

Foundations of Teamwork and Collaboration

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The term *teamwork* has graced countless motivational posters and office walls. However, although teamwork is often easy to observe, it is somewhat more difficult to describe and yet more difficult to produce. At a broad level, teamwork is the process through which team members collaborate to achieve task goals. Teamwork refers to the activities through which team inputs translate into team outputs such as team effectiveness and satisfaction. In this article, we describe foundational research underlying current research on teamwork. We examine the evolution of team process models and outline primary teamwork dimensions. We discuss selection, training, and design approaches to enhancing teamwork, and note current applications of teamwork research in real-world settings.

Keywords: teams, groups, teamwork

In battle, you may draw a small circle [of people] around a soldier. . . . These [persons] primarily will determine whether he rallies or fails, advances or falls back.

—U.S. Army Col. S. L. A. Marshall (1947, p. 154)

Probably the most important thing I've learned up here is the importance of teamwork.

—NASA Astronaut Douglas Wheelock (2007, p. 1)

Although these statements are separated by some 70 years, they both allude to the importance of teams in achieving important goals. Moreover, these statements point to past accomplishments on the battlefields of World War II and to future challenges in the exploration of space. We study teams and teamwork for several reasons. First, teams are viewed as central building blocks to accomplish tasks in

a wide variety of applied contexts—the military (Dalenberg, Vogelaar, & Beersma, 2009), spaceflight (Salas et al., 2015), health care (Hughes et al., 2016), aviation (Littlepage, Hein, Moffett, Craig, & Georgiou, 2016), sports (McEwan & Beauchamp, 2014), and other domains. As Marks, Mathieu, and Zaccaro (2001) noted, “Much of the work in organizations is completed through teamwork” (p. 356).

In a classic text on group dynamics, Cartwright and Zander (1953) cited four reasons that teamwork is an important focus of scientific interest: (a) teams are ubiquitous, (b) teams mobilize powerful forces that produce effects of importance, (c) these forces can result in both positive and negative consequences, and (d) understanding team dynamics permits the possibility that positive consequences can be deliberately enhanced. This rationale is as apt today.

Finally, the study of teams and teamwork is a primary and flourishing topic in the field of psychology. Mathieu, Hollenbeck, van Knippenberg, and Ilgen (2017) reviewed the growth of research on work teams over the past decades within the *Journal of Applied Psychology* and chronicled a “marked upward curve” (p. 453) in the prevalence of this research. This observation is supported by bibliographic analyses of teamwork topics conducted by Weiss and Hoegl (2015), who found that topics related to teamwork have demonstrated a steadily increasing trajectory both in scholarly outlets and also in the broader cultural literature, resulting in what the authors term a growing diffusion of teamwork throughout society. Thus,

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the notion that teamwork is a growing interest has a sound basis.

On the other hand, team researchers have argued that this growth has been stunted to some extent because teamwork processes have not been clearly defined or adequately specified (see Coultas, Driskell, Burke, & Salas, 2014; LePine, Piccolo, Jackson, Mathieu, & Saul, 2008; Marks et al., 2001). In this article, we describe foundational research underlying current perspectives on teamwork. After a brief discussion of team effectiveness in general from an input-process-output (IPO) perspective, we focus specifically on teamwork processes. We examine the development of teamwork process models and then outline primary teamwork dimensions. Finally, we examine selection, training, and design approaches to enhancing teamwork, and note current applications of teamwork research in real-world settings.

Teamwork and Collaboration

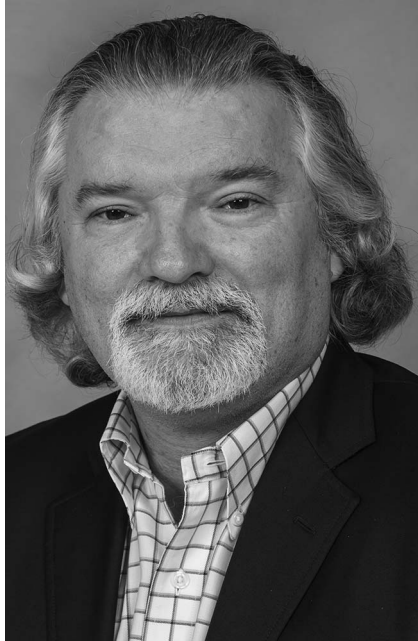
We are social beings. In a very meaningful sense, teamwork is part of our nature. As Newcomb (1950) stated, “Humans are so thoroughly socialized that virtually all their problems must be met by coming to terms with other people” (p. 283). In fact, a number of authors have proposed that humans have a basic need to form relationships. For example, Baumeister and Leary (1995) argued that the need to belong is a fundamental human motive. However, as Leary (2010) noted, affiliation alone can only get you so far. We believe the capacity to band together to solve problems is one of the primary characteristics of *Homo sapiens*. Thus, the basic need to form relationships may encompass both primarily interpersonal bonds as well as primarily instrumental bonds formed to achieve shared goals.

The challenges of survival propelled individuals to organize into interdependent, cooperative groups. However, our rich vocabulary indicates that this propensity is not limited to humans—geese flock, porpoises school, cattle herd, and so on. In fact, some have argued that human cooperation likely emerged in small, related hominid groups, and that banding together had clear survival benefits. That is, individuals in groups can share labor, hunt more effectively, and defend themselves against bands of enemies. Moreover, there are not only direct benefits, in that cooperative groups may have been more successful, but cooperation led to reciprocity from others, supporting the emergence of social norms of interaction (Nowak, 2006; Rand & Nowak, 2013; S. A. West, El Mouden, & Gardner, 2011). Thus, if I help you, you are likely to help me in the future (direct reciprocity), or if I help you, I will develop a reputation of being helpful and thus more likely to receive help from others in the future (indirect reciprocity). S. A. West et al. (2011) argued that we are not the only species that cooperates—so do ants, wasps, and a variety of plant species—but we are unique in developing elaborate and complex decision rules for negotiating cooperation.

What is teamwork? In brief, teamwork refers to the enactment of teamwork processes that support effective team performance (Salas, Rosen, Burke, & Goodwin, 2009). Or, more precisely, teamwork has been termed “the integration of individuals’ efforts toward the accomplishment of a shared goal” (Mathieu et al., 2017; p. 458). Teamwork is often viewed within the framework of an IPO model of team effectiveness (Mathieu, Maynard, Rapp, & Gilson, 2008). In an IPO model, *inputs*, such as team member characteristics, team-level factors, and organizational or contextual factors, influence team *output* or effectiveness through the operation of team interaction *processes*. According to Hackman (2012), “the core idea of the model is that input states affect group outcomes via the interaction that takes place among members” (p. 431). In this manner, team processes are a fundamental element of team functioning and effectiveness. Team processes are the means through which team resources are directed to achieve desired team outcomes, or in other words, team processes define how team inputs are transformed into outputs. Team outputs include important and valued outcomes such as quality or accuracy of performance, satisfaction, and commitment. In the following, we describe the evolution of teamwork models that embody this basic framework.

Teamwork Models

Early scientific research on group phenomena can be traced to scholars in the early part of the last century, and included work on primary groups (Cooley, 1909/1956), work groups (Roethlisberger & Dickson, 1939), mobs (Le Bon, 1895/1960), and wide variety of other topics. This



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research flourished in the 1950s and 1960s, spurred by the practical requirements and investment of resources stemming from the war efforts of World War II (J. E. Driskell & Olmstead, 1989). This research is exemplified by the work of Stouffer and colleagues (Stouffer et al., 1949), who conducted a landmark program of social psychological research on group dynamics on the battlefield.

The research activity spurred by the demands of the war years eventually abated, and in 1975, Hackman and Morris lamented that “we still know very little about why some groups are more effective than others” (Hackman & Morris, 1975, p. 2). However, there was a resurgence of research on team performance in the 1980s, driven, not surprisingly, again by applied research interests (J. E. Driskell, King, & Driskell, 2014). It is further interesting that, during this time period, there was a shift in the academic disciplines in which this team research was carried out. In the 1950s and 1960s, most small groups research was conducted within the domains of sociology and social psychology (Mathieu et al., 2017). Much of this work was concerned with conducting empirical research to test theory on group processes and dynamics. Laudable examples include seminal research on group status relations (Berger, Cohen, & Zelditch, 1966), patterns of group interaction (Bales, 1950), and intergroup conflict and cooperation (Sherif, Harvey, White, Hood, & Sherif, 1961). Beginning in the 1980s, group research was eagerly adopted by industrial/organizational psychologists, who emphasized team outcomes and conducted theory-driven research to examine applied outcomes such as team effectiveness and productivity. These researchers lamented that whereas we have a considerable understanding of who team members are, how they interact, and what they do to

accomplish the task, we have less of an understanding of how this contributes to team performance (Ilgen, 1999; Mathieu et al., 2008). Thus, we have witnessed what Mathieu et al. (2017) termed “a major reorientation of group research from social psychology to organizational settings” (p. 460). The difference between these two traditions is nuanced, but team research has proliferated under this new regime, and subsequent research has focused on team effectiveness and, specifically, on the teamwork processes that drive team effectiveness.

During the late 1980s, two of the pioneering efforts to characterize teamwork dimensions were related to the study of Army teams (Nieva, Fleishman, & Rieck, 1985) and Navy teams (Morgan, Glickman, Woodward, Blaiwes, & Salas, 1986). In one of the earliest attempts to identify teamwork dimensions, Nieva et al. (1985) examined “dimensions of group process that are directly relevant to performance” (p. 61). They proposed four major categories of team performance functions, described as what a team *does* to get work done. These include (a) team orientation functions such as eliciting and communicating information regarding the task and developing an integrated model of the environment, (b) organizational functions such as coordination, (c) adaptation functions such as cooperation and mutual adjustment among team members, and (d) motivational functions such as energizing task efforts and resolving conflicts.

Morgan et al. (1986) further addressed the problem of understanding the development of teamwork as a determinant of team effectiveness. They cited Hackman and Morris (1975) as stating that “something important happens in group interaction which can effect performance outcomes” (p. 49), but lamented there was little agreement about what that “something” was. They adopted a critical incident technique to query naval instructors on effective and ineffective behaviors observed in teams. A content analysis of responses revealed seven teamwork dimensions, including communication, adaptability, cooperation, team morale, coordination, giving suggestions, and accepting criticism. Glickman et al. (1987) collected data on intact naval teams and found that effective teams exhibited more positive teamwork behaviors within the identified dimensions. Moreover, a subsequent factor analysis resulted in the identification of both a taskwork factor and a teamwork factor underlying team performance.

Other early foundational research on teamwork processes occurred in the context of aviation. Siskel and Flexman (1962) described aircrew skills as including the ability to work together, to anticipate others’ needs and actions, to inspire confidence and mutual encouragement, and to communicate effectively. Subsequent research on aircrew coordination skills resulted in the concept of crew resource management (CRM; Helmreich, Wilhelm, Kello, Taggart, & Butler, 1990; Salas, Bowers, & Edens, 2001). This pro-



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gram of research generated such an impact that in 1990, the Federal Aviation Administration required U.S. air carriers to provide CRM training to all commercial flight crews, and this model has been adopted by other industries such as health care (Alonso et al., 2006).

Finally, there are several modern iterations of teamwork models. Extending the work initiated by Morgan et al. (1986), Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995) identified eight central or core teamwork dimensions, including adaptability, shared understanding of the situation, performance monitoring and feedback, leadership, interpersonal relations, coordination, communication, and decision making. Moreover, they further elaborated the distinction between *taskwork*, or the task-specific behaviors related to performing the task at hand, and *teamwork*, or the set of behaviors that facilitate the coordinated functioning of the team itself.

Perhaps the most cited and most accepted model of team processes was presented by Marks et al. (2001). The authors described this model as a comprehensive effort to integrate previous teamwork models and build on the work of Morgan et al. (1986), and others. However, this approach is unique in that it offered a multiphase (or recurring phase) perspective within a hierarchical structure of team process dimensions. That is, specific team processes are viewed as nested within separate temporal phases (see Table 1). *Action phase* processes refer to activities that are engaged in during action sequences of goal-directed activity. *Transition phase* processes occur between action episodes, during which the team is evaluating, planning, or adjusting task performance strategies. *Interpersonal processes* focus on the management of interpersonal relationships and are expected to occur throughout both action and transition phases.

Specific to action phase processes are the teamwork dimensions of monitoring progress toward goals, systems monitoring, team monitoring and backup, and coordination. Specific to transition phase processes are the dimensions of mission analysis, goal specification, and strategy formulation and planning. Specific to interpersonal processes are the dimensions of conflict management, motivating and confidence building, and affect management. Note that this formulation is not rigid—specific teamwork processes can occur at any time in the team’s life span but are proposed to be more prevalent in the specified phases.

Support for this model has been provided in a meta-analysis of teamwork processes reported by LePine et al. (2008). The results of this research provide support for the hierarchical nature of this model, with the 10 teamwork dimensions loading onto three higher order dimensions corresponding to transition, action, and interpersonal processes, which were themselves reflective of an overarching teamwork factor. Moreover, in keeping with the IPO perspective, team processes were shown to have a positive effect on team outcomes: The results indicated that the 10 teamwork dimensions were positively associated with team performance and team member satisfaction. In the follow-

Table 1
Teamwork Processes, Dimensions, and Activities

Types of processes	Teamwork dimensions	Representative activities
Transition processes	Mission analysis, formulation and planning Goal specification Strategy formulation	Analyzing the task, constraints, and resources; planning Goal setting Developing courses of action
Action processes	Monitoring progress toward goals Systems monitoring Team monitoring and backup behavior Coordination	Tracking progress; identifying shortfalls; providing feedback Monitoring resources and constraints internal and external to the team Monitoring other team members’ behavior; providing assistance Coordinating behavior; communicating information
Interpersonal processes	Conflict management Motivation and confidence building Affect management	Managing conflict; resolving disagreements Promoting and maintaining positive interpersonal relations Regulating team member emotions

Note. Adapted from Marks, Mathieu, and Zaccaro (2001).

ing, we provide a brief overview of these teamwork processes.

Teamwork Processes

We note two qualifications regarding the teamwork processes described in the following sections. First, researchers have noted that there are a large number and variety of teamwork dimensions described in the overall research literature, which can lead to conceptual confusion and ambiguity (LePine et al., 2008). The Marks et al. (2001) teamwork model was an attempt to reduce this ambiguity. This model reduces this problem but does not eliminate it—different authors still apply different labels to different teamwork dimensions (see Rousseau, Aubé, & Savoie, 2006). Second, these 10 teamwork dimensions should not be viewed as inerrant or final. They were selected by the authors to achieve a balance between generalizability (e.g., the 10 dimensions are broad enough to be applicable to various types of teams) and parsimony (e.g., the 10 dimensions are specific enough to be manageable).

Transition Processes

Mission analysis, formulation, and planning. *Mission analysis, formulation, and planning* refers to the process of analyzing the team's goal(s) and identifying constraints and resources to achieve task success (Marks et al., 2001). One critical task, planning, is often overlooked in teams (Hackman & Morris, 1978), although research has clearly demonstrated the value of planning and pretask briefings to team performance (Janicik & Bartel, 2003). Other activities include identifying and prioritizing goals and paths to achieve those goals and the development of alternative courses of action for goal attainment (Marks et al., 2001). Dalenberg et al. (2009) found that members of military teams who engaged in a brief strategy discussion prior to mission engagement exhibited greater coordination and better overall performance. Mathieu and Rapp (2009) found that teams that produced high-quality teamwork plans (regarding how the team will work together) and taskwork plans (regarding performance strategies for the task) early in their performance achieved higher performance. Fisher (2014) further elaborated the distinction between taskwork and teamwork planning, and found that the two forms of planning produced distinct effects on teamwork processes. Specifically, taskwork planning impacted coordination, whereas teamwork planning impacted interpersonal processes, and both exhibited an indirect relationship to team performance.

Goal specification. *Goal specification* refers to the identification of goals and subgoals leading to accomplishment of the task. Defining attainable goals allows team resources to be aligned with activities required for task completion and supports a shared understanding of the

team's objectives (Marks et al., 2001). In a meta-analysis of the effects of goal setting on group performance, Kleingeld, van Mierlo, and Arends (2011) found a large overall positive effect for goal setting on group performance (Cohen's $d = .56$); that specific, difficult goals were more effective than nonspecific goals; and that individually focused goals had a negative effect on group performance, whereas group goals had a positive effect.

Strategy formulation. *Strategy formulation* refers to the development of alternative courses of action for task accomplishment. Often, teams engage in an initial strategy for task accomplishment that may require adjustment based on dynamic and changing task contingencies or conditions. The term *adaptability* refers to adjustment of task strategies or team behaviors in response to changes in the team or task environment. Hackman and Morris (1978) noted that adaptability is one of the few universally effective group strategies. Burke, Stagl, Salas, Pierce, and Kendall (2006) defined *team adaptation* as "a change in team performance, in response to a salient cue . . . that leads to a functional outcome for the entire team" (p. 1190). They further noted that adaptability includes stages of (a) situational assessment, or recognition of the need for change; (b) plan formulation; (c) plan execution; and (d) team learning, or incorporation of these adjustments into knowledge to guide future behavior.

Action Processes

Monitoring progress toward goals. *Monitoring progress toward goals* refers to activities such as tracking progress toward task accomplishment, determining deficiencies and shortfalls, and providing performance feedback to the team members (Marks et al., 2001). These activities allow the team to assess discrepancies between goals and goal achievement as a means of self-regulation. Rapp, Bachrach, Rapp, and Mullins (2014) found that team goal monitoring mediated the relationship between team efficacy and performance, such that for teams that engaged in high levels of team goal monitoring, there was a strong positive relationship between team efficacy and team performance. However, for teams engaged in a low level of team goal monitoring, performance was greater at intermediate levels of efficacy (suggesting that overconfident teams may suffer from lack of team goal monitoring). Other research indicates that performance feedback is central to self-regulatory processes and team performance (Kozlowski & Ilgen, 2006). Geister, Konradt, and Hertel (2006) found that process feedback (which included feedback on taskwork behaviors and teamwork behaviors) increased performance of virtual teams, and increased motivation and satisfaction, but only for less motivated team members.

Systems monitoring. Systems monitoring includes tracking and monitoring the internal environment (e.g., per-

sonnel, tools, and equipment) and the external environment (e.g., external stressors, and task-relevant changes to the external context in which the team works). This is especially important for teams that operate in dynamic environments as well as in multiteam systems (MTSs) in which teams must synchronize joint actions (Mathieu, Marks, & Zaccaro, 2001). In fact, Marks, DeChurch, Mathieu, Panzer, and Alonso (2005) found that the most effective MTSs were those who were able to shift attention from within-team activities to cross-team activities as external circumstances required.

Team monitoring and backup behavior. Team monitoring and feedback behaviors include monitoring other team member's actions, identifying errors, providing constructive feedback, and offering advice for performance improvement (McIntyre & Salas, 1995). *Backup behavior* refers to the provision of task support to assist another team member who may be overloaded or experiencing difficulty (Porter et al., 2003). Backup behavior is important because, as Marks et al. (2001) stated, "if teammates are not looking out for, or willing to help out, each other, the team will fail when any one member fails" (p. 367). Porter et al. (2003) found that when teams were under high workload, backup behavior had positive effects on team performance. However, Barnes et al. (2008) found that there were costs as well as benefits to providing backup behavior in teams. When workload is unevenly distributed among team members, providing backup behavior may lead a team member to overlook their own taskwork, and those who receive high amounts of backup behavior may lower their efforts on subsequent tasks.

Coordination. *Coordination* refers to the "process of orchestrating the sequence and timing of independent actions" (Marks et al., 2001, pp. 367–368). Behaviors that support effective coordination include matching team member resources to task requirements, regulating the pace of team activities, and coordinating the response and sequencing of team member activities (Fleishman & Zaccaro, 1992). A related term, *collaboration*, has been defined as the process by which two or more persons engage in a joint activity to achieve a shared goal (Bedwell et al., 2012). Coordination requires effective communication or exchange of information among team members. Effective communication behaviors include exchanging information in a timely manner, acknowledgment of information, double-checking that the intent of messages was received (closed-loop communication), clarifying ambiguity, and the appropriate use of verbal and nonverbal cues (Salas et al., 2009). In a meta-analysis of information sharing and team performance, Mesmer-Magnus and DeChurch (2009) found that, overall, information sharing was positively related to team performance and that sharing uniquely held information was more predictive of team performance than simply sharing a greater amount of information, although teams did tend to

spend more time discussing commonly held information than uniquely held information.

Interpersonal Processes

Conflict management. To maintain positive interpersonal relations, real or perceived disagreements or incompatibilities among team members must be resolved. Broadly speaking, team conflict can be task-based (disagreements over ideas and opinions related to the task), relationship-based (interpersonal disagreements), or process-based (disagreements over responsibilities and how to get the task done; Behfar, Peterson, Mannix, & Trochim, 2008; Jehn, 1997). Further, Behfar et al. (2008) found that poorly performing teams tended to take an ad hoc approach to managing conflict, rarely correcting the root causes of conflict, whereas highly performing teams tended to develop conflict management strategies that promoted understanding, provided equitable treatment of all parties, and emphasized the concern with managing both task accomplishment and the interests of individual team members. Moreover, Shaw et al. (2011) found that when relationship conflict was high, there was a negative linear relationship between task conflict and team performance, whereas when relationship conflict was low, there was a curvilinear relationship such that moderate effects of task conflict was associated with better team performance. These results underscore the importance of conflict management in teams, especially at the interpersonal level.

Motivation and confidence building. Bales (2001) argued that one functional problem that all groups must solve is the development and maintenance of positive relations, both to foster pleasing interpersonal interactions and to ensure the continuance of the group. Team members may optimize interpersonal relations by preemptive conflict management (Marks et al., 2001), encouraging cooperative behavior, and building team morale. These are primarily socioemotional behaviors oriented toward ensuring smooth interpersonal relations (Driskell, Salas, & Driskell, 2015). Hüffmeier and Hertel (2011) developed a model for how social support may trigger motivational gains within teams. According to this model, social support is viewed as team member attempts to provide psychological or emotional support to other team members, and may be of two types: affective and task-related. *Affective support* includes statements of social recognition or statements of social encouragement that are oriented toward providing emotional support. In contrast, *task-related social support* consists of instrumental information provided to a team member regarding the task itself. This may include information-related support that conveys advice on task procedures or strategies. Hüffmeier and Hertel further argued that affective support primarily functions to enhance group member motivation, whereas task-

related support primarily promotes gains in coordination within teams.

Affect management. *Affect management* refers to the regulation of team member emotions during task interaction. As defined by LePine et al. (2008), affect management “represents those activities that foster emotional balance, togetherness, and effective coping with stressful demands and frustration” (p. 277). Moreover, they noted that the primary hallmark of affect management activities is that they focus on emotional issues versus task or process issues. Structured activities like team building (Salas, Rozell, Mullen, & Driskell, 1999), afteraction reviews or debriefs (Tannenbaum & Cerasoli, 2013), or informal activities like “bull sessions” may offer the opportunity to air emotional concerns. Meta-analytic results reported in LePine et al. indicated that affect management activities were positively related to both team performance and satisfaction. Given the likelihood of negative mood spreading throughout the team (Barsade, 2002), it is important that emotional issues be dealt with in a timely fashion, rather than allowing prolonged and possible escalating negative affect.

Interventions

Consistent with the IPO perspective, and with Cartwright and Zander’s (1953) missive, understanding teamwork processes should facilitate deliberate attempts to vary input factors and reap the benefits on enhanced teamwork and performance. For example, to the extent that we can compose teams or select team members with specific characteristics that support teamwork processes, team effectiveness should be enhanced. Second, to the extent that we can train certain knowledge, skills, and abilities that support teamwork processes, team effectiveness should be enhanced. Finally, to the extent that we can design features in the team context or environment that support teamwork processes, team effectiveness should be enhanced. In the following, we examine selection, training, and design approaches to support teamwork.

In describing the supporting empirical research, it is important to note that studies are fairly rare in which the full IPO relationship is examined (LePine, Buckman, Crawford, & Methot, 2011). That is, studies that manipulate input factors, assess effects on specific teamwork processes, and measure performance outcomes are the exception rather than the norm. Most existing studies examine either the direct effect of a specific factor on team effectiveness or the direct effect on team processes.

Selection

Team composition research examines the extent to which team member attributes impact teamwork processes and performance outcomes. Research has been conducted to

examine a variety of attributes, including personality (Bell, 2007; LePine et al., 2011), generic teamwork skills (Salas et al., 2009), cognitive ability (Devine & Philips, 2001), task knowledge (Mathieu & Schulze, 2006), team orientation (J. E. Driskell, Salas, & Hughes, 2010), goal orientation (LePine, 2005), resilience (B. J. West, Patera, & Carsten, 2009), and other characteristics. Mathieu, Tannenbaum, Donsbach, and Alliger (2014) described four types of team composition models. The first is a traditional *personnel-position fit* model that emphasizes the particular set of individual knowledge, skills, abilities, and other characteristics (KSAOs) that contribute to successful performance in a specific position or role. Morgeson, Reider, and Campion (2005) noted that an organization does not usually have the luxury of selecting or hiring an entire team, but instead selects an individual to place in a team. Faced with this task, the overarching question is “What makes a good team player?” (J. E. Driskell, Goodwin, Salas, & O’Shea, 2006). Most existing research on this topic has examined how individual personality traits contribute to effective team performance. In terms of the Big Five personality dimensions, there is a reasonable consensus on broad personality factors that support effective team behavior (see Bell, 2007; J. E. Driskell & Salas, 2013; LePine et al., 2011; Prewett, Walvoord, Stilson, Rossi, & Brannick, 2009). Thus, individuals who are *conscientious* are more dependable, organized, hardworking, and likely to be responsible and provide “backup” or support to other team members (Porter et al., 2003). Individuals who are *agreeable* are more considerate, trusting, sympathetic, helpful, and cooperative (Mount, Barrick, & Stewart, 1998). Individuals who are *extraverted* (especially those scoring high on the facet of *sociability*; see J. E. Driskell et al., 2006; Prewett, Brown, Goswami, & Christiansen, 2016) are more sociable, friendly, interested in social interaction, and interpersonally skilled. Individuals who are *emotionally stable* are well-adjusted, calm, self-confident, and less likely to experience negative affect or transmit this to other team members (Morgeson et al., 2005). Individuals who are *open to experience* are likely to be more flexible, adaptable, and able to adjust their behavior to changing interpersonal situations (Paulhus & Martin, 1988). However, there is also the possibility of curvilinear effects, such that too much extraversion can be detrimental, for example, because it may interfere with instrumental task activities (see J. E. Driskell, Hogan, & Salas, 1987).

The second type of team composition model is a *personnel model with teamwork considerations* that emphasizes the role of team-generic competencies in enhancing team effectiveness (Cannon-Bowers et al., 1995). For example, Morgeson et al. (2005) found that teamwork knowledge was positively related to contextual performance in teams. J. E. Driskell et al. (2010) found that collective orientation (the preference for working in collective or team settings) pre-

dicted performance on separate team tasks involving decision-making, negotiation, and task execution. This research suggests that to the extent that team members possess team-generic competencies, the team is more likely to be effective.

The third type of team composition model is a *team profile* model that considers team member's attributes collectively in terms of how they are distributed in the team. For example, in selecting a new team member to an existing team, consideration should be given to the mix of attributes within the team. This poses more complex questions of how we match one team member's attributes to another team member's attributes—that is, the question of who prefers to work with whom and who is more effective working with whom (Tett & Murphy, 2002; Tett, Simonet, Walser, & Brown, 2013). Moreover, research is needed to examine trait interaction (LePine et al., 2011). For example, a person that is high on the personality trait of conscientiousness but low on agreeableness may be a pain to work with in a team environment.

The effects of heterogeneity or diversity of team member attributes on team outcomes has also been examined. For example, team member personality variability has been examined in terms of supplementary traits (i.e., a trait for which similar scores among team members or homogeneity is preferred, such as emotional stability) and complementary traits (i.e., a trait for which greater diversity or heterogeneity is preferred, such as extraversion). For example, Humphrey, Hollenbeck, Meyer, and Ilgen (2007) argued that conscientiousness operates as a supplementary trait, in that high variance (with some team members working hard and some not) can lead to other team members lowering their effort.

The fourth type of team composition model is a *relative contribution* model that examines the relative or disproportional impact that some characteristics may have on team effectiveness, such as a negative or overly critical team member (Felps, Mitchell, & Byington, 2006). For example, minimum scores on team member attributes are informative if it is expected that a single individual with a very low score may disproportionately impact team performance. For example, Stewart (2003) claimed that a single team member low on emotional stability, agreeableness, or conscientiousness could potentially impair the functioning of the entire team. Humphrey, Morgeson, and Mannor (2009) examined attributes of core versus peripheral team members. They found that attributes such as task-related skill and experience were predictive of effective team performance, but that this relationship was stronger when the attributes were held by core team members versus noncore members.

In brief, we know a considerable amount about selecting “good team players” at a broad level. More complex questions regarding attribute heterogeneity, diversity and interactions, including research on faultlines or “splits” among team

members on some attribute (Bezrukova, Spell, Caldwell, & Burger, 2016), and network analyses (Pearsall & Ellis, 2006) are currently being addressed.

Training

Team training is “a set of instructional strategies and tools aimed at enhancing teamwork knowledge, skills, processes, and performance” (Tannenbaum, Salas, & Cannon-Bowers, 1996, p. 516). Team training has been shown to have a positive impact on team performance, enhancing affective, cognitive, process, and performance outcomes (Salas et al., 2008; Salas, Nichols, & Driskell, 2007). Interventions designed to enhance teamwork include cross-training, which focuses on providing team members with exposure to the roles and responsibilities of the other positions on the team (Blickensderfer, Cannon-Bowers, & Salas, 1998; Marks, Sabella, Burke, & Zaccaro, 2002; Volpe, Cannon-Bowers, Salas, & Spector, 1996); team dimensional training, which involves training in team briefings and debriefings in order to develop a shared team vision (Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008; Smith-Jentsch, Zeisig, Acton, & McPherson, 1998; Tannenbaum & Cerasoli, 2013); team coordination training, which focuses on training coordination and adaptation processes (Burke et al., 2006); and team building, which focuses on enhancing the affective characteristics of teams (Klein et al., 2009; Salas et al., 1999; Tannenbaum, Beard, & Salas, 1992); among others.

In short, team training is designed to target teamwork competencies. It is important to note that *team-generic* competencies (such as collective orientation or communications skills) are transportable to any type of team or team task (Smith-Jentsch et al., 2015). Moreover, Ellis, Bell, Ployhart, Hollenbeck, and Ilgen (2005) found that generic teamwork skills training enhanced overall team effectiveness, and that this training was more valuable for team members in certain team roles than others. Gregory, Feitosa, Driskell, Salas, and Vessey (2015) advanced specific guidelines for the development and implementation of team training (see Table 2). A comprehensive and holistic approach to team training, incorporating team training tools (e.g., team task analysis), sound instructional methods (i.e., information, demonstration, and practice), focused training content (e.g., teamwork skills), and thorough evaluation (e.g., feedback), should lead to more effective teamwork (Driskell & Salas, 2014).

Design

Following Stewart (2006), team design features include three broadly defined categories: task design, group composition, and organizational context. Although this classification may underspecify the entirety of team design fea-

Table 2
Elements of Team Training for Effective Teamwork

Training elements
Establish a positive training climate to ensure trainee buy-in
Create conditions for successful teamwork
Conduct a team-level needs analysis
Design a measurement and evaluation plan
Focus training on teamwork skills
Incorporate appropriate instructional strategies
Provide diagnostic feedback to support positive team development
Evaluate the team training
Promote transfer of training
Reinforce and sustain training gains

Note. Adapted from Driskell and Salas (2014) and Gregory et al. (2015).

tures, it strikes a good balance between parsimony and explanatory value.

Task design. Unsurprisingly, the nature of the task(s) that teams perform effects team processes and performance. Task interdependence has been identified as an important moderator of team functioning and the importance of team processes during task execution. Task interdependence can be described as the degree to which team members must rely on each other to complete task performance. Saavedra, Earley, and van Dyne (1993) identified four types of task interdependence: pooled, sequential, reciprocal, and team. Highly interdependent tasks require higher levels of teamwork. Task type can also be characterized as being either divisional or functional (Harris & Raviv, 2002). Divisional tasks are interchangeable and can be completed by any member of a team, whereas functional tasks require specific skills and expertise and are less likely to be able to be completed by multiple team members. Functional tasks require higher levels of team cognition, in that team members need to know where the expertise lies among the team (i.e., transactive memory).

Team autonomy. Team autonomy or the degree to which the team controls its own activities has also garnered substantial attention in relation to task design. Although this relationship has been shown to be more nuanced than previously thought (Leach, Wall, Rogelberg, & Jackson, 2005), increased autonomy has been positively linked to motivation and learning behaviors, and negatively linked to strain and emotional exhaustion (Leach et al., 2005; Stewart, 2006; van Mierlo, Rutte, Vermunt, Kompier, & Doorewaard, 2007).

Hackman and Oldham (1980) deemed work to be perceived as meaningful if either one or all of the following job characteristics are met: there is skill variety, task identity, and task significance. *Skill variety* is the degree to which a job affords the individual the opportunity to use a variety of KSAOs. *Task identity* is the degree to which a job allows individuals to produce a complete piece of work that has a tangible outcome. And *task significance* is the degree to

which the task has a significant impact on the life or work of the individual or the lives or work of other people. According to Stewart (2006), meaningful work should increase team member motivation and, in turn, increase team performance. Stewart's meta-analysis demonstrated a positive relationship between task meaningfulness and team performance, although that relationship varied by team type.

Team Composition

Team composition in terms of team member attributes has already been addressed, but Stewart (2006) also considers how teams are "composed" in terms of design features such as group size. Whereas larger teams are more like to bring together greater resources, abilities, and perspectives (Kozlowski & Bell, 2003), other research suggests that larger groups may suffer coordination and socioemotional losses (Aubé, Rousseau, & Tremblay, 2011; Mullen, Symons, Hu, & Salas, 1989).¹

Teams are also composed of specific roles. A role is an established set of behaviors that is characteristic of an individual in a particular setting (Stewart, Fulmer, & Barrick, 2005). Recent attention has been given to team role composition as a means of enhancing team functioning (T. Driskell, Driskell, Burke, & Salas, 2017). According to the team role balance hypothesis, teams function best if they have a balanced representation of roles (see Aritzeta, Swales, & Senior, 2007). T. Driskell et al. (2017) developed a model of team roles based on the primary dimensions of dominance (role behaviors that involve directing and leading), sociability (role behaviors that involve socioemotional support and interpersonal relations), and task orientation (role behaviors that involve task achievement and organization). Driskell et al. conducted a cluster analysis of existing team role taxonomies that resulted in the identification of 13 primary team role clusters that map onto this three-dimensional model, allowing role balance to be examined across this conceptual space.

Organizational context. The third design feature, organizational context, refers to team members' perceived level of support from the organization. Stewart (2006) noted that "perceptions of support from the leader can be nearly synonymous with perceptions of support from the organization" (p. 31). Results from Stewart's meta-analysis demonstrated the efficacy of transformational and empowering leadership on term performance. Transformational leadership is characterized by lifting subordinate team member interests beyond that of the self for the good of the team (Bass, 1985). Empowering leadership is characterized by giving team members authority to make decisions and implement actions (Zhang & Bartol, 2010). Moreover, re-

¹ This brings to mind Old's (1946) tongue-in-cheek suggestion that the optimal size for a group is approximately 0.7 people.

search on team leadership behaviors shows that both task- and person-focused behaviors relate to team performance, with empowerment behaviors notably showing a strong relationship with team performance outcomes (Burke et al., 2006).

Applications

As Vannevar Bush so eloquently stated, “Basic research leads to new knowledge. . . . It creates the fund from which the practical applications of knowledge must be drawn” (Bush, 1945, para. 3.3). Applications of teamwork research are many and varied. For example, Britt and Oliver (2013) examined the effects of enhancing morale and cohesion in building resilience in military teams (see also Alliger, Cerasoli, Tannenbaum, & Vessey, 2015). Prewett et al. (2016) examined personality and teamwork behaviors in business (retail) teams. McEwan and Beauchamp (2014) examined teamwork in sports teams. Cooke and Hilton (2015) examined teamwork and scientific collaboration.

Two representative areas in which teamwork research is flourishing perhaps deserve special mention—the value of teamwork in health care and in extreme environments such as spaceflight.

At the time of writing, a Google search reveals over 12 million hits for the combined search of the terms *teamwork* and *health care*, and in the most recent year (2016) alone, there were approximately 915,000 hits compared with 12,000 hits 10 years prior in 2006. In the landmark Institute of Medicine (2000) report, *To Err is Human*, the authors estimated that at least 44,000 Americans die each year as a result of medical errors. Moreover, they noted the complexity inherent in medical care, especially emergency medicine, and issued a recommendation to improve teamwork to reduce errors in health care. In subsequent years, this call has been embraced. In a recent meta-analysis of team training effectiveness in health care, Hughes et al. (2016) found that team training interventions were effective at multiple levels of analysis, including individual (e.g., individual learning), team (e.g., teamwork performance), and organizational (e.g., safety climate) levels. As one example, Weaver et al. (2010) introduced a training program to optimize teamwork in operating room teams, and observed significant improvement in the quality of presurgery briefings and in the display of teamwork behaviors during actual cases. They noted that it is critical that health care providers are not only proficient clinicians (e.g., taskwork) but also proficient team members (e.g., teamwork).

Many extreme performance environments, such as mountaineering in high-altitude settings (Wickens, Keller, & Shaw, 2015) and military operations (T. Driskell, Salas, & Driskell, 2017), are simply not attainable without team efforts. One such extreme performance environment is spaceflight. NASA is currently preparing for the *Mission to*

Mars, slated for the 2030s, and research on human performance and teamwork is a central focus (Salas et al., 2015). In terms of extreme performance conditions, this setting has it all. This mission will entail a long-duration (approximately 3-year) journey for a crew of four to six persons of varying backgrounds in a confined space in an inhospitable environment. The crew will be undertaking an unprecedented journey so far away that earth will fade from view, and the crew will be highly autonomous as communications between the crew and Earth at these distances will be time-delayed. There will be periods of very high workload as well as periods of low workload and monotony. Finally, the crew will be working in a risky and dangerous environment in which the consequences for error may be severe. Current research efforts include research on unobtrusive approaches to tracking the effects of stress on cognitive and socioemotional states in teams (T. Driskell, Burke, Driskell, Salas, & Neuberger, 2014), team resilience (Alliger et al., 2015), the examination of behavioral sensors or badges to capture team process dynamics over time (Kozlowski, 2015), the use of guided debrief approaches to enhance teamwork behaviors (Eddy, Tannenbaum, & Mathieu, 2013), and the examination of changing role dynamics (Burke, Driskell, Driskell, & Salas, 2016). Current research efforts that may support teamwork on Mars are taking place in realistic analog environments such as NASA’s Human Exploration Research Analog, the NASA Extreme Environment Mission Operations habitat, and the Antarctic.

Further Research

Researchers have noted that current teamwork perspectives have limitations, and there are a number of things that we do not know regarding teamwork processes. First, the traditional IPO model is beginning to show its age. As Mathieu et al. (2008) concluded, “The IPO model and its latter-day derivatives (e.g., IMOI) have served the field well” (p. 460); however, this approach is less suitable for modern team structures that are more dynamic, complex, and adaptive. That is, modern teams are likely to perform multiple tasks over a period of time; coordinate with external teams; team members may come and go; the team may reconfigure as the task progresses; and so on. Kozlowski and Ilgen (2006) concluded that “while the I-P-O model is a useful organizing heuristic, treating it as a causal model encourages taking a limited and static perspective on team effectiveness and the dynamic processes that underlie it” (p. 80).

Second, other processes, such as team creativity, do not fit as neatly into the current teamwork model. Mathieu et al. (2008) noted that creativity has been viewed as a driver of team effectiveness, yet creative processes have been under-researched. Status processes, or patterns of authority relations within teams, are also not clearly defined within cur-

rent teamwork research. Further research is needed on variants of traditional team structures, such as MTSs (Marks et al., 2005) and virtual teams (J. E. Driskell, Radtke, & Salas, 2003; Maynard, Mathieu, Rapp, & Gilson, 2012). Marks et al. (2001) also distinguished between team processes and emergent states, and this distinction has become widely accepted. Whereas team processes involve team member's actions, emergent states are cognitive, motivational, or affective states that emerge from interactions among team members. Emergent states such as cohesion, team climate, and team efficacy mediate the relationship between team inputs and outcomes (Coultas et al., 2014). Given the focus of this article on team processes, we have not elaborated on emergent states; however, further research is needed on the relationships between inputs, team processes, emergent states, and team outcomes.

Finally, the field is replete with calls for more complex research designs—designs that capture the entire input–process–emergent-state–output relationship, designs that examine team variables over an extended period of time, designs that incorporate multiple levels of team and organizational systems, multistep analytic approaches, and studies that examine a broad array of team inputs, processes, and outcomes. These are all forward looking and well advised. However, as a counterpoint, it is useful to consider what we may have lost as the study of teams and team processes has migrated from social psychology to a more applied industrial/organizational perspective. At the risk of igniting an age-old discussion of experimentation and generalizability, many experimental researchers attempt to *reduce* complexity in studying team phenomena. That is, there is a broad distinction between research designed to test theory and research designed to apply theory (J. E. Driskell et al., 2014; Webster & Sell, 2014). Basic researchers will see the primary value of their work as building theory or expanding a body of knowledge, whereas applied researchers will see the primary value of their work as solving a real-world problem (although there is a considerable amount of research that is carried out between these two poles). In the shift of team research from a discipline that is more oriented toward basic research to a discipline that is more oriented toward applied research, we do not want to forget the value of fundamental research conducted to develop general principles. There is no better statement than Kurt Lewin's famous quote:

Many psychologists working in an applied field are keenly aware of the need for close cooperation between theoretical and applied psychology. This can be accomplished in psychology, as it has been accomplished in physics, if the theorist does not look toward applied problems with highbrow aversion or with a fear of social problems and if the applied psychologist realizes that there is nothing so practical as a good theory. (Lewin, 1944/1951, p. 169)

Conclusions

It is sobering to reflect that whereas effective teamwork once enabled us to band together to pursue bison for survival, we are now teaming together to journey to another planet. Moreover, our understanding of teamwork has been advanced in both basic and applied research and is informing practical issues of immediate and future concern. Although it seems that we are in a golden age of interest and research activity related to teamwork, much of what we know is preliminary and points to further research. Nevertheless, the wealth and breadth of research activities taking place now provide encouragement that these challenges (yes, even Mars) are within reach.

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