THE IMPACT OF LEADERSHIP NETWORK STRUCTURE ON MULTITEAM SYSTEM INNOVATION

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THE IMPACT OF LEADERSHIP NETWORK STRUCTURE ON MULTITEAM SYSTEM INNOVATION

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SUMMARY

Generating innovative solutions for large-scale multifaceted problems increasingly requires the carefully orchestrated coordination and collaboration of complex collectives composed of multiple teams. However, there are many difficulties inherent in collaborative work, which are often exacerbated when individuals hail from multiple fields, perspectives, cultural backgrounds, and geographical locations. Although collective creativity can be maximized when teams leverage functionally diverse information, often residing outside the boundary of the team, this is only true to the extent that teams can effectively reconcile often-competing perspectives. Resolving these countervailing pressures requires leadership networks - patterns of emergent influence - that enable organizational teams to explore and exploit diverse informational sets. In this thesis, I turn to leadership networks in order to understand how the social structure of influence within cross-functional multiteam systems (i.e., MTSs) holds the potential to catalyze innovative new ideas. I evaluate hypotheses about the structure of leadership networks and resulting creative output in a sample of geographically distributed cross-functional MTSs formed using students completing linked semester-long projects across two universities in the US and France. Findings reveal the structure of leadership networks, both during early exploration and later exploitation phases, has important downstream consequences for innovation. First, my results suggest that throughout exploration and exploitation, innovation arises in those MTSs who exhibit leadership networks high in bridging ties and whose leaders have strong mutual influence on one another. Second, I find innovation arises in those MTSs whose leadership networks are highly concentrated around a relative few members during the exploitation phase.

CHAPTER 1

INTRODUCTION

Generating *innovative* (i.e., novel and useful; Amabile, 1996) ideas to solve complex problems is essential to organizational growth and profitability in the global marketplace (Baer, 2012; Christensen & Raynor, 2009; Whelan, Parise, de Valk, & Aalbers, 2011). Much of the creative ideation needed for innovation transpires within teams (Bruns, 2013; Shalley & Perry-Smith, 2008), who are formed to capitalize on the diverse expertise and skill sets of multiple individuals (e.g., Harrison & Humphrey, 2010). However, as the availability of knowledge and the complexity of organizational challenges continue to grow exponentially (de Solla Price, 1986, 1963; Priem, Li, & Carr, 2012), innovation increasingly demands the creative potential of specialized teams who traverse their borders in search of fresh ideas from similarly specialized but differently minded teams (Cross, Ehrlich, Dawson, & Helferich, 2008; Uzzi & Spiro, 2005). Moreover, some of the most pressing and perplexing "grand challenges" facing organizations (e.g., new product development) and society as a whole (e.g., disease prevention, disaster response) hinge on the capacity for multiple functionally-specialized teams to innovate across functional and geographic boundaries (DeChurch & Zaccaro, 2010; Börner et al., 2010; Falk-Krzesinski et al., 2011; Boardman & Ponomariov, 2011). These teams, in essence, form cross-functional *multiteam systems* (i.e., MTSs) - whose constituent teams pursue both distinct functional goals, as well as shared superordinate cross-functional goals (Mathieu, Marks, & Zaccaro, 2001; Davison, Hollenbeck, Barnes, Sleesman, & Ilgen, 2012; Zaccaro, Marks, & DeChurch, 2012).

Despite the critical need for multiteam innovation, there are many unanswered questions regarding the drivers of success in these complex collectives. Successful innovations are at the same time creative and novel as well as useful, and able to be integrated into the existing environment (e.g., Amabile, 1996). Thus innovation requires a dual focus on creative idea generation, critical evaluation of those ideas, and convergence toward a solution. However, the promotion of innovation in MTSs poses an organizational conundrum, in that *creativity* thrives when diverse individuals come together, whereas *collectives* and collective *alignment* thrives when members share a common frame of reference (Uzzi & Spiro, 2005; Wuchty, Jones, & Uzzi, 2007; Cummings & Kiesler, 2008). Therefore, promoting innovation in MTSs requires striking a delicate balance of the forces that give way to creativity and alignment in collectives (e.g., Ahuja, 2000; March, 1991). An emerging body of work suggests resolving the countervailing pressures for innovation requires *leadership* that encourages both creativity and alignment (e.g., Aryee, Walumbwa, Zhou, & Hartnell, 2012; Hunter & Cushenberry, 2011; Rosing, Frese, & Bausch, 2011; Gebert, Boerner, & Kearney, 2010).

There is an important realization in recent literature that our understanding of leadership in today's networked and knowledge-driven organizations can be improved upon by capturing how leadership reveals itself as a collective process (e.g., Morgeson, DeRue, & Karam, 2010). Whereas traditional views of leadership emphasize the skills, traits, and behaviors of individual leaders and their interactions with followers (e.g., see Avolio, Walumbwa, & Weber, 2009), theories of shared or collective leadership recast the basic concept of leadership itself as an emergent *network* of influence processes that connect multiple members and enable an interconnected flow of influence among individuals and subsystems (Denis, Langley, & Sergi, 2012; Friedrich, Vessey, Shuelke, Ruark, & Mumford, 2009; Pearce & Conger, 2003; Carson, Tesluck, & Marrone, 2007; Contractor, DeChurch, Carson, Carter, & Keegan, 2012; Mehra, Smith, Dixon, & Robertson, 2006). Given the overwhelming evidence suggesting tightly-bound specialized teams struggle to forge diverse ties within the team (Bruns, 2013; Harrison, Price, Gavin, & Florey, 2002) or externally with other teams (Brewer, 1979; Hogg, van Knippenberg, & Rast, 2012), I turn to leadership networks in order to understand how the social structure of influence within MTSs holds the potential to catalyze innovative ideas.

Although some theoretical work has begun to identify potential emergent leadership structures in MTSs (Zaccaro & DeChurch, 2012), these ideas have not yet been tested empirically (See Table 1 for a brief overview of research on leadership in MTSs). This thesis seeks to extend prior work on collective leadership in teams and MTSs (e.g., Carson et al., 2007; Hiller, Day, & Vance, 2006; Zaccaro & DeChurch, 2012) first by identifying leadership network structures in cross-functional MTSs and second, by examining the relationship between these structural signatures and MTS innovation performance. Specifically, I test predictions about the characteristics of leadership networks that enable effective multiteam innovation using data from two student samples of geographically distributed cross-functional MTSs. The contributions of this study are twofold. First, by examining antecedents of multiteam innovation, I highlight the MTS form as an essential vehicle of organizational innovation. Second, this study is the first to delve into the complex patterns of emergent *leadership* networks in MTSs and to link these patterns theoretically and empirically with innovation. The main contribution to theory involves advancing the notion that MTSs whose informal emergent leadership structures enable integration of diverse perspectives and match the shifting needs of innovation over time can most effectively generate creative and useful cross-functional ideas.

TABLE 1

ADVANCEMENTS IN MULTITEAM SYSETM LEADERSHIP THEORY

Authors, Year	Study type	Key advancements for MTS leadership theory
Mathieu, Marks, Zaccaro (2001)	Theoretical	▪ Introduced concept of MTSs ▪ Identified functional leadership theory as appropriate for MTS context
DeChurch & Marks (2006)	Empirical	▪ Functional MTS leadership aimed at the team-to-team interface facilitates interteam coordination and MTS performance
Zaccaro & DeChurch (2011)	Theoretical	▪ Linked MTS leadership functions to task phase and type of interdependence ▪ Introduced possible forms of MTS leadership
DeChurch et al. (2011)	Historiometric	▪ Identified leadership functions focused within-teams, between-teams, and across the MTS boundaries with external embedding environment
Carter & DeChurch (2012)	Theoretical	▪ Introduced social network analysis as appropriate tool for evaluating emergent MTS leadership ▪ Linked SNA to leadership *forms*, *functions,* and *foci* (i.e., within-teams, between-teams, across system, among subsets of members)
Lanaj et al. (2013)	Empirical	▪ The positive effects of decentralized planning (i.e., a key leadership function) in MTSs are offset by increased risk-seeking and coordination failures.
Current master's thesis	Empirical	▪ Links MTS leadership network structural signatures to MTS innovation performance.

Multiteam Systems

To address today's challenges, organizations have become flatter, and structuring work into teams has become a standard practice (Cannon-Bowers & Bowers, 2010; Gully, 2000; Kozlowski & Bell, 2003). Teams allow organizations to address complex issues by drawing quickly on the skills and expertise of diverse individuals (Kozlowski, Gully, Nason, & Smith, 1999). As teams become the fundamental unit of organizational work, specialized teams increasingly need to work interdependently with *other* teams to tackle larger and more complex problems requiring disparate skills and expertise (e.g., DeChurch & Zaccaro, 2010). These organizational forms are termed *multiteam systems* (i.e., MTSs; Mathieu et al., 2001), and a growing set of findings demonstrate that between-team processes are critical drivers of MTS performance (Davison et al., 2012; DeChurch & Marks, 2006; Lanaj, Hollenbeck, Ilgen, Barnes, & Harmon, 2013; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005).

Conceptualized as larger than a single team, but smaller than an entire organization, a MTS is defined formally:

> *"by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in doing so exhibit input, process, and outcome interdependence with at least one other team in the system" (Mathieu et al., 2001, p. 290).*

In alignment with this definition, MTS effectiveness depends on accomplishment of proximal team-level goals, and, in addition, on how well the MTS as a whole coordinates collectively to accomplish the distal goals shared by multiple teams in the system (Mathieu et al., 2001). The existence of input, process, and output interdependence implies that the performance of one component team may supply the input for another team. The degree to which these interdependencies exist determines the degree to which teams must share resources (i.e., input interdependence), or interact across team boundaries (i.e., process interdependence), and the degree to which outcomes received by team members in one component team depend on the successful goal attainment of another component team (i.e., output interdependence; Mathieu et al., 2001).

A key element of MTSs is that all component teams in the system share at least one superordinate goal (Mathieu et al., 2001). Thus, while working to achieve system-level goals, MTS component teams must manage their own internal (i.e., intrateam) dynamics while simultaneously managing the relationships that occur across team boundaries with members of other teams (i.e., interteam dynamics; Marks et al., 2005). For example, Marks and colleagues demonstrated that when interteam dynamics are not managed appropriately and cross-team coordination is not achieved, it is possible for component teams in a system to be "successful" individually, while the system as a whole still fails to reach its objectives (Marks et al., 2005).

Thus, MTSs challenge organizational researchers to consider the broader environment within which individual teams are nested. Many of the phenomena thought beneficial to team performance (e.g., team cohesion) may be in conflict with the success of MTSs (Lanaj et al., 2012). For example, building component teams with strong team identities and high levels of within-team cohesion might create perceptions of in-group vs. out-group differences that are detrimental to system-wide performance (Hogg et al., 2012). Creating a system of strong component teams may maximize goal attainment within each team individually. However, when the ultimate system-level goal requires synchronization across teams, then building better teams without facilitating cross-team coordination and collaboration will not necessarily benefit the desired outcomes.

As work is increasingly organized into teams, MTSs have become highly prevalent in today's organizations (Tannenbaum, Mathieu, Salas, & Cohen, 2012). Given their relevance to organizational success, recent theoretical work has called for more examination of MTSs, particularly the drivers of MTS effectiveness across multiple contexts (DeChurch & Zaccaro, 2010; DeCostanza, DiRosa, Rogers, Slaughter, & Estrada, 2012; Wageman, Gardner, & Mortensen, 2012). However, the majority of prior empirical work on MTSs has focused on identifying antecedents of success in action-oriented systems (e.g., military tasks; Davison et al., 2012; Marks et al., 2005; DeChurch & Marks, 2006; Lanaj et al., 2012). The present study focuses instead on cross-functional knowledge generation systems.

Multiteam Innovation

In March's (1991) discussion of organizational learning, he distinguished exploration activities (e.g., experimentation, play, flexibility, discovery, innovation) from exploitation activities (e.g., refinement, selection, implementation, execution) and argued that organizational adaptation requires "both exploitation and exploration to achieve persistent success" (1991: 205). Although March's initial work listed "innovation" as an exploration activity, more recent perspectives on the topic of innovation contend that successful execution of the process of innovation requires both exploration and exploitation processes over time as groups generate, vet, and implement creative and useful ideas (e.g., Benner & Tushman, 2003; He & Wong, 2004; Goh, Goodman, & Weingart, 2013).

The competing needs for exploration and exploitation in innovation drive the composition and structuring of collectives whose goal is to innovate. First, the divergent thinking at the core of creative idea generation and new knowledge seeking necessitates diversity of expertise. Second, the countervailing need for critical evaluation and eventual convergence toward a solution benefits from specialization. In fact, the inherent nature of many complex innovation challenges often gives rise to cross-functional MTSs composed of highly specialized teams of experts who come together to consider specific aspects of the larger problem (DeChurch & Zaccaro, 2010). These teams are coupled with other specialized teams from other disciplines considering other parallel aspects, bringing their unique knowledge and skills to bear throughout idea generation, selection, and implementation. Moreover, in cross-functional innovation-focused MTSs, constituent teams each contribute uniquely to both exploration and exploitation.

Building on March's initial exploration/exploitation premise, scholars typically rely on theories of ambidexterity and/or punctuated equilibrium to conceptualize organizational innovation (Gupta, Smith, & Shalley, 2006). *Ambidexterity* refers to the way that systems are structured to address competing innovation needs. Whereas *differentiated* ambidexterity implies systems that are organized into coordinated subunits each focusing on either exploration or exploitation, *integrated* ambidexterity implies systems whose subunits are engaged in both processes over time (Raisch, Birkinshaw, Probst, & Tushman, 2009). Theories of *punctuated equilibrium* consider the cyclical temporal dynamics of innovation systems as a whole, arguing collectives focus the majority of their time and efforts toward exploitation but experience punctuated periods of exploration (Burgelman, 2002). Like integrated ambidexterity, punctuated equilibrium theory is appropriate for understanding collectives whose members engage in both exploration and exploitation processes (Gupta et al., 2006). Thus, cross-functional innovation MTSs can best be conceptualized through the punctuated equilibrium lens as integrated ambidextrous systems—engaging in both exploration and exploitation over time.

Leadership plays a primary role in helping systems balance the challenges of exploration and exploitation over time (Hunter & Cushenberry, 2011; Rosing et al., 2011; Gebert et al., 2010). Effective leadership for innovation both facilitates divergent thinking as well as guides critical evaluation and instantiation of creative ideas. Similarly, research on drivers of MTS success suggests that leadership is a fundamental force that facilitates critical interteam coordination by helping teams overcome their natural tendencies toward insularity (DeChurch & Marks, 2006). Thus, I focus the following discussion on leadership for multiteam innovation, adopting a functional perspective.

Functional Leadership Theory

In response to increased organizational reliance on teams, leadership researchers have begun to address the question of how leaders create and manage teams and MTSs (e.g., Avolio, Jung, Murry, & Sivasbramanian, 1996; Day, Gronn, & Salas, 2004; DeChurch & Marks, 2006; Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996; Zaccaro & Marks, 1999; Zaccaro, Rittman, & Marks, 2001). Leaders occupy a special role in the social hierarchy, allowing them to exert influence over followers' perceptions and constructions of social reality (Bales, Strodtbeck, Mills, & Roseborough, 1951). For example, team leaders play a central role in shaping team interaction processes (e.g., Zaccaro, & Klimoski, 2002) and in developing needed team cognitive, affective, and motivational emergent states (e.g., Zaccaro et al., 2001; Kozlowski & Ilgen, 2006; Mayer, Davis, & Shoorman, 1995; McAllister, 1995).

Teams researchers have presented *functional leadership theory* as especially appropriate for conceptualizing the role of the team leader. Functional leadership theory addresses the leader's broad relationship to the group (Hackman & Walton, 1986) in that the core duty of the leader is "to do, or get done, whatever is not being adequately handled for group needs" (McGrath, 1962, p. 5). This theory is consistent with the systems view of organizations (Katz & Kahn, 1978) as well as the input-process-output (I-P-O) team effectiveness model (McGrath, 1984) and the more recent input mediator output input (IMOI) model (Ilgen, Hollenbeck, Johnson, & Jundt, 2005), in that leadership inputs shape interaction processes, emergent states, and other types of mediators, which in turn, shape system-level outcomes. Moreover, functional leadership theory focuses on the role leadership plays in facilitating group outcomes. Leadership functions impact the group's ability to engage in effective teamwork and taskwork, impacting their ability to achieve collective goals.

In other words, functional leadership theory is an appropriate lens for understanding leadership in collectives because the focus is on how leadership develops needed interaction processes and system states, as opposed to other views of leadership which focus more on the traits and behavior of leaders (e.g., Judge, Bono, Ilies, & Gerhardt, 2002; Judge, Piccolo, & Ilies, 2004), or on the dyadic relationships between leaders and followers (e.g., Dansereau, Graen, & Haga, 1975; Gerstner & Day, 1997).

The functions leaders serve in teams often include diagnosing problems, generating solutions, and implementing those solutions within social domains (Zaccaro et al., 2001).

Over the past 35 years, researchers have clarified the application of functional leadership within the team context. Hackman and Walton (1986) argued that effective team leaders monitor the situation and take actions to foster five conditions that are necessary for team effectiveness: a) a clear direction; b) a facilitating group structure; c) a supportive context; d) expert coaching; and e) sufficient resources. Fleishman et al (1991) summarize the activities team leaders should engage in to maintain these necessary conditions. These authors developed a typology of 13 types of activities organized around four general dimensions: a) information search and structuring; b) information use in problem solving; c) managing personnel resources; and d) managing material resources.

Kozlowski and colleagues (Kozlowski et al., 1996) furthered the functional leadership perspective in the team context by considering the changing role of leadership as teams move from nascence to maturity. Specifically, team leaders are thought to develop effective teamwork processes over time—from team formation and development to team performance management phases (Bell & Kozlowski, 2002). In 2001, Zaccaro et al. further clarified the implications of Fleishman et al.'s (1991) typology of functional leadership behaviors within the team context. Zaccaro and his colleagues' theoretical work described how functional leadership activities can have unique and important implications for team cognition, motivation, affect, behavioral processes, and performance.

In recent years, scholars have extended the functional view of team leadership to the MTS context. Consistent with the functional viewpoint, MTS leaders are thought responsible for interpreting and defining MTS task requirements, and MTS leadership is conceptualized as including discretion and choice in the solutions applied to a given problem (Mathieu et al., 2001). For example, when requirements shift, as is the case in dynamically changing environments, and entrained responses are no longer appropriate; MTS leaders must define or redefine system directions (e.g., vision, task requirements; Mathieu, et al., 2001).

Functional Leadership as a Collective Phenomenon

Functional leadership theory highlights the role that leadership plays in collectives. However, this theory does not imply that leadership functions are the sole responsibility of a single formal leader. In fact, researchers have been careful to note that multiple people in a group may enact important leadership functions, simultaneously, or rotated over time (Hackman & Walton, 1986; McGrath, 1962; Morgeson et al., 2010; Zaccaro & DeChurch, 2012). As such, functional leadership theory is an appropriate lens to view theories of "collective" "shared" or "distributed" leadership, which posit that leadership can be the result of the joint actions of multiple individuals (Denis et al., 2012; Pearce & Conger, 2003). Collective leadership perspectives argue that leadership may be better conceptualized as a group-level property, a set of functions that the group enacts collectively (Gibb, 1954).

Such conceptualizations are also consistent with Yukl's (1989) general definition of leadership as "influence processes involving determination of the group's or organization's objectives, motivating task behavior in pursuit of these objectives, and influencing group maintenance and culture." This broad definition makes no claim as to who enacts the influence processes. Certainly, a "formal" group leader may enact all of these processes. However, leadership may also emerge internally within groups—influence can derive from some or all group members. Moreover, shared or collective theories of leadership contend that leadership is an emergent property of a collective that results from the distribution of influence processes among members (Denis et al., 2012; Pearce & Conger, 2003).

Collective Leadership for Multiteam Innovation

Leadership plays a primary role in helping systems balance the challenges of exploration and exploitation over time (Hunter & Cushenberry, 2011; Rosing et al., 2011; Gebert et al., 2010). Effective leadership for innovation both facilitates divergent thinking as well as guides critical evaluation and instantiation of creative ideas. Due to the rapid increase in flatter, team-based organizational structures, however, there are recent calls for leadership scholars to shift from relying on relatively simplistic models of leaders and followers toward a broader conceptualization of leadership for innovation as a shared, distributed, or collective process (e.g., Pearce & Conger, 2003; Day et al., 2003). As much of today's innovation challenges occur in teams, this patterned (e.g., distributed) approach may well hold the key to understanding the leadership arrangements requisite to multiteam innovation.

In fact, shared leadership, a "dynamic interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals, or both" (Pearce and Conger 2003, p. 1) is considered particularly appropriate for conceptualizing leadership for group innovation (Hoch, 2012). When many members of a group accept responsibility for influencing one another and generating solutions to problems, the collective can capitalize on a greater breadth of available ideas and information during exploration phases and more critical discussion and evaluation of potential solutions during exploitation phases (Hoch, 2012; Hooker & Csikszentmihalyai, 2003; Pearce & Manz, 2005). Further, as innovation challenges increase in complexity, and teams work with other specialized teams to solve large-scale problems, component teams may be geographically distributed, and thus are likely to rely on virtual communication tools to collaborate. Recent work suggests that shared leadership predicts team performance in virtual environments where it is difficult for one formal leader to monitor and control all follower actions and interactions (Wassenaar, Pearce, Hoch, & Wegge, 2010).

What shared leadership brings in the way of empowerment and insight, however, comes at a cost to efficiency. For example, to facilitate inter-team coordination in action MTSs (e.g., military tasks), multiteam leadership often needs to be centralized through a leadership team or subset (Lanaj et al., 2013). Moreover, as systems increase in size and complexity—from single co-located teams to diverse systems of teams who are distributed geographically—all members leading one another simultaneously can be confusing, unsustainable, and unnecessary.

In actuality, there are numerous patterns of leadership enactment (i.e., collective leadership networks) possible within collectives with differential effects on group outcomes (Mehra, et al., 2006; McIntryre & Foti, 2013). In order to reap the benefits of shared leadership while avoiding the process losses, collective leadership in MTSs innovation may need to reflect more complex configurations of relationships than those typically implied by studies of shared leadership in single teams (e.g., Carson et al., 2007; Small & Rentsch, 2010). As such, MTS researchers should employ methods of analysis that more broadly capture the way that leadership is distributed across the system (Carter & DeChurch, in press).

Social network analysis (SNA) techniques (Wasserman & Faust, 1994) hold particular promise for the evaluation of leadership distribution (Bavelas, 1950; Mehra et al., 2006; Carson et al., 2007). Considering the network of leadership relationships that exist in MTSs allows researchers to capture the way influence flows among members (Carter & DeChurch, in press). Aggregating team members' perceptions regarding the degree of shared leadership within the team does not provide precise information about how or where collective leadership emerges and functions; evaluating leadership as a network of ties provides a viable alternative.

The study of leadership networks dates back over 50 years (Bavelas, 1950; Stogdill, 1948; Shaw, 1964). For example, Bavelas (1950) found that manipulating team members' ability to pass information to one another influenced members' perceptions of how leadership was distributed in the team. In recent years, empirical studies examining shared leadership in teams have adopted the leadership network approach (e.g., Carson et al., 2007; Mehra et al., 2006). In the following, I consider three critical characteristics of leadership networks for MTS innovation.

Leadership Network Cross-Functional Influence

The challenge for innovation MTSs is to maintain an optimal balance between both the competing needs of exploration and exploitation over time, as well as the competing needs of multiple component teams. Although MTSs offer the promise of comprehensive solutions to complex problems, the nature of these structures can also prove challenging to innovation. Tight coupling of members within teams (e.g., high cohesion) reduces interactions between teams (Hogg et al., 2012; Lanaj et al., 2013). Given the need to seed innovation with diverse idea sets in initial exploratory phases of innovation, insular teams present a problem. Research shows teams struggle with divergent thinking, and trend naturally toward convergent thinking (Nemeth & Nemeth-Brown, 2003). However, creativity benefits from relationships that bridge boundaries—termed *structural holes* in social network research (Uzzi & Spiro, 2005; Oh, Chung, & Labianca, 2004). Thus, team creativity is maximized when members bridge team boundaries and gain influence over members of different functional teams in the system.

During exploitation phases, constituent cross-functional teams must coordinate and collaborate intensely as they work in concert with one another toward a different superordinate goal (i.e., converge upon and/or implement the innovation). Broadly speaking, MTS success depends on the degree to which component teams effectively coordinate with one another (Davison et al., 2012; DeChurch & Marks, 2006; Lanaj et al., 2013; Marks et al., 2005). Thus, especially during phases of intense coordination (i.e., exploitation) leadership requires a shift in focus from facilitating processes within single teams, to facilitating processes connecting distinct component teams (DeChurch, Burke, Shuffler, Lyons, Doty, & Salas, 2011; DeChurch & Marks, 2006).

MTS leadership networks reflect the patterns of influence connecting members within and across team boundaries (Carter & DeChurch, in press). Specifically, the extent to which influence relationships "bridge" functionally diverse teams reflects the degree to which distinct component teams rely on one another for leadership. The extent to which influence relationships exist connecting members within component teams reflects the amount of leadership relationships that “bond” fellow team members together (i.e., the focus of prior work on shared leadership in single teams; Carson et al., 2007).

I argue that influence relationships traversing *across* functionally diverse team boundaries (i.e., “bridging” leadership), should be beneficial for MTS innovation, and relatively more so than influence connecting members *within* component teams (i.e., “bonding” leadership). Because of the importance to MTS innovation success of leadership that allows the flow of diverse perspectives throughout the system and aligns component team efforts toward common goals, I hypothesize the following:

> *Hypothesis 1: Leadership networks that bridge functionally distinct teams during exploration (Hypothesis 1a) and exploitation (Hypothesis 1b) predict MTS innovation.*

Leadership Network Concentration

There is an inherent tradeoff as leadership structures move from more to less distributed. On the one hand, leadership that is simultaneously enacted by all members of a collective maximizes member participation and empowerment, and may well facilitate greater incorporation of members’ ideas and perspectives. However, such an extreme flat structure may be chaotic and lack a clear direction—particularly as group size increases from team to MTS. On the other hand, a strict vertical leadership structure (i.e., one leader) provides clear direction for group members, but may not encourage incorporation of multiple group members’ perspectives into decision-making, and could be draining on the single leader. Effective *multiteam* leadership structures may be those that strike an optimal balance between these two competing ends, with the precise structuring depending on the task demands of the system.

In their discussion of ambidextrous organizations, Benner and Tushman (2003) argue that subunits of ambidextrous systems focused on exploration should be small, decentralized, and open to new ideas and processes, whereas subunits focused on exploitation should be larger, more centralized, and have more controlled processes. For integrated systems engaged in both exploration and exploitation over time, however, leadership structures should shift to match the needs of the innovation phase.

Centralized structures are more efficient for tasks with clearly defined components (Ahuja & Carley, 1999; Shaw, 1964; Monge & Contractor, 1998; Perrow, 1970). Thus, concentrated leadership patterns are better suited for phases of innovation performance that require higher levels of coordination as members enact previously developed plans. Although collectively enacted leadership benefits idea generation and evaluation, too little coherence in leadership during idea selection/exploitation phases can lead to disorganized coordination and communication patterns, an unclear chain of command, and too much diffusion of responsibility—especially as systems increase in size and geographic distribution. As such, I expect that concentration in leadership—with fewer members emerging as key players in the leadership structure relative to other members—becomes necessary as systems shift from idea generation to implementation phases when coordinated interteam action becomes more critical.

Hypothesis 2: Leadership networks with high concentration in a relatively few individuals during the exploitation phase predict MTS innovation.

Leadership Network Mutuality

Although the structure of influence relations need to shift over time to enable the differing needs of exploration and exploitation phases, shared leadership processes *among* emergent leaders is necessary for both types of innovation processes. Recent work on collective leadership structures in teams suggests that when leadership is distributed among two or more team members, the degree to which those emergent leaders are mutually reliant on one another for leadership predicts team processes and performance (Mehra et al., 2006; McIntrye & Foti, 2013). This coordination among key leaders increases members' perceptions that the system is functioning as a coherent whole, thereby decreasing possible ingroup-outgroup perceptions and making members more open to collaboration (Hogg et al., 2012)

Moreover, across both phases of MTS innovation, whether few or many MTS members are engaging in leadership processes, those emergent members of the leadership set should be mutually reliant on one another for leadership. Mutuality among emergent leaders should enable the benefits of shared leadership (i.e., expanded ideas, motivation, and coordination) to accrue within the leadership core itself, benefiting the quality of leadership throughout the MTS. Thus, I argue

Hypothesis 3: Leadership networks characterized by high mutuality during exploration (H3a) and exploitation (H3b) predict MTS innovation.

CHAPTER 2

METHODS

Hypotheses were tested in a sample of 49 MTSs (456 individuals); each MTS was comprised of geographically distributed teams, and functional expertise was similar within each team, but differed across teams. Individuals worked in MTSs for an academic semester as part of a cross-functional, international project linking students at three universities located in the US and France. The study was run over two academic semesters, with 19 MTSs collected during the Fall (i.e., Sample 1), and 30 MTSs collected during the Spring (i.e., Sample 2).

Participants

Sample 1 consisted of 19, 4-team MTSs. In total 202 individuals (43% male) participated in the study in Sample 1 in exchange for course credit in one of four different courses at one of two universities: one in the US and one in France. Each MTS was comprised of a 2-4-member Ecology team comprised of students enrolled in an undergraduate Applied Ecology course at the US University, two 2-3-member Psychology teams comprised of students enrolled in one of two sections of an undergraduate Social Psychology course at the same University, and a 2-4-member Business team comprised of students enrolled in a masters-level Business Innovation Management course at the French university.

Sample 2, collected in the Spring Semester of the data collection (i.e., Semester 2) consisted of 30, 3-team MTSs. A total sample of 254 individuals (41% male) participated in the study in Sample 2 in exchange for course credit in one of three different courses at one of two universities: one in the US and one in France. Each MTS was comprised of one 2-member Ecology team from the same Applied Ecology course used in Sample 1, one 3-member Psychology team one section of the same Social Psychology course used in Sample 1, and a 3-4-member Business team comprised of students enrolled the same Business Innovation Management course used in Sample 1.

Within each semester, students were randomly assigned to teams within their classes, and each team was randomly assigned to a MTS. Table 2 displays descriptive statistics regarding the ages and gender proportions within the different classes across the two semesters. Table 3 displays descriptive statistics for component teams and MTSs in terms of their team- or MTS-size, age, and gender proportions.

MTS Task

Each MTS worked collaboratively across the majority of their respective semester on an innovation-focused group project. MTSs were assigned the goal of combining expertise in Ecology, Psychology, and Business to develop an innovative solution to a complex environmental problem. The course projects were slightly different between the two semesters, but the overall goal (i.e., develop an interdisciplinary innovative way to change human behavior to positively impact an environmental problem) and project flow (i.e., two key phases of MTS innovation performance) remained similar. Moreover, both projects were designed such that MTSs engaged in exploration processes early on (e.g., search, discovery, idea generation) and exploitation processes later (e.g., selection, refinement, efficiency) MTS members communicated with one another throughout the project using a variety of media (i.e., face-to-face, telephone, video chat, email) including a virtual conferencing platform affording video and text capabilities, screen and file sharing, and shared workspaces.

TABLE 2

SAMPLE SIZE, AGE, AND GENDER DESCRIPTIVE STATISTICS FOR PARTICIPATING COURSES

		Age				Gender
Sample 1	***N***	**Min**	**Max**	***M***	***SD***	**%Male**
Teams Sample #1: Social Psychology Course, USA	48	18	59	23.83	9.20	19%
Teams Sample #2: Social Psychology Course, USA	55	18	34	22.56	3.55	19%
Teams Sample #3: Applied Ecology Course, USA	60	19	50	23.06	5.18	53%
Teams Sample #4: Business Innovation Management Course, France	39	22	28	24.75	1.57	58%
Full Sample 1	202	18	59	23.50	5.9	43%
Sample 2	***N***	**Min**	**Max**	***M***	***SD***	**%Male**
Teams Sample #1: Social Psychology Course, USA	60	18	49	23.18	5.81	22%
Teams Sample #2: Applied Ecology Course, USA	90	19	35	22.43	3.88	50%
Teams Sample #3: Business Innovation Management Course, France	104	20	30	23.18	2.07	53%
Full Sample 2	254	18	49	22.52	4.23	41%

Note. *n* = 49 multiteam systems

TABLE 3

TEAM AND MULTITEAM SYSTEM SIZE

	Team and MTS Size			
<u>Sample 1</u>	**Min**	**Max**	***M***	***SD***
Teams Sample 1a: Social Psychology Course, USA	2	3	2.53	.51
Teams Sample 1b: Social Psychology Course, USA	2	3	2.89	.32
Teams Sample 1c: Applied Ecology Course, USA	2	4	3.16	.50
Teams Sample 1d: Business Innovation Management Course, France	2	3	2.05	.22
Multiteam Systems Sample 1	9	11	10.63	.60
<u>Sample 2</u>				
Teams Sample 2a: Social Psychology Course, USA	3	3	3	0
Teams Sample 2b: Applied Ecology Course, USA	2	2	2	0
Teams Sample 2c: Business Innovation Management Course, France	3	4	3.43	.50
Multiteam Systems Sample 2	8	9	8.43	.50

Note. n = 49 multiteam systems

In Sample 1, MTSs were required to integrated information from the three areas of expertise to develop a written action plan for a policy or product, which had strong potential to positively impact an impending environmental disaster—the potential collapse of the Atlantic Ocean fisheries. The eight-week group project commenced in a series of two task phases.

In Task Phase 1 (lasting approximately 3 weeks), MTSs completed two primary tasks: a) each component team researched an aspect of the MTS project unique to their functional area of expertise; and b) the entire MTS brainstormed methods of combining these areas of expertise to address the MTS-level goal. The Ecology teams analyzed the nature of the Atlantic Ocean fishery ecosystem and identified human behaviors that are adversely affecting it. The Social Psychology teams devised strategies for applying human attitude and behavior change strategies to change the behavior of the consumers, fisherman, retailers, and/or policy makers believed to be harming the fish stocks. Meanwhile, the Business teams researched the value network of individuals and organizations that play key roles in the sustainability of the Atlantic Ocean fisheries—the specific individuals, groups, and/or organizations that could be targeted by attitude and behavior change strategies meant to improve the environment.

In Task Phase II (lasting approximately 5 weeks), MTSs integrated ideas generated during Phase 1 to develop written proposals containing actions plans to improve the sustainability of the Atlantic Ocean fisheries. MTSs were asked to include the following three components in their proposals: a) the human behaviors that need to change; b) the methods that would most effectively change these behaviors; and c) how the value network of organizations and consumers could be used to facilitate the proposed behavior change strategies. A 10-member panel of subject matter experts (SMEs) rated the novelty and utility of the ideas in these initial proposals across each functional area of expertise. MTSs were provided with the initial SME feedback. Then, MTSs were asked to revisit their initial proposals, critically evaluate their initial ideas, refine their solutions, and resubmit revised proposal plans. Final innovative performance (SME ratings) was assessed at the end of Phase II. Leadership relationships were assessed twice, at the conclusion of Task Phase I (week 3), and at conclusion of Task Phase 2 (week 7).

In Sample 2, MTSs were required to integrate their knowledge and develop a plan for a "smart phone application" that innovatively addresses an ecological problem of their choice. Like Semester 1, the eleven-week project in Semester 2 commenced in a series of two phases, however due to non-overlapping holiday breaks between the universities, the project timeline was slightly longer.

In Task Phase 1 (lasting approximately 4 weeks), MTSs completed two primary tasks: a) each component team researched an aspect of the MTS project unique to their functional area of expertise; and b) the entire MTS brainstormed methods of combining these areas of expertise to address the MTS-level goal. The Ecology teams identified a specific ecological problem affecting either climate change or pollution. The Social Psychology teams diagnosed consumer behaviors that contributed to the ecological problem. Meanwhile, the Business teams researched business ecosystems and possible revenue models for smart phone applications.

In Task Phase II (lasting approximately 7 weeks), MTSs integrated ideas generated during Phase 1 to develop written business proposals for their "app plans." The students were told that their final “app plans” must address a high-impact ecological problem for which humans are a major cause and demonstrate creativity and potential for effectiveness with regard to changing human behavior on as large a scale as possible while generating revenue (i.e., a sustainable business model). An 8-member panel of subject matter experts (SMEs) rated the novelty and utility of the ideas in these initial proposals across each functional area of expertise. MTSs were provided with the initial SME feedback. Then, MTSs were asked to revisit their initial proposals, critically evaluate their initial ideas, refine their solutions, and resubmit revised proposal plans.

Within each semester, *final innovative performance* (SME ratings) was assessed at the end of Phase II. *Leadership relationships* were assessed twice, at the conclusion of Task Phase I (week 3 or 4), and at conclusion of Task Phase 2 (week 8 or 11).

Virtual Collaboration Tool

In order to facilitate virtual collaboration between the four distributed teams over the course of the project, researchers provided each MTS with their own account and login information for a virtual communication platform (i.e., WebEx). The virtual conferencing platform allowed all MTS members to communicate with one another simultaneously via video or telephone. The platform also allowed members to share their computer screens or specific files with other members, and enabled shared workspaces (i.e., whiteboards), note-taking, and collective annotation of documents. All MTSs were required to attend a virtual training session hosted by a researcher that familiarized the members with this platform, and MTSs were required to schedule and attend at least one other virtual meeting using the platform. Students were not restricted to this form of communication. They were allowed to use other communication tools (e.g., face-to-face, instant messaging, text, email). However, this platform enabled a consistent method of communication that all MTS members had access to, and it facilitated meetings that all MTS members could attend and participate in. Figure 1 displays a screen shot of the WebEx meeting interface.

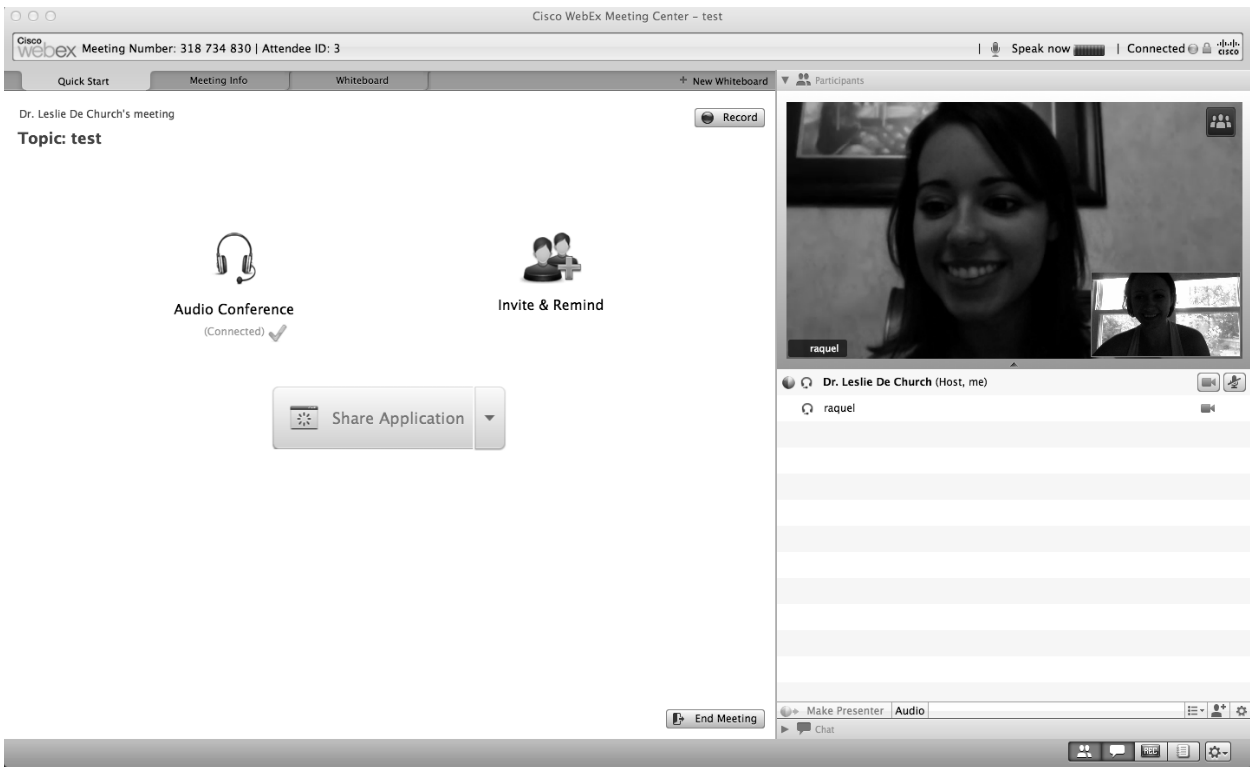


FIGURE 1. VIDEO CONFERENCING TOOL

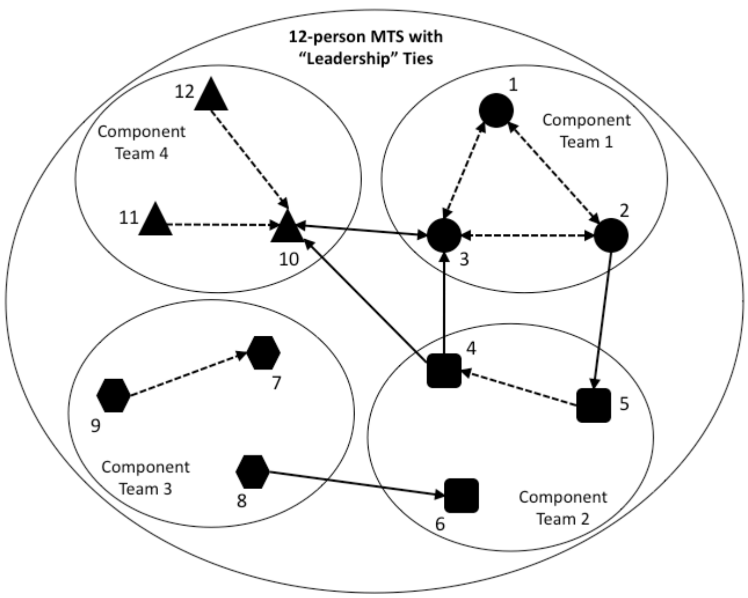
MEASURES

Leadership Networks

I used a perceptual social network measure of leadership to capture emergent MTS leadership structure (Carson et al., 2007; Carter & DeChurch, 2012; Contractor et al., 2012; Gockel & Werth, 2010; Mayo, Meindl, & Pastor, 2003; Mehra et al., 2006; McElroy & Shrader, 1987; Sutanto, Tan, Battistini, & Phang, 2012). Following Contractor et al. (2012), I first elicited participants' sociometric perceptions of the extent to which they relied on each other MTS member for leadership while working on the project. The sociometric prompt similar to that developed by Carson and his colleagues (2007) was used: "*Whom do you rely on for leadership?"* Participants were given a roster, which included the names of all MTS members, and they were asked to choose the names of all of the members whom they relied upon for leadership. This type of general prompt is thought to capture individuals' underlying beliefs about the nature of "leadership" (Mehra et al., 2006) and is consistent with prior sociometric research on leadership in teams (Bavelas, 1950; Carson et al., 2007) and with the conceptualization of a "leader" as someone who is perceived as such by others (Meindl, 1993; Pfeffer, 1977; Mehra et al., 2006). Next, I used social network metrics to characterize the degree to which the following leadership topological characteristics existed in each MTS: "bonding" or within-team focused leadership, "bridging" or between-team focused leadership, leadership concentration, and leadership mutuality. All network indices were calculated using the statnet package in R (Handcock, Hunter, Butts, Goodreau, & Morris, 2003).

Bridging vs. Bonding Leadership Ties

I computed two metrics to capture the amount of bonding and bridging leadership in each MTS: within-team density and between-team density. Within-team density is the number of observed leadership ties connecting members within each of the component teams divided by the number of possible leadership ties that could be present within each team. This metric yields one score per team capturing the degree to which each component team is densely connected to one another through leadership. Between-team density is the number of ties connecting the members of each of the teams with those of other teams divided by the possible number of ties that could connect members of different teams (Wasserman & Faust, 1994). This metric yields one score per MTS capturing the degree to which component teams are densely connected to one another through leadership. Figure 2 illustrates within and between team leadership relationships.

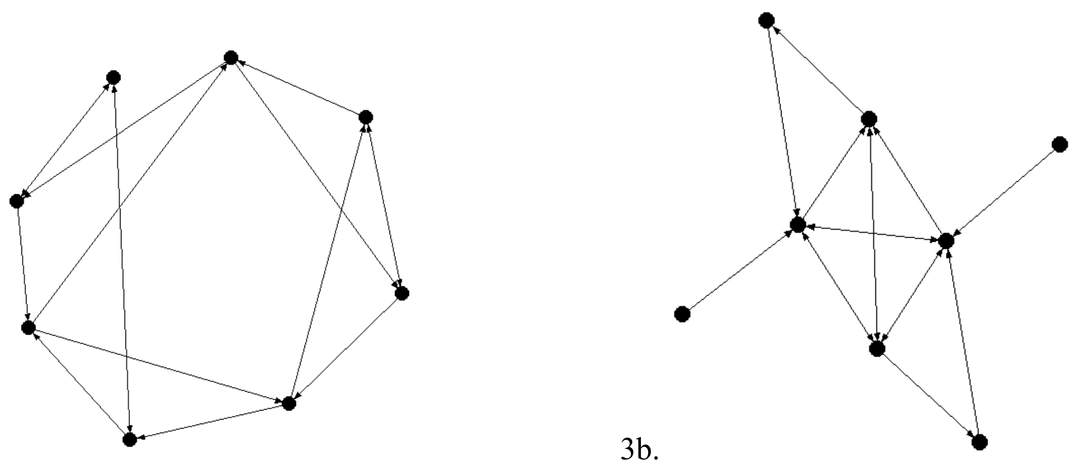


Number of directional leadership ties in the MTS = 20
Number of “bonding” (within-team) leadership ties = 16
Number of “bridging” (between-team) leadership ties = 4

FIGURE 2. BONDING AND BRIDGING TIES WITHIN/BETWEEN TEAMS
Note. Illustration of a 12-person MTS comprised of 4, 3-person teams showing leadership ties (i.e., influence relationships) connecting actors (i.e., MTS members) in a MTS leadership network. The nodes represent MTS members, and ties represent leadership reliance. Different shapes (circle, square, triangle, diamond) represent members of different component teams. Directional arrows represent reliance of one node on another for leadership (e.g., node 5 relies on node 4 for leadership). Dashed-line arrows indicate bonding ties; solid-line arrows indicate bridging ties.

MTS Leadership Concentration

To represent MTS leadership concentration, I computed Freeman's (1977) measure of centralization for each MTS at each time point. Centralization captures the concentration leadership or the degree to which certain members of the MTS have many leadership ties, whereas others have only a few. A concentrated MTS leadership network is one exhibiting substantial variation in the amount of leadership enacted within the MTS by different individuals, whereas a MTS with low leadership concentration is one where MTS members are participating in the leadership of the system approximately the same amount. Figure 3 depicts teams with low and high leadership concentration.



3a. 3b.

FIGURE 3. LEADERSHIP NETWORK CONCENTRATION
Note. Illustration of two 8-person 16-tie leadership networks with lower (3a) and highgher (3b) degree centralization scores.

MTS Leadership Mutuality

To represent MTS leadership mutuality, following Krackhardt (1994) index of hierarchy, I computed a measure of the degree to which existing ties between MTS members are reciprocated at each time point. Krackhardt's index provides the ratio of the number of pairs of actors that have a unidirectional relationship relative to the number of pairs where a tie exists. Taking the inverse of Krackhardt's measure provides a measure of the degree to which emergent leadership relationships *are* reciprocated.

MTS Innovative Performance.

In semester 1, I operationalized MTS innovation as the average ratings of proposal innovativeness as determined by a 10-member subject matter expert (SME) panel. The SMEs included 4 academic social/organizational Psychologists, 2 academic Environmental Scientists, 2 Environmental Scientists working in policy, and 2 management academics. Successful innovation is both novel and useful (e.g., Amabile, 1988). In particular, interdisciplinary innovation integrates ideas from multiple fields of expertise to arrive at a novel, useful, and comprehensive solution for a problem. Thus, SMEs were instructed to consider the short- and long-term utility, novelty and overall impact of the proposed action plans. To establish interrater reliability and agreement, I calculated the two-way mixed effects $ICC(A1) = .64$, with raters as fixed effects and targets as random effects (LeBreton & Senter, 2008; McGraw & Wong, 1996).

In semester 2, I operationalized MTS innovation as the average ratings of proposal innovativeness as determined by a 6-member SME. The SMEs included 2 academic social/organizational Psychologists, 2 academic Environmental Scientists, and 2 management academics. As in semester 1, the SME panel was instructed to consider the short- and long-term utility, novelty and overall impact of the proposed action plans from their unique areas of expertise and as a whole. The two-way mixed effects *ICC(A1)* for this sample of raters and targets was .66.

CHAPTER 3

RESULTS

Means, standard deviations, and correlations among all key study variables are displayed in Table 4.

Tests of Hypotheses

To test my hypotheses, I conducted two hierarchical regression analyses: 1) regressing MTS innovation performance on exploration leadership network characteristics; and 2) regressing MTS innovation performance on exploitation leadership network characteristics. All analyses were conducted on the full sample (i.e., Semesters 1 and 2) with semester code (i.e., Fall vs. Spring Semester) and bonding leadership ties included as controls. Hierarchical regression results are presented in Table 5. In each model, I entered the control variables in step 1, bridging leadership ties in step 2, leadership network concentration in step 3, and leadership network mutuality in step 4.

As can be seen in Table 5, there was a significant mean difference in SME ratings between semesters, with SMEs giving higher ratings in semester 1 as compared to semester 2 ($\beta = -.40$, $p < .01$). The degree to which leadership ties existed during exploration that bonded fellow team members was a marginally significant predictor of MTS innovation, ($\beta = .23$, $p = .09$). However, the degree to which bonding leadership ties existed during exploitation did not predict MTS innovation, ($\beta = .07$, $p > .05$).

<u>Hypothesis 1</u>

In support of Hypothesis 1a, leadership ties that bridged functionally diverse teams during exploration significantly predicted MTS innovation, ($\beta = .48$, $p < .01$), accounting for an additional 21% of the variance in MTS innovation over and above the

TABLE 4

MEANS, STANDARD DEVIATIONS, AND BIVARIATE CORRELATIONS AMONG STUDY VARIABLES

					Bivariate Correlations							
	Min	**Max**	***M***	***s.d.***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Dependent Variable												
1. MTS Innovation	2.13	3.98	2.83	0.41								
Initial (Exploration) Leadership Networks												
2. Bonding Leadership	2.0	10.0	5.59	2.06	.15							
3. Bridging leadership	2.0	18.0	7.41	3.31	.49**	.31*						
4. Leadership Concentration	0.09	0.74	0.33	0.14	.22	-.12	.40**					
5. Leadership Mutuality	0.18	1.0	0.77	0.22	.62**	.08	.44**	.33*				
Final (Exploitation) Leadership Networks												
6. Bonding Leadership	2.0	13.0	6	2.17	.05	.35*	.16	.13	.08			
7. Bridging leadership	2.0	21.0	7.96	4.64	.58**	-.05	.28†	.19	.52**	.14		
8. Leadership Concentration	0.10	0.70	0.34	0.16	.54**	-.15	.15	.22	.54**	-.02	.63**	
9. Leadership Mutuality	0.0	1.0	0.74	0.31	.57**	.15	.05	.04	-.46**	-.03	.65**	.60**

Note. n = 49 MTSs, $^{\dagger}p < .10$, * $p < .05$, ** $p < .01$

TABLE 5

HIERARCHICAL REGRESSION RESULTS

	Final MTS Innovation Regressed on Exploration Leadership Network Characteristics				Final MTS Innovation Regressed on Exploitation Leadership Network Characteristics			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model4
Control variables								
Sample Semester Code	-.40**	-.39**	-.40**	-.24*	-.36*	-.08	.16	.31†
"Bonding" Leadership Ties	.23†	.08	.07	.05	.07	-.03	-.02	.01
Tests of Hypotheses 1a and 1b								
"Bridging" Leadership Ties		.48**	.51**	.35*		.54**	.41**	.23*
Test of Hypothesis 2								
Leadership Concentration			-.07	-.10			.41*	.41*
Tests of Hypotheses 3a and 3b								
Leadership Mutuality				.40**				.37*
R^2	.18*	.39**	.39**	.49**	.13*	.34**	.40**	.46**
ΔR^2		.21**	.00	.10**		.21**	.05*	.06*

Note. Standardized coefficients are reported; n = 49 MTSs; MTS = Multiteam Systems, $^{\dagger}p < .10$, $* p < .05$, $** p < .01$

controls ($F_{3, 45} = 9.43$, $p < .01$). Similarly, in support of Hypothesis 1b, bridging leadership ties during exploitation significantly predicted MTS innovation, ($\beta = .54$, $p < .01$), and accounted for an additional 21% of the variance in MTS innovation over and above the controls ($F_{3, 45} = 7.83$, $p < .01$).

Hypothesis 2

Hypothesis 2 argued that concentration in leadership would be predictive of MTS innovation during exploitation phases of MTS innovation. As suggested in Gockel and Werth (2010) when using network centralization to assess leadership concentration, one should account for the number of ties in the leadership network. This is because a network can display high concentration at all amounts (few vs. many) of network ties. Moreover, although I expected effective leadership structures to display more concentration in later stages of MTS innovation, I did not expect there to be *fewer* leadership relationships in effective structures—just that those relationships would be more concentrated around key players in the MTS (i.e., an emergent group of leaders). Thus, to evaluate this hypothesis, I added MTS leadership concentration at the respective phases to the two hierarchical regression analyses after accounting for semester and the total number of ties in the entire leadership network (i.e., bonding and bridging team ties). In support of Hypothesis 2, the concentration of leadership ties during exploitation was a significant predictor of MTS innovation, ($\beta = .41$, $p < .05$), accounting for a significant increase (5%) in the variance in MTS innovation explained by the model ($F_{4, 44} = 7.25$, $p < .01$). As expected, leadership concentration was not a significant predictor of MTS innovation during exploration.

Hypothesis 3

Finally, Hypotheses 3a and 3b argued that MTS emergent leadership forms—be they highly concentrated or less so—are most facilitative of MTS innovation when those who participate in the leadership of the system leadership mutually accept influence from one another. In support of Hypotheses 3a, leadership mutuality during exploration was a significant predictor of MTS innovation, ($\beta = .40$, $p < .01$) accounting for a significant increase (10%) in the variance explained by the model, ($F_{5, 43} = 8.36$, $p < .01$). Similarly, in support of Hypothesis 3b, leadership mutuality during exploitation significantly predicted MTS innovation accounting for an additional 6% of the variance, ($F_{5, 43} = 7.34$, $p < .01$).

CHAPTER 4

DISCUSSION

Innovation wins when teams leverage functionally diverse information, often residing outside the boundary of the team, but only to the extent that teams can effectively reconcile often-competing perspectives. Resolving these countervailing pressures requires leadership networks - patterns of emergent influence - that enable organizational teams to explore and exploit diverse informational sets. This thesis reveals the structure of MTS leadership networks, both during early exploration and later exploitation phases, has important downstream consequences for innovation. In particular, I report two important discoveries about how leadership structure relates to final MTS innovation. First, throughout exploration and exploitation phases, innovation arises in those MTSs who exhibit leadership networks high in bridging ties and whose emergent leaders have strong mutual influence on one another. Second, innovation arises in those MTSs whose leadership networks are highly concentrated in a relative few leaders during the exploitation phase.

Theoretical and Practical Contributions

The present thesis leverages multiteam systems thinking to push the theoretical bounds of both group social capital and shared leadership. Group social capital has until now distinguished internal from external ties, and advocates the value of teams forging external ties (Oh, Labianca, & Chung, 2006). The current findings use the lens of multiteam systems theory to provide an important qualification to the value of external ties. These findings reveal that innovation benefits from external ties to those with functionally different expertise, but who also share a distal MTS goal. Prior research on group social capital has focused on predicting the performance of teams (Oh et al., 2004), whereas the current study predicts the innovative performance of multiteam systems. Given that MTS research highlights the very real possibility that teams will succeed to the determinant of larger systems (Marks et al., 2005) mapping the network structure that leads to MTS innovation represents a sizeable step forward.

Secondly, these findings advance thinking about shared leadership. Recent work argues that collective leadership approaches—with some or all members assuming responsibility for generating, evaluating, and implementing novel and useful ideas—hold particular promise for understanding how leadership can facilitate innovation (e.g., Hoch, 2012; Hooker & Csikszentmihalyai, 2003; Pearce & Manz, 2005). Our results are consistent with this view. Across both phases of innovation, sharing in leadership across component teams and leadership mutuality accounted for substantial portions of variance in MTS innovation performance.

However, prior work on shared leadership has focused on the dispersion of leadership, or density, to use network parlance (Carson et al., 2007; Small & Rentsch, 2010). This work adds needed complexity to the network approach to shared leadership. Results highlight the structural affordances that come from leadership influence that involves "bridging ties", "concentrated ties", and "mutual ties", by conceptually grounding them in dynamic team needs at evolving stages of the innovation cycle.

In alignment with prior work stressing the importance of MTS leadership that connects distinct teams (e.g., DeChurch & Marks, 2006), "bridging" leadership relations focused toward the team-to-team interface were relatively more predictive of MTS innovation in the current study as compared to shared "bonding" leadership. In other words, conduits of influence that connect members of different component teams are an important structural element of multiteam leadership forms for innovation.

Furthermore, after accounting for the number of leadership relationships in the MTS leadership network, concentration (i.e., the degree to which those relationships were centralized) predicted final innovation during a later stage of performance. Certainly, leadership in high performing MTSs was still enacted collectively at this stage (i.e., multiple MTS members). As such, leadership was still “shared.” However, in alignment with a recent study that found centralized planning structures were more effective for MTS coordination as compared to decentralized structures (Lanaj et al., 2013), MTS innovation success was not predicted by the degree to which leadership relationships were diffused among all MTS members during the exploitation phase. Interestingly, these results lend support for a phase-based approach to conceptualizing leadership structure. Effective leadership of teams and MTSs requires different functional behaviors depending on the phase of task performance (e.g., transition, action; Marks, Mathieu, Zaccaro, 2001; Morgeson et al., 2010; Zaccaro & DeChurch, 2012). Similarly, effective leadership forms for multiteam innovation appear to involve different patterns of leadership distribution as systems move from ideation toward exploitation and implementation.

Moreover, these results reflect a need for more precise theories of collective leadership—theories that make more specific predictions for how the patterns of influence relationships should appear based on task demands and member characteristics. This study provides an initial depiction of emergent leadership structures in MTSs. However, future research should continue to consider what other defining characteristics of leadership structures facilitate particular outcomes (e.g., innovation, coordination) and the mechanisms through which these leadership structures impact outcomes. Finally, although promising guidelines have been offered regarding how formal leaders or managers might encourage collective leadership processes (e.g., Yammarino, Mumford, Vessey, Friedrich, Ruark, & Brunner, 2010), empirical research linking these suggestions to the development of particular collective leadership structures and group outcomes is still limited. A more thorough understanding of the facilitating conditions (e.g., individual differences, organizational climate, teamwork processes) that enable optimal emergent patterns of collective leadership will enable more precisely designed collective leadership interventions.

An additional contribution of this thesis is the extension of social network analytic techniques for studying collective leadership to the MTS context. Using sociometric prompts and basic network descriptive indices (i.e., edges, centralization, hierarchy) we identified patterns of emergent leadership in our sample MTSs, and linked these to system-level outcomes. By distinguishing between those leadership relationships occurring *within* teams and those *connecting* distinct teams, we were able to identify the location in the leadership network where shared influence was most critical. Interestingly, the relative importance of bridging leadership as compared to bonding leadership highlights how certain members' connections to one another can be relatively more important for group-level outcomes as compared to other members' connections to each other. Rather than assuming all relationships are equal in a given leadership network, these results suggest the benefits of considering both the "senders" and "receivers" of influence when examining leadership patterning. As noted above, by examining centralization after controlling for the number of ties in the network and by including a measure of mutuality of emergent leadership, the indices we used provided a more detailed perspective of the emergent leadership structures that existed in our sample MTSs than would a pure MTS-level “density” score alone (i.e., the approach taken in studies of single teams; Carson et al., 2007).

Limitations and Directions for Future Research

As with any research study, there are several limitations worth noting. First, a central limitation of the present study is the correlational nature of the data. Although results showed linkages between MTS innovation performance and characteristics of emergent leadership network structures, there may have been other alternative explanations for the observed covariation. Certainly, other constructs play an important role in collective innovation. For example, scholars have argued that individual and collective-level motivation is especially important for innovation processes because of the need for individuals and collectives to dedicate substantial effort to generate new ideas and evaluate and implement solutions (Chen, Farh, Campbell-Bush, Wu, & Wu, 2013). A climate that is supportive of innovation, with members sharing a collective perception that innovative and collaborative activities are expected, valued, and supported is thought to motivate higher innovative performance in teams (e.g., Anderson, DeRue, & Nijstad, 2004; Hülsheger, Anderson, & Salgado, 2009). Individual differences factors, such as intelligence and individual creativity (e.g., Taggar, 2002) have been shown to affect the degree to which groups can generate innovative solutions. The degree to which members’ quickly engaged in effective teamwork processes (e.g., Mark et al., 2001) within and across team boundaries is also fundamental to effective collective outcomes. Many of these same constructs (e.g., motivation, individual differences) may also affect the likelihood leadership relationships form in a particular pattern (e.g., between-teams, reciprocated).

Importantly, the level of some of these constructs (e.g., positive climate; member traits) may have caused both the manifestation of particular leadership structures in the sample MTSs as well as highly innovative performance. For instance, although students were randomly assigned to MTSs, systems may have varied on the level of a trait that enables both successful innovation and leadership network structure—confounding the linkage between leadership networks and innovation. The current work did not incorporate these other constructs into the substantive questions, as the purpose of this thesis was to purely to identify aggregate structures of leadership relationships that relate to eventual MTS innovation performance. However, more research is needed that improves on the internal validity of the present work by experimentally manipulating the patterning of leadership to more precisely identify how leadership structure plays a role in facilitating group outcomes. Additionally, more research is needed that identifies antecedents of leadership structural patterning and innovation, the mechanisms through which leadership structures enable successful innovation, and the relative importance of leadership structures in comparison to other constructs in predicting MTS innovation.

Secondly, the data was from a student sample, which may limit the generalizability of the results. Although the sample allowed for a comparable set of MTSs, with similar goals, developmental lifespan, and composition, further research is needed to clarify this line or research that examines "real-world" innovative outcomes in organizational MTSs. Additionally, the sociometric leadership item (i.e., "Whom do you rely on for leadership?), was a perceptual "follower-focused" measure of leadership. This measure did not capture the degree to which "followers" changed their behavior based on the "leader's" suggestions (Zhu, Kraut, & Kittur, 2012). Also, this sociometric item did not capture the degree to which individuals enacted multiple leadership functions (e.g., Yukl, 2013); nor did it capture the degree to which a focal individual saw him or herself as a leader—another important aspect of the leadership process (DeRue, 2011). Additional work is needed to assess the degree to which follower-based measures of leadership align with these key aspects of leadership.

Finally, our results indicated that more successful innovation MTSs were characterized by leadership networks that shifted toward a more concentrated structure over time. However, prior research suggests that completely flat structures actually run counter to human nature. People naturally trend toward some degree of hierarchy (Ahuja & Carley, 1999). Through an evolutionary process of natural selection, certain group or organizational members tend to emerge as more central than others in relational networks (Simon, 1977). Over time, even in groups with no formal hierarchical structure, members begin to identify those members with specialized knowledge and/or expertise (Lewis, 2003). Through repeated interactions, groups' informal structures become more stabilized and centralized such that relationships are centered around fewer people (e.g., those possessing the most relevant expertise). On the other hand, there may be situations in which, due to changing environmental demands, MTSs must dynamically shift *back* toward more diffused leadership forms. Future research should identify ways to facilitate such a shift—one that may run counter to human nature. Currently, our understanding of globally distributed multi-disciplinary MTSs lacks empirical grounding. However, these

MTSs are commonly relied upon to tackle critical issues (Asencio, Carter, DeChurch, Zaccaro, & Fiore, 2012; DeChurch & Zaccaro, 2010). Because of the increasing global relevance of multi-disciplinary MTSs, future research should continue to build on this initial work and investigate the drivers of innovation in these complex systems.

Conclusion

In sum, this thesis demonstrates that characteristics of leadership forms play a principal role in facilitating innovation in complex collectives. Understanding the characteristics of network structures that afford the most benefit to system-level outcomes necessitates a thorough understanding of the particular challenges faced by the system. What matters is the *fit* of relational structures to system goals (Krackhardt & Hanson, 1993). Findings suggest that for MTS innovation, effective leadership networks are those that enable system-level creativity and alignment by allowing mutual reciprocated influence to flow between diverse teams of experts.

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