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Creativity and Innovation in Multiteam Systems

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CREATIVITY AND INNOVATION are often collective endeavors. Creativity typically entails the generation of novel yet useful ideas, whereas innovation reflects a combination of both idea generation and idea implementation (Amabile, 1996; Hülsheger, Anderson, & Salgado, 2009; Mumford & Gustafson, 1988; West & Anderson, 1996). Most process models of creative problem solving and innovation specify various phases, including problem construction, idea generation, solution evaluation, and solution implementation (e.g., Hunter, Gutworth, Crayne, & Jayne, 2015; Mumford, Medeiros, & Partlow, 2012) during which multiple people can work together to move from one phase to the next. For example, Hunter and Cushenbery (2011) noted that while individuals may generate ideas, other individuals within the team are often needed to vet and evaluate emergent ideas. Likewise, in innovation projects, different individuals may contribute to idea procurement (exploration) and implementation of innovative outcomes (exploitation) (e.g., Gupta, Smith, & Shalley, 2006). Hülsheger et al. (2009) noted the collective aspect of creativity and innovation, stating that "It is, of course, the case that within organizations new ideas will usually be proposed and pursued toward implementation by work teams" (p. 1128). Accordingly, given that creative and innovative performance is often vested in teams, a number of researchers have focused specifically on the qualities of teams that influence creativity and innovation (e.g., Hülsheger et al., 2009; West, 1990, 2002).

Other researchers have noted that large-scale innovation typically encompasses the use of multiple teams working closely together. For example, in research and development (R & D) projects, different units may work together at different phases through product launch (Agostini & Caviggioli, 2015; Fernández, Del Río, Varela, & Bande, 2010; Hoegl, Weinkauf, & Gemuenden, 2004). Large-scale science endeavors such as the Hubble space telescope entail multiple science and engineering teams closely engaged with one another and collaborating at different project phases (Hubble space telescope, n.d.). In addition, a recent medical innovation by Program for Appropriate Technology in Health (PATH) was described as an endeavor entailing interactions across multiple partnering teams (Furtwangler, 2015). Mathieu, Marks, and Zaccaro (2001) labeled these organizational arrangements as "multiteam systems" (MTSs). As these examples indicate, large-scale creativity and innovation are often the province of such systems.

Despite the ubiquity of MTSs engaging in creative enterprises, there is very little research on the role of MTS processes, structures, and attributes in creative performance (see DeChurch & Zaccaro, 2013, as an exception). For example, two recent volumes on MTSs did not include any chapters on creativity and innovation (Shuffler, Rico, & Salas, 2014; Zaccaro, Marks, & DeChurch, 2012a). The closest reference was about new product launches, reflecting the implementation side of innovation (Marks & Luvison, 2012). Some recent research on cybersecurity incident response, which entails collective knowledge work and often involves the development of creative responses to novel cyber events (Steinke et al., 2015), defined several MTS-level processes that relate to creativity in a taxonomy of incident response performance (Zaccaro, Hargrove, Chen, Repchick, & McCausland, 2016). However, almost the entirety of research on MTSs has focused on action-oriented MTSs (e.g., DeChurch & Marks, 2006; Davison, Hollenbeck, Barnes, Sleesman, & Ilgen, 2012).

The purpose of this chapter is to provide a framework for exploring MTS-level creativity and innovation. Although we use the more populated literature on team creativity as a gateway to draw inferences about MTS creativity, we do argue that the inherent tensions that can arise from the MTS structure mitigate the full application of knowledge about team creativity. Because the MTS structure consists of two or more teams working closely together (Mathieu et al., 2001), there is a high likelihood of countervailing forces across levels in an MTS, where (a) drivers of component team performance impair MTS functioning, or (b) drivers of MTS performance impair team functioning (DeChurch & Zaccaro, 2013; see also Zaccaro, Marks, & DeChurch, 2012b). These forces can override factors shown to foster collective creativity.

In this chapter, we begin by summarizing the nature of MTSs and their attributes, particularly with respect to creative problem solving. We then draw some inferences from the team creativity literature about potential drivers of MTS creativity. In doing so, we elaborate on several themes offered by DeChurch and Zaccaro (2013) about innovation in MTS science teams. We describe how MTS attributes that may drive creativity can conversely also increase MTS differentiation (Luciano, DeChurch, & Mathieu, 2015) and countervailing forces (DeChurch & Zaccaro, 2013) that can in turn impair between team collaboration and overall MTS creativity. We conclude with some suggestions on managing such forces to mitigate their influences on MTS creativity.

Multiteam Systems

Mathieu et al. (2001) described MTSs as a specific organizational form designed to be particularly responsive to large-scale challenges. They defined MTSs as follows:

> Two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals. MTS boundaries are defined 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 on other team in the system. (p. 290)

They argued that MTSs were not simply an aggregate of teams that coexisted in the same organizational space, but that they are teams tightly bound together through various integrated actions and task-related interdependencies (see also Zaccaro et al., 2012b).

Defining Features of Multiteam Systems

Mathieu et al. (2001; see also DeChurch & Mathieu, 2009; Zaccaro et al., 2012b) specified several key distinguishing features of MTSs. First, they noted that an MTS is composed of two or more component teams. When linked component teams come from within the same organization, the system is called an "internal MTS." However, Mathieu et al. also noted that MTSs can transcend organizational boundaries, where component teams come from different organizations. They labeled such MTSs as "external MTSs." Regardless of their location, each team is characterized by a strong degree of entitativity, which means that the teams are clearly distinguishable from one other in terms of functions, role structures, and spatial parameters (Campbell, 1958; DeChurch & Zaccaro, 2013). Thus, the contrasting boundaries of the component teams, rather their size, determine whether the entity is an MTS as opposed to a large team.

A second characteristic that differentiates MTSs from other organizational forms is the degree of interactions among the component teams (Mathieu et al., 2001; Zaccaro et al., 2012b). Mathieu et al. described these interactions as input, process, and outcome interdependence. Input independence involves the sharing of environmental challenges and the resources to address those challenges. Outcome interdependence refers to the extent to which outcomes such as rewards and benefits of performance are mutually dependent upon the goal accomplishments of each component team. Although these two forms of interdependence are common to many organizational forms (e.g., departments), MTSs are typically distinguished from other organizational forms by the high degree of process interdependence that also exists among component teams.

Researchers have defined four types of interdependence within teams and MTS (Mathieu et al., 2001; Tesluk, Mathieu, Zaccaro, & Marks, 1997; Thompson, 1967). The first is pooled interdependence, where team members (or component teams) work independently from one another, and their products are aggregated to define the team (or MTS) outcome. A second type is sequential interdependence, where one team member (or component team) completes work on a task, which then is passed to another member (or component team) for additional work. These two forms of process interdependence characterize most work interactions of teams within organizations; however, teams organized in an MTS typically enact two higher forms of interdependence (Zaccaro et al., 2012b). One is reciprocal interdependence, where teams engage in an iterative recycling of tasks and ideas until they produce a final product. The other form is intensive interdependence, where the activities of two or more component teams are "integrated in such a manner that they transpire in simultaneous (or rapidly sequential and reciprocal) collaboration" (Zaccaro et al., 2012b, p. 10). These various levels of higher interdependence both define the work of MTSs, as well as provide the wellspring of the kinds of tensions that can occur between teams that impair the overall creative performance of MTSs.

One other important characteristic of teams in an MTS is that they are linked by a goal hierarchy that defines the component teams' performance requirements necessary to accomplish the overall MTS goal. An MTS goal hierarchy has at least two proximal goals and a distal goal (i.e., one goal for each component team and one shared goal for the MTS). All of the teams in an MTS contribute interdependently to accomplishing the distal goal. In larger MTSs, with multiple component teams, two or more teams may share the same proximal goal in the hierarchy. Indeed, more complex goal hierarchies can entail teams working on multiple proximal goals with multiple and different teams (Zaccaro et al., 2012b).

These defining attributes of an MTS have typically been explored mostly in action teams (e.g., Davison et al., 2012; DeChurch & Marks, 2006). However, they apply equally well to teams tasked with decision-making problems or other forms of knowledge work (e.g., Chen et al., 2014), where the exchange and production of ideas define the primary performance of the teams in an MTS. Thus, two or more teams may work together to solve a novel problem or create a new product (e.g., Hoegl et al., 2004). Each team may be responsible for different aspects of the problem or for different phases of the product development (i.e., different proximal goals), but share information and build on each other's ideas to finalize the outcome (i.e., distal goal accomplishment). The integration of team actions, as well as their information exchange and utilization processes, would appear as input and output interdependence. Thus, while most prior empirical work has examined MTSs based on tasks requiring coordinated behavioral actions, knowledge work and creative problem solving also occurs using these organizational forms.

Taxonomy of Multiteam System Attributes

Thus far, we have described core elements of MTS structures, including membership, nature of interactions (i.e., interdependencies), and goal hierarchies. Zaccaro et al. (2012b) provided a classification of MTS attributes that elaborated these structural elements, several of which are more directly applicable to MTS creativity, a theme we come back to later in this chapter. This classification, shown in Box 9.1, contains three categories of attributes: *compositional, linkage*, and *developmental*. We will briefly describe these categories here; we refer the reader to Zaccaro et al. (2012b) for more elaborated descriptions.

Compositional MTS attributes refer to demographic characteristics of the MTS and its component teams, and to the alignment of team goals with the MTS distal goal (Zaccaro et al., 2012b). MTSs can vary both in terms of the number of teams and number of individuals included in them. According to Zaccaro et al., larger MTSs will likely to have more

BOX 9.1

Dimensions of Multiteam System (MTS) Characteristics

COMPOSITIONAL ATTRIBUTES

Number: Number of component teams within the MTS

Size: Total number of individual members across teams

Boundary status: Component teams come from single organization (internal) versus multiple organizations (cross-boundary)

Organizational diversity: In a cross-boundary MTS, the number of different organizations represented among the component teams

Proportional membership: In a cross-boundary MTS, the percentage of teams from different organizations

Functional diversity: Degree of heterogeneity in the core purposes and missions of component teams

Geographic dispersion: Co-located or dispersed component teams

Cultural diversity: Degree to which component teams come from different nations/cultures

Motive structure: Degree of commitment of each component team to the MTS; the compatibility of team goals and MTS goals

Temporal orientation: Level of effort and temporal resources expected of each component team

LINKAGE ATTRIBUTES

Interdependence: Degree of integrated coordination (e.g., input, process, outcome) among members of different component teams

Hierarchical arrangement: Ordering of teams according to levels of responsibility

Power distribution: The relative influence of teams within the MTS

Communication structure

Network: The typical patterns of interteam communication

Modality: The modes of communication (e.g., electronic, face-to-face, mixed) that occur across component teams)

DEVELOPMENTAL ATTRIBUTES

Genesis: The initial formation of an MTS as either appointed or emergent

Direction of development: From emergent to formalized; an evolution from an early formal state

Tenure: The anticipated duration of the MTS
Stage: The stage of MTS development from newly formed to mature
Transformation of system composition
Membership constancy: Fluidity versus constancy of component teams as members
Linkage constancy: Fluidity versus constancy of linkages among component teams

Source: From Zaccaro, Marks, and DeChurch (2012b). Reprinted with permission from Routledge.

complex, multilayered goal hierarchies, with component teams displaying varying degrees of interdependence with other teams; smaller MTSs will likely have flatter goal hierarchies with higher levels of interaction among component teams.

According to Zaccaro et al. (2012b), MTSs may also vary in terms of several dimensions of diversity. First, MTSs may be composed of teams entirely from a single organization (i.e., internal MTSs) or teams from different organizations (i.e., external MTSs). Second, organizational diversity within an external MTS refers to the number of different types of organizations reflected in the goal hierarchy. Third, MTSs often have varying levels of functional dispersion or diffusion in the core missions and functions of component teams. Fourth, diversity may also be reflected in how much geographic dispersion exists among the component teams, and/or how many different national cultures are represented in the MTS. Finally, greater degrees of diversity within the MTS can cause variation in the motive structures and temporal orientations of the component teams—motive structures refer to the strength of the connections between team functional goals and the overall MTS goal, and temporal orientation refers to the amount of time and effort component teams are expected to devote to MTS goal accomplishment.

Linkage attributes refer to the structural arrangements (i.e., interdependency patterns) that exist among component teams within an MTS (Zaccaro et al., 2012b). Connections among component teams can vary according to degree of interdependence around proximal and distal goals. Some component teams may work sequentially or in a pooled arrangement around goals, whereas other teams may work together in a reciprocal or intensive fashion. Likewise, some component teams may have greater responsibility for overall MTS goal attainment than other teams or have different levels of relative influence or power within the MTS. Finally, component teams can exhibit typical patterns of communications, where particular teams will communicate more with some teams than with others. Also, depending upon geographic dispersion and location, some component teams may communicate more often face to face, whereas others may have to rely exclusively or primarily on electronic modes of communication.

Developmental attributes refer to features related to the initiation and growth of the MTS. MTSs can either be appointed by governing entities, or they can emerge informally around a developing crisis or significant problem. Once formed, MTSs can vary in terms of their tenure, with some disbanding at the resolution of a problem, others adjusting into a stasis mode waiting to reemerge for similar problems that may arise later, or still others continuing on to address repetitive or continuous problems. MTSs can also be characterized by their maturity level as either relatively nascent or mature in their processes and protocols. Finally, system composition in terms of which component teams comprise the MTS may vary as teams enter and leave the MTS structure. Likewise, while team membership may remain constant, the nature of linkages and interactions among them may change significantly as the environment or context of the MTS changes, and different kinds of problems need to be resolved.

Based on analogous findings in the team creativity literature, we will argue later in this chapter that several of these attributes have significant implications for MTS creativity (DeChurch & Zaccaro, 2013). However, we will also argue that certain attributes of MTSs, particularly cross-level dynamics among component teams and the overall MTS, can moderate the actions of these attributes on creative dynamics across and within component teams. Before articulating these relationships, we turn first to a description of within- and between-team processes and emergent states that contribute to MTS performance.

Multiteam System Processes and Emergent States

Thus far, our focus has been on the structural elements of MTSs. However, MTSs also entail specific interaction processes and emergent states. These processes and states occur both within each component team and across component teams in an MTS. Marks, Mathieu, and Zaccaro (2001) defined sets of transition and action processes that occur within team performance episodes. Transition processes include mission analysis and environmental sense-making, goal specification, and strategy formulation. The goal of these processes is to prepare the team for execution of tasks in the action phase. Action processes include monitoring the team's progress to goal accomplishment and resources relative to shifting environmental conditions, having team members back up other members of the team who need help or provide feedback on their courses of action, as well as reflecting the coordinated sequencing and timing of individual actions relatively to one another.

These are processes that occur within component teams and contribute to their effectiveness. Component team performance, in turn, contributes to overall MTS performance (DeChurch & Marks, 2006; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005). However, Marks et al. (2005) also demonstrated that transition and action processes occurring between teams contributed significantly to overall MTS performance beyond the effects of each team's internal performance processes. Thus, for effective MTS performance, component teams need to coordinate actions with other component teams for both the transition phase (e.g., mission analysis, goal specification, and strategy formulation) and the action phase (e.g., collective monitoring of goal progress, backup behaviors from multiple component teams, and the synchronization and timing of component team actions relative to one another).

Marks et al. (2001) argued that team performance was also a function of emergent states that reflect properties of the team derived from team member interactions. They specified cognitive, motivational, and affective states that can emerge from such interactions. Cognitive emergent states include shared situational awareness, shared interaction mental models, transactive memory, and shared norms; motivational and affective states include cohesion, trust, and collective efficacy (DeChurch & Mesmer-Magnus, 2010; Marks et al., 2001). Several meta-analyses have demonstrated the significant link between these team states and overall effectiveness (Balliet & Van Lange, 2013; DeChurch & Mesmer-Magnus, 2010; Gully, Devine, & Whitney, 1995; Gully, Incalcaterra, Joshi, & Beaubien, 2002).

In MTSs, emergent states occur not only within teams but also between teams, and these between-team states have implications for overall MTS functioning (DiRosa, 2013; Jimenez-Rodriguez, 2012). For example, Jimenez-Rodriguez (2012) found that MTS collective efficacy, or the shared belief that the component teams can act effectively together in performing MTS tasks, influenced information sharing between teams, and the emergence of between-team transactive memory and shared mental models (SMMs). MTS trust also influenced information sharing and transactive memory formation between component teams. This work suggests that MTS effectiveness is a function of emergent states within and between component teams in an MTS.

Multiteam System Creative Problem-Solving Processes

As we noted, most prior work on MTSs has centered on action teams; few if any studies have looked at creativity in MTSs. This neglect raises the question of what transition and action processes that occur within and between component teams define creative problem solving at the MTS level. Table 9.1 indicates a creative process model offered by Mumford et al. (2012) that several researchers have applied to team creative problem solving (Carmeli, Gelbard, & Reiter-Palmon, 2013; Mumford, Feldman, Hein, & Nagao, 2001). In this chapter, we apply it as well to creativity and innovation in MTSs.

According to Mumford et al. (2012), the initial steps in the creative problem-solving process include problem definition, information gathering and organization, and conceptual combination. These steps entail constructing the elements of the problem, including "the goals, procedures, restrictions, and information needed to solve the problem" (Reiter-Palmon & Illies, 2004, p. 58), and then using this construction to gather and organize new information to further understand problems and potential solution parameters. New information is then combined and integrated into conceptual categories that are used as a basis for idea generation (Mumford, Mobley, Uhlman, Reiter-Palmon, & Doares, 1991). The process of defining the problem involves the use of problem representations and analogies from prior experiences that are triggered by cues in the problem environment (Reiter-Palmon, Mumford, Boes, & Runco, 1997). Once the problem is defined, the new problem representation is used to identify and organize necessary information for subsequent idea generation (Mumford, Baughman, Supinski, & Maher, 1996). According to Mumford et al. (2012), the reorganization of existing representations into new knowledge structures provides the basis for the emergence of novel ideas integral to creativity.

After these processes, individuals then generate and evaluate ideas, vetting them against solution parameters defined in the problem construction process. Once a best-fitting idea emerges, cognitive processes are directed toward planning its implementation. Once a solution is implemented, individuals engage in solution monitoring that entails goal regulation processes, comparing expected and actual progress toward problem solutions, and making adjustments when actual progress falls short of expectations (Mumford et al., 2012).

This model, then, specifies a range of cognitive processes in creative problem solving that entail the search and utilization of knowledge. In teams, such

Table 9.1 Team and Multiteam System Creative Processes

Team Processes	Creative Processes Model[1]	Team Creative Processes	Multiteam System Creative Processes
Transition processes	Problem definition	**Sharing of different member problem representations; collective specification of solution goals, constraints and parameters among team members**	Sharing of different problem representations from multiple component teams; collective specification of solution goals, constraints, and parameters among members from different teams
	Information gathering Information organization Conceptual combination	**Internal and external knowledge gathering (within and outside the team); information combination and integration to organize new information and create new shared knowledge structures**	Knowledge gathering occurs within teams, between teams, and external to the MTS; members from different teams combine information and integrate it across component teams to organize new information and create new shared knowledge structures
	Idea generation	**Members generate ideas based on shared problem knowledge structure**	Members of different component teams offer ideas for collective consideration across the MTS
	Idea evaluation	**Multiple team members vet and evaluate generated ideas against shared solution model; best-fitting ideas emerge from team macrocognitive processes**	Generated ideas are vetted and evaluated by multiple component teams; best-fitting ideas emerge from combined team and MTS macrocognitive processes

(*continued*)

Table 9.1 Continued

Team Processes	Creative Processes Model[1]	Team Creative Processes	Multiteam System Creative Processes
	Implementation planning	**Team members plan implementation, including member role assignments, and sequencing and timing of members' actions**	Component teams plan implementation, including team assignments, and the sequencing and timing of team actions within the MTS goal hierarchy
Action processes	Solution implementation[1]	**Members coordinate solution implementation; members engage in back-up behaviors**	Component teams coordinate solution implementation; teams engage in back-up behaviors
	Solution monitoring	**Members monitor team progress toward solution implementation, including monitoring of team resources and shifting environmental conditions**	Component teams or MTS leaders monitor MTS progress toward solution implementation, including monitoring of component team resources and shifting environmental conditions

[1]The creative process model is adapted from Mumford, Medeiros, and Parltrow (2012), with the exception of solution implementation, which was added to the model for the purposes of this chapter.

processing becomes "externalized" through communication and information exchanges among members (Carmeli et al., 2013; Fiore, Smith-Jentsch, Salas, Warner, & Letsky, 2010). Teams can direct greater cognitive resources and capacity to creative problem solving through member knowledge and information sharing (Hülsheger et al., 2009; Mesmer-Magnus & DeChurch, 2009). For example, when constructing problems, particularly novel ones, multiple problem representations are likely to be associated with more creative idea generation and creative solutions (Reiter-Palmon et al., 1997). The greater cognitive capacity and diversity in teams may facilitate problem examination from multiple frames of reference and the search for new information that also drives idea generation (Taggar, 2002).

However, the exchange of information represents one aspect of the team creative problem-solving process. Fiore and his colleagues offer a model of macrocognitive processes in teams that are used in complex collaboration (Fiore et al., 2010; Salas & Fiore, 2004; Salazar, Lant, Fiore, & Salas, 2012). Salazar et al. (2012) describe such processes in diverse science teams where, through information sharing and collective reflection, team members develop new mental representations of problems and solutions by integrating contributions from multiple team members. These processes involve not only the exchange of individual ideas but also how those individual ideas are addressed by the team; teams can accept all or part of the ideas, perhaps providing more refinement and elaboration, or they can reject the idea in favor of others (Kohn, Paulus, & Choi, 2011). Thus, whereas the initial idea generation occurs through individual offerings, the evaluation and vetting of ideas occur through collective information processing (Hunter & Cushenbery, 2011). The result is an evolution of individual creative ideas to shared problem and solution frames.

These macrocognitive processes describe how teams and MTSs engage in the creative problem-solving processes noted in Table 9.1. At the problem definition stage, members may share different problem representations from their individual experiences; team discussions produce a common or shared problem state. Such a SMM would then guide individual team members in information search, categorization, and the development of refined shared knowledge structures; these in turn would guide ideas generated from multiple members and serve as a frame for the collective evaluation and elaboration of generated ideas (Mumford et al., 2001). When team members converged on a creative solution, they begin planning its implementation, which includes member role assignment and the coordination of member actions. During the implementation of creative solutions, members monitor their coordination of integrated actions and engage in back-up behaviors when necessary. Finally, members collectively monitor team progress toward solution goals, making adjustments when goal progress is less than expected. Thus, team creative problem solving begins as an externalized cognitive process and concludes with coordinated action in solution delivery, with different members offering different roles in this iterative progression.

A similar process may occur among the component teams in MTSs, where externalized creative problem-solving processes take place both within and between component teams (see Table 9.1). However, the multilevel nature of MTS structures can impose challenges for the MTS creative problem solving that are not typically present at the team level. In particular, the processes of problem definition, information gathering, organization, category combination, idea generation, and idea evaluation may all occur within each component team before all component teams come together to develop a common solution. That is, each team may consider the problem frame from the perspective of its own mission priorities and functional roles. Each team then engages in information search and organization from this frame, and it generates and evaluates ideas reflecting the functional expertise extant with that team. Only after members of each team agree to a possible idea do the component teams come together to determine the overall MTS solution.

Such a process is to be expected, as group members are likely to be more oriented to sharing information and opinions with others internal to their group than with outsiders, especially when members share a common functional framework (Festinger, 1950, 1954). Also, there are some advantages to this approach. Ideas that emerge from internal team processes may display a deeper functional grounding and, through internal vetting, may represent a stronger contribution from the component team to the overall MTS. However, these advantages may be outweighed by several issues. First, multiple component teams can provide greater cognitive capacity and broader perspectives toward problem construction and idea generation. Having teams engage first in internal processes and then with other component teams can create inefficiencies and process loss (Steiner, 1972) in collective creative thinking, and, consequently, the untimely consideration of multiple perspectives. Second, as teams coalesce around internal ideas, they may become more resistant to changing these ideas, especially if the teams are highly cohesive (Festinger, 1950). Accordingly, MTS processes may break down as teams fail to reach a consensus on creative solutions.

These arguments suggest that individuals of different component teams may need to engage in boundary spanning and information sharing early in the creative problem-solving process by sharing ideas that are developed within component teams. The results should be a greater representation of multiple perspectives in early problem construction, knowledge categorization, and idea generation. Also, generated ideas can be vetted against these multiple perspectives, preventing a team from coalescing around an idea that could be in conflict with the functional roles and proximal goals of other component teams. The result should be an overall higher quality creative solution. This suggests the following proposition:

Proposition 1: Earlier involvement and integration of multiple component teams in the MTS creative problem-solving process will lead to higher quality MTS creative solutions than when information sharing, elaboration, idea generation, and evaluation occur first within component teams.

This proposition rests on the greater availability of the full cognitive resources and capacities of the MTS early in the creative problem-solving process. Research on team creativity has suggested that the consideration and integration of multiple perspectives in team creativity become more important when teams have higher levels of process and outcome interdependence (Hülsheger et al., 2009; Marks et al., 2005). In MTSs, these forms of interdependence, particularly those related to between-team interactions, can vary across the goal hierarchy. For some proximal goals, two or more component teams may be required to work together intensely to achieve the shared goal. For other proximal goals, teams may work sequentially or their contributions may be pooled with little or no interactions. This suggests that in an MTS goal hierarchy, the degree to which the accomplishment of proximal and distal goals requires higher forms of process interdependence, the more important early integration of component team processes in creative problem solving will be for overall MTS success.

Proposition 2: The relationship between early involvement and integration of multiple component teams in the MTS creative problem-solving process and overall MTS creativity is moderated by goal interdependence, such that this relationship will be stronger when interdependence is higher.

Drivers of Multiteam System Creativity: Lessons From the Team Creativity and Innovation Literature

Few studies have examined empirically the factors that promote creativity and innovation in MTSs. However, the related question has been examined extensively at the team level. Indeed, Hülsheger et al. (2009) conducted a meta-analysis of predictors of team innovation in studies published over a 30-year span. In this chapter, we will use some findings from that meta-analysis to provide some insight and propositions about attributes of MTSs that can foster—or inhibit—creativity and innovation. Specifically, we will focus on their findings regarding team composition, team emergent states, and team communication processes. While we first apply these findings on team creativity and innovation in a straightforward and analogous manner to MTSs, we will also highlight how characteristics of MTSs, and cross-level tensions, can mitigate this application.

Job-Related Diversity

Hülsheger et al. (2009) argued that when team members displayed considerable heterogeneity on such factors as professional knowledge, functional expertise, and educational background, their teams could be more innovative because increased cognitive diversity and a wider range of perspectives could be applied to creative problem solving. Also, people from different functional and perspective backgrounds would likely have access to different social networks outside of the team, which would expand the amount and variety of external perspectives available to the team. The results from their meta-analysis indicated a small but significant effect of job-related diversity on team innovation.

Earlier in this chapter we noted multiple forms of job-related diversity that can exist in an MTS (see Table 9.1), including organizational diversity and functional diversity. Organizational diversity, which reflects "the number of different organizations represented among component teams" (Zaccaro et al., 2012b, p. 14), is derived from the boundary status of the MTS, meaning whether the MTS is an internal one, where component teams come from a single organization, or an external one, where teams come from different organizations. Different organizations can bring different approaches and perspectives to problem construction and idea generation. They also provide a basis for vetting solutions that are generalizable across different contexts; in doing so, they are also more likely to uncover cross-organizational implementation issues that may not be readily apparent from the perspectives of teams from a single organization. These greater cognitive resources that can accrue from organizational diversity indicate that this form of MTS diversity should foster greater MTS creativity and innovation.

MTS functional diversity reflects "heterogeneity in the core purposes and missions of [different] component teams" (Zaccaro et al., 2012b, p. 14). In most MTSs, component teams will have different functional responsibilities for shared proximal and distal goal accomplishment. For example, in the car accident example provided by Mathieu et al. (2001), four component teams compose an MTS to handle severely injured accident victims: firefighters, EMTs, the surgical team at a hospital, and the recovery team. Each team has a core function that varies to a lesser or greater degree from the other teams. The EMTs and firefighters have distinct functions, but ones that are more similar to one another than those of the surgical and recovery teams. Thus, this MTS has a moderate degree of diversity. Asencio, Murase, DeChurch, Chollet, and Zaccaro (2016) describe a multidisciplinary science MTS tasked with developing innovative solutions that foster behaviors contributing to environmental sustainability. This MTS included psychology, ecology, and business teams that interacted throughout a semester-long project. Each team had a function that was clearly distinct from those of the other teams. Such an MTS exhibits a higher degree of functional heterogeneity.

As with organizational diversity, functional diversity expands the cognitive resources and perspectives that can be applied to creative problems. Each form of diversity may influence the creative problem-solving process in different ways. Diverse organizations may have access to different external stakeholders and therefore be able to provide different kinds of information for problem construction and idea generation, as well as for planning solution implementation. Teams with diverse functions may be able to bring different conceptual frames of reference to a creative problem. Innovation may derive from the combination of ideas that are conventional within each component team but novel to the other teams (cf. Uzzi, Mukherjee, Stringer, & Jones, 2013). Thus, functional diversity may have greater impact on idea generation and cross-functional idea vetting. Finally, such diversity may expand the resources and stakeholder reach that can facilitate successful idea implementation. These effects of organizational and functional diversity suggest the following propositions:

Proposition 3: MTSs with higher numbers of component teams from different organizations will display higher levels of creativity and innovation than MTSs with lower numbers of component teams from different organizations.Proposition 4: MTSs with greater degrees of functional diversity across component teams will display higher levels of creativity and innovation than MTSs with less functional diversity.

A Caveat: The Problem of Differentiation

The aforementioned propositions are based on the assumption that component teams will collaborate well as they engage in creative problem solving. However, Luciano et al. (2015) point to the problem of structural *differentiation* in MTSs that can impair cross-team collaboration by strengthening each team's boundary relative to the other component teams. They described the MTS dimension of differentiation as "the degree of difference and separation between MTS component teams at a particular point in time" (p. 4). They defined five subdimensions of MTS differentiation: *goal discordancy, competency separation, norm diversity, work process dissonance*, and *information opacity*.

Organizational and functional diversity directly relates to each of these facets of MTS differentiation. Goal discordancy refers to the incompatibility of proximal goals across component teams. For example, when component teams come from different organizations, priorities from multiple memberships in each team's parent organization and the MTS can cause such incompatibility. Marks and Luvison (2012) note the possibility of goal discordance in strategic alliance MTSs that are composed of teams from different partnering organizations and are launching an innovative product. In such instances, they noted that "there are likely to be competing objectives between the firms, so that respective teams will exhibit different motivations" (p. 49). Similar goal discordance can come from functional diversity, as different job tasks can foster alternative and possibly conflicting goals. Marks and Luvison describe an example of this in engineering, marketing, and sales teams that form an MTS to launch new innovative technology. The goals of the engineering to develop, test, and include the latest and more complex technologies may conflict with the marketing and sales teams' goals of getting the product to market as soon as possible.

According to Luciano et al. (2015), competency separation refers to the distribution of work-related expertise across the MTS. This is directly analogous to MTS functional diversity. We noted the effects of such diversity on goal discordancy. However, it can also influence a third facet of differentiation—informational opacity—which refers to the degree to which there is a lack of transparency in information and communication about the activities of each component team. When teams represent very different functions, language and concepts used within teams can be unfamiliar to those of other partnering teams. They also may understand problems differently and form solutions based on their own functional perspectives, but not share those creative ideas with other teams due to a lack of shared language. Organizational diversity can also contribute to information opacity, as teams hesitate to share information and activities considered property of their home organizations.

Organizational and functional diversity may also contribute to both norm diversity and work process dissonance. Norm diversity refers to component teams in an MTS having "incompatible work practices and heterogeneous norms" (Luciano et al., 2015, p. 14), while work process dissonance reflects incongruity of *intra*team work processes. Teams from different organizations may bring to the MTS different beliefs and expectations about how particular tasks should be completed. For example, one company may use a bottom-up approach to idea generation, where brainstorming is encouraged by all members, while another may prefer a more top-down approach, where ideas for consideration are provided by organizational leaders. These differences can influence how teams work together on creative projects across company boundaries such that one team may defer to initial ideas suggested by MTS leaders, while the other would expect to generate initial ideas. Likewise, different organizations and their representative teams can hold different expectations about how ideas are to be vetted, who should be involved in the vetting process, and how solution implementation should occur. Similar effects can happen with functionally diverse teams, as different professions and areas of expertise may call for different expectations and norms about how to collaborate throughout the creative problem-solving process.

Accordingly, Luciano et al. (2015) suggested that as MTS differentiation increases, component teams develop stronger, less permeable boundaries, which reduce the likelihood of cross-team communication and collaboration. Such an outcome would negate the proposed effects of MTS diversity on creative problem solving. However, Luciano et al. also suggested that certain MTS emergent states such as SMM and transactive memory systems (TMS) can serve to respectively offset or compensate for the effects of diversity-driven differentiation. Indeed, a number of studies have supported the influence of these and other emergent states in collaborative creative problem solving. We turn now to these influences.

The Role of Multiteam System Emergent States in Counteracting Diversity-Related Differentiation

One approach to reduce possible effects of differentiation on MTS creativity and innovation is to increase distal goal saliency. Classic work on intergroup competition (Sherif, Harvey, White, Hood, & Sherif, 1961, 1988) highlights the role of shared goals in effective collaboration. In this work, conflicting and competing teams were often brought into greater harmony by establishing a clear superordinate (i.e., distal) goal that bound these teams in collective and integrated action. MTSs are already structured with a goal hierarchy that includes a distal goal whose accomplishment requires interdependent action from all component teams. However, when working on a creative task, component teams may focus more resources on idea generation around their proximal goal and lose sight of the distal goal. This tendency is exacerbated in diverse MTSs where proximal goals often reflect distinct professional, functional, or organizational achievements. In such contexts, component teams may perceive the accomplishment of their proximal goals as a sufficient and rewarding outcome of their effort. For example, when science teams are working together ostensibly to achieve a cross-disciplinary breakthrough, each team may instead choose to focus on research papers and articles for outlets germane to their own discipline. Achievement of the distal goal becomes secondary to accomplishment of outcomes related to their own professional goals.

This tendency may be counteracted by having MTS leaders increase distal goal saliency and goal commitment for component teams. They can do so by ensuring a higher degree of outcome interdependence across the MTS, where component teams perceive that the benefits of achieving their own goals are inextricably tied to distal goal accomplishments. Referring to such interdependence as *goal cooperativeness*, Mitchell, Boyle, and Nicholas (2009) found that it fostered stronger norms among team members for *open-mindedness*, which reflected a "belief that members should be able to freely express their views, even those that conflict with majority perspectives, and the motivation to investigate, value and utilize others' knowledge and contributions" (p. 641). In their study, such norms were associated with higher levels of team knowledge creation. In terms of MTS creative problem solving, such norms would aid interteam ideation and solution vetting.

Research on the related concept of project commitment in product development research has suggested similar effects in studies of cross-functional teams (Ehrhardt, Miller, Freeman, & Hom, 2014) and MTSs (Hoegl et al., 2004). Project commitment refers to "the acceptance of and the strong belief in the goals and values of the project, the willingness to engage in the project, and the desire to maintain membership in the project" (Hoegl et al., 2004, p. 40). Hoegl et al. examined project commitment in a longitudinal study of R & D multiteam systems engaged in innovative productive development. They gathered assessments of such commitment along with interteam coordination and constructive communications at three points of time in the project, corresponding to the concept (i.e., idea generation), design (i.e., ideal evaluation), and product preparation (i.e., idea implementation). They found that team project commitment was significantly and positively associated with interteam coordination at the concept and design phases. Interteam coordination, in turn, was positively associated with overall project performance. These findings support the idea that a shared goal motivation fosters better coordination in the form of communication around idea generation, solution design, and solution implementation.

In their meta-analysis of team innovation, Hülsheger et al. (2009) also reported significant effects for two related forms of shared goal motivation. One of these was *vision*, which they referred to "the extent to which team members have a common understanding of objectives and display high commitment to those goals" (p. 1131). The other was *task orientation*, which, according to Hülsheger et al., refers to "striving for the highest standards of performance achievable" (p. 1131). Both team states fostered a greater motivation for collaboration and greater displays of "mutual monitoring and feedback, and by regular appraisals of ideas and performance" (p. 1131). This suggests that these states promote team and MTS idea vetting, evaluation, and back-up behavior in solution implementation. Hülsheger et al. also found some of the strongest corrected correlations in their meta-analysis between shared vision and task orientation, respectively, and team innovation.

These findings suggest that shared goal motivation and commitment can compensate for the differentiation caused by forms of MTS diversity (Luciano et al., 2015). Shared commitment may help component teams persist through diversity-related difficulties such as low compatibility of norms, work processes, and language. Increasing distal goal commitment can also help reorder goal prioritization among component teams relative to their proximal goals. Accordingly we propose the following:

Proposition 5: The effects of MTS diversity on MTS creative problem solving will be moderated by MTS goal motivational states, so that the relationship will be stronger under conditions of higher shared goal motivation.

Shared motivational states are not the only MTS-level emergent states that can mitigate the effects of MTS diversity on creative problem solving. Luciano et al. (2015) argued that an SMM or understanding among component teams about the MTS mission and how to accomplish it can offset diversity effects. Mumford et al. (2001) argued that SMMs may facilitate team creative problem solving by (a) increasing the likelihood that idea generation among members would be more relevant to the problem and (b) fostering a common reference for idea evaluation. They also argued that the increased efficiency from these two effects would free resources to engage in idea elaboration. These consequences of SMMs at the team level may occur at the MTS level as well.

Luciano et al. (2015) also argued that a second shared cognitive state, TMS, may compensate (rather than offset) the effects of diversity-driven differentiation in MTSs. This state refers to the shared knowledge among the members of which individual (or component team) possesses which functional expertise (Austin, 2003). A well-developed TMS across component teams in an MTS can help reduce information opacity and therefore clarifies which team can offer what relevant information. It can also increase the efficiency of idea vetting and evaluation as teams and MTS leaders know more quickly who to turn to for specific advice and assessment. These arguments, along with those for MTS SMMs, suggest the following proposition:

Proposition 6: The effects of MTS diversity on MTS creative problem solving will be moderated by MTS cognitive emergent states, such that the relationship will be stronger under conditions of higher shared cognition.

We have argued that motivational and cognitive MTS emergent states may moderate the effects of MTS diversity on MTS creativity. Research on team innovation suggests that affective emergent states, such as trust and cohesion, may also moderate these effects. Team trust can increase the willingness of members to offer unusual ideas in idea generation phases of creative problem solving and the perceived psychological safety to vet, challenge, and evaluation these ideas (e.g., Barczak, Lassk, & Mulki, 2010; Gong, Cheung, Wang, & Huang, 2012). Hülsheger et al. (2009) argued that such psychological safety was also a product of team cohesion, defined as the personal attraction and commitment of members to others in the team. They noted that "team members who have strong feelings of belongingness and feel attached to other team members are more likely to cooperate, interact with each other, and exchange ideas" (p. 1132). Luciano et al. (2015) argued that one effect of team differentiation was to reduce such feelings of belongingness at the MTS level. Thus, fostering greater cohesion, trust, and psychological safety at the MTS level may counteract this effect within component teams. Indeed, multiple studies have linked such affective emergent states to team innovation (Büchel, Nieminen, Armbruster-Domeyer, & Denison, 2013; Edmondson & Lei, 2014; Hülsheger et al., 2009; Joo, Song, Lim, & Yoon, 2012). Similar effects would likely accrue for MTS innovation as well. For instance, Jimenez-Rodriquez (2012) found that multiteam trust was associated with more open information sharing between component teams. Based on these studies, we propose the following proposition:

Proposition 7: The effects of MTS diversity on MTS creative problem solving will be moderated by MTS affective emergent states, such that the relationship will be stronger under conditions of higher shared positive affect.

Although team members are the ones who collectively develop these emerging states that are critical to fostering creativity in MTSs, the leaders play a core role in facilitating the growth of trust, cohesion, and safety in both their individual teams as well as the MTS. Research has shown that these states emerge when leaders encourage information sharing, promote "speaking-up" behavior, and empower subordinates (Carmeli et al., 2013; Edmondson, 2003; Edmondson & Lei, 2014). Likewise, leadership actions have been found to be influential in fostering cognitive and motivational emergent states as well (Marks, Zaccaro, & Mathieu, 2000; Zaccaro, Rittman, & Marks, 2002).

We have suggested that each set of emergent states may moderate the effects of MTS diversity on MTS creative problem solving in both similar and different ways. Indeed, we would argue that counteracting the differentiation effects of MTS diversity may required a coevolution and integration of all three types of MTS emergent states; the result should be fairly strong connections across component teams.

A Caveat: The Problem of Countervailing Forces in Multiteam Systems

We have argued that the potential effects of differentiation on MTS creativity and innovation can be countered by facilitating stronger MTS-level emergent states. However, one danger of such actions may be the instigation of *countervailing forces* that can harm team identity and performance. DeChurch and Zaccaro (2013) defined countervailing forces as processes or emergent states occurring at the team and MTS levels, respectively, that can have opposing (positive and negative) influences across these two levels. From this combination, DeChurch and Zaccaro specified four types of countervailing forces in MTSs: (I) originates at the team level; beneficial to team, but harmful to the MTS; (II) originates at the team level; harmful to the team, but beneficial to the MTS; (III) originates at the MTS level; beneficial to the team, but harmful to the MTS; and (IV) originates at the MTS level; harmful to the team, but beneficial to the MTS.

A full exploration of these types of forces is beyond the scope of this chapter. However, we would note instances of Type I countervailing forces when high component team differentiation from MTS diversity causes stronger team identity and cohesion and hurts between-team interactions. Alternatively, when MTS identification is strong, member identification with their respective component teams is diminished, resulting in a Type IV countervailing force (e.g., Asencio et al., 2016). Such a force can diminish the potentially positive effect of component team diversity on overall MTS creative problem solving in several ways. First, problem construction may not reflect perspectives of the different component teams. Although MTS diversity allows for a possibly broader and more complex definition and construction of creative problem elements, if concerns about disrupting MTS cohesion by offering different understandings of the issue at hand become too strong, then teams may seek to defer to an established perspective that satisfies the broadest constituency but may be missing some unique information. Second, during idea generation, teams may fail to offer ideas unique to their own perspective, choosing instead to work with ideas and information that are common to or shared by all of the teams (Stasser & Titus, 1985, 1987). Finally, idea vetting and evaluation requires a critical analysis by members of other teams (Hunter & Cushenbery, 2011). However, a preference for not disturbing MTS cohesion may reduce the tendency of teams to challenge emerging ideas that may not be the best solutions from their unique perspectives.

Note that these effects not only impair between-team dynamics in MTS creative problem solving, but they also hurt team-level processes, as team information processing defers to imperfect decisions and creative solutions emerging across other teams. Thus, strong MTS cohesion or trust, while beneficial for the MTS as a whole, can harm the within-team creative problem-solving processes that contribute to the quality of overall MTS creativity and innovation.

Multiteam System Team Boundary Management: Counteracting the Effects of Countervailing Forces

Research on both team innovation and MTS effectiveness suggests that processes of component team boundary management can mitigate or reduce the emergence of countervailing forces. However, such management may entail the careful balancing of external and internal foci. For example, Faraj and Yan (2009) provided evidence for the positive influence of three boundary processes in knowledge work (of which creative problem solving is a subset): boundary spanning, boundary buffering, and boundary reinforcement. Boundary spanning refers to reaching out to stakeholders and constituencies in the team's external environment to acquire information, resources, and other capacities (Marrone, 2010). Boundary buffering refers to when teams minimize interactions with their external environments, perhaps in order to reduce outside distractions, disruptions, and interferences (Faraj & Yan, 2009). Boundary reinforcement refers to activities "in which a team internally sets and reclaims its boundaries by increasing member awareness of boundaries and sharpening team identity" (Faraj & Yan, 2009, p. 607). Faraj and Yan found that the three boundary processes were positively associated with team psychological safety, and that under particular conditions of task uncertainty and resource abundance, were also positively related to team knowledge work performance.

Hülsheger et al.'s (2009) meta-analysis also found support for the positive influence of boundary spanning on innovation; external communication exhibited the second highest of 15 mean overall corrected correlations with team innovation (ρ = .48). However, while Büchel et al. (2013) found additional support for the positive influence of the number of external knowledge ties on innovation in new product development teams, they also found that centralized trust ties with stakeholders (suggesting a form of boundary spanning with fewer external stakeholders) were also associated with more effective new product teams. In addition, several studies have demonstrated that more centralized communications and planning by a core set of boundary spanners or MTS leaders was more strongly related to MTS performance than more decentralized boundary spanning among many team members (Davison et al., 2012; de Vries, 2015; Lanaj, Hollenbeck, Ilgen, Barnes, & Harmon, 2013).

These studies suggest that the relationship between boundary management and creativity/innovation may not be a simple one. Boundary spanning across component team borders in diverse MTSs is necessary to foster the exchange of different ideas and perspectives. However, too much information exchange can also lead to coordination losses (Davison et al., 2012; Lanaj et al., 2013). Also, Asencio et al. (2016) found that high levels of component team boundary spanning were associated with weakened team identities, fostering greater possibility of Type IV countervailing forces. To avoid each of these effects, component teams may need to balance boundary-spanning activities with boundary-buffering and reinforcement activities. A moderate amount of each type may be sufficient to (a) provide enough outside information to inform component team creative information processes (boundary spanning), (b) strengthen the team boundary enough to avoid the effects of Type IV countervailing forces on team and MTS creative problem solving (boundary reinforcement), and (c) protect the team and MTS from coordination inefficiencies that can accrue from too much communication (boundary buffering). Accordingly, we suggest the following proposition:

Proposition 8: Component team boundary spanning, reinforcement, and buffering will exhibit a curvilinear relationship with MTS creative problem solving, such that highest levels of such problem solving will be associated with moderate levels of each set of boundary management activities.

Summary

In this chapter, we explored several dynamics associated with MTS creativity and innovation. Creative problem solving is often a collective activity entailing the sharing of ideas and information, not only with other individuals in a team, but with those from other teams as well. We noted that MTS diversity can have similar effects on creativity and innovation as those in teams and that MTS structures can give rise to strong team differentiation, which can impair team creativity and innovation. Accordingly, we argued that strong MTS cognitive, motivational, and affective emergent states will moderate the effects of MTS diversity on creativity and innovation. However, we also noted that such emergent states can give rise to countervailing forces that can hurt team contributions to MTS creative problem solving. We suggested that these forces can be mitigated by moderate levels of particular boundary management activities. Our analysis in this chapter suggests that creative problem solving in MTSs is exponentially more complex than in individuals and teams, requiring a careful balance of intra- and interteam dynamics. Future research will be needed to integrate such issues as problem phase (Marks et al., 2001), environmental dynamism (Luciano et al., 2015), and leadership systems (Carter, DeChurch, Braun, & Contractor, 2015) into this analysis. The result should be a more nuanced yet rich understanding of how creative problem solving can flourish in multiteam systems.

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PART IV

Applications