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Valerie Sessa
Montclair State University, sessav@mail.montclair.edu

Manuel London
Stony Brook University

Marlee Wanamaker
Montclair State University

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How multiteam systems learn

Valerie I. Sessa
Department of Psychology, College of Humanities and Social Sciences, Montclair State University, Montclair, New Jersey, USA

Manuel London
College of Business, State University of New York at Stony Brook, Stony Brook, New York, USA, and

Marlee Wanamaker
Department of Psychology, College of Humanities and Social Sciences, Montclair State University, Montclair, New Jersey, USA

Abstract

Purpose – Extending a model of how teams learn, this paper aims to present a model of multiteam system (MTS) learning, comparing similarities and differences between how MTSs learn and how component teams learn. The paper describes the value of adaptive, generative and transformative learning for increasing MTS development over time.

Design/methodology/approach – The model proposes that environmental demands trigger adaptive, generative and transformative MTS learning, which is further increased by the MTS's readiness to learn. Learning can happen during performance episodes and during hiatus periods between performance episodes.

Findings – Learning triggers coupled with readiness to learn and the cycle and phase of MTS process influence the learning process (adaptive, generative or transformative), which in turn influences the learning outcomes.

Research/limitations implications – The study offers a number of research propositions with the idea that the model and propositions will stimulate research in this area.

Practical implications – This model allows MTS and component team leaders and facilitators to recognize that MTS learning is a process that is needed to help component teams work together and help the MTS as a whole perform in current and future situations, thereby improving MTS effectiveness.

Originality/value – Little attention has been given to the notion that MTSs learn and develop. This manuscript is the first to emphasize that MTSs learn and identify processes that can improve learning. Adaptive, generative and transformative processes describe how MTSs learn and produce changes in MTS structure and actions.

Keywords Learning, Multi team systems, Performance episodes

Paper type Conceptual paper

Multiteam systems (MTSs) are an organizational form that consists of multiple teams in a fluid, a semi-permanent network. The MTS pursues at least one shared goal in addition to each component team's goals and tasks (Luciano *et al.*, 2015; Shuffler *et al.*, 2015; Shuffler and Carter, 2018). MTSs are increasingly recognized as important, yet challenging, organizations that are receiving increasing attention from researchers in an effort to understand their operation and identify ways to improve their effectiveness (Zaccaro *et al.*, 2012; Shuffler and Carter, 2018). Although MTSs are similar in some ways to stable organizations and teams, they are different enough entities to warrant understanding them separately (Luciano *et al.*, 2015). Examples of MTSs are emergency response teams, military missions, large-scale projects such as a NASA launch, and productions, such as the process of organizing music festivals and producing films. MTSs are expected to respond effectively to complex challenges.

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The concept of learning applies to teams and organizations just as it does to individuals (Argyris and Schön, 1996). In teams, members learn how to work together. They develop a shared mental model of how they work together to accomplish the team's goal, that is, a transactive memory system (Mohammed and Dumville, 2001; Wegner, 1987, 1995). They may adapt, generate new ways of working and indeed transform themselves as the environment and demands change (London and Sessa, 2007; Sessa and London, 2006). Here, we consider how MTSs learn. We describe the challenges of MTS operations and development over time, compare MTS learning to team learning, consider factors that trigger learning and examine MTSs learning as they perform (for instance, responding to emergencies) and during hiatus periods between performance episodes. We consider dimensions of an MTS's readiness to learn. Our model, presented in Figure 1, emphasizes the importance of learning triggers to stimulate adaptive, generative and/or transformative learning. How learning evolves depends on whether the MTS is operating (a "performance episode") or is between operations (a "hiatus" period) and has time to be generative and transformative, and the MTS's readiness to learn. This is a developmental process in which MTS learning increases readiness to learn in the future. The paper concludes with implications for research and practice on leading, coordinating, and facilitating MTS learning.

Challenges and opportunities for multiteam system learning

Teams are likely to have a relatively stable structure of leaders and members, goals, ways of operating and time lines. These characteristics of a team may evolve over time as members and the situation change. However, MTSs are dynamic by nature. The teams that make up the MTS may come and go depending on the need and their role. MTSs need to develop inter-team linkages, but they also need to be responsive and adaptable to often highly uncertain and changing situations (Luciano *et al.*, 2015; O'Leary *et al.*, 2012). Indeed, they may reconfigure for each situation (including the possibility of a different set of component teams or a changing set of component teams as the situation unfolds) and perform, often in non-routine ways with unique responses. MTSs need to learn how to configure and reconfigure and how to be effective in their environment working toward and reaching their

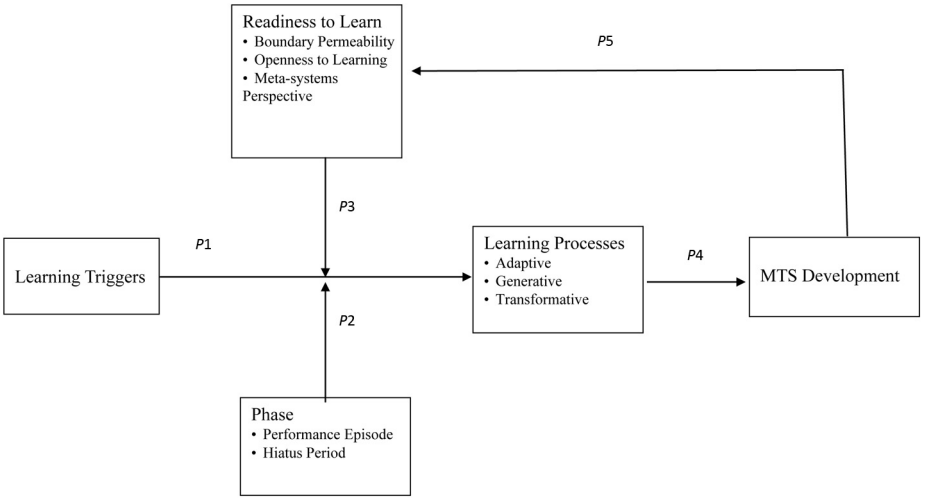

Figure 1.
MTS learning processes

goals. However, little attention has been directed toward understanding how MTSs learn to do this (Shuffler and Carter, 2018). We present an integrative learning model drawing on team dynamics to understand similarities and differences between MTSs and component team development and address how the model can be applied to understand and facilitate MTS learning.

Characteristics of multiteam system that influence learning

Consider characteristics of MTSs and how they differ from their component teams. Challenges for MTS Learning:

(1) Organization
- Component teams have their own life and purpose. The teams have dotted line reporting relationships to the MTS.
- The teams in the MTS need to be integrated – the MTS is more than a sum of its component teams.

(2) Responsiveness
- MTSs need to adapt to changing conditions and need to increase their preparedness for the future and to do this continuously. As such, they need to be generative learners, adopting new ways to work together, incorporating new technologies and work methods, drawing on, and integrating, the different functions of the component teams and experimenting with new methods.
- MTSs may be formed quickly for immediate response. This may occur ad hoc with teams that are available and depending on volunteers. As such, capabilities and experience of component teams may be variable.
- MTSs deal with complex and uncertain conditions. The MTS needs to act rapidly to establish needs and determine effectiveness.

(3) Leadership and communication
- Top down control may not work well in an MTS because component teams have their own perspectives and because individuals in the component teams have to respond immediately to current conditions.
- Communication between teams and between leadership and teams may be unclear or incomplete.
- The coordination of plans and training depend on component team availability and willingness.
- Leaders of the MTS do not choose component team leaders or members but may influence their membership and training.

(4) Development
- The MTS needs to learn and develop over time yet be ready for action at any one point in time.
- MTSs need to learn how to configure and re-configure and how to be effective in working toward and reaching goals.
- Learning in an MTS occurs as the MTS is operational (engaged in "performance episodes"), as well as when it is forming and between performance episodes. During hiatus periods, the lead team, if there is one, and the MTS component teams plan, learn (participate in various learning

exercises, such as case studies, simulations and drills), assess capabilities and look for ways to improve.

- Learning in an MTS occurs at the individual, team, MTS and organizational levels.

(5) Performance

- Outcomes need to be assessed during actual events and during training by using the information for continuous improvement.
- The dynamic nature of situations reduces control and predictability.

From the standpoint of organizational structure, MTS component teams have their own life and purpose separate from the MTS. Likely, the component teams have dotted line reporting relationships to the MTS coordinator or coordinating team. The teams in the MTS need to be integrated. That is, the MTS is more than a sum of its component teams. It has an identity and purpose that the members of the component teams recognize. This includes the purpose of each component team but go beyond these teams. Similar to individuals having different identities and roles (work, family and nonwork activities) and identities within these different roles (e.g. being a member of different committees and task forces at work), teams operate on their own and within the context of one or more MTS. Similar to teams, MTSs need to adapt to changing conditions and increase their preparedness for the future and to do this continuously. As such, they need to be generative learners, adopting new ways to work together, incorporating new technologies and work methods, drawing on, and integrating, the different functions of the component teams and experimenting with new methods. We will compare how these elements of MTS learning are similar to and different from team learning.

MTSs may be formed quickly for immediate response. This may occur ad hoc with teams that are available. As such, capabilities and experiences of component teams may be variable. MTSs deal with complex and uncertain conditions. The MTS needs to act rapidly to establish needs and determine effectiveness. Unlike teams, top down control may not work well in an MTS because component teams have their own perspectives and because individuals in the component teams have to respond immediately to current conditions. Communication between teams and between leadership and teams may be unclear or incomplete. The coordination of plans and training depend on component team availability and willingness. Leaders of the MTS do not choose component team leaders or members but may influence their membership and training.

Similar to teams, MTSs learn and develop over time yet need to be ready for action at any one point in time. However, as indicated above, MTSs need to learn how to configure and re-configure over time. Learning in an MTS occurs as the MTS forms and operates during "performance episodes" and during "hiatus periods" between performance episodes. During hiatus periods, the lead team, if there is one, and the MTS component teams plan, assess capabilities, learn (participate in various training exercises, such as case analyses, simulations and drills) and look for ways to improve. As such, learning in an MTS occurs at the individual, team and MTS levels. Similar to teams, performance outcomes need to be assessed as the MTS operates – that is, during actual events and training. While the MTS, like a high performing team, strives for continuous improvement, the dynamic nature of situations faced by MTSs reduces control and predictability.

Multiteam system continuous learning

We define MTS continuous learning as

> A deepening and broadening of an MTS's capabilities within and across teams (re)structuring to meet changing conditions, adding new skills and knowledge, and (re)creating into a more and more sophisticated system through reflection on its own actions and consequences.

Focusing on the MTS as a learning entity, we consider key characteristics of MTSs that present challenges to learning. MTSs are composed of teams that have their own purpose and established (learned) ways of working that contribute to, and sometimes conflict with, the MTS. MTSs are fluid – formed to address a particular situation so there are no ongoing methods of operations that can be refined and repeated exactly or even stable and clear channels for communications (Fodor and Flestea, 2016). They are dynamic – changing as the situation evolves with different teams coming in and out requiring educating new teams on goals and process and reconfiguring relationships. They have a loose organizational structure (unclear and/or changing hierarchy of authority) which makes determining lines of authority difficult. They may not be well-defined as distinct entities as multiple coordinating individuals and entities may be involved, making for potential disagreements over what needs to be done, how and by when. They experience times between actions, which may or may not be used constructively, for instance, to take the opportunity for debriefing, identifying and practicing improved methods of interaction.

Understanding MTS learning is similar to team and organizational learning in that it calls for identifying parallel learning constructs and processes that apply similarly at the individual, team and organizational levels (Sessa and London, 2006; London and Sessa, 2007; Sessa *et al.*, 2011). MTSs are formed to address a particular situation drawing on existing teams, each of which has its own structure and purpose. Individuals learn behaviors that they apply within teams. Individuals within teams learn to interact in ways that produce team outcomes. Teams within MTSs learn between-team linkages that use team-level expertise to contribute to overall MTS goals. Teams within MTSs have their own functions and ways of operating. Unlike teams within a permanent (although changing) organization, MTS component teams do not necessarily work together unless the need or opportunity arises. Yet when they do work together, they need to address immediate concerns as projects and events unfold. Between events, they may prepare, analyzing ways to work together more effectively based on what worked well and what did not in the past and then practice (e.g. emergency drills). This is how the MTS as a whole learns.

As suggested by organizational learning theories (Crossan *et al.*, 1999; London and Sessa, 2007; Wenger, 1999), individuals can learn and trigger learning in their component teams and in the MTS. Consider ways this learning occurs. First, the MTS as a whole can engage in learning processes. This could happen through mechanisms such as drills and simulations to practice current processes and procedures via adaptive learning, try new technology or communication systems using generative learning processes or even try a novel, transformative structure. Second, learning can happen in the MTS's leadership team (Davison *et al.*, 2012), and the learning can flow down to the component teams via the leaders or integrating members (team members who communicate with members of the other teams). Third, learning can happen first in a component team and flow into the MTS as a whole. Component teams come from other organizations, can be their own stand-alone entity and can work in other MTSs. As they learn and change in other settings, they can bring that new learning into the MTS. Fourth, learning can flow horizontally from team to team via multi-team memberships (O'Leary *et al.*, 2011). Multi-team membership occurs when people are concurrently members of multiple component teams in the MTS.

So learning can happen in a variety of ways:

- MTS members have a view of their own team, other teams and the MTS. They see how these entities interact, and they may suggest ways to smooth out the processes and procedures.

- A component team can engage in learning processes on its own, then the multi-team member can suggest to other teams what, when and how to make changes based on the learning in the first team.
- The multi-team member acts as a communication conduit between teams, thereby facilitating a shared mental model as well as greater integration between them.

Learning triggers

Figure 1 describes elements of team learning that apply to the dynamic nature of MTSs. *Learning triggers* are the first element of the model. They are demands that affect the MTS such that it cannot continue to perform in the same way and be successful without learning. The demands may be interruptions, changing conditions or opportunities that impose more and/or different expectations for the MTS to provide emergency services, meet a major objective, solve a problem, etc. Triggers vary in clarity, immediacy and force (London and Sessa, 2007). In teams, triggers interfere with action and stimulate reflection and adaptation (Oertel and Antoni, 2014). Examples of learning triggers for an emergency response MTS for rescue operations during a hurricane might be a major change in the weather for the worse, flooding causing electric line failure across a wide swath of territory, an explosion, the failure of equipment or loss of personnel. These learning triggers change routines and influence knowledge transfer activities (Zellmer-Bruhn, 2003). Triggers that are clearer, more immediate and more forceful are more likely to be recognized and acted upon by the MTS. Leaders of MTSs and their component teams can improve MTS processes by recognizing characteristics and conditions in themselves and their teams that allow them to learn when the MTS is in action and when it is not in action:

P1. Changes in the environment and associated expectations for the MTS trigger learning. The stronger the trigger, the more learning is necessary to respond to the environment and meet expectations.

Adaptive, generative and transformative learning in teams and multiteam systems

Our model articulates three types of learning: adaptive, generative and transformative (Sessa and London, 2006). These types of learning refer to the way teams and MTSs learn and what is produced. *Adaptive learning* is a reactive mechanism due to a change in the environment that the system adjusts to and may be unnoticed by the system. *Generative learning* is purposefully adding and using new behaviors, knowledge and skills to their repertoire. *Transformative learning* is transforming into a different entity through reframing and experimentation. Teams learn and make more major changes (generative and transformative) when there are forces (triggers) in the environment and when they are open to change (readiness to learn). One type of learning is not necessarily better than another.

Which type of learning occurs depends on what is needed. This depends on the strength of the trigger that produces the learning and the MTS's readiness to learn. Learning that leads to adaptations may be sufficient to improve the effectiveness of an MTS during a performance episode and make refinements to operations during hiatus practice sessions. An MTS that is stymied by unanticipated events may be stimulated to search for, and indeed invent, methods. They learn generatively through exploration and discovery and transformatively by inventing and experimenting with methods that disrupt the way the MTS had worked in the past.

Consider how adaptive, generative and transformative learning differ between teams and MTSs, outlined in Table I. When teams operate outside the context of an MTS, they have time to learn. They engage in adaptive learning by changing assignments, schedules and procedures as errors occur and situational demands change. Adaptive learning in MTSs may be adopting what worked elsewhere or at an earlier time. MTSs may redirect component team assignments and operations and bring in new teams to add power. Component teams may be used to make changes in response to changing conditions, but within the MTS, they need to conform to the changes required by the larger system. Teams can be generative, exploring new ways of working. Members make suggestions. Members discuss alternative methods, and they try them, testing and measuring as they aim for continuous improvement. MTSs may create new configurations on the fly in response to unexpected occurrences and sudden increases in demand. They engage in rapid trial and error learning recognizing and communicating new procedures as they perform, and then come together after an event to recognize what they did that worked well, codify effective processes (i.e. making recommendations in an after-action report for improved procedures for future missions) and incorporate these processes in preparedness training (e.g. drills and simulations). Team learning can be transformative. Teams experiment by comparing one method of operating to another, adopting new methods (e.g. technologies), comparing results and making refinements.

What occurs as multiteam systems learn

Team learning has been characterized as a multilevel (individual, team and organization) continuous learning process (Burke *et al.*, 2006). The process starts with situation assessment (learning triggers) and planning based on individual and team capabilities and readiness to learn, task design (transactions that need to be learned), planning, monitoring, leadership and eventually the development of shared mental models, team situation awareness that deepens over time and psychological safety. Feedback provides input for continuing the learning process. As learning occurs, MTSs, similar to teams, establish and improve operations. Consider how the MTS develops over time:

- The MTS creates norms that regulate how to "be" an MTS in each new performance episode (Fodor and Flestea, 2016).
- A transactive memory system emerges about what needs to be done, how and when (Wegner, 1987, 1995).

Modes of learning	Individual teams	MTSs
Adaptive	Teams shift assignments, schedules, and procedures in response to errors and changes in the situation	MTSs adopt what worked elsewhere or earlier, redirecting component team assignments and operations and bringing in new teams to add power
Generative	Teams explore (suggest, discuss, and try) alternatives (e.g., new procedures) for continuous improvement with time for testing and measurement	MTSs create new configurations on the fly in response to unexpected occurrences and sudden increased demand; rapid trial and error learning; recognizing, codifying, and communicating new procedures
Transformative	Teams experiment by comparing one method of operating to another, adopting new methods (e.g., technologies), comparing results, and making refinements	MTSs may implement what has never been tried before as a rapid response to suddenly shifting conditions

Table I.
Learning in teams and MTSs

- A shared mental model develops – that is, an agreement among teams and their members about how the teams will work together, such as set goals and time lines, make team assignments, etc. (Fiore *et al.*, 2001).
- An expected pace of operations develops (what the teams will do and when; Ancona and Chong, 1996; Standifer and Bluedorn, 2006).
- In addition, and importantly, the MTS learns how to learn, that is, how best to set time aside for reflection during periods of action and transitions between action periods when the MTS is not in operation. The MTS learns how to capture (codify) the learning so it can be repeated and passed on to new members (component teams and individuals). The MTS needs to take time to recognize processes that worked well and those that did not and document the successful methods so they can be repeated when similar conditions arise.
- Members of component teams and stakeholders (including beneficiaries of the MTS's actions) develop confidence and trust in the MTS. Methods of operation evolve. For instance, new technologies are integrated into MTS operations.
- The MTS knows how to be retrospective in examining past actions and accomplishments and prospective in planning improved response patterns.

In adaptive learning processes, MTSs can develop and practice routines and fine-tune patterns of behavior, interactions and coordination (Berry and Dienes, 1993; Reber, 1993).

The focus is on learning what teams (and who within the teams) have what skills. This is the emergence of a transactive memory system. The MTS teams can set up communication channels and method of communication and practice them to create consistency in workflow, performance and response time.

In generative learning processes, the MTS is proactive in discussing and analyzing past processes to determine what worked and what did not, seeking knowledge and skills, reviewing new information and data, developing new protocols and tests and practicing them. Generative learning processes in MTSs include scenario planning, simulations, creation of MTS charters, after-action reviews and introducing and learning new technologies (e.g. methods for communicating). For example, Asencio *et al.* (2012) examined the use of charters to promote collaboration among teams within MTSs. Teams developed and agreed on plans for tasks that needed to be carried out and processes, such as regular meetings and practice drills, to establish teamwork.

In transformative learning processes, the MTS and component teams transform goals, structure and roles during reflection and action teamwork processes to form new and flexible ways of working together. In Argyris and Schön's (1996) terms, this is Model II double-loop learning. It is not just a building process for growth (a hallmark of generative learning) but a result of reflection, critical analysis, deconstruction and rebuilding (Mezirow, 1991). The MTS may change or add component teams, integrate roles of teams and team members within teams across functions and establish new leadership and communication processes that are flexible, changing as the situation changes. Teams within the MTS learn to move from action team to support team (and back again) depending on the performance episode or the stage of the performance episode (Davison *et al.*, 2012). Essentially, the MTS learns how to change as the performance episode needs change and as insights from previous episodes emerge. For instance, FEMA learned from Hurricane Katrina that top-down control does not work well. In Hurricane Harvey, 12 years later, FEMA representatives embedded themselves in local teams to be able to be more responsive to immediate needs. (Philips, 2017).

Adaptive, generative and transformative learning processes can occur at different times within the same MTS, and some behaviors and interactions may have elements of each process. An MTS can engage in adaptive learning processes while meeting immediate needs and engage in generative learning processes to add new behaviors or new knowledge, which may prompt transformative learning processes as the MTS realizes it needs another component team or realizes the MTS component teams need to interact differently.

Learning during periods of performance and hiatus

MTSs operate when they are needed. We call these performance episodes. Within a performance episode, there are times for action and times for reflection and transition. These may overlap, for instance, when coordinators and team leaders meet to evaluate the situation and make adjustments to operations, perhaps calling for additional resources and more teams to join the MTS. After a performance episode, the MTS is in hiatus. A coordinating body may analyze what happened during the performance period and capture learning that can be used during future performance episodes by the same MTS or other MTSs. Also, periods of hiatus are times for MTS training, component teams undergoing drills (e.g. simulated emergencies) to incorporate new methods, be sure new members on the component teams are familiar with MTS protocols and ingrain cross-team transactions (i.e. develop a transactive memory system through shared experiences that can be enacted when needed). For instance, a performance episode for a municipal emergency response team might be a hurricane. An action phase within the episode is when actions are taken, for instance, to rescue stranded citizens. There may be periods of hiatus in between actions when teams have a chance to renew and analyze their actions. The time between hurricanes or other emergency events is when planning, warning systems, methods of communication, practice drills and other means of preparedness can occur.

The idea of performance episodes stems from Marks *et al.*'s (2001) temporally based phase model of team processes. Performance episodes are distinguishable periods of time over which performance accrues and feedback is available (Mathieu and Button, 1992, as cited in Marks *et al.*, 2001). More than one performance episode can occur simultaneously, and within some MTSs, there are times when no performance episode is occurring at all (a hiatus period during which the component teams may go about their business independent of the MTS). Within a performance episode, there are periods of action (the "doing" or "taskwork") and periods of transition (the monitoring, assessment and strategizing). Performance episodes vary in degree of complexity of their environments (Mathieu *et al.*, 2001), their duration (a few hours to decades) and the length of time between performance episodes (hiatus periods).

During action phases within performance episodes, MTSs may not notice or be able to respond to learning triggers beyond adaptation even if they are clear, immediate and strong because the action phase entails "doing." During transition phases, learning processes may be more easily activated even if triggers are not particularly clear, immediate or strong. Thus, adaptive learning during action phases may lead to generative or transformative learning processes activated when they take time to reflect, during transitions as performance episodes unfold and during periods of hiatus between performance episodes.

Whether the MTS is in a performance episode or a hiatus phase affects whether the MTS will notice triggers for learning. During performance episodes, the environment may already be so rich in stimuli that the MTS is busy reacting to perform or even survive (Kapucu and Garayev, 2011). MTSs may not notice or be able to respond to learning triggers beyond

adaptation in this instance, even if they are clear, immediate and strong as they are busy "doing." However, a strong trigger, such as an unanticipated emergency and failure of MTS efforts may stimulate innovations that give rise to new knowledge and transformation of MTS structure and actions. During hiatus periods, in some cases, the MTS may disband entirely until the next performance episode, making any triggers difficult to notice. However, hiatus periods provide time for deep after-action analysis that generates insights and knowledge that was not evident during the performance episode – knowledge that can be shared among teams and that paves the way for improved functioning in the future. This analysis can lead to innovation design, trial, practice and implementation that can be transformative (e.g. identifying or developing new technologies, which in turn can produce different configurations of component teams and new operational strategies for the next mission).

P2a. The stronger the trigger, the more the MTS will go beyond adaptive learning to learn in generative and transformative ways and produce associated changes in MTS structure and actions.

P2b. The phase within a performance episode (action or transition) moderates type of learning that will occur in response to triggers for learning. Triggers during performance episodes are more likely to be adaptive, while triggers during hiatus periods when there is time for practice and experimentation are likely to produce generative and transformative learning and associated changes in MTS structure and actions. However, sufficient demands during performance episodes may generate new knowledge and lead to transformations in how an MTS works.

Readiness to learn

Readiness to learn refers to how open the MTS is to change and how likely the MTS is to participate in learning activities in response to pressures in the environment and opportunities to improve. Individuals, teams and MTSs vary in their readiness to adopt or maintain a change ranging from not being aware of the problem to making significant changes in behaviors and interaction protocols (Prochaska *et al.*, 1992; Prochaska *et al.*, 2001). Consider three factors that increase an MTS's readiness to learning: boundary permeability, openness to learning and a meta-systems perspective.

Boundary permeability

On the one hand, the function of the boundary is to buffer and close off the system from the environment to protect it. On the other hand, boundaries need to allow resource exchange (Yan and Louis, 1999; Sessa and London, 2006, 2008). If anything, MTS boundaries are likely to be too permeable, sometimes with little clarity about what teams are actually a part of the MTS or the extent to which different teams recognize that they are a part of the MTS. *Permeability* is the system's openness to external influences. System permeability is accomplished through boundary spanners, gate keepers, scouts, ambassadors, sentries and guards and mechanisms such as communications technology (Ancona and Caldwell, 1988; Katz and Allen, 1985; Tushman and Katz, 1980). Systems vary in the permeability of their boundaries and struggle to maintain an optimum balance between stability and change (Alderfer, 1980). In MTSs, all team leaders and members may be boundary spanners, creating challenges for the team leaders and the MTS leadership to maintain sufficient structure to operate as a system.

Boundary permeability varies in openness, described in the next section, in ways that differentiate systems that learn readily from systems that appear more reticent to learn (Capra, 2003). Openness allows the process of learning to be set in motion. Systems vary in their openness to disturbances. This facilitates, and sometimes stimulates, the learning process. MTSs deal with disturbances in the environment, and as such, they face disturbances to their coherency as a system. MTSs need to learn how to respond effectively to events.

Openness to learning

MTS learning requires that the system is open to disturbances and is ready to learn how to deal with them. MTSs' openness to disturbances can be understood in terms of the learning goal orientation of individuals and teams within the MTS (LePine, 2005; Porter, 2005), as well as what will become the learning culture of the MTS as a whole. In other words, the MTS needs to be ready to learn as it goes and as it processes outcomes.

Second, systems vary in their openness to, or tolerance for, uncertainty (including confusion, pain, ambiguity and doubt). This allows the system to try different options and engage in learning experiences as a means of reducing ambiguity. Openness to uncertainty can be understood in terms of psychological safety (Edmondson, 1999) and trust (Bunderson and Sutcliffe, 2003; Edmondson, 1999) within the MTS – the confidence of the MTS leaders and team members that they are part of an effective MTS and members of effective teams that have their own goals separate from the MTS. Also, systems vary in their openness to novelty. This openness allows the system to innovate. Openness to novelty can be understood in terms of team voice – input from members about goals and operations (Li *et al.*, 2017). Openness to disturbances, uncertainty and novelty allows the system to generate or transform rather than merely adapt. This may mean doing things quite differently in response to never before seen events.

Meta-systems perspective

Factors that differentiate component teams from each other and disrupt coordination between teams are likely to reduce the MTS's readiness to learn. Factors that connect component teams to each other and enhance coordination among teams are likely to enhance the MTS's potential to learn (Lanaj *et al.*, 2017; Zaccaro and DeChurch, 2012). For example, Luciano *et al.* (2015) delineated team characteristics that affect the extent to which component teams in an MTS can coordinate or have trouble coordinating. For instance, boundaries between teams may prevent or challenge coordination among teams. These boundaries may include differences, ambiguity and incompatibility of team goals, competencies, norms (policies and expectations), work processes and information about team operations. Changes in these characteristics may change operations within teams and facilitate coordination between teams in the MTS. For instance, these changes might be in team goals to be aligned with MTS goals, the time and certainty of what tasks are required for teams to achieve these goals and improvements in how the teams are linked together (e.g. how they communicate and report to each other).

MTSs that have a systems perspective understand the roles, responsibilities and capabilities of component teams. This usually emerges over time as the component teams become acquainted with each other during preparation and demonstrate their ability to contribute to the MTS goal when working as a unit. The stronger the systems perspective, the more the component teams are likely to be ready to respond to each other's initiatives for learning and change and the more they are likely to see the situation similarly and initiate learning that others will respond to positively. Such a system will be more likely to be

unified on its perceptions of the environment, the forces that impinge on it as individuals and as component teams, and the behaviors that are called for as a response.

MTSs that are able to maintain the boundary permeability of the component teams, as well as the MTS as a whole, build on their openness to learning and reinforce a meta-systems perspective will learn continuously and be open to generative and transformative change. MTSs that are ready to engage in learning become increasingly ready to learn in the future and will be more responsive to triggers for learning. Hence, the stronger the MTS's readiness to learn, the more the MTS will move from adaptive to generative learning and be open to transformative learning.

Table II describes actions that demonstrate MTSs readiness to learn. These occur at the team level, with a focus on interactions with other teams in the system, and at the systems level, they are coordinated across multiple or all teams in the system. Also, these occur during performance episodes and hiatus periods. During performance episodes, boundary spanning is evident when teams observe other teams and copy MTS operations from earlier episodes and from MTSs elsewhere facing similar situations. The MTS's openness to learning during performance episodes occurs when teams gather information from within and outside the

Readiness factors	During performance episodes	During hiatus periods
Boundary Spanning	Observing other teams and MTSs Copying other MTSs' experiences elsewhere	Communicating across teams Holding joint meetings and events for review, training, and planning
Openness	Gathering information from within and outside the MTS Seeking and reviewing results from teams across the MTS Changing actions in response to feedback	Engaging in the design, implementation, and evaluation (trials, comparisons, and controlled experiments) of methods to improve outcomes (increasing rapidity and comprehensiveness of response and effectiveness of actions)
Meta-systems Perspective	Sharing and integrating experiences and results across teams within the MTS Improving communication, coordination, and tracking mechanisms Increasing interdependence among component teams	Developing new command and control structures and ways to communicate, control, and track operations (fine tuning existing methods based on prior outcomes and creating and testing new methods) Finding synergies of operations that increase team interdependence—during practice, discovering the potential for integrating teams when necessary or taking advantage of capabilities for working together Strengthening the brand of the MTS—its identity among the component teams and outside the MTS (logos and insignia, laudatory communications from officials, etc.) Celebrating MTS successes and recognizing achievements of individuals and teams' contributions to the MTS
Learning	Adaptive responses Sparks of insight and spontaneous serendipitous events and outcomes that create generative and transformative learning	Adaptive learning toward continuous improvement of team and MTS operations Generative learning from explorations of the new methods and generation of new knowledge Transformative learning from discoveries and inventions within and across disciplines that improve outcomes for individual teams and for the MTS as a whole

Table II.
Actions that promote MTS readiness to learn

MTS, seek and review results from teams across the MTS and change actions in response to feedback. During a performance episode as actions occur or during intervals when there is some time, at least for some teams, to reflect, the MTS with a meta-systems perspective will likely share and integrate experiences and results across teams and find ways to improve communication, coordination and results tracking. This can lead to greater interdependence among the teams, which produces tighter operations (e.g. closer coordination of component team actions and avoiding duplication of effort and errors resulting from miscommunications). Overall, the readiness factors during a performance episode lead to adaptive responses. Sparks of insight from spontaneous and serendipitous events and outcomes may suggest novel ways to attack a problem, providing new knowledge and potentially be transformative learning experiences.

During hiatus periods, the MTS with boundary spanning experiences is likely to communicate across teams, for example, holding joint meetings and events for reviews, training and planning. The MTS that is open to learning is likely to engage in the design, implementation and evaluation (trials, comparisons and controlled experiments) of methods to improve outcomes, increasing rapidity and comprehensiveness of response and effectiveness of actions. During downtimes, the MTS with a meta-systems perspective is likely to develop new command and control structures (reporting relationships) and ways to communicate, control and track operations (e.g. electronic response coordination technologies), fine tuning existing methods based on prior outcomes and create and test new methods. During practice sessions, the MTS may find synergies of operations that increase team interdependence. This could include the potential for integrating teams when necessary or taking advantage of capabilities for working together. The MTS could create and distribute logos and insignia that reinforce identity with the MTS. MTS leaders can send messages to component teams and individuals within them congratulating and thanking them for prior service. The MTS can hold celebrations of success and give awards to teams and individual team members. As a result, hiatus periods with MTSs that are ready to learn could produce adaptive learning toward continuous improvement of team and MTS operations, generative learning for MTS growth from explorations of the new methods and generation of new knowledge, and transformative learning from discoveries and inventions within and across disciplines that improve outcomes for individual teams and for the MTS as a whole.

P3a. MTSs that have higher boundary permeability, openness to learning and meta-systems perspective are more open to triggers than MTSs with lower boundary permeability, openness to learning and meta-systems perspective.

P3b. Boundary permeability, openness to learning and a meta-systems perspective encourage and support generative and transformative learning.

Multiteam system development

MTSs can move from a set of independent, fragmented teams with few structures, processes or routines that bind them together as a system to a more pooled operation with simple structures, processes and routines in place and then further to a tightly knit set of teams that interact in predefined and well-practiced ways. As such factors as interteam trust, communication and shared mental models develop, MTSs become more coordinated (Wijnmaalen *et al.*, 2018). As more complex and sophisticated structures and processes emerge, the component teams begin to work as a unit (Kasl *et al.*, 1997). Each team knows its

function and how it fits into the system. The more the MTS works as an integrated unit, the more a change in one element of the unit will affect other elements and the unit itself.

When an MTS is still a set of fragmented teams and processes, adaptive learning may occur, but will probably occur slowly. However, if the premature MTS is pressured into working frequently as a unit, the MTS may not have the time to evolve systematic processes and behave as a unit. As the MTS gains traction as a unit (that is, forms structures, processes and routines), it will become proficient at adaptive learning. As the MTS matures, acquiring and integrating new modes of operation will become easier (generative learning). Ultimately, after demonstrating effectiveness, the MTS will actively seek and experiment with novel ideas, technologies and methods (transformative learning).

P4a. Adaptive, generative and transformative learning increase the MTSs level of development for future actions.

P4b. Generative and especially transformative learning, while rarer than adaptive learning, produce greater change than adaptive learning – change that makes the MTS stronger, more unique, and offers directions for other MTSs.

P5. Adaptive, generative and transformative learning increase readiness to learn in the future (increases in boundary permeability, openness to learning and a meta-systems perspective).

Discussion

Although MTSs are organizational forms that are expected to be fluid, adaptable and capable of responding effectively to complex situations, little theory or research to date has been directed toward understanding how to make this happen. Students of MTSs are beginning to recognize the lack of attention in this area and are calling for guiding information to help address this need (Shuffler and Carter, 2018). The purpose of this paper was to consider how MTSs learn and develop by extending an existing multi-level model to MTSs. We described three learning processes (adaptive, generative and transformative) and learning outcomes, as well as factors that trigger learning processes, processes that create and reinforce readiness to learn. The more pressures, demands, challenges and opportunities occur, the more likely learning processes will be triggered. When and how the MTS notices triggers in the environment and responds by engaging in learning processes depends on the MTSs' readiness to learn, which is influenced by boundary permeability, openness to learning and member and team meta-systems perspective. Although triggers may be more likely to occur during performance episodes, they are more likely to be addressed beyond adaptation during hiatus periods. Finally, we suggest that learning can occur all at once or can flow through the system.

Implications for research

Our goal was to broadly cover the main processes entailed in MTS learning and offer research propositions. At present, there is little or no research on MTS learning. Research is needed on factors that could impact team learning that are not addressed in this model, such as having the "right" set of component teams in the MTS (teams with needed capabilities), leadership processes (Wijnmaalen *et al.*, 2018; Zaccaro and DeChurch, 2012), intra-team processes impacting inter-team processes (Shuffler and Carter, 2018), conflict and power dynamics among component teams, effects of changes in membership and processes within and between teams and creating an environment for continuous learning to name a few

possibilities. The purpose of presenting this model is to encourage researchers to think about and pursue MTS learning studies.

Implications for practice

Although there is yet little research on this topic, our model suggests ways to diagnose an MTS's learning potential, which in turn can be used to formulate learning interventions or how to structure the MTS environment for learning to occur more easily:

(1) Recognize that learning is a process that MTSs can and need to engage in to help component teams work together and to help the MTS as a whole perform in the current situation and in the future. Learning can be adaptive, generative and/or transformative. MTSs need to be adaptive learners, coalescing component teams to follow agreed-to policies and consistent operating procedures. MTSs, because of the severe pressures they are often under, also need to be generative and transformative learners, inventing and trying new methods, experimenting with and incorporating new technologies and integrating new teams and individuals. MTSs capture this learning during reflection periods of performance episodes so successful processes can be repeated and unsuccessful processes avoided.

(2) Use hiatus periods as rich learning opportunities and opportunities to codify learning. MTSs can prepare during hiatus periods. Practice drills and other training methods are adaptive learning. MTSs can also use hiatus periods for generative and transformative learning, experimenting with new structures and processes.

(3) Pinpoint triggers for learning. Challenging situations necessitate learning during performance episodes. During hiatus periods, alternative scenarios can be considered and alternative operational processes can be tested. MTSs that practice reacting to a wide range of challenges are likely to learn how to be generative and transformative.

(4) Help MTSs be ready to learn. Extend and take advantage of boundary permeability, help the MTS develop into a more unified system and help members and teams see the bigger picture and better understand their purpose in the system. This might include joint meetings between teams during hiatus periods to debrief a performance episode. Joint training exercises will emphasize to team members that their team has an identity and roles as a component of the MTS, that their team contributes to the effectiveness of the MTS as a whole, and that the teams within the MTS are mutually dependent. MTSs that are open to ideas and information beyond the borders of component teams and the MTS itself are likely to:

- develop routines and charters that are firmly ingrained (adaptive learning); and
- revise those routines and build new and increasingly more effective mental models (generative and transformative learning).

(5) Provide resources for learning and resources for capturing the learning. MTS leaders, members and resources need to understand and can facilitate, adaptive, generative and transformative learning following the strategies noted in Table I. Adaptive learning may occur by examining and adopting methods from after action reports of this and other MTSs. Generative learning can be facilitated by a willingness to try new configurations and strategies during performance periods and assessing and refining them as outcomes emerge. Transformative learning during performance periods can come from experiments, for example, trying a new method or technology in one location and a different method or technology in

another. Hiatus periods provide more time for experimentation, possibly splitting teams to form two or more MTSs and engage in drills to compare the outcomes of different strategies. As we proposed (*P5*), the more the MTS engages in strategies for learning, especially generative and transformational learning, the more open the MTS will be to learning in the future, including during performance episodes when the MTS is under pressure to perform.

Conclusion

We extended a multi-level model of team learning to how MTSs learn. MTSs learn continuously, especially when individuals and component teams are ready to learn and the environment imposes triggers for learning. Environmental triggers impose demands for adaptive learning and opportunities for generative and transformative learning. Boundary spanning, openness to learning and a meta-systems perspective of the component teams and the MTS as a whole increase the MTS's readiness to learn. Adaptive learning is most likely to occur during performance episodes although unexpected and severely increased disturbances can produce the need for generative and transformative learning. Hiatus periods provide time for reflection, invention and experimentation to promote MTS growth (generative learning), and sometimes transformation, in preparation for future missions.

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About the authors

Valerie I. Sessa, PhD, is the Director of the Industrial and Organizational Psychology master's program and a Professor of Psychology at Montclair State University. She received her PhD from New York University in Industrial and Organizational Psychology. Her areas of research are individual, group and organizational learning and leadership development. Valerie I. Sessa is the corresponding author and can be contacted at: sessav@mail.montclair.edu

Manuel London, PhD, is the Dean of the College of Business at the State University of New York at Stony Brook and SUNY Distinguished Professor of Management. He received his PhD from the Ohio State University in Industrial and Organizational Psychology. His areas of research interest are leadership development, group learning, performance management and career development.

Marlee Wanamaker is an Adjunct Instructor of Psychology at Montclair State University. He received his MA from Montclair State University in Industrial and Organizational Psychology. His areas of research interest include job attitudes, group learning and career development.

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