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Space Exploration Illuminates the Next Frontier for Teams Research

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Abstract

Effective teamwork is beneficial for organizations on Earth, but is a sine qua non for teams venturing into outer space. The prospect of sending a team to Mars by the year 2030 invites organizational scientists to take stock of what we know and what we still need to know about teams. The team endeavoring to Mars will be multicultural and interdisciplinary, living and working in uncomfortable and dangerous conditions, and doing so in close collaboration with distant teams back on Earth. Tackling the teamwork challenges associated with a mission to Mars present an opportunity to rapidly accelerate the science of teams. In this conceptual review, we explore seven complexities of teams that are both important and understudied. Results of structured interviews with experts on human space exploration regarding the nature of teamwork in long-duration space exploration illuminate seven complexities, or key features of teams, *in general*, that serve as a catalyst for identifying, informing, and motivating future directions of inquiry about teams. These features, and the research they inspire, may enable organizations to build more effective teams on Earth and beyond.

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For over five decades, *teamwork* has been a primary focus of the organizational sciences (Kozlowski & Ilgen, 2006; Levine & Moreland, 1990) with scholars devoting substantial research attention toward understanding phenomena related to team effectiveness, such as team composition (Bell, 2007), interaction processes (Weingart, 1997), cognitive architectures (DeChurch & Mesmer-Magnus, 2010), and interpersonal relationships (De Dreu & Weingart, 2003). In addition to the thousands of primary studies on team effectiveness, dozens of meta-analytic integrations (e.g., LePine, Piccolo, Jackson, Mathieu, & Saul, 2008) and theoretical extensions (e.g., Crawford & LePine, 2013; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Marks, Mathieu, & Zaccaro, 2001) signal a growing maturity to the science of teams.

The National Aeronautics and Space Administration (NASA; 2015a) has set its sights on Mars as the "next tangible frontier for expanding human presence" (p. 1). The science of teams is now being called on to proffer specific recommendations for crew composition, habitat design, communication protocol logistics, scheduling systems, training procedures, and other preemptive and reactive team interventions that will be needed for a mission to Mars (Salas et al., 2015). In the dangerous and uncharted territory of deep space, teamwork is a *sine qua non*. Thus, the need to prepare a human team for a mission to Mars is challenging organizational scientists to take stock of what we know about teams—and what we still need to know—to provide life-sustaining recommendations.

We collaborated with NASA to conduct a series of semi-structured interviews with experts on human space exploration to better understand the nature of teamwork required during long-duration space exploration (LDSE). The astronaut team making the maiden voyage to Mars will face unprecedented and extreme difficulties and dangers. Interestingly, these interviews revealed several parallels between the context and dynamics of space exploration teams and the context and dynamics of *teams* in a broader sense. Our interviews painted a picture of teams, *in general*, that departs substantially from the team as a bounded, stable, and isolated set of individuals, interdependent toward a common purpose (Alderfer, 1977; Wageman, Gardner, & Mortensen, 2012). Wageman and her colleagues (2012) questioned whether traditional definitions of teams are still appropriate in today's globalized workplace, or instead, whether they leave out something essential. Our interviews suggest many of the pressing challenges of collaboration would benefit from a broader conceptualization of teams.

Our discussions with these space experts revealed seven key features of teams that must be understood for effective inter-planetary teamwork. These features have theoretical grounding within the extant literature, but are currently underrepresented within studies of teams. The seven features we delineate are new frontiers for teams researchers inviting the field to study teams in ways that are even more challenging—conceptually, methodologically, and analytically—than current work on teams. By better incorporating these space team inspired features into future research, we can enhance the generalizability of our findings not only to teams in LDSE contexts but also to teams in many other modern workplaces requiring complex forms of collaboration.

Understanding the "Team Risk" in LDSE

Planning and executing a successful Mars mission requires scientists across numerous fields to rapidly apply their knowledge and skillsets in new ways to mitigate the risks facing LDSE crews. Among these risks are bone loss, radiation, food replenishment, and *teamwork* (McPhee & Charles, 2009). NASA has identified the "*team risk*"—or *the possibility of performance decrements due to inadequate cooperation, coordination, communication, and/or psychosocial adaptation within and between the flight crew and ground support*—as a critical factor that might prevent us from successfully landing a human team on Mars (NASA, 2015b). The team risk has always been a factor in bold human endeavors. When humans first set out to explore the region on Earth that is most like Mars—Antarctica—human capability was one of the major barriers: "Men, as Amundsen likes to say, are the unknown factor in the Antarctic" (Huntford, 2010, p. 49).

By highlighting the team risk inherent in a Mars mission, NASA has given teams researchers a puzzle to solve: How can we help ensure that a single-, four-, or six-person team can function seamlessly on an approximately 3-year mission to Mars (and back)? The team will certainly be multicultural and interdisciplinary, working in uncomfortable and dangerous conditions while at an extreme distance—up to 128 million miles—from component teams back on Earth (roughly the equivalent of 142 trips to the moon!). These astronauts will live and work in spaces the size of an average prison cell and will experience limited contact with anyone outside their crew during these lengthy missions. Communication with family and co-workers on Earth will be severely limited and conducted entirely via technologies that have inherent communication delays. The crews will encounter extreme levels of physical and psychological stress coupled with periods of intense boredom. Perhaps most saliently, they will be unable to leave this context or their team until the mission is over.

Structured Interviews With Space Exploration Experts

The team risk invites organizational researchers to critically evaluate the degree to which the science of teams is prepared to address this risk and, where there are gaps, to frame out the kinds of investigations needed to close them. To better understand the team challenges posed by a Mars mission, we conducted a series of semi-structured interviews via teleconference with 10 individuals involved in various aspects of the space program. We use these interviews as an intriguing and compelling context to illuminate the advancements that will be needed to close the gap between our current knowledge about teams and their reality. In other words, these interviews serve as a catalyst for identifying, informing, and motivating future directions of inquiry about teams in general (Gilson & Goldberg, 2015).

Our interviewees included astronauts who had served on the International Space Station (ISS) and on shuttle missions, as well as members of their various support teams—psychologists, trainers, operations managers, flight directors, and engineers. We followed a semi-structured format, beginning with a standard set of questions, and then using follow-up questions to customize the interview to the particular expertise of the interviewee. Each interview lasted approximately 1 hr. Questions probed the nature of teamwork during both typical and extreme events, the role of technology and tools in the work of space teams, the nature of within- and between-team interdependencies and interactions, training issues, and challenges that could be anticipated in long-duration and long-distance space missions. Interviews were transcribed so that consistent themes could be identified and specific illustrative quotes could be gleaned. The appendix provides additional information regarding the interviewees and interview procedure, including exemplar questions from the interview protocol.

As we performed this "deep dive" into the NASA team problem, we realized that although LDSE crews will undoubtedly face unprecedented demands, they are not the only kinds of teams that push the bounds of traditional conceptualizations of teams. Other types of "extreme teams" (e.g., winter-over research in Polar Regions, deep-sea and underwater oil drilling, commercial ice fishing, special forces operations) also work in unpredictable and/or dangerous settings (see also research on high-reliability organizations; Weick & Roberts, 1993; Weick & Sutcliff, 2011). Furthermore, many non-extreme teams in contemporary workplaces also differ from the archetypal team in terms of their diversity, context, and interdependencies.

Table 1. Space Exploration Reveals Seven Key Features of Teams.

1	Team contexts affect the learning, well-being, and productivity of their individual members.
2	Team members shift among individual and collective tasks.
3	Team members are also members of other teams.
4	Teams are embedded in larger interdependent systems.
5	Teamwork is sociomaterial and multimodal.
6	Teamwork is a moving target.
7	Team adaptation is the new team performance.

Over the course of our interviews, we identified seven team features—on Earth and in LDSE contexts—that require additional research attention before teams researchers will be able to adequately solve NASA's "team problem" (see Table 1, for a list of these features). These features reflect the complexities facing many teams in the real-world.

These features are not necessarily new. Researchers have considered each of these issues in the past, although typically in distinct and diverse studies. However, the NASA team risk has provided teams researchers with a compelling impetus to address problems related to such complexities. Given the almost universal nature of these realities for teams, by recognizing and *solving* teamwork challenges related to deep space exploration, teams researchers will accelerate advancements for teams on Earth.

Conceptual Review: The Next Frontier for Teams Research

NASA's mission to Mars poses a challenge and a deadline that is driving teams researchers to consider some hard truths and inherent complexities about teamwork that not only apply to space exploration teams but more generally to teams on Earth. We delineate each of the seven team features that were revealed through our interviews with human space exploration experts. For each feature, we discuss findings from our interviews that demonstrate the relevance of the feature within LDSE contexts. We also review theoretical and empirical work within teams research that emphasizes the importance of the feature for teams on Earth. Then, we offer exemplar questions to guide research going forward (see Table 2), as well as guidance with regard to *how* teams researchers might tackle these new research questions. Our goal is not simply to address the LDSE team problem; rather, it is to clarify how the LDSE team problem provides incentive to study modern teams more effectively.

Table 2. Future Research Directions on the Next Frontier.

	Team features	Exemplar research questions
1	Team contexts affect the learning, well-being, and productivity of their individual members.	What aspects of the team are key to influencing individuals' learning, well-being, and productivity? What series of events in the course of a team's life span might lead a team member to decide they will exit the team?
2	Team members shift among individual and collective tasks.	What are the barriers and facilitating factors involved in switching among individual and collective tasks? What are the costs of switching between individual and collective tasks for individual and collective effectiveness?
3	Team members are also members of other teams.	What process losses are incurred by switching efforts/attention across multiple teams? What are the implications of multiple team allegiances for individual and team outcomes, particularly when team goals are not in alignment?
4	Teams are embedded in larger interdependent systems.	How do the patterns of interactions within and between component teams affect the functioning of larger systems? How does the functioning of larger systems affect the functioning of their component teams? What training interventions facilitate effective teamwork within and across multiple teams?
5	Teamwork is sociomaterial and multimodal.	How do team members' interactions through various modes of technology either enable or impair teamwork? What countermeasures that can be used to maintain effective team performance as team process becomes intertwined with technology?
6	Teamwork is a moving target.	What dynamic patterns of teamwork processes underpin team performance? How do team emergent states develop over time and co-evolve with behavioral processes?
7	Team adaptation is the new team performance.	What dynamic patterns of team members' cognitive, motivational, affective, and behavioral modifications (across tasks, teams, tools, and levels of interdependence) will best facilitate team effectiveness in response to extreme disruptions? What are the barriers and facilitating factors involved in team adaptation (across tasks, teams, tools, and levels of interdependence)? What predictors and criteria should be used to assess team adaptability?

Feature 1: Teams Affect the Learning, Well-being, and Productivity of Their Members

Teams research, as well as commonplace knowledge of teams, suggests that each member of a team can affect overall team success. Substantial research attention has been devoted to understanding the impact of individuals on team-level viability, affect, and performance (e.g., Balkundi & Harrison, 2006; Carron, Eys, Burke, Jowett, & Lavallee, 2007; Pirola-Merlo & Mann, 2004; Stewart, Fulmer, & Barrick, 2005). Similarly, colloquial sayings, such as “a chain is only as strong as its weakest link” and “one bad apple can spoil the bushel,” underscore the critical importance of making appropriate selection decisions when designing teams. Indeed, NASA’s team risk began with a drive to determine how to go about selecting members of the “dream team” that would contribute effectively to team-level outcomes (e.g., group survival) during an historic space mission to Mars.

Yet, the first theme elucidated by our interviews is that although the individual affects the team, the team also affects the individual. There is a context in all teams that affects their inner workings (Hollenbeck, Beersma, & Schouten, 2012), and these team contexts have important implications for the learning, well-being, and productivity of the individuals who make up the team. Moreover, the resulting effects of team contexts on individual members are crucial antecedents of the success of the overall team. In this way, the nature of impact between individual and team is reciprocal as well as dynamic.

One interviewee noted that even high performers experienced strain when placed in a team environment with high time pressures.

> . . . they are lifetime high performers, concerned with doing things the right way, and when they get into these team simulation environments (especially when they are young or new) it’s easy to put them in situation where they are feeling a lot of pressure to perform under time pressure.

Another noted that adjusting to the team context on a space mission leads the astronaut to change in unexpected ways.

> The most common learning [first-timers experience] is that they think they know what it will be like [to work on the mission] but that they really need to change how they thought they would do business . . .

Team contexts are likely to affect members’ desire to continue to contribute to the team as well as their decision to *quit* working on behalf of the team. Context can also affect member perceptions of which behaviors matter and which do not, and could cause a previously effective team member to decide to prioritize individual goals over those of the team. For example, in his diary studies of astronauts working on the ISS, Stuster (2010) similarly observed the idea that the team context can all of a sudden lead an individual to want to withdraw:

> I woke up this morning thinking, "OK I don't want to 'play' anymore. I just want to be home sleeping in our bed, eating at the dining table, sitting in my recliner." (p. 19)

Scholars have long recognized that group or team contexts affect individuals. For example, early groups research on conformity pressures (Asch, 1956), production blocking (Nijstad, Stroebe, & Lodewijkx, 2003), and evaluation apprehension (Rosenberg, 1969), recognized the important role of the group context on the behaviors and performance of an individual. In fact, Hackman's (1983) definition of team effectiveness included the "impact of the group experience on individual members" (p. 21) as a critical component of team effectiveness.

However, although empirical studies considering how dynamics at the team-level affect individual outcomes are not entirely absent from the extant literature about teams on Earth (e.g., Chen, Kanfer, DeShon, Mathieu, & Kozlowski, 2009); as a discipline, we are not yet able to provide coherent guidelines for LDSE teams regarding how the team context will shape individuals' learning, well-being, and productivity. This is because once teams researchers began in earnest to investigate the predictors of team-level processes and output, we began to neglect the reality that teams also affect individuals in meaningful ways.

The reality that individuals and teams affect each other reciprocally and dynamically points to the existence of a bidirectional and iterative loop between bottom-up and top-down dynamics in teams (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013). By recognizing that team contexts affect individual members, it is no longer sufficient to simply model the combined effects of individuals' attributes and behaviors on team-level outcomes (as is more commonly studied; cf. Bell, 2007; Kozlowski & Ilgen, 2006). Rather, this reality requires researchers to study the complex interplay across individual, team, and multiteam levels of observation, both in situ and across time, to fully elucidate the dynamics of teamwork (Hackman, 2003).

One promising avenue for future research is to renew efforts that began in classic social psychological research on groups (e.g., Asch, 1956; Sherif, 1936). Teams researchers also may be able to draw from research in other areas of psychology that could speak to the role of work context and demands on individual learning, well-being, and productivity, like that of workplace stress

(Karasek & Theorell, 1992), emotional labor (Mesmer-Magnus, DeChurch, & Wax, 2012), and role conflict (Kahn, Wolfe, Quinn, Snoek, & Rosenthal, 1964), to name a few. Questions that continue to uncover the ways in which individuals are affected by their interactions within the team are profitable directions for future research: *Which aspects of the team are key to influencing individuals' learning, well-being, and productivity?* and *Which events in the course of a team's life span might lead a team member to decide he or she will exit the team?*

Feature 2: Team Members Shift Among Individual and Collective Tasks

Much research on teams has examined the nature of the team's task (e.g., level of interdependence; Courtright, Thurgood, Steward, & Pierotti, 2015; Gully, Incalcaterra, Joshi, & Beaubien, 2002) and the nature of members' interactions while performing the team's task (e.g., information sharing, cohesion building; Carron et al., 2007; Mesmer-Magnus & DeChurch, 2009). Indeed, research is often conducted under the assumption that everything team members do is directly related to the team's goals. Yet, our interviews revealed a second feature about teams—members of teams do not work on the team task incessantly but, instead, shift intermittently among a variety of individual and collective tasks.

For example, although astronauts work interdependently with other crew members while in orbit, they also carry out independent work:

> On the [space station] we got instructions at night . . . Person A said what you needed to do [the next day] . . . [the amount of] coordination depended on the task . . . For the experiments on board, I was independent on those and worked alone, but sometimes would need help from other guys and they would come in to help me . . . While I was on board the space station they did five EVAs [Extra-Vehicular Activities, i.e., spacewalks] and that was a very integrated team task. While they were outside, I was inside doing the com, etc.

In fact, crew members reported that working interdependently as part of a team with the crew in orbit could actually be infrequent, although seamlessly switching to the team task was essential to effective team performance:

> On the [space station] the crews do their individual tasks—they only come together infrequently for intact activities.

The reality that team members are simultaneously responsible for both individual and collective tasks requires researchers to understand the complexities associated with team members' shifting attentions (e.g., the potential for members' prioritizations of certain goals to differ within the team, or the potential for aspects of alternate tasks, like their relative complexities, attractiveness, and requirements, to carryover and disrupt performance on team tasks; Wickens, Santamaria, & Sebok, 2013). This makes modeling and predicting individual and team effectiveness more difficult.

Whether forced or by choice, switching among different tasks and between independent and interdependent work may impede productivity through cognitive decrements and longer response times (Allport, Styles, & Hsieh, 1994; Huey & Wickens, 1993; Kiesel et al., 2010; Monsell, 2003; Rogers & Monsell, 1995). For example, it may be difficult for an astronaut to switch from an individual activity that requires a high degree of focus (like conducting an experiment or analyzing data) to engaging with his or her team on an EVA, particularly when he or she may be entrained in the "flow" of the individual task (Csikszentmihalyi, 1996; Jett & George, 2003).

Although research is emerging in the human factors literature that explores the dynamics and consequences of switching among tasks, tools, and, to a lesser extent, team versus individual contexts, on *individual* performance (Trafton & Monk, 2007; Wickens et al., 2013), much less attention has been given to the implications of these switches for *team* processes, emergent states, and outcomes. Not only might switching tasks lead to performance losses as the individual cognitively "lets go" of the prior task and gets up to speed on the new task, the involvement of *others* in one's work complicates the process of task switching. When individuals switch from an individual to a team task, for example, they must entrain to the rhythm of their teammates to synchronize their activities (McGrath & Kelly, 1986) as well as relinquish some control and rely on their teammates for goal accomplishment (McDonald, DeChurch, Mesmer-Magnus, Asencio, & Carter, 2015). Similarly, switching back from a team task to an individual task requires the individual to adapt their working style, rhythm, and attention to the new task.

Furthermore, these shifts introduce an inherent tension or paradox of teamwork, in which individuals must choose between contradicting elements (Lewis, 2000). For example, there is a tension between the achievement of individual versus collective goals, such that members must decide whether to devote effort toward a team or multiteam goal at the expense of individual gains (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004; Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005). Similarly, there's a tension between learning and performance, such that team members are faced with the choice of devoting their efforts toward long-term gains (i.e., learning) versus immediate gains (i.e., performance; Smith & Lewis, 2011).

Among other forces, a variety of motivational factors are likely to be associated with switching among individual and collective tasks. For example, research on team cohesion (Beal, Cohen, Burke, & McLendon, 2003; Festinger, 1950) suggests that individuals may be more motivated, and thus faster, to engage in a team task as opposed to an individual task when they feel strongly attached to the team. Similarly, expectancy theories of motivation (Vroom, 1964) imply that when team members' experience a strong sense of collective efficacy with fellow teammates, they might be more willing to engage in interdependent activities. Moving forward, research is needed to bridge the gap between the micro-cognitive approach to task switching and the literature on team effectiveness. Thus, exemplar research questions in this area include the following: *What are the barriers and facilitating factors involved in switching among individual and collective tasks? What are the costs of switching between individual and collective tasks for individual and collective effectiveness?*

Feature 3: Team Members Are Also Members of Other Teams

Teams researchers have often studied teams out of context (e.g., in the laboratory), adopting an underlying assumption that members devote their time and effort to a single team, and as noted above, a single task, at a time (Mortensen, Woolley, & O'Leary, 2007). Invoking this assumption has allowed researchers to intentionally focus on the dynamics of the focal team while holding constant myriad external influences. Although this approach enables feasible study designs and data analytic procedures, such isolated and bounded conditions are not the reality faced by most teams today (Wageman et al., 2012). Our interviews substantiated O'Leary, Mortensen, and Woolley's (2011) theory of *multiple team membership* (MTM) wherein individuals often work on multiple teams either simultaneously or over time, and must therefore divide their attentional resources and allegiances across these teams.

Many of the astronauts we spoke to mentioned finding themselves at the intersection of multiple teams:

> . . . [throughout the mission] I really thought there were only three people who knew what was going on . . . myself, Person A, and Person B . . . but, on board there was [a fourth person] Person C and myself, so I was a subset of both groups.

> . . . there is overlap in these teams . . . just because you are in one team doesn't mean you can't be part of other teams . . .

Furthermore, the team memberships of those involved in space missions often change *over time*, posing further challenges to collaboration and coordination.

> [although] they've trained together . . . the crew up there changes . . . three old and three new faces [rotating through the mission]
>
> . . . every 3 months it is a "changing group" . . . politically the commander changes every 3 months . . . it's not really a big change but the commander makes important decisions, and [this affects everyone as] each astronaut also has his own schedule and is controlled by his own space center . . .
>
> The new crew Member A and Member B showed up . . . originally I wasn't supposed to be there for a crew swap . . . I knew Member A, but I had never met Member B. I met Member B for the first time on orbit.

The reality that members of teams are members of *multiple* teams requires more complex models of team effectiveness that account for members' potential allocation of effort, attention, and allegiances across multiple teams. The broader network of team interlocks that are created when individuals work across multiple teams are likely to have critical implications for the behavior and productivity of these individuals and their teams that should be included in models of team effectiveness (Grewal, Lilien, & Mallapragada, 2006; Gulati & Westphal, 1999; Kang, 2008; Zika-Viktorsson, Sundström, & Engwall, 2006). Moreover, an individual's cognitive and physical resources are likely to be taxed when working across multiple teams (Engwall & Jerbrant, 2003; Zika-Viktorsson et al., 2006), and the performance decrements associated with switching tasks are magnified when the collective element is introduced (Goldratt, 1997). When engaged in MTMs, members are challenged to switch among the social contexts of different teams; adapt to new norms, practices, and goal structures (O'Leary et al., 2011); and manage increasingly larger numbers of social and task relationships (Krackhardt, 1994). Thus, researchers must attempt to model the antecedent, mediating, and moderating conditions that predict individual effectiveness across multiple teams. Going forward, research on MTM should consider the following: *What process losses are incurred by switching efforts/attention across multiple teams*? and *What are the implications of multiple team allegiances for individual and team outcomes, particularly when team goals are not in alignment?*

Feature 4: Teams Are Embedded Within Larger Interdependent Systems

As noted in the previous section, teams researchers have tended to focus on understanding the inner dynamics of teams. Because of this, teamwork processes spanning larger intraorganizational or interorganizational systems are not yet well-modeled in existing teams research. However, a fourth feature is that the teams people participate in are embedded within large, complex, and interdependent networked systems comprised of multiple other individuals and teams, each with different, and potentially conflicting, sets of goals, norms, tools, and technologies.

Our interviews suggested that the LDSE crew traveling to Mars is just one of many component teams in the broader *multiteam system* (i.e., two or more component teams that exhibit interdependencies toward shared superordinate goal(s); Mathieu, Marks, & Zaccaro, 2001) that will tackle the goal of a successful Mars mission. The Mars mission multiteam system will represent individuals and teams from multiple space agencies and nationalities. There will be ample opportunities for conflicting roles, norms, goals, and loyalties within and across teams.

The nature of the complex multiteam system involved in space exploration was alluded to in this comment:

> The crew depends on the ground to analyze the data and to tell them what they needed to know to execute the missions. From liftoff to landing, they rely on the ground to be able to execute the flight.

In other words, in most missions, the LDSE crew is the vehicle through which space exploration is carried out, but the mission activities are guided and managed by other teams on Earth. As one interviewee put it,

> Crew is our eyes . . . Ground is the brain.

Not only is extensive coordination required between the crew and ground, but the ground support also consists of multiple interconnected teams, whose members might exert effort toward a variety of distinct subordinate and superordinate goals (Hoffman & Kaplan, 1997).

> When we're talking about "teams" . . . when we are sitting in the main flight control room, one thing not so obvious is that there are lots of back-room teams . . . that help create a pure flow in making decisions.

The consequence of high levels of interconnectivity and interdependence with other teams is that what happens locally (e.g., within a team) reverberates globally (e.g., across teams) and vice versa. For example, if one team experiences a high level of conflict among its members, these negative interactions might ricochet throughout the system causing detriments to inter-team collaboration. In turn, global patterns of interactions (e.g., between teams) can shape teams' abilities to succeed. As an example, when coordination and information sharing between multiple ground crews break down, the LDSE crew's performance can suffer:

> crew in orbit was one team, and the support team on the ground was another. Each team assisted astronauts with different tasks, which can create confusion on the part of the astronaut when determining which team could provide the required resources for a given assignment.

Our interviewees highlighted other difficulties stemming from a lack of shared context across the teams:

> [There is a] classic disconnect between the crew and ground engendered by the distance . . . [members of ground control] don't know what it is like to live on orbit, how long it takes to organize tools, etc., and the crew doesn't understand the ground so there can be issues and conflict between the groups . . .

> . . . as individuals get on orbit and are surprised what it is like to be a remote crew member with ground and how quickly you can get off kilter with the ground . . . they can see you, but you are in a fishbowl so when you look out you have a distorted idea of what is going on outside your bowl . . .

This aspect of teamwork highlights the importance of a variety of fairly complex inter-group dynamics, which are likely to impinge on team functioning (e.g., inter-group conflict and loyalties; Luvison & Marks, 2013; Tajfel & Turner, 1979). Addressing and managing these inter-group issues is critical for ensuring the effectiveness of the focal team as well as component teams within the larger system.

Moreover, research that better elaborates the interplay of intra-team and inter-team dynamics is likely to lead to the creation of new training interventions that facilitate the success of larger collectives. For example, research demonstrates that cross training (Marks, Sabella, Burke, & Zaccaro, 2002) and team-interaction training (Marks, Zaccaro, & Mathieu, 2000) can benefit team processes and performance. However, team training is distinctly different when a multiteam perspective is taken and the methods become more complex. The specialized training needed to prepare teams to operate interdependently with other teams in extreme environments has not been examined. One of our interviewees highlighted the need for such a "system-level thinking" approach to team training:

> The flight controllers are comfortable working technical issues (they are engineers) but are uncomfortable working with soft skills . . . [they handle]

> design reviews for each component well because this is an engineering process and also deal well with problems with money . . . But, when we run behind schedule [they will fail to effectively communicate about changes], and we may find we've taken out capabilities that maybe the ops guys needed . . . so, in the end the vehicle we fly will not be as capable as we want and expect, and it will be delivered late and it will surprise us . . . I am not sure how a flight control team that is operating on a 40-minute delay is going to work with a team that faces a problem that was not anticipated before launch . . .

A number of constructs, including *behavioral processes* (Davison, Hollenbeck, Barnes, Sleesman, & Ilgen, 2012; DeChurch & Marks, 2006; for example, functional leadership, inter-team coordination), *motivational properties* (e.g., collective identification; Asencio, Murase, DeChurch, Chollet, & Zaccaro, 2015), and *cognitive states* (e.g., inter-team mental models: Murase, Carter, DeChurch, & Marks, 2014) are emerging as critical intervening mechanisms of multiteam functioning. Yet, there are still significant gaps in our understanding of the interplay between individual, team, and multiteam functioning (DeChurch & Zaccaro, 2013).

In the LDSE context, the interconnectivity between teams makes it imperative to look beyond the boundaries of single teams to better clarify how the dynamics *across* teams underpin team and system effectiveness. Teams are part of larger networked collectives (e.g., multiteam systems; Lanaj, Hollenbeck, Ilgen, Barnes, & Harmon, 2013; Marks et al., 2005) that operate within complex organizational frameworks such as matrixed organizations or multinational corporations, which in and of themselves create the potential for multiteam systems and multiteam memberships (Galbraith, 1971). This highlights the importance of more research that explores the following: *How do the patterns of interactions within and between component teams affect the functioning of larger systems? How does the functioning of larger systems affect the functioning of their component teams*? and *What training interventions facilitate effective teamwork within and across multiple teams?*

Feature 5: Teamwork Is Sociomaterial and Multimodal

Today's teamwork is intertwined with tools and technology to such an extent that it is impossible to effectively study the effects of one without considering the other (Gilson, Maynard, Young, Vartiainen, & Hakonen, 2015; Guinea, Webster, & Staples, 2012; Maynard & Gilson, 2014; Scott & Orlikowski, 2013). Our interviews emphasized that astronauts interact with a variety of tools and technologies in the course of their work and interactions with their team. In fact, they cannot accomplish the vast majority of their work or team communications without engaging technology. The fifth feature revealed by our interviews is (a) teamwork involves bidirectional, interwoven relationships between teamwork interactions and the medium through which these interactions occur (i.e., teamwork is *sociomaterial*; Leonardi, 2013), and (b) teamwork occurs through a variety of tools and technologies (i.e., teamwork is *multimodal*; Fletcher & Major, 2006).

Viewing teamwork as *sociomaterial* means acknowledging that the *social forces* (e.g., team communication and other team processes; Marks et al., 2001) and the *material forces* (i.e., technology; Leonardi, 2011; Orlikowski & Scott, 2008) in teams are inextricably linked such that changes in one trigger changes in the other (Seely, 2015). Although the sociomaterial nature of communication is receiving significant attention in the information systems literature (Parmiggiani & Mikalsen, 2013), teams research has tended to examine technology-related issues in teams as though the nature of teamwork can be disentangled from the nature of technology (Faraj & Sproull, 2000; He, Butler, & King, 2007; Maynard, Mathieu, Rapp, & Gilson, 2012; Yoo & Kanawattanachai, 2001). For example, studies have compared virtual teams with face-to-face teams (e.g., Martínez-Moreno, González-Navarro, Zornoza, & Ripoll, 2009; Mesmer-Magnus, DeChurch, Jimenez, Wildman-Rodriguez, & Shuffler, 2011) or examined the effects of different aspects of virtuality on team performance (e.g., Schweitzer & Duxbury, 2010), often assuming that technology is an input or moderator of teamwork rather than an inherent part of the teamwork itself.

As communication technologies are so pervasive in today's workplaces, they actually dictate the social dynamics of communications that occur among team members. The proliferation of emoticons and emojis in today's text-based communication software is one example of the dynamic interplay between technology and communication. As textual communication is devoid of the sorts of non-verbal cues that convey emotion (Daft & Lengel, 1986), emoticons and emojis have developed to help senders convey aspects of a message that are insufficiently communicated via the written word alone.

Another example of sociomateriality arose through our interviews: When astronauts on the ISS interact with members of support teams on the ground, they often use *text-based* communication platforms as opposed to video- or audio-based mediums. By virtue of the dynamics of text-based exchanges, astronauts will often type a series of multiple messages about different topics before they receive a response from the ground. When personnel on the ground do respond, an astronaut sometimes misallocates the relevance of the received response to a message about which it was not intended because he or she has moved on to consider a more recently sent message. Not only does the reliance on text-based chat increase the chances the recipient may misconstrue the response, it might also force the recipient to continuously cognitively switch among various topics, a process which carries its own cognitive costs in the form of lost concentration and momentum. These problems can be exacerbated when a lengthy time delay between communications is introduced—as will be the case in during a mission to Mars. To combat these problems, researchers developed protocols requiring the sender and recipient to send communications in a specific format (Fischer & Mosier, 2015). The need for such communication protocols further intertwines the dynamics of the technology with those of the team's interactions.

Complicating the bidirectional relationships between the social and material forces in teams, the *breadth* of communication technologies available to today's teams is increasing exponentially—thus, teamwork is increasingly *multimodal*. Our interviews identified a number of issues LDSE crews encounter with regard to the multimodal nature of their communication. For example, interviewees referred to a variety of tools that were used for information sharing and coordination, each with different norms for use and each considered more or less formal in terms of the content communicated. Whereas space exploration teams may use an interactive timeline with "sync points" to document various team member actions, they may use a common communication channel (i.e., the "flight loop") to communicate information that may impact various teams across the system, particularly in the case of an off-nominal event. Each technology brings its own challenges. One interviewee indicated that listservs, for example, are not always reliable:

> The flight director was sending out the emails to his team . . . using a distribution list he thought was correct . . . but when he was inviting people to the post EVA celebration, he realized that the email list didn't get to the people he needed it to get to.

Considering the sociomateriality and multimodality of technology in teamwork places additional boundary conditions on the generalizability of research studies that have examined teamwork in specific technological contexts. Recognizing that teamwork is enmeshed with technology, rather than distinct from it (Leonardi, 2011), suggests a need for more dynamic and evolutionary models of teams that can delineate the ways in which team members and technology jointly shape team interaction. Although to some extent the extant literature has discussed how teams use different forms of technology for teamwork (e.g., Maznevski & Chudoba, 2000), we need a greater understanding of how teamwork is intertwined with the *multiple* modalities that teams employ. Potential research avenues in this vein include the following: *How do team members' interactions through various modes of technology either* *enable or impair teamwork? What countermeasures that can be used to maintain effective team performance as team process becomes intertwined with technology?*

Feature 6: Teamwork Is a Moving Target

Extant teams research has tended to study teamwork as if it were an overall quality about the team (e.g., "this team is highly cohesive" and "that team has poor behavioral process"). However, teams are complex adaptive systems (Arrow, McGrath, & Berdahl, 2000); their context is created over the course of many interactions and feedback loops within the embedding environment (Kozlowski et al., 2013). Teams interact through a series of dynamic events occurring across people, tasks, multiteam memberships, multiteam systems, tools, and technologies, and thus, the effect of any particular interaction on a team also includes the sum of the iterative effects of all previous interactions.

Our interviews elucidated this complex dynamism as the sixth key feature: Team processes and attributes are not stable and shared characteristics of a team as a whole, but rather, are dynamic moving targets connecting members to one another across time. For example, one interviewee stated,

> . . . in terms of cohesion of on board crew for exploration class missions, we will need to get away from the layperson's misconception, including ground control, that assumes that relationships are static . . . that the relationships of the crew at launch are not unchanging and [will] be the same when they are done with the mission . . . [cohesion] will change over time . . . our conceptions do NOT allow the idea that the relationships are fluid/dynamic . . .

Even after building a cohesive team, the team may splinter because of extreme negative event. One astronaut discussed how behaviors related to a particularly salient event on the space station led to hard feelings in what was otherwise a cohesive crew.

> When the progress vehicle crashed on MIR . . . [Group A] was not sharing information with [Group B] even though [Group B] had members on the space station. There was a lot of reassessment to the flow of information. When we did emergency exercises, we realized that the most challenging part was that the control centers weren't interacting effectively, not sharing information, and telling crew contradictory things.

The observation that teamwork is a moving target is akin to the idea that team process is microdynamic (Humphrey & Aime, 2014; Kozlowski et al., 2013)—that there is a series of discrete events that aggregate over time to develop an overall culture or context of the team. Team efficacy, affect, and performance are built by these micro-dynamisms. For example, as our quotes demonstrate, team cohesion is built over the course of many interactions among members of the team, and the cohesion of a team can suffer from salient negative events.

Our understanding of teamwork attributes and processes needs to account for the fluidity of their emergent properties. To understand teamwork, we must study patterns of teamwork processes (Crawford & LePine, 2013) as they unfold temporally, rather than taking snapshots of team process and attempting to draw inferences across the life span of the team. Likewise, understanding the development of affective constructs like team cohesion requires examining their trajectory over time rather than examining these states at any single point in time. Undoubtedly, this aspect of teams highlights the need for more longitudinal research that captures, models, and predicts dynamic patterns of interactions and emergent psychological relationships (e.g., trust) over time at a fine-grain resolution. To move teams research into the next frontier, we suggest exploring questions such as the following: *What dynamic patterns of teamwork processes underpin team performance? How do team emergent states develop over time and co-evolve with behavioral processes?*

Feature 7: Team Adaptation Is the New Team Performance

Finally, existing teams research often examines the team context as one where the types of interactions across people, technology, and teams that are predictive of successful performance will remain constant over time. However, teams commonly encounter unexpected, and sometimes dramatic or dangerous, events, the responses to which may significantly alter the direction of the team permanently. The seventh team feature made salient by our interviews is that teams must be able to make adaptive cognitive, affective, motivational, and behavioral modifications (i.e., performance adaptations; Baard, Rench, & Kozlowski, 2014) in response to changing goals, conditions, and task requirements—what has worked in the past for a team may not be what works in the future. Consider this plausible scenario:

> An LDSE team is in transit toward Mars. They are on the fifth month of their trip. Until this point in the endeavor, things have gone according to plan. Take-off from Earth went well. The ship successfully docked with the supply vehicle in orbit. The crew took amazing pictures of Earth from space, and participated in press conferences about their upcoming expedition. Navigation out of orbit and on toward Mars met no problems. Communications with Mission Control

> and support teams on Earth went according to protocol. To date, the team's interactions and process have been sufficient to ensure effectiveness. Crew members are going about their normal activities. Research projects, ship maintenance, daily fitness, etc. are all underway. Everyone is on schedule. And then . . . KABOOM! . . . An explosion. The crew looks at one another, frozen in place. Their hearts stop, their breath catches. And then, the whispered exclamations begin: "What was that?!" "What are we going to do?!" "Mission control can't help us! Comm delay is too long! We're on our own!"

At this moment, the team knows the only way they will survive is if they can ramp up their performance dramatically. The ways in which they have gone about the mission until this point will not ensure their success now. All prior expectations for their performance are thrown out the window. They must adapt to this crisis, and quickly!

Similarly, the quote below references a situation wherein the crew needed to awaken from sleep to resolve a crisis. Effectively solving this problem required the crew to get up to speed quickly and work to solve the problem with members of night-shift mission control teams who they had not had extensive experience working with previously.

> I was on CAPCOM while the crew was sleeping when the computers went down and the alarm went off . . . The crew needed [to help resolve the issue]. I had to wake up the crew, and they said well we're already there, so the ground and the crew worked together [to fix the problem].

NASA refers to these unusual turbulent events as "off-nominal" (e.g., explosions, fires, loss of cabin pressure, and so on, scenarios where there are life and death implications for poor performance). Many of our interviewees referenced the need to shift between nominal/routine and off-nominal events repeatedly during missions. They remarked that the shift to an off-nominal event usually included additional strains relating to shifts among tasks, teams, and/or tools. In this way, a crew's need to adapt quickly to respond to the off-nominal event is further complicated by the need to shift attention and effort physically, cognitively, and/or socially to meet the demands of the current crisis.

Undeniably, the teams involved in a mission to Mars must be ready to respond and adapt to dramatic off-nominal events. However, nonlinear team performance situations are certainly not exclusive to LDSE teams. For instance, research on high-reliability organizations, such as naval aircraft carriers, nuclear power-generation plants, or offshore drilling rigs, which perform hazardous and highly technical tasks, has long emphasized that many collectives must respond adaptively to dangerous and dynamic contexts (e.g., Rochlin, La Porte, & Roberts, 1987; Weick & Roberts, 1993). As Baard and colleagues (2014) put it, "Stability and routine are two words that can rarely be used to describe the present-day workplace" (p. 48).

Some research on teams—such as that stemming from theories of *punctuated equilibrium* in team performance behaviors (Gersick, 1988) or work on the need for organizations to match structure and processes to the turbulence of the environment (e.g., Emery & Trist, 1965)—has begun to explore the reality that teams must adaptively tackle off-nominal events. However, the extant literature has yet to adequately unpack what is needed for a team to adapt to dramatic crises. The study of adaptability will likely require the development and validation of new metrics that assess the degree to which a team has the *capacity* to adapt effectively. As one interviewee lamented,

> Our conceptions do NOT allow the idea that the relationships are fluid/dynamic . . . [for example] there is an assumption that the team must always be cohesive . . . our perception of what a crew team cohesion needs to be like over the mission needs to be dynamic but it is not currently considered in our models.

Going forward, we must recognize that the performance requirements of a team evolve as the task progresses, and that moderating circumstances, like a shift from routine events to turbulent events, involves nonlinear shifts in team performance. Future research is needed that models team adaptability—investigating how the meaning of team effectiveness or viability may shift with time and turbulence—and how team process needs to adapt to accommodate extreme events: Specifically, we wonder, *What dynamic patterns of team members' cognitive, motivational, affective, and behavioral modifications (across tasks, teams, tools, and levels of interdependence) will best facilitate team effectiveness in response to extreme disruptions? What are the barriers and facilitating factors involved in team adaptation (across tasks, teams, tools, and levels of interdependence)? What predictors and criteria should be used to assess team adaptability?*

Discussion and Future Directions

Space travel has sparked numerous innovations that are now central to our way of life, including Velcro, freeze dried foods, cordless tools, insulation, joysticks, memory foam, scratch resistant lenses, smoke detectors, water filters, and certain telecommunication tools (LAOROSA, 2012). Even now, research devoted to solving problems within the intriguing context of space exploration is yielding solutions that benefit humans on Earth. For example, biomedical specialists are considering how best to mitigate problems related to the rapid and dangerous levels of astronaut bone loss in microgravity environments (Oshima, 2015). Findings suggest that by combining exercise with the ingestion of a therapeutic medicine called bisphosphonate and a regimen of nutritional supplements, astronauts can significantly reduce their risk of bone loss in outer space. This biomedical breakthrough will not only improve astronauts' lives, the insights gleaned through this research are also enabling recommendations for patients on Earth. Although bone loss is a common problem for bedridden and elderly patients, it took the very salient need that arose for astronauts traveling to Mars to arrive with their bones intact, to accelerate this science.

Just as the prospect of astronaut bone loss has resulted in significant advancements in medical science for patients on Earth, we expect that the Mars team challenge will accelerate breakthroughs and innovations in team science for teams on Earth. Our goal is to urge our fellow teams researchers to accept that we have collectively harbored a series of convenient fictions about teams in our research agendas, and ignoring the realities of today's teams will prevent us from moving the science of teams into the next frontier. As an anonymous reviewer pointed out, each of the features we have enumerated "are a reflection of the state-of-the-science in team effectiveness" research in general. However, the extreme context of NASA's "team problem" has brought these features sharply into focus.

Overcoming the Challenges of Teams Research

The seven features discussed herein underscore an overarching reality, that *team tasks and contexts have become increasingly complex*. To provide a foundation for future research that better acknowledges the complexity of today's teams, we have delineated exemplar research questions, drawing from other literatures that may be relevant to teams (e.g., communications, information technology, workplace stress, high-reliability organizations, human factors). These questions emphasize the importance of understanding ways in which teams and their members modify their behavioral processes, as well as their cognitive, motivational, and affective states, in response to ever-changing environmental conditions.

Studying the complex tensions facing today's teams will require significant developments in robust, relevant, and valid measurement. Acknowledging the critical importance of adaptability as an indicator of team effectiveness, for example, suggests a pressing need to identify appropriate ways of operationalizing team adaptability. Theoretical work delineating the components of a "collective mind" (i.e., "a pattern of heedful interrelations of actions in a social system"; Weick & Roberts, 1993, p.

357) could be used as the basis for understanding the dynamic interactions in teams that signal adaptive capacity.

Several research approaches show promise in overcoming the "inconvenience" of studying today's more complex teams (DeChurch et al., in press). For example, network analytic techniques continue to gain popularity among organizational researchers as a way to identify, explore, and predict dyadic interactions among team members as well as between team members and their external environment (e.g., Crawford & LePine, 2013; Reagans & Zuckerman, 2001). Relational event models, which capture the patterning of dyadic interactions over time, are a relatively new way to explore the evolution of team processes at a much higher resolution as compared with traditional self-report methods (Butts, 2008; Leenders, Contractor, & DeChurch, 2016). Furthermore, both the analysis of static networks and temporally dynamic models of networks (e.g., relational events) can use digital traces of team interactions as data sources, which allow researchers access to more unobtrusive and elaborate views of team interactions.

Our interviews revealed team members switch their attention and efforts across different tasks, tools, teams, and levels of interdependence. To investigate the drivers of these switches, researchers might consider using policy capturing techniques, which quantify how decision makers use available information to make evaluative judgments (Karren & Barringer, 2002; Zedeck, 1977). Computational modeling approaches (Kozlowski et al., 2013; Vancouver & Weinhardt, 2012) are also likely to aid our understanding of team dynamics, though they require extensive theoretical development and primary studies to establish the relevant variables and significant weights to design in the models.

A thorough exploration of the complex team phenomena we have highlighted will likely require the use of several approaches in combination. Contractor (1999) proposes a structured multi-step analytic approach for the study of self-organizing systems, and suggests researchers begin by building theoretical frameworks of the phenomena deduced from existing literature. He recommends that researchers use computational modeling to (a) evaluate the effects of numerous factors (e.g., team composition, team interactions, MTMs, extreme disruptions) on individual actions and collective outcomes, and (b) develop additional hypotheses to test in real-world settings, the results of which can be used to further refine theory. The combination of computational methods alongside traditional methods (e.g., policy capturing, laboratory, and field studies) maximizes the utility of often costly and limited teams data sources, and also reduces the risk that researchers will become "overwhelmingly metaphorical" in their attempts to understand complex team phenomena (Contractor, 1999, p. 154).

In addition to these advanced quantitative approaches, we suggest that teams research also leverage more qualitative approaches. Qualitative approaches can provide a deeper understanding of an individual's worldview and capture the underlying motives that drive behavior by exploring individual experiences and other external influences (Smith, 2007). Descriptive research can introduce a phenomenon through the exposition of case studies and observation (e.g., Wageman et al., 2012). Grounded theory (Glaser & Strauss, 1967), content analysis (Elo & Kyngäs, 2008), and phenomenological approaches (which are often used in nursing research for building knowledge and theory from the bottom-up; Husserl, 1970) may reveal important insights, shared experiences, and common themes among individuals (Starks & Trinidad, 2007) and help researchers abandon preconceived notions about a phenomena so they may discover understudied and important realities (Mintzberg, 1979).

Conclusion

The study of teams, by its very nature, has always been a complicated scientific endeavor. Our deep dive into the team challenges associated with space exploration have highlighted seven critical features shared by space teams and many teams on Earth: members dynamically manage multiple tasks, switch across multiple teams, interact within and outside their team boundaries, work with and through technology that affects and is affected by the team, and encounter unexpected events. The challenge of space exploration, linking teams on Earth, Mars, and in between, invites the field to embrace these seven understudied aspects of teamwork with the promise of building more effective teams on Earth and beyond.

Appendix

Interviewee Information and Exemplar Interview Questions

I. Interviewee information. We collaborated with NASA to conduct 10 semi-structured interviews with human space exploration experts using teleconference technology during April and May 2014. NASA personnel from the Behavioral Health and Human Performance Division identified potential interviewees and arranged all interview appointments. A member of this division was also present during the beginning of each telephone interview to introduce the interviewee and researchers, though disconnected from the call following the initial introductions. The particular interviewees selected for these interviews were chosen with the intent of providing us with unique perspectives on the space exploration context relevant to long-duration space exploration.

II. Exemplar questions from interview protocol. We adopted a semi-structured interview methodology wherein we used a core set of questions to generate discussion, and then allowed follow-up questions to lead us down fruitful avenues of questioning. We began each interview with a rapport building discussion wherein we introduced ourselves and explained our purpose in conducting the interviews. We were given 1 hr with each interviewee. During that time, we attempted to balance our discussion between asking our core questions and following up on interesting avenues of discussion. Often during the course of our discussions, interviewees would touch on topics relevant to other questions, so to allow fluidity in discussion, we would not always ask questions in the same order. There were four categories of questions/discussion: (a) background and teamwork, (b) team interactions and interdependence, (c) training, and (d) future directions.

Background and Teamwork

- What is your unit's primary responsibility during space missions? What kinds of activities do the members of your unit do? Who do you consider part of your immediate work team? How often do the members of your unit interact with each other?
- What are some of the ways that your team works together (e.g., shared files, meetings, emails, SharePoint)? Explain some of the processes you engaged in as a team to work through your planning.

Interactions and Interdependence

- What are some situations that require your group/unit to work closely with others who are outside your group/unit?
- In a typical spaceflight mission, how often would your group/unit need to work together closely with members who are outside your group/unit? Is this closer to hourly, daily, every few days, about once a week, about once a month?
- Are there any groups that you're pulled into on an "as needed basis"? When does/might this occur and does this help you have a bird's eye view of what's going on? Are there ways that your interactions with these other groups benefit your primary group/unit (e.g., by gathering critical information, understanding priorities and constraints)?
- In what ways is it stressful and/or challenging to interact with individuals outside your immediate unit/team?
- How often do members of the space crew need to work with members of the ground crew (hourly, daily, every few days, about once a week,

about once a month)? What types of information/support is needed in these types of interactions?

- Thinking back to your mission experience, for nominal events (i.e., routine operations), what type of communications occur that you have found essential? What about in off-nominal situations?
- Thinking back to your mission experience, have you experienced situations where you were not sure which crew member or teammate you could count on to help you with a task, or where you were unclear as to who had the greatest expertise in a certain area?

Training

- Have you experienced any training that you think was particularly helpful for preparing teams to be better at problem solving, planning, decision making, etc.?
- What sorts of training have you been through, either individually or as part of a team, that you think really helped you to communicate/interact/work with your fellow teammates/mission control?
- What sorts of training might need to be added for LDSE missions to help team members and/or mission control sub-teams stay on the same page with each other?

Future Directions

- What do you see as the most critical team related issues/problems/gaps presented by long-duration space exploration?
- What situation assessment, decision making, or planning issues do you think NASA teams will face during long-duration missions for which current practices have not yet accounted?

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