

## **Training Forward Surgical Teams: What role do simulators play?**

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### **ABSTRACT**

The military and healthcare have relied on simulation-based training for decades. To better prepare US Army Forward Surgical Teams (FST) for deployment overseas, a number of initiatives were proposed to expose military medical personnel to combat-like injuries (e.g., gunshot wounds, blast injuries). One of these initiatives was the development of the US Army Trauma Training Center (ATTC). Each month a 20-person FST attends a two-week training program at ATTC which focuses on classroom, simulation-based, and hands-on clinical experience. Within six months of training, FSTs begin applying what they have learned in theater. Given that, the purpose of this paper is two-fold. First, we sought to understand trainees' reactions to the training once deployed—if training was useful, what did they like, and how could the training be improved. This information is critical for making continuous improvements to the training provided to the FSTs. Second, based on trainees' feedback and our own observations, we created a list of lessons learned. It is our hope that these lessons learned will assist both the military and healthcare communities as they embark on similar endeavors.

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### INTRODUCTION

Warfighters on today's battlefield endure many insurmountable threats. However, despite this, it is estimated that 90% of those injured on the battlefield survive their injuries (Clark, 2007). Simulation-based training (SBT) has often been the strategy chosen to train medical providers in both the civilian and military communities as it is a powerful tool offering a safe, non-consequential, cost-effective, systematically-controlled environment to practice applying knowledge and skills and receive feedback on performance. SBT can be depicted in terms of a 'life cycle' consisting of seven interrelated and critical stages—(1) determining trainees' competencies, (2) identifying tasks and competencies to be trained, (3) developing training objectives, (4) creating scenarios, (5) developing performance metrics, (6) collecting performance data and (7) providing feedback (Cannon-Bowers, Burns, Salas, & Pruitt, 1998).

A report published in 1998 shed light on the lack of military medical preparedness during the Gulf War (GAO, 1998). For example, at the time, only two of 16 surgeons stationed on one Navy ship had recent trauma experience. Furthermore, surgical support teams operating in the battlefield in fact had no actual surgeons on the team. This led to a number of initiatives to improve pre-deployment training for US Army medical personnel. These initiatives focused on providing surgical teams with not only classroom and simulation training, but also hands-on training with actual trauma patients.

The severity of injuries being seen on the battlefield today is like none other that these medical teams have faced before—specifically those resulting from improvised explosive devices (IEDs). Furthermore, many of these injuries, resulting from IEDs, gunshot wounds, or other blunt and penetrating trauma, require immediate care and stabilization before soldiers can be transported out of the war zone. This requires that Forward Surgical Teams (FSTs) be able to respond rapidly and effectively to save lives during the "golden hour". It is within these first 60 minutes after a trauma

occurs that care is required to significantly improve a trauma victim's chance of survival.

To address the concern over a lack of preparedness, efforts stemming from the GAO report focused on exposing military medical providers to combat like injuries. As a result, seven joint trauma training centers were opened (Moore et al., 2007), including the US Army Trauma Training Center (ATTC) in 2001.

While previously unable to gain expertise on battlefield-type injuries prior to deployment, ATTC offers a two-week intensive team training program which combines classroom, simulation and actual clinical experiences for FSTs. At each stage, FST trainees are put to the test applying the knowledge and skills learned. Simulations are especially critical in that trainees are provided with the opportunity to apply what they have learned in a controlled and safe environment where they can receive constructive and timely feedback on performance.

Although initial reactions data is currently collected during the two-week training course, also important is long-term reactions to the training program post-deployment. Therefore, the purpose of this effort was two-fold. First, we gathered trainee reactions to the simulation-based training provided at ATTC after deployment to Iraq or Afghanistan. With this information, strengths of the program can be highlighted and improvements made in areas where necessary. Second, we generated a list of lessons learned from the feedback received and our own observations.

### METHOD

#### Procedure

US Army FSTs attended the two week training program at ATTC. As a part of this training, the team participated in two simulations. The first simulation involved using a patient mannequin simulator (i.e., Meti-Sim). The 20 person FST was broken down into

four five-person teams for the simulation. Each team received two training scenarios—one involving a burn victim and the other involving a patient with a penetrating wound. The second simulation is a live simulation that recreates a mass casualty (i.e., MasCal) situation involving anesthetized porcine subjects. A total of six patients are brought in to the FST's simulated mobile hospital. The team as a whole must plan and execute a response plan of action to a mass casualty situation—triage, surgery, and critical care.

Within six months of completing training at ATTC, an email was sent to trainees asking for their participation in this survey-based research. A link to the online survey was distributed via email to all US Army FST personnel who attended training at ATTC between 2005 and 2007. The survey was developed internally by University of Miami Miller School of Medicine staff and ATTC instructors and pilot tested among ATTC participants that had trained at the ATTC prior to these dates. The survey was then disseminated via KeySurvey and asked questions pertaining to their experience in mannequin-based simulations and a mass casualty simulation. Questions were both quantitative (using a five-point Likert rating scale) and qualitative and focused on trainees' reactions to the training.

### Participants

Survey respondents were 135 US Army personnel (an approximately 50% response rate) who participated in the ATTC two-week team training program between January 2005 and June 2007. Participants were a mix of surgeons (15.2%), nurses (registered nurses: 19%, nurse anesthetists: 10.5%, vocational nurses: 16.2%), operating room techs (15.2%), emergency medical transporters (12.4%), administrators (2.9%) and others (8.6%).

## RESULTS

Overall, participants rated the simulation exercises highly. Over 75% and 90% of participants agreed that the mannequin simulation and MasCal, respectively, were valuable. Likewise, the quantitative responses were also positive. A majority of participants stated that they wanted more time using mannequin simulations, but a few felt that more scenarios pertaining to the operating room would be beneficial. Similarly, the MasCal was seen as very useful at demonstrating the importance of teamwork in a 'chaotic' situation and helped them while deployed, although some attendees felt that the "patients" were not realistic enough.

### Quantitative Responses

Questions were broken down around two areas – reactions to experiences in the mannequin-based simulations and reactions to the MasCal. Overall, the quantitative responses were extremely positive. The results are broken down next.

**Table 1. Questions Pertaining to Mannequin-Based Simulations**

Question	SA	A	N	D	SD
Training on simulators was beneficial.	38.5	37.8	14.8	3	0.7
I learned new information/skills training on simulators.	26.7	37	20	9.6	1.5
Training skills learned on simulators was applicable to resus* environment.	32.6	43	15.6	2.2	0.7

\*Resus is the unit that responds to incoming traumas to the Ryder Trauma Center. Note: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD); All values are percentages.

**Table 2. Questions Pertaining to MasCal Simulation**

Question	SA	A	N	D	SD
During the MasCal exercise, I understood my role and function.	58.8	33.8	2.9	3.7	0.7
During the MasCal exercise, I felt confident in my ability to diagnose injuries.	40.4	37.5	14	2.2	0
During the MasCal exercise, I felt confident in my ability to stabilize the patient.	47.8	36.8	7.4	3.7	0.7
During the MasCal exercise, I felt confident in my team's ability to develop and carry out a plan of treatment.	50	36.8	8.8	3.7	0.7
I believe the MasCal exercise was a valuable experience.	63.9	27.1	3.8	5.3	0

Note: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD); All values are percentages.

### Qualitative Responses

In addition to quantitative questions, survey respondents were also asked open ended questions about their experience during the simulation event as well as what they thought could be improved. Overall, positive responses outweighed negative response. For example, one trainee wrote, "It works very well, but the

problem is not the simulator...just don't have enough time to train with it". Other trainees commented that "Simulators helped build teamwork with new team", "I learned you have to be fast and be able to multi-task", and "I believe [the MasCal] was probably the best exercise we attended at ATTC". These comments and the other positive comments (see Tables 3 and 4 for additional comments) highlight the importance of training using mannequin and live simulations when training forward surgical teams. Tables 5 and 6 present the areas most commonly discussed by trainees as in need of improvement.

**Table 3. Positive Responses Regarding Mannequin-Based Simulations**

The simulators were excellent—as close to the real thing as I have seen.
I am currently on my third deployment with this FST, and I have been to ATTC twice; the simulators are a great way to teach new personnel more advanced procedures and refresh the skills of senior members at the same time.
I think [the simulation] worked well to reinforce what we already know and provide an outside look at how to perform as a team when you do have a trauma.

**Table 4. Positive Responses Regarding MasCal Simulation**

The MasCal exercise definitely illustrated the need to prioritize tasks and function under stress.
I think the MasCal is one of the most instructive aspects of the course.
When we first finished the exercise I wasn't impressed but while deployed I would notice things that I was taught and realized it was a very good learning tool.

**Table 5. Areas of Improvement Regarding Mannequin-Based Simulations**

Time is always the issue with a two week class.
Most of the training on the simulators was aimed toward the nurse and doctors.
Include common distracters of the resus* bays [in the simulations] (e.g., extra people, noise, etc.)
Create a simulator for the OR [operating room].

\*Resus is the unit that responds to incoming traumas to the Ryder Trauma Center.

**Table 6. Areas of Improvement Regarding MasCal Simulation**

The MasCal was a little confusing because our skills were not honed yet.
MasCal could have been improved if the patients were brought in more rapid sequence or several patients at a time.
I believe a lecture on MasCal before we did the exercise would have been much better than going into the exercise cold.

## LESSONS LEARNED

Our interactions with US Army FSTs training at ATTC over the last three years have led us to uncover a number of lessons learned. Here we present 10 lessons that we have learned through our observations and trainee feedback about the training provided at ATTC. We have broken down these lessons into the phase of training in which they are most relevant—pre, during and post training.

### Pre Training

- 1. Provide adequate pre-training to ensure that trainees have the necessary knowledge and skills to adequately perform in training scenarios.**

Researchers recognize that training effectiveness and outcomes are impacted by factors that occur before the training, such as trainee competencies (i.e., knowledge, skills, and attitudes) or previous experience (Salas, Rhodenizer, & Bowers, 2000; Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995). Given this, efforts must be made to ensure that all students are adequately prepared for training. For example, trainees should be given resources (e.g., pre-training lectures, read-ahead documents) to ensure that they all meet a basic criterion. This includes technical knowledge and skills, as well as familiarity with the simulation (e.g., how to intubate the mannequin, where equipment is located). When team members do not have equivalent base level knowledge and skills or are unfamiliar with the simulator that they must perform on, this takes away from the learning that is to take place. Trainees spend so much time getting team members up to speed or learning how to use the simulator that they are not able to focus on the task at hand. This can lead to frustration and de-motivate trainees not only in the current activity, but in future activities as well.

## **2. Design simulation scenarios to elicit the desired competencies.**

Knowing that trainees are at an adequate level of competency prior to engaging in a simulation, scenarios should be developed such that they elicit the desired competencies (i.e., knowledge, skills, and attitudes). These competencies should be based on the training objectives (i.e., the competencies trainees are expected to learn and demonstrate as a result of the training) (Wilson, Priest, Salas & Burke, 2005). Trigger events should be embedded within the scenarios to ensure that the desired competencies are elicited. Without these trigger events, it is not possible to know when or if a competency is demonstrated. This is especially useful for instructors, as they will be able to anticipate the timing of a trigger event and the subsequent competency that should be applied. However, keep in mind that due to the complexity of emergency medicine, it may not be practical or meaningful to capture all competencies at once (Vreuls & Obermayer, 1985; Rosen, Salas, Silvestri, Wu, & Lazzara, in press). Therefore, in some cases a subset of the competencies should be focused on in a given scenario. Multiple scenarios can be used to elicit all of the desired competencies.

## **3. Develop context relevant scenarios.**

Training is more likely to be successful if it takes place in a meaningful context—one that represents (as closely as possible) the operational environment, thus increasing the likelihood of a transfer of training (Hays & Singer, 1989). Therefore, it is important that the simulation scenarios developed be applicable to the theatre that will be faced by FSTs. Emergency care by its very nature is chaotic, and emergency care on the battlefield adds a separate host of obstacles. These teams, when deployed, will be faced with injuries that are unique and cannot be recreated in a clinical environment, namely injuries due to explosives. The benefit of SBT is that it allows us to “simulate” battlefield injuries, providing FSTs with an opportunity to respond as a team and receive feedback on what worked and what didn’t work. Critical to the success of simulations at ATTC is frequent communication with those on the front lines. Feedback as to the types of injuries that are occurring in theatre drive the development of new scenarios for trainees.

## **4. Design scenarios to engage all trainees.**

It is critical that training scenarios be developed such that they target the desired knowledge and skills, promote training objectives, and also provide meaningful practice opportunities for all trainees. Utilizing scenarios that only focus on medics or only on surgeons does not make for useful training. Therefore,

when designing training scenarios, the entire FST should be taken into consideration and trigger events should be embedded in to the scenarios that engage all members of the FST. Not only will these scenarios demonstrate the importance of all team members, but will also help to keep trainees motivated for future performance.

## **5. Utilize a behavioral checklist to record team performance.**

Measuring teamwork is a significant challenge facing training instructors and team researchers. Team tasks are dynamic, requiring interdependent team members to manage multiple resources and adapt to changing conditions cohesively. As such, team evaluations require *dynamic assessment* or “the ability to track, assess, and interpret the moment-to-moment changes that occur in team performance so that appropriate feedback can be devised and/or other remediation implemented” (Cannon-Bowers & Salas, 1997). In these situations, the best performance metrics are behavioral checklists. These checklists highlight the behaviors that a team should demonstrate to be effective. Feedback from instructors (and the literature; e.g., Rosen et al., in press) suggest that using a Likert-type rating scale is not feasible, and adequate is a more simplistic yes/no format to indicate whether the behavior occurred or not. Where exceptional (or, in some cases, less than exceptional) performance was observed, the checklist should also provide instructors with space to generate notes that can be utilized during the after action review.

## **6. Properly train instructors on how to observe trainees and provide feedback.**

The overall goal of training performance evaluations is to be able to describe, evaluate and diagnose team performance with the goals of facilitating feedback and supporting the instructional process. Knowledge of exercise results can alert trainees to performance problems and helps them assess their own progress towards training goals. This kind of post-exercise feedback provides both directive and motivational direction for trainees (Cannon-Bowers & Salas, 1997). Given this, it is critical that instructors be properly trained on the competencies to be demonstrated, use of the rating form, and how to provide constructive, meaningful feedback to trainees (Salas, Wilson, Burke, Wightman, & Howse, 2006).

## **During Training**

### **7. Provide multiple opportunities for teams to demonstrate knowledge and skills.**

As the adage goes, "Practice makes perfect." When training for emergency care, there is no substitute for hands on practice. The training received by forward surgical teams at ATTC is the last (and in some cases first) opportunity for the team to apply their skills prior to deployment. Therefore, it is critical that these teams be provided with multiple opportunities to perform (e.g., Prince, Brannick, Prince, & Salas, 1997). In addition, providing multiple performance opportunities will result in more reliable measures of performance (Beaubien, Baker, & Salvaggio, 2004). The training provided at ATTC has evolved over time to incorporate multiple simulation opportunities. Specifically, the training curriculum currently provides trainees with five opportunities to perform in a simulated environment—twice on day 1 (mannequin simulation), once on day 2 (MasCal) and twice on day 13 (mannequin simulation). The benefit of multiple opportunities is not only to provide more hands on practice, but also the distribution of simulations across the training program allows trainees to see an improvement over their two weeks of training (Salas et al., 2000). Although time restrictions are the biggest obstacle faced at ATTC, we hope to include additional mannequin simulations into the training program in the near future.

### **8. Demonstrate the relevance of the competencies being trained.**

It is important that trainees understand the critical nature and value of knowledge and skills being trained, as well as the significance of their individual role in the team composition. The lack of a clear understanding of the appropriate operational competencies for each team member can negatively affect team performance (Volpe, Cannon--Bowers, Salas, & Spector, 1996). When trainees understand the utility of the competencies trained, their position as well as the roles of their team members, the team exhibits higher coordination and team spirit. Additionally, instructors (some who have experienced combat themselves) should emphasize that the simulated scenarios have been created to be as combat-relevant as possible; thus, reinforcing to trainees that these scenarios are apt preparation tools for training them to save the lives of others as well as ensuring their own safety in theatre.

## **Post Training**

### **9. Provide meaningful feedback using videotaped performance.**

Feedback is well documented as an important tool for facilitating learning (e.g., Azevedo & Bernard, 1995; Kluger & DeNisi, 1996). Of the benefits from simulator-based exercises, perhaps the ability to videotape (and thus review) these team interactions is one of the most valuable. By using videotapes of the forward surgical team's performance in the simulations, instructors are able to conduct learner-centered debriefings in order to pinpoint areas of improvement in teamwork and technical skills. Videotaped simulations are beneficial in that trainees are able to actually watch what worked and what didn't work, rather than having to recall these instances from memory. This also allows feedback to better focus on team processes (e.g., communication) rather than just outcomes (e.g., the patient was saved) (Johnston, Smith-Jentsch, & Cannon-Bowers, 1997). To say that a patient's life was saved is not enough. It is important that teams understand why the patient was saved and what areas of performance can be improved to improve the process in the future. Focusing solely on outcomes may miss these diagnostic tools for assessing team process (Salas et al., 2000).

### **10. Conduct a multilevel evaluation to understand the full impact of training.**

Researchers have developed and advocated a multi-level training evaluation model that focuses on trainee attitudes and perceptions of training (i.e., reactions), learning and knowledge acquisition (i.e., learning), behaviors and skills demonstrated (i.e., behaviors) and organizational impact (i.e., results) (Kraiger, Ford & Salas, 1993; Kirkpatrick, 1976). Evaluations at multiple levels provide management with a more robust picture of the overall program so that revisions and improvements can be made in the future. It is important that this evaluation come from both a subjective and objective perspective. For example, at the completion of each exercise, trainees are asked to complete a TIPS (Team Input Promotes Success) card in which trainees rate their team's performance in the previous task. This feedback is then incorporated in to the after action review and instructor feedback. In a separate effort, data is also being collected to gather trainees' reactions to the training activities as well as the learning that occurs through a card sorting task. This information is used in conjunction with instructor observations to get a complete picture of training's effectiveness.

## DISCUSSION

The US Army Trauma Training Center at the Ryder Trauma Center has been in existence since 2001. The purpose of this effort was to determine reactions to simulations (mannequin and live) by forward surgical teams who attended the two-week training program offered by ATTC. Overall, reactions are positive – the opportunity to perform as a team in their respective roles in a simulated environment and to handle multiple patients in a mass casualty situation was beneficial.

The ability to operate in a simulated environment, however, is not without its limitations. For example, it is not possible to accurately recreate all traumatic injuries that will be seen in theatre and time restrictions limited the amount of simulation time received. The feedback received from trainees shed light on areas within the program in need of improvement. This led to the development of a number of lessons learned.

A larger effort is underway to address the concern over not enough time to train and also the desire to attend training closer to the time of deployment. Forward surgical teams attending ATTC typically deploy as an intact team within six months of training. Because it cannot specifically be predicted when a team will be deployed, and also to minimize the amount of time that the teams are away from their families, ATTC is exploring the use of portable technologies (e.g., iPod Touch) to provide procedural animations/videos and other educational materials to teams that can be viewed prior to deployment. The use of such portable devices is that educational materials, serving as a refresher course, can be stored on the device and viewed at any time by trainees (e.g., in transport, during downtime) and as often as one would like.

## CONCLUSIONS

The nature of war is not static. Today's warfighters are not facing the same enemy as in previous wars. Likewise, the injuries are not the same either. Therefore, we will continue our efforts to evaluate the training put forth at ATTC to ensure that trainees get the best experience possible to be prepared for what they will soon face. The results of our effort indicate that SBT is beneficial to FST personnel being deployed and a number of lessons learned have been generated. It is our hope that these lessons will assist others in the military and medical communities in similar endeavors.

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## REFERENCES

- Anderson, J. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.
- Azevedo, R., & Bernard, R. M. (1995). A meta-analysis of the effects of feedback in computer-based instruction. *Journal of Educational Computing Research, 13*(2), 111-127.
- Beard, R. L., Salas, E., & Prince, C. (1995). Enhancing transfer of training: Using role-play to foster teamwork in the cockpit. *International Journal of Aviation Psychology, 44*(5): 131-143.
- Beaubien, J. M., Baker, D. P., & Salvaggio, A. M. (2004). Improving the construct validity of line operational simulation ratings: Lessons learned from the assessment center. *The International Journal of Aviation Psychology, 14*(1), 1-17.
- Cannon-Bowers, J. A., & Salas, E. (1997) A framework for developing team performance measures in training. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theory, methods and applications* (pp. 45-62). Mahwah, NJ: Erlbaum.
- Cannon-Bowers, J. A., Burns, J. J., Salas, E., & Pruitt, J. S. (1998). Advanced technology for scenario-based training. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: implications for individual and team training* (pp. 365-374). Washington, DC: American Psychological Association.
- Cannon-Bowers, J. A., Salas, E., Tannenbaum, S. I. & Mathieu, J. E. (1995). Toward theoretically based principles of training effectiveness: A model and initial empirical investigation. *Military Psychology, 7*(3), 141-164.
- Clark, C. (2007). *90 percent now survive battlefield injuries*. Retrieved January 23, 2008, from: <http://www.signonsandiego.com/news/military/20070215-9999-6m15ortho.html>
- Government Accounting Office (GAO). (1998). *Medical readiness: Efforts are underway for DOD training in civilian trauma centers* (Rep. No. GAO/NSIAD-98-75). Washington, DC: Author.

- Hays, R. T., & Singer, M. J. (1989). *Simulation fidelity in training system design*. New York: Springer-Verlag.
- Johnston, J. H., Smith-Jentsch, K. A., & Cannon-Bowers, J. A. (1997). Performance measurement tools for enhancing team decision making. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theory, methods, and applications* (pp. 311-327). Mahwah, NJ: Erlbaum.
- Kluger, A. N. & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, 119, 254-284.
- Kirkpatrick, D. L. (1976). Evaluation of training. In R. L. Craig (Ed.), *Training and development handbook: A guide to human resource development* (2<sup>nd</sup> ed., pp. 1-26). New York: McGraw Hill.
- Kraiger K., Ford, J. K., & Salas, E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology*, 78, 311-328.
- Moore, E. E., Knudson, M. M., Schwab, C. W., Trunkey, D. D., Johannigman, J. A., & Holcomb, J. B. (2007). Military-civilian collaboration in trauma care and the senior visiting surgeon program. *The New England Journal of Medicine*, 357(26), 2723-2727.
- Prince, A., Brannick, M., Prince, C., & Salas, E. (1997). The measurement of team process behaviors in the cockpit: Lessons learned. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theory, methods, and applications* (pp. 289-310). Mahwah, NJ: Lawrence Erlbaum Associates.
- Rosen, M.A., Salas, E., Silvestri, S., Wu, T., & Lazzara, E.H. (in press). A Measurement Tool for Simulation-based Training in Emergency Medicine: The Simulation Module for Assessment of Resident Targeted Event Responses (SMARTER) Approach. *Simulation in Healthcare*
- Salas, E. & Cannon-Bowers, J.A. (1997). Methods, tools and strategies for team training. In M. A. Quiones & A. Ehrenstein (Eds.), *Training for a rapidly changing workplace: Applications of psychological research*. Washington, DC: American Psychological Association.
- Salas, E., Rhodenizer, L., & Bowers, C. A. (2000). The design and delivery of Crew Resource Management Training: Exploiting Available Resources. *Human Factors*, 42(3), 490-511.
- Salas, E., Wilson, K. A., Burke, C. S., Wightman, D. C. & Howse, W. R. (2006). The design, delivery and evaluation of CRM training: A checklist. *Ergonomics in Design*, 14(2), 6-15.
- Volpe, C. E., Cannon-Bowers, J., Salas, E., & Spector, P. E. (1996). Walking in each other's shoes: The impact of cross-training on team functioning. *Human Factors*, 38, 87-100.
- Vreuls, D., & Obermayer, R. W. (1985). Human-system performance measurement in training simulators. *Human Factors*, 27, 241-250
- Wilson, K. A., Priest, H. A., Salas, E., & Burke, C. S. (2005). Can training for safe practices reduce the risk of organizational liability? In Y. I. Noy & W. Karwowski (Eds.), *Handbook of human factors in litigation* (pp. 6-1 – 6-32). Boca Raton, FL: CRC Press.