

## Symposium/Forum

### TITLE

Staying Alive! Training High-Risk Teams for Self Correction

### ABSTRACT

Research examining teams working in high-risk operations has been lacking. The present symposium showcases research on team training that helps to optimize team performance in environments characterized by life or death situations arising spontaneously after long periods of mundane activity by pulling experts from diverse areas of industry: space flight, health care, and medical simulation.

### PRESS PARAGRAPH

Although research on team training and performance has made significant advancements in recent years, studies focusing exclusively on high risk occupations are needed for researchers to more accurately train teams involved in this work. This symposium highlights the challenges unique to occupations characterized by a punctuated equilibrium of high risk activity following prolonged routine work. In crisis situations, teams should be trained to coordinate quickly and effectively as well as to correct potential errors as they arise. The presentations draw data from a variety of industries including space flight, health care, and medical simulation to demonstrate training methods that have been proven effective.

## Overall Summary

### *Staying Alive! Training High-Risk Teams for Self Correction*

Chairs:

Emily M. David, University of Houston

Kathryn Keeton, NASA/EASI

Not all teams are created equally; for some occupations, such disparities can literally mean the difference between life and death. This symposium brings together four papers, each of which considers the importance of training teams in high-risk environments to self correct and deal effectively with crisis situations. Past reviews have highlighted the sizeable impact that training can have on individual (Farrell & Hakstian, 2001), firm (Nguyen, Truong, & Buyens, 2010), and team performance (Salas, DiazGranados, Klein, Burke, Stagl, Goodwin, & Halpin, 2008). A key gap in the literature exists however in understanding the role of team training in the context of professions characterized by long periods of routine or mundane activity punctuated by high-risk crisis situations. In these teams, members must function as an integrated whole while still retaining their individual problem solving and situation awareness capabilities. When crises do erupt, the teams must quickly coalesce into one well coordinated mechanism to adapt to the changing situation. Investigations on this topic are timely, as researchers have only recently begun to emphasize the importance of team training to reduce costly errors (in the medical industry: Alonso, Baker, Holtzman, Day, & King, 2006; Morrison, Goldfarb, & 2010; Rudy, Polomano, Murray, Henry, & Marine, 2007; in the aviation industry: Burke, Wilson, & Salas, 2003; in the space industry: Hysong, Galarza, & Holland, 2007 using simulations: Salas, Rosen, Held, & Weissmuller, 2009).

In the first paper, Slack, Schmidt, and Keeton discuss the importance of training interpersonal competencies in preparation for long-duration space flight. Space Flight Resource

Management (SFRM) is a training program used to develop the skills necessary for critical team functioning aboard the International Space Station. The authors discuss the components of this training program as well as its integration into tabletop simulations and outdoor crisis-training activities.

In the second paper, Noe, Dachner, and Saxton use an interview method to identify the team training needs for crews preparing for extreme long-duration missions to Mars and beyond. In their presentation, the researchers will integrate research from the training literature as well as specific findings in NASA analogues and other isolated and confined environments. Their results show that the ability to problem solve in ambiguous environments as well as work together as a team to combat the psychological issues of boredom and loneliness will be key factors for success in future space flight missions.

In the third presentation, Weaver and Salas continue to underscore the importance of training teams to identify internal problems and self-correction strategies. Their research is unique in that it investigates this issue in the context of health care teams. Although the medical industry shares the high stakes of space flight in that a single error can cost a life, doctors face the added barrier of little formal exposure to team training. The authors compared three training approaches for developing the capacity for self correction in health care teams and provide insight into the effectiveness and implementation of these programs.

In the final contribution, Musson also looks at teams within the health care industry but focuses on the examination of teamwork in the context of simulation-based training. Specifically, he suggests how this type of training can be utilized to provide teamwork training for health professionals. Efforts to test the implementation of simulation and team skills across

multiple disciplines are discussed by those involved at McMaster University as well as the extension of this training model to health care teams in remote and extreme environments.

Presenters will highlight the common team training theme that links these studies. After the presentation of practical and research findings, Steve Kozlowski in his role as discussant will comment on each of the papers and highlight additional considerations regarding self-correcting teams in high-risk environments. Dr. Kozlowski brings a unique perspective to this symposium given his extensive research on adaptive teams (e.g., Kozlowski & Ilgen, 2006; Kozlowski, Watola, Jensen, Kim, & Botero, 2009). To conclude the session, the audience will be invited to ask questions and to discuss directions for future research.

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## Presentation 1

### Developing Self-Correcting Astronaut Crews

Kelley J. Slack<sup>1</sup>, Lacey L. Schmidt<sup>2</sup>, and Kathryn E. Keeton<sup>2</sup>

NASA-Johnson Space Center

<sup>1</sup>LZ Technology    <sup>2</sup>EASI

Errors are made. Even by astronauts. Being a member of one of the most elite groups in the world does not ensure them against errors. The fact that they are very intelligent, their technical skills are honed, or that they work with ground support of similar caliber does not make astronauts perfect. In the inhospitable, unforgiving atmosphere of space, reducing human errors can save lives.

Although the training flow for the International Space Station (“ISS”) spans 2 ½ years, each astronaut or cosmonaut largely trains alone. Rarely have all six ISS crewmembers trained together, even more rarely have the six lived together prior to launch. How then does this crew quickly become a team—a team that must respond flexibly yet decisively to any situation? And, how does the crew learn to be self-correcting? The way things work on the ground is not necessarily how they work in space; and ground support’s ability to render help is limited both by distance and the availability of communication.

We think the answer is Space Flight Resource Management (“SFRM”), the so-called “soft skills”. Based on Cockpit Resource Management, SFRM was developed first for shuttle astronauts and focused on managing human errors during time-critical events (Rogers, et al. (2002). Given the nature of life on ISS, the scope of SFRM for ISS broadened to include teamwork during routine operations (O’Keefe, 2008).

The ISS SFRM model resembles a star with one competency for each point: Communication, Cross-Culture, Teamwork, Decision-making, Team Care, Leadership/Followership, Conflict Management, and Situational Awareness. These eight competencies, developed with international participation by the Human Behavior and Performance Training Working Group, have been used at NASA to build an SFRM training flow for newly selected astronauts (“ASCANs”) that integrates “soft skills” into the practice of technical skills. This flow is multi-modal: involving classroom instruction, paper-based simulations, technical simulations, and expeditionary field exercises.

ASCANs receive a classroom introduction to the competencies and the associated “STAR” Model. The STAR model is a decision-making mnemonic borrowed from the Calloway Nuclear Plant that requires users to Stop, Think about the situation and soft skills involved, Act based on a plan that uses these soft skills, and Review the outcomes to adjust the plan and skill involved as needed. The basic concepts are learned during stand-alone classes taught by SFRM experts. Later real operational examples of SFRM are provided by flown ISS astronauts during a two day workshop.

Once the ASCANs learn the basics, they participate in a series of three low-fidelity, tabletop simulations or games. The premise of these simulations is to traverse from launch pad to Moon base and back within certain constraints and under progressively more difficult situations. ASCANs play the role of control center or are one of several field crews and must work together as a team to achieve mission goals. The Moon base simulation game is designed to require use of SFRM competencies to succeed and the versions coincide with technical milestones within their training flow. ASCANs are also provided the opportunity to practice SFRM during a 12-day outdoor experience led by the National Outdoor Leadership School

(“NOLS”) that is specifically geared towards honing SFRM behaviors under stress and during the adversity of an expeditionary mission.

SFRM competencies are measured during the Moon base game using behaviorally anchored rating scales. Improvement in SFRM ratings over the increasingly difficult versions of the Moon base game provide evidence that the classroom coursework has transferred to hands-on practice of SFRM during simulations.

Evidence that the SFRM training is effective outside of the training environment is at this point largely anecdotal. One ground support crewmember, after encountering his first major system failure, attributed his successful handling of the crisis to SFRM: “SFRM and STAR is a really valuable tool and it gives people the impression that I did something that is beyond my scope. Instead it’s the training that I received that is above and beyond the ordinary.” And, training has even transferred outside of work. After a day of trying out her orienteering skills, one astronaut called a STAR moment with her husband near the top of a mountain when she realized that they were not where she thought they were. After she explained what a STAR moment was to her baffled husband, they were able to brainstorm and implement their selected plan of following their footsteps in the snow back to the last marked trail on the map. As she says, “it’s a good story, since we made it back to tell it!”

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## **Presentation 2**

### *Team Training for Self-correction on Long-duration Missions in Isolated and Confined*

#### *Environments: Evidence from NASA*

Raymond Noe, Ali Dachner, and Brian Saxton  
Department of Management and Human Resources  
Fisher College of Business, The Ohio State University

NASA faces new training challenges as it prepares to send manned missions to planets such as Mars. Compared to previous space missions, during a six month Mars mission the multinational flight crew will spend extended time together in a confined space with more free time. They will experience communications delays of up to twenty minutes with flight controllers. The novelty of the mission ensures that unexpected issues will arise that will require the crew to be resourceful and act independently from ground support. Meeting these challenges will require new approaches and emphasis in team training focusing on self-correction. This presentation will discuss the results of a study we conducted at Johnson Space Center based on interviews of astronauts, flight controllers, trainers, and other subject matter experts. The interviews were used to identify the important issues that team training needs to address to enhance team self-correction skills, review current NASA team training practices, and provide recommendations for team training practices and future research needs based on current team training research and the interview results.

Research on team training, crisis events, multi-team systems, team mental models, cross-cultural agility, and crew resource management is especially important for understanding team training in isolated and confined environments for long duration missions. Team training has been shown to improve team effectiveness (e.g., Delise et al., 2010; Salas et al., 2008). Team training is important for shaping the collective cognition needed for effective teamwork

(DeChurch & Mesmer-Magnus, 2010). It is important to recognize that the flight crew is part of a larger multi-team system (Mathieu, Marks, & Zaccaro, 2001). Mission accomplishment is dependent on development of an effective multi-team system including the flight crew and flight controllers (Marks, DeChurch, Mathieu, Panzer, & Alonso, 2005). Cultural agility, the ability to quickly and comfortably work in different countries and with individuals from diverse cultures is critical for multinational flight crewmembers to develop credibility and communicate and work together effectively (Caligiuri, 2010).

Recent research on isolated and confined environments (e.g., Kanas et al., 2009; Ball and Evans, 2001; Orsanu, 2005) suggests that training must include realistic simulations that test trainees' corporate citizenship, interpersonal skills, and emphasize metacognitive skills that enable trainees to solve problems in dynamic, uncertain environments. Stachowski, Kaplan, and Waller (2009) found that training should emphasize the use of protocols as tools but not rigid guides for interaction in crisis events.

One of the primary methods used to encourage development of team members shared mental models and self-correction in reaction to crises in high-risk occupations is crew resource management training (Flin, O'Connor, & Mearns, 2002). Crew resource management (CRM) involves team members in simulated scenarios where their technical and teamwork behaviors are observed and evaluated. While evaluative research into the effectiveness of crew resource management training is in its beginning stages (O'Connor et al., 2008), it appears to build skills in time management, advance awareness of possible errors or changing conditions, and optimal responses to sudden unanticipated events. These skills will be critical for a Mars mission where crew survival will depend on their ability to deal with a crisis after long periods of quiescent operations.

NASA is involved in team training in several different ways including the use of analogue high fidelity training settings. NASA's Extreme Environment Mission Operations (NEEMO), is an undersea laboratory that provides astronauts with a hostile environment simulating space. Another analogue used by NASA is the National Outdoor Leadership School (NOLS) that tests the ability of astronauts and candidates to work together in a stressful outdoor setting. Careful scenario design in these analogues can simulate the challenge associated with rapid self-correction in crisis situations. Use of these analogues can help crewmembers develop cultural agility as they interact with peers from other cultures and learn to test their assumptions and the limits of their personal knowledge. Also, these analogues emphasize use of Space Flight Resource Management (SFRM), based on CRM, to help flight crews and controllers develop shared mental models and team skills.

Further research is needed to better understand the effectiveness of CRM/SFRM, how to develop high fidelity training scenarios; evaluate team performance during scenarios, and effective debriefing techniques. Also, how to effectively train crewmembers to monitor themselves and others should be investigated. On a long duration mission, crewmembers must be able to exchange roles and help one another deal with the psychological issues (boredom, loneliness) that are inherent in long duration space missions.

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### **Presentation 3**

*Training Teams to Self-Correct when the Lives of Others Depend on it:  
Team Training for Patient Safety*

Sallie J. Weaver and Eduardo Salas  
Department of Psychology  
Institute for Simulation and Training  
University of Central Florida

Teamwork is a vital component of quality, safe healthcare given the complex nature of care systems today. However, healthcare teams often do not fit some of the most well studied definitions of the team construct. Describing healthcare team as interdisciplinary action teams (Sundstrom et al., 1990), Edmondson (2004) notes that these teams bring together unique constellations of highly specialized expertise under conditions that range from highly dynamic and time pressured to relatively routine. Additionally, the care environment is often characterized by dynamic shifts in both workload and team membership within a single care episode (Edmondson, 2004; Xiao et al., 1996). These elements of punctuated equilibrium in workload and team membership fluidity require healthcare teams to self-correct under both routine and novel conditions in order to function effectively (Baker et al., 2005; Edmondson, 2003). To maintain reliable, safe care during routine procedures these teams must commit to mutual performance monitoring, maintain a vigilant sensitivity to errors, and work to sustain collective mindfulness (Weick & Sutcliff, 2005). During emergency situations these teams must also demonstrate enhanced deference to expertise, commit to adaptation, and engage in high levels of open information sharing in the context of fluid team membership. The team's ability to engage in continuous learning through effortful self-correction activities is a critical element of both routine and novel care scenarios.

There are significant barriers to activities that promote team self-correction, such as collective debriefing, in healthcare, however. While the premise of *individual* self-regulation lies at the heart of the “ideology of medical professionalism” (Wynia, 2010, pg. 210), this ideology presents a very real barrier to critical elements of patient safety including error reporting and open discussion of opportunities for improvement at the collective team, unit, or organizational level. In a recent study of physicians, DesRoches and colleagues (2010) found that 17% of respondents directly knew a colleague whom they felt did not meet competency requirements for practice. However, nearly 1/3 of these respondents reported that they did not speak up about their concerns. An autonomous, individually focused culture combined with the complexities of the care environment present a unique challenge when conceptualizing how to best train healthcare teams to self-correct and how to support the transfer of team self-correction skills into daily practice.

The current paper compares three training-based approaches for developing team-self correction capacity in healthcare teams. The three training strategies were utilized in the field across a range of healthcare contexts, including surgical care, trauma/emergency care, endoscopy, and pain management. Comparisons among the three approaches are drawn based upon existing theoretical models of team adaptation (e.g. Burke, Salas, et al., 2007; Burke, Stagl, et al., 2006), adaptive expertise (Ramachandran et al., 2010), and training transfer (Baldwin & Ford, 1988; Burke & Hutchins, 2007; Cheng & Ho, 2001). The first training program focused specifically on communication and early identification of adverse events, whereas, the second training program focused on a comprehensive teamwork-based approach by including content related to mutual support, back-up behavior, and leadership. The third program also focused on developing a comprehensive battery of teamwork competencies; however, it specifically



incorporated simulation and extensive practice of guided debriefings during training sessions. Implementation strategies also differed significantly between the three training programs; one utilized a bottom-up approach while the other two took a top-down approach to implementation. Results from multi-level evaluations of these programs will be discussed in light of the different approaches taken to enhance team self-correction through team training. Discussion will be designed to offer insight for researchers and practitioners studying high-risk teams and pioneering the integration of organizational science into the science of healthcare.

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## Presentation 4

### Training Teams: From the Operating Room to Extreme Environments

David Musson, McMaster University

Although traditional health professional education addresses both core knowledge and clinical skill acquisition, such education typically takes place within profession and discipline-specific silos. Despite the fact that modern healthcare is delivered by multi-professional and multidiscipline teams, formal training in teamwork is virtually absent from existing medical and nursing school curricula. This problem also exists at more advanced training levels, such as medical and surgical residency programs. Residency training more closely approximates an apprenticeship model with virtually all learning occurring in concert with actual clinical practice through an experiential and mentorship model, yet even in those programs, little exists in terms of formal training in teamwork.

Recent efforts in patient safety and curriculum design have highlighted a systematic deficiency in health sciences education in the area of developing and delivering team skills and in formal preparation for practicing in multidisciplinary and multi-professional working settings (Kohn, Corrigan, & Donaldson, 2000). Combined with ever-increasing capabilities provided by high fidelity simulation, formal team training is becoming increasingly important in modern health professions education. In particular, acute care areas such as operating room, intensive care unit, obstetrical care, and emergency medicine environments lend themselves to simulation as a means to deliver team skills.

Currently, there is some debate over the most effective manner in which to deliver such training, as well as the most appropriate content for such training. Team skill curricula have

borrowed heavily from aviation's Crew Resource Management (CRM) training models (Gaba, Howard, & Fish, 2001; Helmreich, Schaefer, & Bogner, 1994). Early acceptance of this approach in healthcare has been largely positive, though not universal. Recent years have seen the development of healthcare and practice domain-specific team skills – also termed “non-technical skills” systems (Baker, 2006; Fletcher et al., 2003; Weaver et al., 2010; Yule, Flin, Paterson-Brown, Maran, & Rowley, 2006). Such programs are becoming increasingly important, as many medical and nursing systems are looking for formal content to inform their simulation and communication training agendas.

This presentation will discuss current efforts at McMaster University to implement simulation and team skills training across multiple academic programs and practice disciplines simultaneously. A model of inter-programmatic team skills delivery that has been developed at the McMaster Centre for Simulation-Based Learning will be presented, along with lessons learned to date in the areas of program building, faculty development and content development. The identification of program and profession-specific goals as key elements in the design of a training program as well as an essential mechanism for the necessary broad-based support will also be discussed. The integration of specific program and learner needs into this training will be discussed.

This presentation will also discuss the extension of this training model to healthcare teams in remote and extreme environments. Building on laboratory experience in telemedicine simulation (Musson, 2007), this project has involved the transport of full high fidelity simulation capabilities to research sites in the Canadian High Arctic and on the Mauna Kea volcano in the Hawaiian Islands. The initial goals for this project were to demonstrate such capability in these settings and to establish a testbed for future studies, however pilot activities suggest the same

broad skills sets involved in tertiary care medical and surgical teams have application in these remote settings. Ten full scenario simulations were conducted at the Houghton Mars Research Project on Devon Island in summer 2009, and another 10 scenarios were conducted at the Mauna Kea site in 2010. In both instances, locally recruited and medically untrained personnel provide front-line care, with tertiary care specialists from surgery, intensive care, and anesthesiology providing real time supervision via an audio-video satellite uplink. Preliminary analysis involving subject matter expert review has identified team management characteristics of successfully managed scenarios. Shared mental models, clear team structure, maintaining situational awareness – all skills identified previously in the CRM and team literature – were identified as key elements by the SME review. These activities have also highlighted a number of non-team skill findings, such as ergonomic design, drug formulary, and clinical skill sets that we be mentioned, but not described in detail. Implications of these findings for distributed tele-medical teams in remote care and space medicine will be discussed.

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