	.33***	-.01	-.03	
11. Productivity (Mean)	.11***	.05	.45***	.04	-.04	.20***

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

The Empty Model

The first step in the multi-level analysis is to estimate an empty model and compute the intraclass correlation (ICC; Bliese, 2000). Table 3 shows the results for two null models; the first associated with the outcome of individual productivity, and the second associated with the outcome of team performance. The ICC for individual productivity is .81. This indicates that 81% of the variance in individual productivity can be explained by properties of the individual. The ICC for team performance is .59. This indicates that 59% of the variance in team performance can be explained by properties of the team. An alternative way to interpret the ICC values is that individuals and teams tend to remain fairly constant in productivity/performance over time, and that there are differences among individuals/teams.

Table 3.

Empty models and associated ICCs for each dependent variable

Outcome		Variance	ICC
Individual Productivity	Intercept	52.74	.81
	Residual	12.75	
Team Performance	Intercept	3.55	.59
	Residual	2.48	

Note: The ICC values are computed by dividing the intercept variance by the total variance.

Modeling Linear and Curvilinear Relationships

Next, I model the linear and curvilinear relationships between the independent variables and the dependent variables. To do this, I include a quadratic term for the focal independent variables in each model in addition to the linear terms. The effect of each quadratic term is orthogonal to its corresponding linear term, which allows examination of both effects within the same model (Bliese, 2013).

Individual Productivity. Table 4 displays the results of a model regressing individual productivity on linear and curvilinear terms for individual multi-teaming degree and teammate variety. Hypothesis 1 stated that there is a u-shaped curvilinear relationship between individual multi-teaming degree and individual productivity. Examination of the fixed effects in Model 1 shows that there is a significant and negative curvilinear relationship between individual multi-teaming degree and individual productivity (B = -1.34, p = .009). A negative curvilinear relationship between individual multi-teaming degree and individual productivity suggests that individual productivity is highest at moderate levels of multi-teaming degree. The quadratic term for multi-teaming

degree predicts variance in addition to the linear term. Furthermore, a chi-square difference test shows that a model that includes the quadratic term fits the data better than a model with only a linear term ($\Delta\chi^2$ (1) = 5.50, p = .019).

Hypothesis 2 posited that there is a negative linear relationship between teammate variety and individual productivity. Results for Model 2 show that there is a significant and negative linear relationship (B = -6.16 p < .001), and a non-significant effect of the quadratic term for teammate variety (B = -.51, p = .340), indicating support for Hypothesis 2. Figure 4 illustrates the linear relationship between teammate variety and individual productivity. Note that the figure shows the simple linear trend without accounting for the role of time or the nesting of observations within individuals.

Model 3 includes all predictors within the same model. In contrast to Hypothesis 1, results for Model 3 indicate that there is a positive linear relationship between individual multi-teaming degree and team performance (B = 4.19, p < .001), while the curvilinear relationship between individual multi-teaming degree and individual productivity is marginal (B = -.98, p = .056). In support for Hypothesis 2 and consistent with Model 2, there is a negative linear relationship between teammate variety and individual productivity (B = -4.99, p = .001).

I conducted chi-square difference tests to assess the comparative fit of the empty model and the target models with predictors. The chi-square difference tests favor the target models, indicating that the target models explain a significant amount of variance compared to the empty model (Model 1: $\Delta\chi^2$ (3) = 72.05, p < .001; Model 2: $\Delta\chi^2$ (3) = 69.52, p < .001; Model 3: $\Delta\chi^2$ (5) = 81.62, p < .001).

Table 4.

Results of models predicting individual productivity

Model	Fixed Effects	Coefficient	SE	z-value	p-value (one tailed)
1	Time	.03	.001	3.89	< .001
	Indiv. Multi-Teaming Degree	5.15	1.22	4.22	< .001
	Indiv. Multi-Teaming Degree^2	-1.34	.57	-2.35	.009
2	Time	.04	.01	5.68	< .001
	Teammate Variety	-6.16	1.58	-3.89	< .001
	Teammate Variety^2	-.51	1.17	-.44	.340
3	Time	.03	.01	3.64	< .001
	Indiv. Multi-Teaming Degree	4.19	1.33	3.15	< .001
	Indiv. Multi-Teaming Degree^2	-.98	.61	-1.59	.056
	Teammate Variety	-4.99	1.63	-3.07	.001
	Teammate Variety^2	.43	1.23	.35	.363

Note: Coefficients are unstandardized regression weights.

Team Performance. Table 5 displays the results of a model regressing team performance on linear and curvilinear terms for each of the focal predictors. Hypothesis 3 stated that there is a curvilinear relationship between a team's number of interlocks with other teams and team performance. This hypothesis was supported. Examination of the fixed effects for Model 4 in Table 5 show that there is a significant and negative curvilinear relationship between team interlocks and team performance (B = -4.54, $p <$ .032). Further, a chi-square difference test supports the inclusion of a quadratic term versus only the linear term ($\Delta\chi^2$ (1) = 4.47, p = .034).

Hypothesis 4 stated that there is a curvilinear relationship between team external range and team performance. This hypothesis was not supported. Results for Model 5 show that there is a non-significant curvilinear relationship between team external range and team performance (B = -4.00, p = .110).

Hypothesis 5 stated that there is a curvilinear relationship between multi-teaming disparity and team performance. In contrast to this hypothesis, results for Model 6 show that there is a non-significant curvilinear relationship between multi-teaming disparity and team performance (B = -3.21, p = .147).

Model 7 combines all of the team level predictors in one model. Examination of the fixed effects in this model shows that there is a significant and negative curvilinear relationship between team interlocks and team performance (B = -7.24, p = .005). Results also show that there is a significant and negative linear relationship between multi-teaming disparity and team performance (B = -5.63, p = .041). However, the curvilinear relationship between team external range and team performance remains non-significant (B = .49, p = .444). Instead, there is a significant and negative linear relationship between team external range and team performance (B = -5.83, p = .038), suggesting that having a high number of non-overlapping external contacts hurts performance.

The chi-square difference tests favor the target models, indicating that the target models explain a significant amount of variance compared to the empty model (Model 4: $\Delta\chi^2$ (4) = 122.03, p < .001; Model 5: $\Delta\chi^2$ (4) = 107.13, p < .001; Model 6: $\Delta\chi^2$ (4) = 106.69, p < .001; Model 7: $\Delta\chi^2$ (8) = 129.70, p < .001).

Table 5.

Results of models predicting team performance

Model	Fixed Effects	Coefficient	SE	t-value	p-value (one tailed)
4	Team Size	.15	.07	2.11	.018
	Time	-.38	.03	-11.21	< .001
	Team Interlocks	15.73	4.00	3.93	< .001
	Team Interlocks^2	-4.54	2.45	-1.85	.032
5	Team Size	.19	.07	2.80	.003
	Time	-.34	.03	-10.52	< .001
	Team External Range	.50	2.86	.18	.429
	Team External Range^2	-4.00	3.25	-1.23	.110
6	Team Size	.19	.07	2.86	.002
	Time	-.33	.03	-10.43	< .001
	Multi-Teaming Disparity	.51	3.41	.15	.440
	Multi-Teaming Disparity^2	-3.21	3.06	-1.05	.147
7	Team Size	.09	.07	1.21	.113
	Time	-.37	.03	-10.74	< .001
	Team Interlocks	20.95	4.61	4.54	< .001
	Team Interlocks^2	-7.24	2.82	-2.56	.005
	Team External Range	-5.83	3.28	-1.78	.038
	Team External Range^2	.49	3.59	.14	.444
	Multi-Teaming Disparity	7.07	3.72	1.90	.029
	Multi-Teaming Disparity^2	-5.63	3.24	-1.74	.041

Note: Coefficients are unstandardized regression weights.

Modeling Random Slopes

Individual productivity. The models above all assume that the relationship between the predictors and the outcomes are constant across all individuals or teams. An alternative way to model these relationships is to allow the slopes to randomly vary (Snijders & Bosker, 2012). I model the slopes for the focal predictors in the study. For the model predicting individual productivity, these predictors include individual multi-teaming degree and teammate variety. However, a model that includes random slopes for

these terms did not converge, suggesting that the model does not fit the data. Therefore, I do not report results for this model because estimates are not reliable.

Team Performance. Similarly, for team performance, I modeled the slopes for team interlocks, team external range, and multi-teaming disparity. A model comparison between the Model 7 in Table 5 and an alternative model with random slopes indicates that a model that allows the slopes between the predictors and team performance to randomly vary fits the data better than a model that fixes the slope to a constant value for all teams ($\Delta\chi^2$ (9) = 76.05, p < .001).

Therefore, the strength of the relationship between team performance and the focal predictors varies among teams. Table 6 provides updated results based on an alternative model with random slopes. Consistent with the results for Model 7, results for Model 7b show that there is a significant and negative curvilinear relationship between team interlocks and team performance (B = -6.69, *p* = .024), and a negative linear relationships between team external range and performance (B = -10.38, *p* = .010). However, in contrast to the findings in Model 7, the negative curvilinear relationship between multi-teaming degree and team performance is marginal (B = -5.55, *p* = .056).

Table 6.

Results of models with random slopes predicting team performance

Model	Fixed Effects	Coefficient	SE	t-value	p-value (one tailed)
7b	Team Size	-.12	.08	1.51	.066
	Time	-.37	.03	-11.61	< .001
	Team Interlocks	23.43	.03	4.35	< .001
	Team Interlocks^2	-6.69	3.37	-1.98	.024
	Team External Range	-10.38	4.44	-2.34	.010
	Team External Range^2	-2.11	3.72	-.58	.281
	Multi-Teaming Disparity	6.88	4.46	1.54	.062
	Multi-Teaming Disparity^2	-5.55	3.50	-1.59	.056

Note: Coefficients are unstandardized regression weights.

Discussion

The concept of multi-teaming is derived from theory of multiple team membership (Mortensen et al., 2007; O'Leary et al., 2011). Theory and interest in this topic continues to grow, but there are very few empirical tests of theory and specific hypotheses surrounding multi-teaming to date. Multi-teaming behavior is manifested at the individual level, but combines to create a web of interrelations at the team level, and therefore, has implications for both teams and the individuals that comprise them. In the current study, I introduce patterns of multi-teaming, and set out to understand how these patterns impact the success of individuals and teams. These findings make several important contributions.

There is much research that explores the impact of individuals on teams (e.g., Bell, 2007). However, this study takes a much less used approach to uncover how participation in teamwork (i.e., multi-teaming) impacts the success of the individual. In particular, I find that when individuals participate in more teams (individual multi-

teaming degree) they have more publications. This is related to the efficiency of multi-teaming (Fricke & Shenhar, 2000; Milgrom & Roberts, 1992). The more teams that individuals belong to, the more opportunities they have to develop ideas that can lead to publications.

Additionally, having a high variety of teammates across one's teams is related to less productivity. Research finds that individuals prefer working with familiar others (Hinds et al., 2000). Having a high number of different teammates may indicate the need to adapt to different norms across teams, as well as engage in a socialization process for every team. Having to focus on new team contexts may pull attention away from getting research written up and out for publication. Particularly in a research context, being familiar with teammates' working style, personality, and schedule, may facilitate a focus on publishing research, rather than turn focus to adapting to new team contexts.

However, this finding is somewhat counter to previous research that suggests that having diverse contacts provides access to new ideas that can aid in individual success (Burt, 2000). The idea is that having different contacts provides access to fresh ideas and perspectives that can shape one's own ideas and perspectives (Perry-Smith & Shalley, 2011). Therefore, having a variety of teammates across multiple teams may enable the exploration, search, and development of ideas (March, 1991). However, there is a trade-off between exploration and exploitation (March, 1991), such that while an individual may explore and gain access to new ideas through a high variety of teammates, gaining publications may require individuals to be efficient and exploit knowledge. The current study explored how teammate variety impacts an individual's productivity as measured by the *number* of publications. However, it may be that as previous research suggests,

having a variety of teammates influences the *quality* of research, through the influx of diverse ideas (Guimera, Uzzi, Spiro, & Amaral, 2005; Jones, Wuchty, & Uzzi, 2008). Therefore, further research is needed that explores the role of teammate variety in affecting individual success.

At the team level, research considers the effectiveness of teams working in isolation (e.g., Kozlowksi & Ilgen, 2006), or at best, evaluates the impact of external connections on the team (Marrone, 2010; Oh et al., 2004). This study examines how participation in multiple teams (not just external ties) has consequences for teams. In particular, I found that team interlocks are beneficial to a point, but performance is hindered when a team has too many interlocks with other teams. Teams need some access to others in order to gain access to ideas and resources (Oh et al., 2004). However, it seems that teams were unable to achieve high performance when they were too embedded in the ecosystem of teams. This finding is interesting because individuals benefit from participating in other teams through an increased number of publications. However, after the number of team interlocks reach a certain threshold, the team's performance begins to suffer. This highlights an important trade-off in multi-teaming, as individuals are faced with achieving both individual and team goals.

I also found that a team's external range is negatively related to the team's performance. This finding is in contrast to previous work, which suggests that having non-overlapping external connections should provide teams access to needed resources that make them successful (Reagans et al., 2004; Reagans & Zuckerman, 2001). Having connections to others that are unique from your teammates' connections create access points for teams to gain new information. However, while external range has the potential

to provide access to ideas and resources (Burt, 2000), accessing ideas is not the same as implementing ideas (Obstfeld, 2005). Research suggests that there is a benefit in establishing a common base with team members, such that by sharing the same contacts, members can more easily exchange and implement new information (Tortoriello & Krackhardt, 2010). This study advances this line of work. In the nanoHUB context, an external tie represents a connection with individuals on another team, and thus an added responsibility. A unique external tie in this case means that an individual has another team membership that none of his/her teammates have, and a relationship that is dependent on their time and effort. Having team memberships that are off the other teammates' radar may have caused a team to struggle in achieving success.

Finally, I predicted that there would be a negative curvilinear relationship between multi-teaming disparity and team performance. I found that the effect of multi-teaming disparity was marginal in the final model in which the slopes were allowed to randomly vary across teams. However, the trend of the findings leaned toward supporting the hypothesized relationship. It appears that to some extent, having a high number of members engage in multi-teaming (i.e., multi-teaming disparity) is harmful for the team's performance. Teams are better able to develop a useful tool when most members are focused on working for a single team. Again, this finding is interesting in light of the previous finding that participating in many teams is beneficial for individual productivity. Individuals are motivated to participate in multiple teams because of the opportunities for publication, but teams do not benefit from having a high number of teammates engaged in other teams. Unfortunately for the teams, the number of members that are engaged multiple teams may be out of anyone's control. The first reason is because online

communities promote multi-teaming, and the second is because many of the nanoHUB tool developers work within a university setting, which rewards multi-teaming. The disparity of multi-teaming may be a reality of collaborative intellectual work that members may be able to live with, but not manipulate. This interpretation, while interesting, should be taken cautiously due to the fact that the effect of multi-teaming degree on team performance was indeed marginal.

Limitations

One limitation is the attrition of subjects and teams over time. Longitudinal data analysis combines the ability of time-series analysis to model dynamic relationships, and the ability of cross-sectional analysis to model between-subject differences (Frees, 2004), giving longitudinal analysis an advantage over either of these alternative methods of analysis in isolation. However, the data obtained in this study is unbalanced, meaning that there are not an equal number of observations for all individuals and teams. The unevenness of the data has to do with individuals or teams dropping out, or becoming inactive within the nanoHUB community. This attrition, or erosion of subjects over time is a common and expected occurrence in this type of longitudinal data that while unfortunate is often unavoidable.

A second limitation is the correlational nature of the data. While I was able to explore patterns of multi-teaming, I did not manipulate multi-teaming behavior, which is problematic for determining causality in the relationships examined. Establishing a clear temporal precedence requires clear start and stop points for multi-teaming behavior. Future research should attempt to manipulate this behavior, which would allow for a controlled environment to observe when multi-teaming precisely occurs. The data

obtained for this study span several years (i.e., 2006-2012), which helps to establish that these relationships occur outside of a single instance. Team performance was assessed at the end of each year, which establishes temporal separation between multi-teaming and performance. However, there may still be a concern of endogeneity (Antonakis, Bendahan, Jacquart, & Lalive, 2014) for the relationships between multi-teaming and individual productivity, as temporal separation was not established between these variables.

A third limitation is that while I obtained measures of multi-teaming through rich and unobtrusive data, I was unable to inquire about perceptions of multi-teaming on nanoHUB. Without measuring perceptions of multi-teaming, I could not determine the psychological mechanisms through which multi-teaming impacts individual productivity and team performance. Thus, these findings are left open to interpretation.

Next Steps

This study offers the advantage of examining how individual and team level patterns of multi-teaming may impact individual and team effectiveness, respectively. However, this study leaves open some questions about the experience of working in a multi-teaming environment. For example, how are individuals challenged to work in a multi-teaming environment? Additionally, beyond just understanding the impact on performance, how does multi-teaming impact individual learning, and team functioning? As a next step in this research, I conduct a qualitative study to address these kinds of questions and glean deeper insight into the experience of multi-teaming.

CHAPTER 5

STUDY 2 – THE EXPERIENCE OF MULTI-TEAMING

Multi-teaming is a largely understudied construct, and as such, a qualitative look at personal experiences of multi-teaming may offer insights that can aid in the construction of a more elaborate theory of multi-teaming. Particularly, beyond performance, there has been little research aimed at understanding how individuals manage and structure multi-teaming, and how multi-teaming may impact individual learning, the development of team cohesion and solidarity, and the leadership of multiple teams.

In Study 2, I take a grounded theory approach (Glaser & Strauss, 1967) to understand personal multi-teaming experiences. I interview individuals engaged in multi-teaming, or individuals working with other multi-teamers to more deeply explore how people perceive and manage multi-teaming. Using a qualitative approach in addition to quantitative approach allows me to expand "the breadth and range of enquiry" by using different methods to explore a phenomenon (Greene, Caracelli, & Graham, 1989, p. 259).

The goal of this study is to take a deeper look at the world of a multi-teamer as well as those that vicariously experience multi-teaming through their teammates. Importantly, I make no attempts to predict outcomes, and instead allow themes to emerge from the data that help to elucidate the experience of a multi-teaming.

Method

Participants

The target sample for this study consisted of research lab directors and their graduate students. This sample was selected because working within a university research

lab typically involves working on multiple projects at the same time, thus providing a multi-teaming context. Additionally, a research lab sample is similar to the sample derived from nanoHUB in that participants of in nanoHUB very often belong to research labs. Therefore, the samples from Study 1 and Study 2 are comparable.

The final sample consisted of 18 researchers including 15 graduate students pursuing a PhD and three lab directors. The sample represents a total of five different research labs. Interviewees came from several disciplines: three in Mechanical Engineering, two in Industrial Design, five in Engineering Psychology, and seven in Industrial Organizational Psychology. One participant was in both Mechanical Engineering and Industrial Design. Table 7 provides a list of the interviewees and accompanying descriptive information.

Table 7.

Interviewee Descriptive Information

Pseudo Name	Lab Number	Role	Gender	Career Stage	Interview Date	Interview Length	Multi-Teaming?	Teammates Multi-Teaming?	Disciplinary Diversity of Teams
Fiona	1	Director	F	Early	4/27/16	46	yes	yes	Moderate
Mary	1	Student	F	Mid	4/27/16	25	yes	yes	Moderate
Harrison	1	Student	M	Mid	5/11/16	34	yes	yes	High
Sam	2	Director	M	Late	4/25/16	18	yes	yes	Low
Frank	2	Student	M	Early	4/26/16	20	yes	yes	Low
Mel	3	Student	M	Mid	4/22/16	20	no	yes	Moderate
Warren	4	Director	M	Late	5/26/16	51	yes	yes	High
George	4	Student	M	Late	4/26/16	20	yes	yes	High
Matt	4	Student	M	Late	4/28/16	26	yes	yes	High
Sal	4	Student	M	Late	5/5/16	24	yes	yes	High
Tina	4	Student	F	Early	4/28/16	21	yes	yes	High
Lori	5	Student	F	Early	4/26/16	14	yes	yes	Moderate
Naomi	5	Student	F	Early	4/25/16	16	yes	yes	Moderate
Parker	5	Student	M	Mid	4/21/16	14	yes	yes	Moderate
Jack	5	Student	M	Mid	5/4/16	14	yes	yes	Moderate
Daria	5	Student	F	Late	4/28/16	25	no	yes	Moderate
Calie	5	Student	F	Late	4/27/16	22	yes	yes	Moderate
Mark	5	Student	M	Late	4/21/16	27	yes	yes	Moderate

Procedure

To solicit interviews, I conducted a manual search for research labs within the university. I narrowed my search by the schools that had a listing of labs available and labs that had web pages available with contact information. I located a web page for 16 different research labs and sent an initial communication soliciting an interview to 129 people.

I constructed an interview protocol based on published research and my own experiences with teamwork and multi-teaming. Through the protocol, I sought to uncover the impact of multi-teaming from the perspective of the "multi-teamer" and teammates of multi-teamers. The interviews were conducted in person, via phone, or via Skype. The full interview protocol is included as Appendix A.

The interview protocol for the interviews lies between a qualitative interview protocol, which contain a small set of topics and open ended questions that may guide conversation (i.e., a mental framework for the interview), and a structured interview protocol, which completely scripts the interviewer-interviewee interactions and contains closed ended questions (Yin, 2010). The protocol in Appendix A begins with an opening and provides a short list of topics, each with a set of open-ended questions. It maintains a loose structure in regards to scripting the conversation. There were several parts to the protocol: participant's description of their team, and roles and responsibilities, team interactions and interdependence, multi-teaming behavior and teammates' multi-teaming behavior, information sharing, cohesion with others, and learning. I used probing questions to draw out responses from the participants, and at times let the direction of the interview be guided by the participant's discourse.

I personally conducted all of the interviews with the aid of a recording device. Recordings were transcribed through an external transcription service. I did a manual check of the transcriptions against the audio to ensure quality. The 18 interviews in this study ranged in length from 14 to 51 minutes, with the average length being 24 minutes. Any identifying information was removed or modified when reporting results to preserve participants' confidentiality.

Analytic Approach

For this study, I have refrained from posing specific hypotheses regarding the effects of multi-teaming. Instead, Study 2 involves a qualitative approach in which I build theory from the data. Using grounded theory methodology (Glaser & Strauss, 1967), I reveal themes in the data that uncover a better understanding of the impact of multi-teaming on outcomes such as learning, information sharing, and cohesion, through the analysis of the interviews.

Analysis of this data first involved understanding the data. I obtained transcripts of the interviews and conducted initial coding of the data. In grounded theory, initial coding involves identifying important words or groups of words that describe a particular text (Birks & Mills, 2011). Codes often take the form of verbs such as, "defining roles & responsibilities", "transferring knowledge", and "accommodating others." Intermediate coding is the next stage, which involves deriving categories and sub-categories from the codes. During intermediate coding, I engaged in constant comparative analysis between incidents, codes, and categories in the data (Charmaz, 1990). As a final step, advanced coding involves the theoretical integration of categories and the development of themes that describe some theory derived from the data (Birks & Mills, 2011). Throughout the

entire coding process, I kept memos of the procedure, trends, and insights gleaned from the data (Charmaz, 1990; 1996). These memos served as a starting point to develop the themes in the data. Table 8 provides a list and description of the categories, subcategories. It is important to note that I used these categories to help sort and understand the data. However, when elucidating the themes uncovered from the data, I do not hold each category as mutually exclusive, and instead detail the themes with an eye towards how the categories overlap and influence one another.

Table 8.

Categories and subcategories derived from interview coding procedure

Category	Subcategories
Structuring Work	• Defining Roles & Responsibilities: *Defining who does what on the team* • Getting Together: *How the team meets and through what mediums* • Interdependence: *Who is reliant on whom* • Getting Organized: *Tools used to organize workload and schedule* • Prioritizing: *Ways of generating priorities*
Building Solidarity	• Shared Understanding: *Feeling a sense of empathy for other members' multi-teaming* • Accommodating Others: *Accommodating work for others' schedules and needs,* • Assessing Commitment: *Determining the level of commitment from others* • Developing Relationships: *Developing interpersonal relationships* • Sharing Goals: *Assessing compatibility between members' goals and interests*
Learning	• Taking Time to Reflect: *Taking time to look back after completing a task* • Finding Time to Explore: *Exploring new ideas, assessing options, and experimenting* • Learning Skills: Gaining or honing skills
Defining the Challenges of Multi-Teaming	• Differing Priorities: *Dealing with different priorities between members* • Scheduling with Others: *Finding time to meet with others* • Finding Time to Work: *Finding adequate time to complete tasks from different teams* • Keeping Track of Projects & Teams: *Keeping track of who needs what* • Lacking Shared Awareness: *Missing an awareness of everyone's commitments* • Blurred Lines: *Dealing with overlap across projects* • Changing Norms: *Dealing with different dynamics and work styles across teams*
Defining the Benefits of Multi-Teaming	• Staying Engaged: *Becoming more focused and motivated to work* • Gaining Ideas & Transferring Knowledge: *Gaining ideas on different teams and transferring knowledge and/or resources from one team to another* • Efficiency: *Producing more output, more quickly* • Networking: *Making connections with others*

To establish the validity of the codes I derived from the data, I used a panel of four subject matter experts. This panel sorted a subset of quotes (n = 85) from the interviews into the categories I created. Inter-rater reliability was assessed using Fleiss'

Kappa. Fleiss' Kappa examines the agreement among a set of raters that assign categorical ratings to a target (Fleiss, 1971). Fleiss' Kappa also represents a conservative measure of interrater agreement in that it accounts for agreement that may be due to chance (Gwet, 2010; Sim & Wright, 2005). I calculated Fleiss' Kappa for each of the higher order categories that I created in the data in order to assess their validity. Values above .61 are considered to indicate substantial agreement, while values between .41 and .61 are considered to indicate moderate agreement (Landis & Koch, 1977). Analyses revealed substantial interrater agreement for the categories of "structuring work" (κ = .68), "building solidarity" (κ = .66), "learning" (κ = .78), "defining challenges of multi-teaming" (κ = .82), and "defining benefits of multi-teaming" (κ = .84).

Results

During the interviews, the participants all discussed their collaborative research, which involved one or more projects with others within and outside of their lab. This analysis indicates that discourses on multi-teaming are replete with paradox, ironies, and trade-offs. Participants described the world of multi-teaming as one that requires structure yet flexibility, involves challenges that are really benefits, pulls individuals between efficiency and learning, and involves conditions that minimize some challenges while exacerbating others. Participants laid out a picture of their own and their teammates' multi-teaming behavior that is captured through the processes of: (a) defining the challenges of multi-teaming, (b) learning through multi-teaming, (c) becoming a team in the midst of multi-teaming, and (d) leading multiple teams. I explore the first three themes through the lens of paradox theory (Lewis, 2000; Lewis & Smith, 2014; Smith & Lewis, 2011) and address the tensions and trade-offs inherent in multi-teaming that arose

through the participants' discourses. Additionally, in the final theme, I elaborate on the strategies and key points for enabling the success of multiple teams at once. I next go through each of these processes, using the participants' discourse to help elaborate on each theme.

Theme 1 – Defining the challenges of multi-teaming

While engaged in multi-teaming, participants struggled between setting a structure to their unwieldy schedules and remaining open to inevitable changes to that structure caused by their teammates', as well as unexpected environmental contingencies. They also identified several big challenges of engaging in multi-teaming, which ironically, could also translate into benefits.

Setting the structure while remaining flexible. When asked how they manage the workload of multiple teams at once, participants expressed the need for getting organized and prioritizing their work. Getting organized helped participants to visualize their workload and their time. George, a graduate student, talked about keeping spreadsheets to organize his work: "I have spreadsheets at the beginning of a semester or a year, I'll say okay, here [are] the projects I'm gonna work on, and here's what needs to get done." Mark prefers to keep a "running list organized in [his] mind." Mary, another graduate student, prefers to "compartmentalize", and stated that things become "mixed up and muddied" if she does not keep her workloads separate. Warren, a professor, discussed keeping a to-do list and calendar that is shared across all of his platforms (i.e., computer, phone, etc.) and with others. His preference is to plan ahead two weeks.

Prioritizing different tasks and teams helps the participants to move through their work in a sequential order. There are several different ways that participants set their

priorities. Some set priorities based on the needs of others. Frank stated, “it's very important to me that my priorities be aligned with my supervisor’s job.” Sal prioritizes keeping others busy. He stated, “I think that becomes a priority because we don’t want people just sitting around not doing anything.” George mentioned that if he’s in the “direct path of someone completing a project, then that’s the highest priority at the time.” Calie discussed focusing on “the fire that’s burning the brightest.”

Others prioritize work by the most pressing deadline. Harrison, a graduate student stated that his approach is: “whatever is due first, is done first.” Lori, another graduate student, stated, “If something is due tomorrow, I’m going to prioritize that over something that’s due next week or two weeks from now.” Warren discussed the process of setting priorities for conference submissions. For him it is important that some submissions receive more attention then others because they deal with subject matter specific to a particular conference, while other submissions could apply more generally to other outlets. He stated, “Okay, these first three [submissions] have to get in here, so we focus on them first. These other ones, if we can get them in here, great. If not, then there’s another conference in three months.”

Finally, others discussed prioritizing projects that are their main responsibility (i.e. they held a leadership role). Naomi stated, “If it came down to there’s a lot to do on both of [the projects] and they were due the same date, I would probably work on [my main project] first, just because I’m more responsible for that right now.” Parker’s main priority is his “own project” to which devotes around “70% of [his] time.”

For participants, setting a structure is a way to take control of their work and their time. However, multi-teaming and working with others that engage in multi-teaming left

some of the structure out of their hands. While Warren liked to plan his time two weeks ahead, he discussed having to deal with "lumps", which he defines as peaks in his work schedule. He stated, "you plan your time for the average, but then you have these peaks when the conference deadline comes. Like tomorrow we have a conference deadline and we have seven papers going in." For others the challenge is about dealing with the needs and priorities of others. While his focus is his main project, Parker finds that he must prioritize his teammates' requests for help, noting that he'd only ask for help "if it was really important", and assumes his teammates do the same. Calie expressed that "what fire is burning the brightest is influenced by you, but it's also influenced by who's talking to you the loudest…and so one of the challenges for us being on multiple teams is that you want to please everybody and you can't, or you can't all at one time." Jack found it difficult to determine what is and is not a priority. He expressed that "you always have multiple things that you could be doing if you're on multiple teams." For Sal, the notion of prioritizing, while good in theory, was sometimes difficult in practice. When asked what happens to his other work when he prioritizes one team, he stated, "In most cases, I think those are just the weeks, or the days that I become more stressed, because it can't not get done…if it can be put off for the next day or until this thing gets done, then I do…if [I] can't, then [I] just have to do two things in a day."

Setting priorities is not the only challenge to setting a structure. There was also mention of teammates being "hard to get in touch with", "being booked solid", or having "crazy busy schedules" that prevents some teams from moving forward. Participants were also challenged in finding enough time to get things accomplished when engaged multi-teaming. Tina mentioned feeling as though she "never [has] enough time to get stuff

done", and mentioned "spending more time in meetings" with her various teams than "getting actual work done." In discussing her workload across projects, Naomi stated, "there's only 24 hours in a day, and these projects require so much time." Lori mentioned feeling challenged by the compiling workload associated with multi-teaming: "Well, if I have ten things due tomorrow, then I'm doing them all a couple days beforehand. That's definitely a challenge." Sal found himself wishing for more time to focus on the quality of his work. He stated, "I think the [conference] paper is fine; it gets accepted, but it could have been even better if I had an extra week to focus on writing." Participants found few solutions for gaining more time in their schedules. Mel proposed that managing time is simply easier with less commitments, Frank "compensated by working harder and longer hours", and Matt not so jokingly mentioned that he "gave up on sleep in 1993…getting up before 4:00am to 5:00am for the last 20 something years."

A final challenge to setting a structure to multi-teaming was physical proximity to teammates. Working in a research lab means that for most participants, their teammates are located in the same room. Being face to face with one's teammates was preferable for some. For example, Sam mentioned that his team "is a very close knit group because they sit together." However, physical proximity also creates the additional challenge of being more available for informal meet-ups and requests, which upsets the structure of the day. In discussing making a daily schedule, Matt stated, "no plan survives contact with the enemy, ever. Your day can't survive contact with other people because you're going to have to make an adjustment."

The result of this reality meant that some participants had to isolate themselves in an attempt complete some work. For Matt, keeping his schedule means setting rules: "do

not touch the phone, do not touch the email, don't do anything other than what's on my schedule." Sal mentioned needing to "push everything out," and telling his teammates, "you're not gonna hear from me for a week." Teammates had no issue making accommodations for another in these times of need. Sal said his teammates "sort of fill in" when he needs to shift his focus to help another student team. George tells his teammates, "Don't touch our project, get your stuff done over here, and then when you come back, you'll have more time." Matt compared his team to an "amoeba", stating, "as we know someone's getting to a deadline, everybody sort of shifts toward that person, [or] we'll even push you away…you need to do this…you go home." Warren accommodated his team and his "lumpy" schedule by repurposing some work that his team could accomplish in time. He mentioned telling his team, "Let's try to get this done for this deadline of April 1st and if we just can't pull off, then we'll recycle it for May or August."

A multi-teaming environment is characterized by a shifting structure. This is evident in throughout the participants' discourses of setting a structure and accommodating their teammates. It was also stated explicitly. For example, Mark stated, "as you move on, there's a lot of different priorities that come up and take a lot of your time, and those priorities shift quite a bit and you find yourself working on things that you might not have though you would have been." Matt was challenged in "trying to determine how much time and effort [he] should allocate at any one time because it's continually changing." He went on to state, "I expect something to change everyday."

These discourses reveal that in a multi-teaming environment, individuals must constantly operate in the tension between two opposing processes. The first is setting a

structure to their work across various teams to maintain order, and the second is to remain flexible in order to adapt to unexpected contingencies. Multi-teaming requires us to abandon the idea that the world is simple and linear, and instead accept that tensions such as that between being structured and being flexible are common realities (Dent, 1999). I consider the dilemma of structure and flexibility through the lens of paradox theory (Lewis, 2000; Lewis & Smith, 2014; Smith & Lewis, 2011).

A paradox is defined as "contradictory yet interrelated elements—elements that seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000, p. 760). Instead of asking when structure or when flexibility may be appropriate, a paradox approach considers how one may navigate these opposing forces simultaneously (Lewis & Smith, 2014). The paradox of structure and flexibility is identified as a system contradiction, which Lewis and Smith (2014) describe as those "tensions that arise as a function of the complexity of system" (p. 9). While operating in the space between structure and chaos introduces complexity to the issue of multi-teaming (Pascale, 1999), it is the world that the participants live in and the picture that they painted through their discourses.

For the participants, it is not a matter of fit - of choosing the right approach (i.e., *either* structure or flexibility) through an "if-then" process; it is using both approaches simultaneously. For example, George stated, "you want to make sure at the beginning of the semester [that] you really set out a very clear timeline and you understand what's going on with [the team], but also be flexible." Both structure and flexibility are necessary for successful multi-teaming and successfully working with multi-teamers. Therefore, the issue is not one of fit, but one of coexistence (Lewis & Smith, 2014).

Participants' discourses on structure and flexibility revealed an underlying need for ambidexterity (Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008; Tushman & O'Reilly, 1996) – an ability to engage in both behaviors concurrently. In practice, individuals must consider structure and flexibility to be interdependent behaviors (Floyd & Lane, 2000), and use one to inform the other. For example, the team sets and maintains a structure that grounds the team in its mission, but that is informed by and open to changes in others' schedules, needs, and commitments. Therefore the team's structure remains open to change, but does not disappear, instead shifting into a new structure through which the team can operate. George discussed this strategy when talking about how he accommodates his teammates: "...we're gonna set goals, but if you can't meet those, let us know ahead of time so we can try and figure out a new plan of attack."

Seeing the challenges as benefits and benefits as challenges. While participants identified many challenges of engaging in multi-teaming and working with multi-teamers these challenges also translated into benefits. Some participants stated the connection between what they believed to be a challenge and a benefit, while some connections between challenges and benefits are made across different discourses. Matt mentioned that a challenge of multi-teaming was "trying to determine how much time and effort" to allocate to his activities. However, when asked how multi-teaming was beneficial he said, "it forces me to do what I have difficulty doing, and what anyone has [difficulty doing], which is allocate the right amount of time and determine what is most important now." Mark posited that a challenge of multi-teaming was dealing with different norms across teams. He stated, "being able to go to another team where maybe they do things on a different timeline, or they do work to various degrees based on their priorities…those

kinds of things, and being sensitive to that immediately when you jump in…can be challenging." When discussing a benefit of multi-teaming Mark stated, "…it helps me as a person to perceive how other people carry out work and do things as a team, [in order to] be able to gain those skills for myself." From Mark and Matt's perspective, a difficulty associated with multi-teaming is helping them to hone a skill.

Multi-teaming challenges also posed a chance to transfer knowledge from one team to the next. Warren discussed the frustration of working with teams that have different technology norms:

> "When you're working on these other teams…they may not use Dropbox or they might have a culture of email, so you're sending these multimegabyte Word documents by email and just keeping track of who edited which document…and so someone will send you a Word document that just says "Results", or it will say "Conference paper"…I try to say, "Certain conference paper draft V2 – [initials]", to assert some kind of structure when I send it back to them, and they'll send me back "Conference paper 2."

However, Warren also expressed gaining new ways to use technology from working with other teams:

> "I often learn from people I'm working with; how they manage their teams…so even with Dana, she arrived and was using Basecamp and we started working on a project together and she said, "Oh, let's use Basecamp" and I had never used that. So I learned about that whole technique by working with someone who used it for another project and now I've rolled that into many of the ways we work."

The multi-teaming challenge of having time to work forced participants to be more efficient. Sal wished he had more time to "focus on writing" and cited "time management" as a challenge of multi-teaming. However, he also noted, "…the project will expand to take up as much time as you allow for it, and so if we constrain the time on a project, then we just do it more efficiently…" Looking across different discourses, Warren also discussed the efficiency of working on several teams at once. He stated, "…related to efficiency…you learn quickly that some percentage of projects are not going to succeed…for a lot of different reasons, and if you're an academic, especially early in your career, you have to hedge your bets."

On the other hand, one benefit actually translated into a challenge. In a lab environment, an individual's teammates may often repeat across several teams (i.e., low teammate variety) because the content matter is similar across different projects in the same research lab. This can facilitate connections between different projects. For example, Naomi mentioned, "I've noticed that as I've been in [Project A] meetings, they always say, 'oh, this relates to [Project B] in this way,' and vice versa." However, Naomi mentioned that the overlap across teams also caused some confusion:

> "It's so many familiar faces, and you go from meeting to meeting…and you're like, 'I think you're also on this [project]', so then you can reference it, but then sometimes they're like, 'no, I don't know what you're talking about.' So it definitely gets really messy…because I know a lot of people are on [Project A] and [Project B], but they're not always on [Project C]…"

While participants were challenged by their multi-teaming in several different ways (i.e., setting priorities, managing different norms, finding time to work), these

behaviors give way to benefits and opportunities, and in one case, a benefit of multi-teaming (i.e., facilitating knowledge transfer through low teammate variety) give rise to a challenge (i.e., blurring the lines between teams). Managing the relationship between challenges and benefits requires reframing how one thinks about challenges. A multi-teaming challenge undoubtedly poses a barrier that must be overcome. However reframing the challenge in terms of opportunities instead of barriers may facilitate individuals in seeing the gains gleaned from their struggles (c.f. Dweck, 2006). This idea is evident in the discourses. For example, in discussing his challenges Mark stated, "I am a firm believer that you can adjust to these things, and you can learn to even see things from a different perspective…that's why I call them a challenge, because I don't see it as drawback…" When discussing the challenge to manage his time, Sal stated, "I feel like in some ways, it's a way to learn, it's one of those skills we learn more than anything else in grad school." For these participants who connected challenges to benefits, the opportunities were clear. For those that do not see the connections, their challenges may pose undue stress when engaging in multi-teaming.

Theme 2 – Learning through multi-teaming

In their discourses, participants referenced having learned many different technical and teamwork skills. Participants mentioned: "making project schedules", "time management", "people management", "writing", "mentoring", " build[ing] allies", "build[ing] relationships", "communicating", and "listen[ing]." Beyond stating the skills that they learned from their participation in multiple teams, participants also revealed the ways in which multi-teaming impacted participants' ability to learn. Interestingly, the

discourses on learning highlight a paradoxical relationship between learning and performance, and exploration and exploitation.

Learning by staying engaged. In discussing the ways that multi-teaming is helpful, Warren stated, "So the fact that I'm working on more than one project, I think it's more interesting. It keeps me more engaged." When work generates interest, the interest may further promote learning (Shiefele, 1991). Interestingly, the catalyst for becoming "engaged" here is the participation in multiple teams, which Warren also cites as a mechanism for efficiency:

> "The most obvious benefit…for an academic is the volume of product…so you have multiple teams intersecting, you're much more able to leverage everybody's time in more efficient ways…so if you can be working on collecting data and at the same time writing up the previous data or data from another project, you can be doing multiple things, and so all of a sudden, you've doubled your efficiency."

What Warren's discourse illuminates is his ability to operate in the tension of two of the most commonly cited opposing forces: learning and performance. Learning involves growth and building needed skills, while performance involves applying existing skills (Elliot & Dweck, 1988). Thus the two processes are often viewed as incompatible or distinct (Elliott & Dweck, 1988; Mueller & Dweck, 1998), but through the paradox lens we see that learning and performance can coexist.

Warren's discourse was not the only one to illuminate a connection between learning and performance through engagement. Sal discussed how multi-teaming helps him fight inertia: "I also like to think that inertia is sort of a thing that acts on me a lot. If I take a break, it's hard to get going again, but if I'm always working on things, I can

move from one thing to the next." Sal finds that his work on multiple teams keeps him "moving all the time", which helps him to do his work "more efficiently, in most cases", but he also discusses how his multi-teaming is tied to his interests: "all this stuff I work on, is always related in some way…and it all answers – it all kind of goes back to my actual research interests and the things that I'm passionate about…" For Sal, engaging in multi-teaming was not only a way to be efficient in his work, but also a way to develop his research.

George's also offers a connection between learning and performance: "It also keeps me engaged. Being on one team, I just get bored. So having a lot going on is actually really helpful for me to be productive." Belonging to multiple teams offer George a "break" from the mundane that gives him the opportunity to contribute to multiple projects, and infuses energy into his work (Jett & George, 2003). While George cites productivity as a consequence of his engagement, he was the only one to mention participating in informal research teams "just because it's interesting." Therefore, George's relief of boredom through multi-teaming has also led him to explore new research avenues.

Learning through idea generation and the transfer of knowledge. Participants signaled their learning through discourses on gaining new ideas and transferring those ideas from one team to another, which reinforces what they have learned (Kolb, 1984). Mary expressed the following:

> "I think the biggest thing is, I find all the time I bring the things I'm learning from one team into another. I think in general it's made my work a lot richer and a lot

more complex…even if it's a time I don't know that I'm necessarily benefitting from both relationships, over time I see [it] kind of manifest in different areas…"

Transferring ideas from one team to other teams facilitates learning as individuals take their experiences from one team and apply them to another (Kolb & Kolb, 2012). Participants' discourses give traction to this idea. When asked to discuss the benefits of multi-teaming Calie mentioned, "translating ideas across different teams…getting ideas that will help within your team, from other teams." Participating in a team offers Calie a concrete experience, and multi-teaming offers the opportunity for the active experimentation of knowledge across multiple team contexts. Jack also discussed a similar experience in which he translated the discussions and ideas from one team to another: "the smaller projects that I'm working on have gotten good ideas through conversations with bigger groups of people." George is able to gain ideas from his teammates' experiences on other teams: "People bring new ideas to the team every time they're working on different projects."

For some, gaining new perspectives and ideas required participants to leverage the diversity across their different teams. For example, Frank stated, "a lot of times I don't have the expertise that I need to help me answer the problem in the most efficient way, and so I consult with [my teammates]. I get their help…I try to bring good ideas and they bring their expertise, and we come up with the best solution." Tina also expressed the benefits of diversity for her learning:

> "I get to see people from [different] backgrounds…it's very different to work with people who [do] work in [psychology] because they know so much more about the literature…being able to talk to them and get their perspective on it and how

they think about things, it's really useful for me [in order] to make sure I don't get stuck in a hole of an idea."

These discourses denote the exploration of knowledge through "search", "experimentation", and "discovery" (March, 1991, p. 71). Their exploration of new ideas and knowledge is in contrast to their exploitation of knowledge through "implementation", "efficiency", and "execution" (March, 1991, p. 71). However, while participants noted generating ideas and transferring knowledge between teams, some also struggle between their needs for exploration and exploitation. The amount of time participants spent working across their various teams often left them with little time to explore. For example, when asked if he had time to ask questions and explore different options in his work, Jack stated, "sometimes we don't only because the time that we have when we're working in multiple groups is so limited that we feel like we have to use it to progress every single time, and we can't talk about what we're talking about or we're wasting time." Sal also struggled with finding time to explore ideas. He stated, "I'd say if there's any downside to working on so many projects, [it's] sort of the fact that I approach it just by sort of juggling what's most important at the time…it's mostly just hit and run and move onto the next one." Jack and Sal are caught in the tension between exploration and exploitation, and through multi-teaming, have difficulty finding the time explore useful ideas, although both expressed the importance of exploration for their work.

Some of the participants discussed using "roadblocks" as a time to pause and explore knowledge. Mel stated, "…usually the roadblocks were good in the sense that they provided buffer time for reflection." Mark discussed how challenges are a good way

to learn new skills: "…we see everything as being a challenge, and so sometimes we just talk about that, 'man, this is rough right now, but hey look, we're learning this really good skill." Naomi uses the "ebb and flow" in her workload between teams to explore: "I think it's kind of out of your control. I can't just be like, 'I get to sit back and think about this week', but if it happens, it does, and I think there's ample opportunity for it." Mel, Mark, and Naomi, took a contingency approach to dealing with the tension between exploration and exploitation (Lewis & Smith, 2014). They opted for an "if-then" plan: if there was a pause in their work cycle, then they could explore and reflect.

A final group of participants uses an ambidextrous approach (Raisch & Birkinshaw, 2008) and allowed for exploration and exploitation to work simultaneously. Tina discussed using a deliverable for a project she supervises as an opportunity to explore and discuss ideas: "one of the deliverables they have to do is sort of a tech report…a way for them to talk about the background, why it's motivating…it's a chance for them to reflect what still needs to get done, or what they think the next steps are…" Matt does not perceive a conflict between exploration and exploitation. To him, stopping his regular schedule to engage in discussion with his team is a means of "getting work done". He stated, "What I like is when people stop [complaining] about not getting work done that day, and then we realize a lot of that screwing off was getting work done." Calie learned how to efficiently convey her ideas. She discussed how through multi-teaming, she developed the ability to communicate "ideas better" in the "limited time" she had with her teammates: "…we would meet with Calvin and he's got very limited time, and so in the 30 minutes that we did have him on the phone, we wanted to be very

clear…" Calie has learned a competency that she can exploit in order to make room for the exploration of new ideas.

Theme 3 – Becoming a team in the midst of multi-teaming

Participants discussed how their teammates' multi-teaming behavior and commitment plays into creating as sense of unity in the various teams in which they participate. Teammates multi-teaming behavior leads to the development of a shared understanding among members, but is also ironically the cause of multi-teaming challenges. A second factor, familiarity, also contributes to building solidarity in the teams, but involves a trade-off between having close-knit or broad social networks. Finally, participants shared that a third factor in building team solidarity involves getting commitment from others.

Solidarity through shared understanding. Research labs typically have multiple projects running at the same time, which creates an expectation that members will need to manage the shifting workloads of multiple teams at once. In a research lab, multi-teaming simply "comes with the territory." The result is that participants develop a shared understanding. Matt mentioned that knowing when his teammates are working on other teams "has to be important." One reason why it may be so important is that a shared understanding establishes the basis for planning ahead. For example, Mark stated, "I don't think you have to work under the assumption that you're the only one that has a lot to do…I think just having that knowledge that everyone's working in that kind of an environment helps you to organize the way that you do work with them as well." Warren discussed that knowing that his teammates are on other teams means that "there's much more negotiation, explicit negotiation of actions, and deliverables, and timelines…"

A second reason why shared understanding may be so important is because the shared understanding among teammates reduces the tensions associated with missed deadlines, "crazy busy" schedules, and differing priorities. For example, in discussing how well his teammates accommodate one another, Sal stated, "we're all in the same scenario and so we all understand each other…we tend to work really well together either out of necessity or just out of good luck of being on the same team." Jack talked about the challenge of differing priorities between him and his teammates, but then stated, "it's not too big of an issue because I think it's the norm…to be working with multiple teams…everybody that I'm with is always doing multiple things." George also mentioned that when teammates cannot meet deadlines "there's no reason to get annoyed" if "your deadline is farther off." Conversely, not establishing a shared understanding can lead to tensions between teammates. For example, Mary has team memberships within and outside the university. She discussed the difficulty of having to "justify" her commitments to others: "I think it's been difficult to form good relationships with people who don't understand or who don't necessarily know the level of commitment that I have outside of school…they have this weird level of resentment, or they will think I'm weird for being so over committed."

There is a reinforcing cycle (Lewis, 2000) of sorts that arises through these discourses. The very thing that reduces the tensions associated with multi-teaming is also a cause of those tensions. Having teammates engaged in multi-teaming breads the shared understanding that helps to minimize the challenges associated with multi-teaming, but the busy meeting schedules, differing priorities, and inability to meet everyone's demands in a timely manner, is a result of teammates participating in other teams. When

asked how his teammates' multi-teaming behavior impacted his ability to form relationships Harrison commented: "I've never seen it being beneficial for someone to be on another team, because they can't show up to meetings sometimes…they can't work on a project because of something else." For Harrison, his teammates' multi-teaming behavior is a complication that he would rather not deal with, however, he also went on to say, "but it's unavoidable right? It really is pretty unavoidable." Fortunately, individuals can manage this paradox by accepting its existence (Lewis, 2000), and from the discourses above, it appears that participants have indeed learned to live with it. They cannot break away from the norm of multi-teaming, but they can use it to their advantage. Participants have acknowledged the difficulties associated with their teammates' multi-teaming, but have also fostered an attitude of empathy and commiseration that allows them build solidarity within their teams.

Solidarity through familiarity. Another consequence of working within a university research lab with multiple projects is that individuals are often working with the same teammates. It also means, as previously mentioned, that teammates are often face-to-face and have the opportunity for information relationships. Having a history with your teammates, having informal relationships, or having them on multiple teams can foster solidarity. Mark discussed how a shared history contributes to the development of relationships:

> "I think the benefit of working with this team for so long, and so regularly, and so frequently is that we know that if something comes up that we have to deal with, we trust each other [knows] that this is an important issue and we're gonna come back and make things right or do our part when we can."

Mark goes on to talk about an incident when he had to excuse himself from a high priority task in one team to work on another high priority task for another team, and concluded: "I think if we didn't have [a trusting] relationship, it probably would have ended up in a pretty rough interaction."

Individuals also choose to work with the same teammates again and again if previous experience has been enjoyable. As a senior student, Sal gets to assemble his own teams at times and discussed his preference for certain people: "I sort of intentionally bring other people on board who I know I can work well with and who I know will be dedicated. I'm a big fan of 'surround yourself with like minded people or people you know will work hard.'" Sal's preference for familiar teammates substantiates what others have observed. For example, Hinds, and colleagues (2000) found that when identifying teammates, individuals looked for similar others that have a reputation for being competent, hard working, and with whom they have a positive working relationship. These findings are consistent with uncertainty reduction theory, which holds that individuals seek information from others that helps to establish some predictability in interactions (Berger & Calabrese, 1975). Further, this theory holds that uncertainty and liking have an inverse relationship: liking increases as uncertainty is reduced.

Teaming up with the same members consistently may help to develop strong relationships, but may also have its downside because having the same teammates limits one's network. When asked how working on multiple teams may help or hinder the development of relationships George commented:

> "I think just being on one project, it would be fine, and you'd probably be really close to one or two people, but being involved in lots of projects is really nice too.

You have more connections. You have better experience with individuals from different backgrounds, which I really enjoy."

Therefore, while not a paradox of multi-teaming, there is a trade-off in choosing familiar teammates. Individuals can build a "close-knit" team, but may not have very broad networks, which was a commonly cited benefit of multi-teaming among the participants, and an established factor for successful teams (Reagans & Zuckerman, 2001). However, participants did not discuss having a problem with expanding their network through collaborations with others outside of the lab. The lab directors, Sam, Warren, Fiona, and those I was not able to interview, all have collaborations with other faculty or organizations, and as a result, all of the students have opportunities for external collaborations that build their social networks.

Solidarity through commitment. When asked about their satisfaction with teammates' commitment levels, participants had varying responses. Sam, Naomi, Matt, Lori, Parker, Jack, and Mark all felt satisfied with their teammates' levels of commitment to their collaborative projects. Others felt that commitment levels varied, and had different reactions to this reality. Some felt disappointed or frustrated at the varying commitment levels on the team. Sal was satisfied with the commitment of other PhD students on his teams stating, "we live and die by the level of success on the projects." However, he expressed that the more transient members on his teams "in some ways kind of are" committed, and that "its hard sometimes." Tina shared frustration over her non-committed teammates: "there are a couple of students who I've had problems with that don't do things, or they will put things off until the absolute last minute…so that can be really frustrating…"

Some were accepting of the fact that commitment levels vary. Frank felt that it was irrational to expect high commitment from all members consistently: "a lot of people would say, 'I wouldn't be happy unless my team is committed to stay for a long time and in it for the long haul'…for me that would indicate that their ability for rational analysis [is limited]." Calie discussed that there are differing levels of commitment across her teams, but is satisfied because as she put it, "I don't feel like somebody isn't commitment enough compared to what [how much] I think that they should be committed." Conversely, Warren expressed that the "heterogeneity" of commitment levels meant that he could never be satisfied: "you're never satisfied because there's so many people and there's so much heterogeneity that…there's always someone who doesn't map exactly onto where I would prefer."

For some, obtaining commitment was an issue of motivation. Daria discussed the lack of motivation she observed in her teammates: "I just felt like they were forced to be there and they never really cared about getting the research, getting the knowledge, getting the answers." Participants discussed appealing to their teammates interests to boost motivation. Mary stated, "I think the biggest thing is finding what motivates people...trying to find that person's strength and then really playing to that and giving them responsibilities based off their strengths…" Similarly, Harrison commented, "…commitment levels have always been pretty good because I think that I have a lot of experience in trying to figure out what…they're trying to get out of the project, and kind of catering to that."

A second strategy for getting commitment from others is to share one another's goals in an effort to gain some compatibility and buy in from all teammates. Harrison

discussed how he and Fiona, his advisor, develop project charters to establish "what the actual goals of the project are, what the deliverables are, who all is involved, what's their contact information, when are we meeting, and what software are we using [to communicate]." Harrison and Fiona's use project charters substantiates previous research that recommends the use of charters in order to secure commitment in writing at the beginning of the project (Asencio, Carter, DeChurch, Zaccaro, & Fiore, 2012; Mathieu & Rapp, 2009). Others also felt that sharing goals fosters commitment to the team. Warren discussed getting his students to buy into the goals of the lab regardless of their own career goals:

> "We have to show them that it all is beneficial and they have to do it all. So you have to work on multiple projects and we're going to push them all to publications…It's basically making everyone aware of the many goals of all of the team members and maximizing; achieving as many of those goals for as many people as you can even if they're not necessarily your first goal."

Not establishing shared goals up front may pull members apart as the project goes on (Schmidt & Kochan, 1972; Thompson & DeHarpport, 1998; Zhang, & Chiu, 2011). Harrison commented on how some of his other teams deviate from common goals: "…sometimes things do tend to deviate without [me] even noticing…I think a lot of it is because there's a lack of cohesion…I feel like most people don't ask…you just assume that you're working on the same goal." To avoid later confusion, Sal talked about discussing goals with a teammate in order to make a project mutually beneficial: "We also sat down and figured out what does each of want to learn from this project and what else do we have as far as ideas for publications and research questions…we had to figure

out how we could work together…it's very 50-50 on that project." Tina shared a similar process with her teammate: "I was really worried that he was expecting something very different out of [the project] and I just had to sit down and have a conversation…"

When individuals are engaged multi-teaming it is important to establish commitment to the team. Otherwise, the team could quickly fall low in the list of priorities, and the incompatible priorities between teammates can begin to cause a rift in the team that they may or may not care to address. Warren discussed encouraging some students along versus leaving uncommitted members to themselves:

> "Sometimes [we give] a little tough love, especially if we feel like there's an investment…but if there's a student, some undergraduate, who's working on a project and is just flaky, we might try a little bit, but if they're just not receptive to that kind of hand holding or that shaping, then we have other projects to spend our time on."

Theme 4 – Leading multiple teams

A final theme that arose from the discourses is that of leading multiple teams. Leaders of multiple teams, have a large and difficult job. They must not only be concerned with their own multi-teaming, but also their teammates' multi-teaming behavior, and how it will impact the success of their teams. For leaders, the main issue is addressing, "what do they need to succeed?" However, it can be difficult keeping track of the ecosystem of teams. George stated constantly questioning, "Who am I forgetting? What team am I neglecting? What stage am I forgetting to help them out with?" Harrison likens the designing a system for the operation of multiple teams to the design of any product:

> "…it is kind of like a human centered design in that aspect too. We're trying to carve out this academic space in a way that these four people can use their skills to develop a solution."

The lab directors spoke to this theme given their formal leadership roles. Additionally, several of the senior students also have leadership roles and must lead several teams at once. During their interviews, participants revealed leading multiple teams requires leveraging the network of resources available to them. This involves connecting teams together to share in ideas, skillsets, and resources. Also important for leading multiple teams was establishing shared awareness of everyone's team memberships and empowering the teams to lead.

Leveraging the network of resources. Participants talked about how they leverage the network of resources within and outside of the lab. They expressed the need to share ideas across multiple teams within the lab. Lab meetings served as touch point when members across all different projects discuss ideas and receive feedback from others. Sam stated, "We all sit down together. We've got a room down the hall with a big table in it and we sit around the table and show results…We all gather around and look at it, and if anybody sees anything that looks funny…then we go into it." Fiona also runs her lab meetings similarly: "it tends to be a meeting where I can check in with students individually, but also, other people can hear what's going on with the project and chime in if they have an idea…" Warren also commented on his meetings: "that whole collection of teams has a common touch point…we can talk about issues and problems and things that came up in their reports and talk about things that go across the entire

project team or across multiple teams." The idea behind the lab meetings was not only to get the progress report on projects, but also to get the teams talking in the same room.

Those in leadership positions are familiar enough with the lab's skillset that they know when to bring in others as a resource to a team that needs help. Fiona mentioned connecting her students: "I'll link them up with each other as they get stuck on things." George also connected members to teams: "I can take people with different skillset and problem solve in other teams." Warren's approach is to make have redundant roles as a failsafe: "I was inspired may years ago by learning about how the navy seals cross trained their team…So we try to have redundancy, and wherever possible, not put someone in a critical path, or if they are in a critical path, make sure that it's fireproofed."

Participants discussed leveraging resources across multiple teams. When speaking of his growing number of teams, George stated, "We only have limited resources, so figuring out who has priority or who actually needs it to actually do the research." Lab meetings are a good way to get a sense of what resources are available and how they can be shared across teams. Warren stated:

> "…we can clarify during the meeting exactly when they think they're gonna need that [resource] and they can discuss it out…in front of everybody…all those other teams can say, 'Okay, well, we won't be done until Friday so why don't you start on Monday', because there's shared resources across all the teams."

Participants also leveraged their own network, using lessons learned from other teams to help guide them in their leadership roles. For example, Harrison explained:

> "You definitely get a sense for different group dynamics, right? So you're able to compare one group dynamic over another group dynamic while it's

> happening…you have this opportunity to see what's working here and what isn't working here, and what could I potentially draw from what working and make the other one better, right?"

Fiona also mentioned getting "mentoring" in other teams with more experienced faculty, that helped train her on how to "advise students" among other skills. She mentioned, "…it's enlightening…seeing that other people can pull it off, and seeing how to be strategic about certain things."

Establishing shared awareness. Warren discussed how leading multiple teams effectively is contingent on establishing "shared awareness" – an understanding of the entire ecosystem of teams. The challenge comes when his students are part of other teams that he is not a part of: "that could be particularly challenging because it's not plugged into our shared team awareness systems…I don't know what their resources are, what their time and other commitments are. I lose awareness of part of their reality." However, while lacking shared awareness is a challenge for leaders, Warren could not bring himself to deny his students opportunities outside of his radar: "it's a reasonable thing for them to be doing. It's work related or they're working on a class project with three or four other people…I can't tell them to stop doing that."

Leaders of multiple teams struggle between their own multi-teaming and that of their teammates. When teammates' multi-teaming falls outside the "shared awareness system", leaders have the added burden of tracking those other commitments if they want to ensure the wellbeing of their members. Fiona talked about her concern over her students' commitments:

> "They won't tell me if they're being pushed too hard…I'll find out because they're in the lab over the weekend and really late at night, and I don't want them to be doing that. I mean…it's part of student life to have to do that sometimes, but at the same time, it shouldn't be a regular thing."

Empowering teams. An additional strategy for leading multiple teams was to step back and let the teams lead themselves. Sam mentioned, "You've got to let them do it, not micromanage, and you've got to provide them [the room] to get egg on their face." Warren noted that it can be difficult for students to bear this burden, but that it is key for leading multiple teams: "Sometimes the tension is that the student has to make a decision…It's okay…I don't think it's a bad thing…they're empowered. That's part of my strategy when I'm on these multiple teams, is to delegate authority and responsibility."

Another form of empowering teams is giving them opportunities to represent themselves and their work. Sam stated, "And of course, you're going to give them opportunities to publish their work and go to meetings to present their work." George also added, "I'll let them present it because it's their work, and I'm just leading it."

Discussion

The goal of this study was to elucidate the notion of multi-teaming from the perspective of those that engage in this behavior and those that work with multi-teamers. The tensions and trade-offs exposed by participants' discourses on the shifting nature of work, challenges, learning, and solidarity reflect a reality of work, and an emerging perspective of a complex world (Dent, 1999). The discourses demonstrate that paradox

pervades in a multi-teaming environment and provide insight into how multi-teamers and their teammates manage to live within the tensions.

Theoretical Implications

Participants manage their engagement in multiple teams by both establishing a structure and remaining flexible to changes. By operating within this tension participants do not become too rigid in their working style, nor do they become too unsettled and unpredictable in their work. However, participants' discourses do not suggest that there is a perfect balance of structure and flexibility. Because their environment is continuously in flux, the notion of a perfect equilibrium between structure and flexibility may not be feasible (Carlisle & McMillan, 2006). Participants also manage their multi-teaming experience by reframing challenges into benefits. By changing their mindset about the challenges, individuals open themselves up to the possibility of growth and self-improvement, which can motivate them to move forward instead of stopping short (Dweck, 2006).

In the process of learning through multi-teaming, participants navigate the tension between learning and performance. Participants discussed how multi-teaming motivates learning by engaging focus and promoting interests (Shiefele, 1991). Working continuously on the tasks of a single team may leave individuals bored and frustrated. Belonging to multiple teams seems to offer "breaks" that give individuals the opportunity to contribute to multiple projects, which infuses energy into work (Jett & George, 2003). Google offers another real world example of this idea. Infusing energy and motivation is part of the reason why Google has "20 percent" projects. At Google, engineers are allowed to spend 20% of their workweek on projects that generate personal interest for

them (He, 2013). Such use of their time not only alleviates boredom for the employees, but also allows engineers to stretch their skills and knowledge, as well as generates interest, which as previously mentioned, promotes learning (Shiefele, 1991). Multi-teaming also promotes efficiency (O'Leary et al., 2011). Participants discussed finding time to work on different tasks within the natural ebb and flow of their workloads (Milgrom & Roberts, 1992), becoming more efficient at meeting demands within their available time frame (Fricke & Shenhar, 2000), and increasing their output by "hedging their bets" and becoming involved in many teams at once.

The tension between exploration and exploitation was more difficult for some. Some participants were challenged to find time for both, some found time for exploration during lag times in exploitation, and some were able to engage in exploitation in an effort to make room for exploration. Again, finding the right mix of exploration and exploitation is difficult to achieve (March, 1998), but participants were on the right track for combining the two approaches to their advantage.

The process of learning through multi-teaming highlights several important issues. There is a great literature on the impact of individuals on teams. For example, research has investigated the role of personality, values, and abilities on team success (Bell, 2007). However, much less work has explored how the team may impact the individuals that comprise it. Virtually no research has explored how membership on not just one, but multiple teams, may impact individuals.

In the process of becoming a team through multi-teaming, participants also navigate the conflicting effects of their teammates' multi-teaming. While teammates' participation in multiple teams is the cause of many multi-teaming challenges, it also

creates a shared understanding that eases the interpersonal tensions caused by those challenges. This insight is interesting in that unlike the other tensions revealed by the discourses, it is one that unique to multi-teaming and has had no attention in the extant literature. Participants also built solidarity by participating in teams with familiar others. There are two ways to view this relationship. Some participants mentioned having an established history with their teammates, which facilitates their participation in multiple teams (Mortensen et al., 2007). Additionally, participants often team up with the same people, and build solidarity by virtue of having them on several teams at once. The trade-off here is that having a close-knit team competes with having a strong external network (Reagans & Zuckerman, 2001). Individuals must strive to achieve closeness within teams, but simultaneously establish a broad network (Oh, Chung, & Labianca, 2004; Oh, Labianca, & Chung, 2006). Finally, participants discussed achieving solidarity through the commitment of others. Strategies for obtaining commitment included appealing to other interests to generate motivation (Klein, Wesson, Hollenbeck, & Alge, 1999) and engaging in open discussion to find compatibility between goals (Colbert, Kristof-Brown, Bradley, & Barrick, 2008).

Participants also laid out the strategies for leading multiple teams. Getting the teams together to discuss ideas and resources was a key way that leaders managed to get their teams on the same page. This is not unlike the between team coordination that is necessary for the success of systems of interdependent teams, or multiteam systems (Davison et al., 2012; Mathieu et al., 2001; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005). Although teams in a multi-teaming environment do not share a superordinate goal as they do in multiteam systems, getting the teams together does

facilitate the sharing of resources and provides the added benefit of sharing ideas. Establishing a shared awareness is also an effective strategy for leading multiple teams. A perfect understanding of the ecosystem of teams may not be possible, but the more complete the view of everyone's memberships, the easier it is to manage the teams and each persons multiple commitments. A final strategy discussed for leading multiple teams, is to empower them to lead themselves. Empowered teams are more proactive and motivated (Kirkman & Rosen, 1999), which decreases the need for leaders to be deeply entrenched in any one team, and also provides opportunities for growth for the team members.

Limitations

While this study contributes to theory and understanding of multi-teaming, there are also some important limitations. The first is the generalizability of the findings. The sample utilized in this study is limited to individuals working within university research labs. The structure and nature of university research labs may provide a unique perspective of multi-teaming. There is a special dynamic between faculty directors and graduate students, and faculty directors and the institution that may obscure the experience of multi-teaming. Future research should explore these ideas in a sample of multi-teamers in organizations or research labs outside of the university setting.

A second potential limitation is the subjective nature of the data. In an effort to provide transparency, I have carefully reported the process that was undertaken to process and analyze the data. However, the fact remains that the themes reported herein are my interpretation of what these data reveal. Therefore, my interpretations should not

be interpreted as ground truth. However, it is important to note that both qualitative and quantitative studies alike require interpretation. As Denzin and Lincoln put it:

> "All research is interpretive; it is guided by the researcher's set of beliefs and feelings about the world and how it should be understood and studied. Some beliefs may be taken for granted, invisible, only assumed, whereas others are highly problematic and controversial" (Denzin & Lincoln, 2005, p. 22).

The themes described herein, while my own interpretations, are grounded in the data as well as tied to the observations and theories of previous research.

CHAPTER 6

GENERAL DISCUSSION

The inescapable reality of modern work is that people often work in more than one team at a time. This phenomenon is commonly experience by many, but not often explored in the literature. Years of research on teams has explored critical issues surrounding teamwork while making the assumption that teams are tightly bound and that individuals exist within a single boundary. This dissertation explores the concept of multi-teaming - an individual level behavior of engaging in more than work team at a time.

A strength of this work is that this dissertation broadens the breadth of research by utilizing a multi-method approach to quantitatively and qualitatively evaluate the effects of multi-teaming. In an empirical study, I evaluate the impact of multi-teaming on individual productivity and team performance. This study sets the stage for answering an important question: How does multi-teaming impact the success of individuals and teams? Given that multi-teaming is a common occurrence, research is needed that explores how this behavior will impact the bottom line. In a qualitative study, I explore how the experience of multi-teaming affects individuals and teams. This multi-method approach not only provides an empirical test of ideas surrounding multi-teaming, but also expands the breadth of this research by using a qualitative approach to more deeply explore how individuals and teams are impacted by multi-teaming behavior (Greene et al., 1989).

This dissertation makes important contributions to theory and research. First, I advance the construct of multi-teaming. Multi-teaming is defined as an individual's

participation in multiple work teams. I push the science of teams forward by further developing the idea of multi-teaming. Multi-teaming is related to two concepts in the extant literature. The first is multitasking. Multitasking refers to an individual's engagement in more than one task at a time (Rosen, 2008). Research on human multitasking has explored multitasking under very controlled lab designs with tasks involving pushing light up buttons (Gladstones, Regan, & Lee, 2007), or more complex behaviors such as texting and academic performance (Junco & Cotten, 2012), and working with multiple patients in the emergency room (Singh, 2014). Multi-teaming may certainly involve multitasking, but individuals need not work on multiple teams to engage in multitasking. In both multi-teaming and multitasking, individuals must engage their focus across multiple stimuli. However, unlike multitasking, multi-teaming does not focus on an individual's micro cognitive processes, and instead addresses a broader behavior in which individual's time and commitments are split across multiple teams.

Second, multi-teaming is related to the concept of teaming or teamwork (Edmondson, 2012; Marks, Mathieu, & Zaccaro, 2001). Teaming refers to the activity of working together (Edmonson, 2012). Teamwork processes involve interdependent actions between team members to carry out team goals (Marks et al., 2001). Multi-teaming does require individuals to come together to accomplish interdependent goals, thereby closely tied to the idea of teamwork. However, multi-teaming is broader than teamwork in that it focuses attention beyond the interdependencies within a single team and considers that teams are interconnected in an ecosystem by virtue of members' interdependencies across multiple teams. Conceptually, the idea of multi-teaming suggests that teamwork cannot be observed and studied in isolation. Instead, the working relationships that individuals

have outside of a single team have influence on how the team functions and performs, as well as how individuals learn and contribute. Therefore, multi-teaming is about teamwork, but it is about teamwork that spans the boundary of a single team.

The notion of multi-teaming behavior that I have described here captures an inherent complexity of teamwork that is important to consider when building successful, well-functioning teams, that also contribute the well-being and development of the individuals that comprise them. This dissertation contributes to a yet small, but growing body of literature on understanding and optimizing multi-team work.

Integration of Study 1 and Study 2

The program of research developed in this dissertation had two goals. The first was to establish an understanding of how multi-teaming affects the success of individuals and teams, and the second was to gain a ground level understanding of the experience of multi-teaming. Each of these goals was addressed in a separate study. However, Study 1 and Study 2 do not exist in isolation. There are several important connections between the findings across the two studies.

First, in Study 1 I hypothesized that the relationship between multi-teaming degree and individual productivity would be curvilinear. The rationale being that while participating in multiple teams provides access to new projects and ideas, individuals have limited attentional resources (Kanfer & Ackerman, 1989; Wickens, 1991). Findings show that the number of teams an individual is on benefits individual productivity. The discourses on multi-teaming support this finding. Warren focused on the efficiency of multi-teaming in his interview, and how efficiency is related to the different roles he has on his teams.

> "…the graduate student, or the external company, or those other professors are experts in their areas, so the fact that they can move the project along and I can make a contribution, but I don't have to be driving every project. So I guess those are two related benefits. One is the interest of being involved in multiple projects, and the ability to be involved in a project with different roles…So it's the multiple roles, the multiple projects because it's more interesting, and then more efficient."

Additionally, Parker and Naomi mentioned focusing most of their time on those projects for which they are in the drivers seat. Thus, while individuals may have a limited amount of attentional resources, being part of multiple teams need not mean that an individual is giving 100% of their time to a team in order to reap benefits (i.e., gain authorship on a publication).

Second, another finding in Study 1 that is explained by Study 2 is the relationship between team external range and team performance. Findings from Study 1 indicate that this relationship is negative and linear. The discourses in Study 2 also help to explain this relationship. Warren discussed what he called "shared awareness" of his teammates' memberships. It seems that establishing shared awareness is a leadership strategy that helps the enable the success of multiple teams, because the leader is in tune to other's resources and time commitments. Having unique connections works against the development of this shared awareness; by definition, these unique connections are outside of a teammates' network. Therefore, while having team memberships is important for individual productivity, teammates may need to share connections in order to better establish the shared awareness that helps multiple (not just single) teams succeed.

The third connection between the two studies is that both studies reveal the complex nature of multi-teaming. Findings from Study 1 reveal trade-offs and conflict between achieving individual and team goals. Further, some of the findings from Study 1 reveal that the effects of multi-teaming on success are not always straightforward. For example, as mentioned above, participating in multiple teams provides opportunities for individuals to succeed, but at the team level, having too many interlocks harms team performance. Findings from Study 2 also reveal the paradoxical nature of multi-teaming. The themes described in Study 2 for the most part, deal with how individuals live in and manage the many paradoxes and trade-offs of multi-teaming.

The core theme of findings in both studies is that multi-teaming and its effects are complex in nature, and cannot be quite manipulated or perfectly balanced. However, balance need not be the goal. There are no levers to pull that can ensure success for any individual or team (Hackman, 2012). Therefore, rather than find the elusive secret formula for success, this research can help us instead to understand the phenomenon of multi-teaming. It is through this understanding that we can begin to make sense of the inherent complexities of work.

Practical Implications

These findings have the potential to inform managers and organizations on multi-teaming practices. First, there are implications for the use of online communities. Virtual forms of organizing are becoming more prevalent (DeChurch et al., 2015). Work is no longer only accomplished in brick and mortar buildings, but within the vast and networked spaces on the internet. Websites such as Wikipedia, nanoHUB, and GitHUB are online communities in which typically anyone who is interested can contribute, and

are changing the ways that companies innovate (Brandtzæg, Følstad, Obrist, Geerts, & Berg, 2009; Di Gangi, Wasko, & Hooker, 2010). Understanding how these communities function is a huge step towards understanding modern work and modern forms of organizing. Multi-teaming is an integral part of these communities, as members are encouraged to team up and create new knowledge together (Thung, Bissyandé, Lo, & Jiang, 2013). Embracing the multi-teaming aspect of these communities facilitates a better understanding of how the broad network of teams impact one another. This dissertation is a big step towards uncovering the mechanisms that facilitate the success of such scientific communities.

These findings also have implications for leadership in multi-teaming contexts. Apart from online communities, multi-teaming is a common occurrence in many fields and workplaces. By understanding how multi-teaming affects both individual and team outcomes, this research can better inform organizations, managers, leaders, and team members on the potential effects of their multi-teaming behavior and provide insight on how to manage or balance multiple team memberships. For example, when leading multiple teams, managers may consider a "common touch point" through which teams can share and exchange ideas, and coordinate the sharing of resources. Additionally, by establishing a shared awareness of the ecosystem of teams, leaders of multiple teams can leverage the network of expertise and consider what connections across teams makes the best use of human and social capital.

Future Directions

While this dissertation makes several contributions to research on multi-teaming, it also opens up new questions and avenues to explore in regards to the multi-teaming

concept. First, future research should explore how people define their teams. Throughout the interviews it became clear that not everyone defines a team in the same way. Some participants spoke of different project teams in which they participated, but also spoke of the their entire lab as a team. Some spoke of working interdependently with others, but did not refer to those relationships as constituting a team. Campbell's (1958) seminal work on the entitativity of teams, suggests that a team is perceived as an entity when it meets three conditions: 1) teammates are proximal to one another, 2) teammates share similar characteristics, and 3) teammates share a common fate. In a research lab setting, it is not a stretch to see why the entire lab may be seen as a "team." Lab-mates are certainly proximal, similar in their disciplines and/or goals, and as one participant put it, "live and die" by the success of the lab. Of course, not all research labs have a heavy teamwork culture, but in the case of the current sample, it was difficult at times for participants to separate when they were on a team with a lab-mate and when they were not. Further research is needed that explores how the definition of what constitutes a team impacts perceptions of multi-teaming.

A second avenue for future research on multi-teaming is the role of diversity. There are multiple ways that diversity is discussed in the literature. One discussion of diversity is found in the innovation literature, which suggests that putting together teams of people with differing characteristics offers new perspectives that result in more creative outcomes (Hoever, van Knippenberg, Ginkel, Barkema, 2012; Hülsheger, Anderson, & Salgado, 2009; Somech & Drach-Zahavy, 2013). In this literature, diversity within the team facilitates innovation and creativity. A second literature on social networks suggests that diversity outside of the team, among the connections of team

members, contributes to the creativity of the team (Chen, Chang, Hung, 2008; Perry-Smith & Shalley, 2014; Reagans & Zuckerman, 2001). Belonging to multiple teams with different teammates (i.e., teammate variety) may or may lead to connections with diverse others. Therefore it is still unclear what type of teammate variety may positively or negatively impact individual and team outcomes.

A third avenue for future research is to explore how multi-teaming influences the exploration and exploitation phases. The interviews revealed that individuals were learning from their experiences on these teams, but it was not explicit in what ways multi-teaming affected their learning. There are multiple explanatory mechanisms for why multi-teaming may influence exploration and learning in teams. The first way is through the transfer of knowledge from one team to another (Argote & Ingram, 2000; Reagans & McEvily, 2003). Research on knowledge transfer has often focused on inter-organizational knowledge transfer (e.g., best practices Szulanksi, 1996). However, knowledge transfer in multi-teaming refers to the generalization of an idea from one team into another. From a learning theory perspective, this transference and re-application of knowledge, fosters learning (Kolb & Kolb, 2012), and is the basis of most training programs (e.g., Cromwell & Kolb, 2004; Leberman & Martin, 2004; Rouiller & Goldstein, 1993). By re-applying knowledge from one context to the next, individuals are engaging in experimentation that can further deepen knowledge (Kolb, 1984).

The second way in which multi-teaming may have influence on exploration and learning is through the generation of new ideas. Being a part of team increases creativity as multiple minds come to bear on a problem (Paulus & Yang, 2000; Wuchty, Jones, & Uzzi, 2007). Individuals accrue resources from their relationships with others (Burt,

2000). Specifically, connections with others expose an individual to different pockets of information. In the multi-teaming context, teaming up with others across multiple teams may offer access to unique information that generates more creativity. Belonging to multiple teams allows for access to new perspectives, which can reframe thinking and stimulate new ideas in a team. For example, Perry-Smith and Shalley (2014) proposed that an individual's diverse connections outside of the team, alters an individual's cognitive schema, which has the potential to generate more creativity. Future research should further explore the link between multi-teaming with exploration and exploitation.

A fourth research direction is to further broaden the scope of multi-teaming by exploring the relationship between multi-teaming and multitasking. Multi-teaming considers that individuals belong to different teams at the same time, but it is also a reality that individuals often engage in different tasks at the same time. It may be valuable to understand how multitasking influences multi-teaming. Potential future questions include, for example: When individuals are engaged in a task, what factors influence their switch from one task to another, or one team to another? What are the mechanisms that promote an effective switch from working individually to working with a team? Future research should look towards integrating the literatures on multitasking and multi-teaming in order to more broadly understand how individuals manage work on multiple tasks *and* multiple teams.

Conclusion

Researchers have often touched on the complex nature of teamwork (Hackman, 2012). However, the exploration of these complexities has lagged behind. This dissertation explicitly abandons the assumption that people work on a single team at a

time. The notion of multi-teaming behavior described herein captures a reality of teamwork that is important to consider in order to advance the understanding of teamwork. This dissertation advances our understanding of how individual and team level patterns of multi-teaming impacts individual and team outcomes. Specifically, individuals are more productive when they are a part of multiple teams and team up with familiar others. Teams fair better when they are not overly connected within the ecosystem of teams and teammates share external connections. This dissertation also provides insights into the experience of multi-teaming. Participants provided a first hand account of their challenges in multi-teaming, learning experiences, process of achieving solidarity, and methods for leading across teams. Overall, this research demonstrates that multi-teaming is not a straightforward process with straightforward effects. The many trade-offs, inconsistencies, and ironies associated with multi-teaming set it apart as an important behavior to consider in team research.

APPENDIX A

Multi-Teaming Interview Protocol

Entering Interview:

General greeting (not scripted)

Begin Interview:

I would like you to think about your current collaborations. If you are able to recall specific instances that can be used to provide detail, that would be very helpful. In particular, I would like you to think of examples that would help clarify your individual experience working on this team, and your team's experience working together. There are certainly no right or wrong answers, I simply want to get a sense of your experience while working on this team.

Before we begin, I would to know if it is okay with you that I record our conversation. I would like to have a recording with the details of what we discuss, which will also allow me to remain attentive to our conversation. Be assured that I will protect your identity, and will not make any reference to you personally in this research.

Do you have any questions before we begin?

A. Background Questions:

- Tell me about your projects. What are you currently working on with your team?
- How did you first come together with your teammates?
- Is this work ongoing or has the team completed their work on this project?

- Can you give a brief summary of your team divided up the responsibilities for this project? What was/is your position on the team? What were/are your teammates roles?

B. Team Interaction and Interdependence:

- How often did/do you meet with your teammates? Did you meet face-to-face or virtually?
- In what ways did/does your team work together? (e.g. shared files, emails, Skype)
- What type of assistance did/do you need from others in order to accomplish your job effectively? How often did/do you interact?
- Who relied/relies on you in order to complete their job effectively? How often did/do you interact?
- In what ways was/is it stressful and/or challenging to interact with individuals in your team?

D. Multi-Teaming:

- How many other teams were/are you contributing to while working on this project?
- How often did/do you meet with those teams? Did/do you meet face-to-face or virtually?
- How did/do you balance the workload of these various teams at once?
- In what ways was/is it challenging to be a part of the other teams while working on this project?

- In what ways was/is it helpful to be a part of the other teams while working on this project?
- To your knowledge, were/are your teammates working on other projects at the time?
- In what ways did/do your teammates' work on other projects make it challenging to work on this project?
- In what ways did/do your teammates' work on other projects help you work on this project?

E. Information Sharing:

- While working on this project, did/do you feel as though you kept your teammates up to date on your activities?
- Did/do you feel as though your teammates kept you in the loop?

F. Team Cohesion:

- Did/do you feel that you and your teammates were united in the goals for this project?
- Were/are you happy with your teammate's level of commitment?
- Did/Do you feel that your involvement in other projects prevented you from establishing good relationships in this team?
- Did/Do you feel that your teammates' involvement in other projects prevented you from establishing good relationships in this team?

G. Learning:

- Did/does working on this project help you gain any new skills or reinforce any existing skills?

- While working on this and other projects at the time, were/are you able to reflect on what you were/are doing? Did/do you take the time to ask questions? Were/are you able to explore different options in your own work?
- Did/does working on other projects at the time help you with your work on this project?
- Did/do working on this project help you with your work on other projects you were working on at that time?

Close Interview:

Thank you very much for your time today, your responses will be very useful in understanding the experience of being a part of multiple teams. At this time, I would be happy to answer any questions that you may have.

Exiting Interview:

General parting (not scripted)

Potential Probing Questions:

Anything else?

Any others?

How do you mean?

Could you tell me more about your thinking on that?

Would you tell me what you have in mind?

What do you mean?

Why do you feel that way?

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