Over the course of the past decade, there has been significant growth in the use of simulation-based training across diverse domains (e.g., military, medical, banking, emergency management). Concurrent with this growth has been a growth in training research and technology development to increase the effectiveness, efficiency and economy of simulation. One model of training, on which much of this research, development and practice is based, is the Scenario-Based Training (SBT) framework (Cannon-Bowers, Burns, Salas, & Pruitt, 1998). In fact, a recent internet search of the term “scenario based training” yielded 2.9 million hits, many of them devoted explicitly to practice. This is not surprising given the generalizability of the model, as well as, its adaptability to a variety of contexts. This flexibility has lead practitioners to depart from the fundamental SBT framework based upon how trainers interact with simulations (e.g., modifying scenarios to capture emerging training needs requiring movement back and forth between the SBT stages counter to the successive nature of the current model; Eitelman, Owens, Fowlkes, Walwanis Nelson, & Atkinson, 2006); unique opportunities that advances in technology present (e.g., artificial intelligence may drive the way events are derived and structured; Graul, McDonald, Walwanis Nelson, & Smith, 2004; Mangos, 2004); scientific exploration of tools that could supplement and/or augment the model (e.g., Situation Judgment Tests have been proposed as a potential tool for use pre, during and post implementation of SBT; Fritzsche, Stagl, Salas, & Burke, 2006); and environments in which the framework is being implemented (e.g., large, distributed tactical teams; Bergondy & Salas, 1999; Eitelman et al., 2006). Despite this considered attention, resulting in many practical and empirically derived principles and guidelines (e.g., Oser, Cannon-Bowers, Salas, & Dwyer, 1999; Salas, Cannon-Bowers, & Daskarolis-Kring, 1999; Salas, Priest, Wilson, & Burke, 2006), the SBT framework remains unchanged in the scientific literature. This is likely due to the fact that modifications made to the model in practice have not necessarily been shared with the scientific community for empirical test. Given this, there is a need to identify these changes so that the training value can be assessed. Likewise, it is incumbent upon researchers in this area to distill the advances in the training theory and identify the remaining R&D gaps of SBT into a comprehensive publication. Furthermore, in SBT, the scenario is considered to be the curriculum (Oser et al., 1999). The end-to-end process of designing, implementing, and analyzing the scenario embeds the pedagogical goals within the training activity. This has lead to an emphasis on the performance assessment methods, tools and strategies underpinning SBT environments. In particular, efforts to drive the behaviors of the models underlying the training environment in response to trainees’ performance have been an area of focus.

This panel will serve as a forum for both practitioners and researchers to discuss the state of what we know about SBT, how the framework is changing and why, the potential impacts to training value, and the necessary research to move SBT to the next level. The panelists’ presentations are structured as a catalyst to generate discussion – the views of training researchers, practitioners, and engineers are represented in the diverse backgrounds of the panelists. These presentations address endeavors to experiment with a variety of performance assessment techniques and embed pedagogical information within the training tools with which the presenters are working, to enhance cognitive fidelity, expand training opportunities, remediate weaknesses in SBT, and tailor training to trainees’ needs. In essence, the panelists will present their work in the area of SBT (both
practical and empirical) and identify challenges that they have identified.

After we provide a brief overview of the panel, Dr. Spiker will discuss work linking principles derived from instructional systems development theories to the SBT model as well as efforts to gather Kirkpatrick Level III data (i.e., results) based upon a system that utilizes SBT to structure training (Kirkpatrick, 1977). Next, Dr. Campbell will discuss some of the challenges associated with implementing automated assessment in SBT and suggest potential methodologies for overcoming these challenges. Following this, Dr. Stripling and Dr. Coyne will provide an overview of the proposed use of physiological data in a Navy training system that utilizes SBT to structure training events. To elaborate on some of the complex contexts in which SBT may need to be expanded, Dr. Fowlkes and Ms. Atkinson will discuss the challenges associated with developing scenarios for large distributed teams and make some suggestions for needed techniques, tools and technologies. Finally, Dr. Stacy and Mr. Colonna-Romano will present a prototype system that utilizes SBT to structure its operation. In building this tool, they have made a significant departure from how SBT events are implemented based upon technological advances, which requires further scientific investigation (Stacy, Walwanis Nelson, & Colonna-Romano, 2007). Following the briefs, a discussion will be waged with the panelists and audience to identify practical and research concerns to be addressed by future efforts.

Using ISD Principles to Promote Scenario Based Training

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Instructional Systems Development (ISD) has been a guiding force behind military and industry training for over 30 years. Despite its successes, ISD has had less impact on SBT due to the absence of applicable guidelines. But given appropriate guidance, scenarios have the potential to improve the effectiveness of simulation training since they define non-trainees roles, serve as a blueprint of what is to happen, and can enhance cognitive realism. In developing a scenario authoring tool (SimDATT) for aviation training, we identified 69 ISD-based guidelines organized around eight areas essential to SBT: synopsis, objectives, conditions, event content, timeline, instructor roles, assessment, and debrief. Each comes with a succinct statement of principle, theoretical rationale, graphic example, and references. Eight particularly useful guidelines will be discussed during the presentation. These include representing scenarios with a five-part structure, linking scenario objectives to student learning goals, linking scenario content to training objectives, including meta-cognitive skills in the scenario skill set, organizing training by varying setup conditions, using a ‘telescoping’ approach to design scenario content, using analogous cases as a training scaffold, and stressing critical thinking in the debrief (Spiker, in press).

The SimDATT authoring system is now being used to create challenging event profiles for advanced simulator training at the Aeronautical Management Training (AMT) department of Arizona State University. AMT offers an ab initio flight training curriculum for undergraduates, where most become employed as pilots by Mesa Air or some other regional airline. SBT has become an integral part of AMT’s curriculum, where SimDATT is used to create scenario profiles, gradesheets, and archive instructor assessments of student performance. An evaluation was conducted to estimate the training effectiveness of SBT by surveying 14 Mesa Airline pilots, instructors, and, corporate officers (Karp & Spiker, 2008). The proficiency of SBT-trained AMT graduates relative to airline industry standards and pilots from other programs was assessed on 22 technical and “soft” skills (e.g., communication, task management, handling emergencies, crew coordination) using a five-point rating scale.

Analysis indicated that SBT-trained AMT graduates were rated higher than other pilots on all 22 skills, with several skills exhibiting exceptionally high ratings (i.e., callouts, checklists, crew coordination). These had been particular targets of SBT, so the evaluation data offered validation of the effectiveness of this emphasis. On the other hand, two skills – radio operations and air traffic management – were rated substantially below the others. The relative inability of SBT to improve these areas was echoed in the respondents’ comments. The department has since taken steps to address these weaknesses (e.g., installing communications training package in its simulators). However, human behavior modeling is another approach with potential, as it can be used to capture the variability and error-proneness in human performance expected from interactions with crew members and entities external to the cockpit.

A scenario-based approach to training, and the SimDATT authoring tool, is now an institutionalized feature of the AMT curriculum and its skill-based simulation training program. The presentation concludes with some thoughts on how a scenario-based approach to training could benefit from, and in turn stimulate, development of human behavior models to provide more realistic training in crew coordination and air traffic control interactions.
Automated Assessment: Finding a Lever Long Enough to Move the World

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Effective training depends upon assessment, or the ability to diagnose the competencies underlying performance. The complexity of SBT, while excellent for preparing trainees for the complexity of the real world, poses a significant challenge for assessment. This is because the many-to-one mapping between the inter-related events unfolding in the simulated environment and the action taken by the trainee leads to an almost impossible interpretation problem. The lever we need to budge this problem is data, and in this presentation we will discuss two very different ways to accumulate and interpret data, both of which are capable of supporting automated assessment.

One method relies on capturing a large quantity of data from a single trainee under a variety of circumstances (Campbell, Buff & Bolton, 2006). This allows you to create an HBR of your trainee in a formalism that can be interpreted and diagnosed for strengths and weaknesses, by abstracting regularities between various environmental contexts and the trainee’s actions. Central to the success of this technique, of course, is establishing the “right” set of circumstances and selecting a viable modeling formalism.

The other method relies on capturing data from a large set of trainees with varying levels of competencies (Mangos, 2004). With this method, rather than building a computational model of an individual, you are essentially “modeling” the environmental contexts the trainees face, by identifying the underlying KSAs (Knowledge, Skills and Abilities) required to successfully process and respond to each one. More specifically, we propose that principles and techniques from Psychometrics, such as item response theory, may be applied within simulation-based training systems.

In this presentation we will discuss the strengths and weaknesses of each method. While there are still plenty of challenges to be overcome, both approaches are capable of increasing our ability to conduct reliable and valid assessments in SBT.

A Tool for Incorporating Psychophysiological Augmentation in Simulation-Based Training Environments

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Prior and recent psychophysiological research has shown that brain patterns change when learning occurs (e.g., Smith & Jonides, 1999; Kerrick, Douglass, & Hatfield 2004). These changes may reflect general cognitive activities levels such as attention, engagement, or arousal, or they may be specific to acquisition and mastery of specific task elements (Hoover & Muth, 2004; Pope, Bogart, & Bartolome 1995; Luu, Tucker, & Stripling, 2007). It is possible that real-time evaluation of such activity can be used to assess learning readiness in students who utilize a simulation-based training paradigm and tailor instructional material to user state. However, the relationship between candidate psychophysiological measures that reflect cognitive states, learning readiness, and other relevant factors and appropriate training manipulations are largely unexplored. A major challenge to this research is the relatively slow cycle of coding, testing, and validating the instructional changes within a desired Simulation. Combining a new research tool, the General Purpose Real-time Mitigation Engine (GPRiME), with a new instructional tool, the U.S. Navy’s Common Distributed Mission Training Station (CDMTS), it is possible to link psychophysiological measures with researcher defined, real-time instructional changes for testing and evaluation purposes – without need for revising the code of CDMTS or any of the simulations that it drives. For example, using GPRiME researchers assessing a trainee’s level of attention can quickly test a variety of changes to the ongoing simulation exercise in order to optimize the trainee’s level of attention. Of broader significance, GPRiME is not conceptually restricted to use with CDMTS, but can work with any GUI based application that enables human operators to modify the application’s settings during operation.

Outgrowing SBT? Meeting the Needs of Distributed, Multi-Team Training

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While SBT has been shown to work in individual and team training environments (Oser et al., 1999;
In a distributed, simulation-based training exercise, the opportunity for a helicopter pilot to practice using sensor fusion to classify contacts is lost when there are no targets in range at the scheduled time. Elsewhere in the exercise, fighter pilots miss the chance to develop their air-to-air skills when the planned surprise encounter with enemy aircraft is missed because the pilots were ahead of the timeline. Just as battle plans do not survive first contact with the enemy, exercise plans rarely survive first contact with the participants. They are, after all, trainees. They will fly, drive, and otherwise operate their virtual simulators as best they can, but inevitably the fact that they are acquiring new knowledge and skills means that their virtual behavior will cause the exercise to deviate from the original intent. Add to this the potential difficulties with equipment, communications failure, and the overhead associated with coordination of human support personnel, and we conclude that the theory of large scale exercises differs from the reality.

Current approaches to scenario definition and execution in these environments focus on providing high fidelity simulation environments via event descriptions. To move these environments from effective practice to effective training, they must incorporate pedagogical knowledge such as training objectives, performance measures, and trainee feedback. With NAWCTSD, we have been working on a system called PRESTO (Pedagogically Relevant Engineering of Scenarios for Training Objectives). PRESTO inserts pedagogical knowledge into the simulation-based training lifecycle via constraints that describe specific scenario-based situations that will give trainees an opportunity to make progress towards their training objectives.

This approach is in contrast to a typical Master Scenario Events List (MSEL) approach where events are often given specific times, locations, and other properties. By expressing important aspects of the scenario as constraints, it is possible to relax unimportant specifics. For example, to meet their training objectives, it may be important that a trainee encounter a SAF (Semi-Automated Forces) entity, but it might not be important exactly where or when the encounter takes place. By focusing on the constraints that matter for training like this, it is often possible to recover from unexpected developments and allow trainees to continue with their training. And since, by definition, events that matter for
training have been described, it is quite natural to specify the accompanying performance measurements, providing trainees with an efficient and effective training environment.

Because it can relax the usual constraints of specific times and locations in a scenario, PRESTO takes an unusual tack on behavior representation: by design, it is only a partial representation. The idea is to capture key entity behaviors that are required for the kinds of training being considered, and to leave the rest unconstrained. Scenarios approached this way can: improve training consistency by providing standard packages of scenario and performance measurement specifications; reduce instructor workload by helping instructors create the best circumstances for training; and support meaningful experiential variation because they leave aspects of the scenario unrelated to training unconstrained. Ultimately, we believe the approach will provide an increase in force readiness at a reduced cost.

Author Note

The views expressed herein are those of the authors and do not necessarily reflect the official position of the organizations with which the authors are affiliated.

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