Guidelines for Facilitating Joint Tactical Scenario-Based Training

Joan H. Johnston, Gary R. Fraas, CDR Charles Frye, USN, Eric Anschuetz
NAVAIR Orlando Training Systems Division
Joan.Johnston@navy.mil, Gary.Fraas@navy.mil, Charles.Frye@navy.mil, Eric.Anschuetz@navy.mil

Hugh E. Carroll
Basic Commerce and Industry, Inc.
Hugh.Carroll@navy.mil

LtCol Julio B. Villalba, USMCR
Program Manager Training Systems,
Marine Corps Systems Command
Julio.Villalba@navy.mil

ABSTRACT

The Department of Defense Training Transformation objective is to implement cross-Service tactical training to improve Joint readiness. The 2003 Interservice/Industry Training, Simulation and Education Conference addressed this initiative through the Operation Virtual Freedom (OVF) demonstration. As the lead coordinator for OVF, NAVAIR Orlando Training Systems Division (ORL TSD) worked with the Air Force, Army, and Marine Corps to conduct a Joint tactical exercise using a distributed network of virtual and constructive simulators located on the exhibit floor, and at the Air Force Research Laboratory in Mesa, Arizona. The OVF objective was to apply the Scenario Based Training approach to the demonstration. OVF success was due, in part, to the common language the scenario-based training materials created in facilitating the distributed Joint exercise. The demonstration provided a case study and lessons learned for facilitating Joint tactical scenario-based training exercises.

ABOUT THE AUTHORS

Dr. Joan Johnston is a Senior Research Psychologist at NAVAIR Orlando Training Systems Division (NAVAIR ORL TSD). Her research focus is team performance measurement and training technologies. She holds an M.A. and Ph.D. in Industrial and Organizational psychology from the University of South Florida.

Gary R. Fraas has over 29 years in training for operational environments, and was the project director for Operation Virtual Freedom (OVF). He is Division Head for Advanced Simulation, Visual, & Software Systems at NAVAIR ORL TSD. Mr. Fraas holds a B.S. in Electrical Engineering from Michigan State University and an M.S. in Computer Engineering from the University of Central Florida.

CDR Charles Frye is a Naval Aviator with 2000 hours as mission commander in the SH60B aircraft, and was the Scenario Development Lead for OVF. He is a Program Manager for PC-based military training simulations at NAVAIR ORL TSD. He holds a B.S. in Engineering from the University of Florida and an M.S. in Operations Research/Systems Analysis from the U.S. Naval Postgraduate School, and was awarded the Navy proven subspecialty codes in Operations Research and Modeling and Simulation

Eric Anschuetz was the technical lead for OVF and is the Branch Head for the Technology Development and Integration Laboratory at NAVAIR ORL TSD. His technical focus is distributed simulation, and simulation interfaces and gateways for both Distributed Interactive Simulation and High Level Architecture environments. Mr. Anschuetz holds a B.S. in both Computer Science and Mathematics from Eastern Michigan University.

Hugh E. Carroll is a former Surface Warfare Officer with 30 years experience. He is currently a Senior Systems Engineer for BCI, Inc., and supports training projects at NAVAIR ORL TSD as a subject matter expert. Mr. Carroll holds a B.S. from the U.S. Naval Academy and an M.S. in Operations Research/Systems Analysis from the U.S. Naval Postgraduate School.

LtCol Julio B. Villalba Jr. has 22 years experience in the active and reserve forces, and currently serves as the Marine Reserve Liaison Officer at Program Manager for Training Systems, Marine Corps Systems Command. He is a subject matter expert on USMC Reserve operational and tactical employment of forces and weapons. LtCol Villalba holds a B. S. in Aeronautical Studies from Embry-Riddle Aeronautical University and is a graduate of Command and Staff College Marine Corps University.

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INTRODUCTION

Currently, Joint Service training exercises occur at the later stages of each Service's pre-deployment training cycles. In order to accelerate readiness, the Department of Defense Training Transformation (DoD TT) Implementation Plan (dated 10 June 2003) requires cross-Service exercises earlier in the workup cycles. The 2003 Inter-Service/Industry Training, Simulation and Education Conference (I/ITSEC) Operation Virtual Freedom (OVF) addressed the DoD TT initiative by demonstrating how modeling and simulation technologies and Scenario-Based Training (SBT) can contribute to optimizing the training return-on-investment using low-cost, small footprint distributed simulations. Participants in OVF were NAVAIR ORL TSD, the Marine Corps Program Manager for Training Systems, the U.S. Army Research, Development, and Engineering Command, the U.S. Army Program Executive Office for Simulation, Training, and Instrumentation, and the Air Force Research Laboratory, Human Effectiveness Directorate, Mesa, Arizona. OVF included a distributed network of over 24 virtual and constructive simulators and supporting tools located on the exhibit floor, and over a long-haul network connection to the Air Force Research Laboratory. The result was a successful Joint demonstration executed from the exhibit floor over the course of three days.

A key issue for each of the Services will be determining how to make cost-wise investments to achieve Joint training objectives (Pierce et al., 1998). Currently, little guidance exists to base decisions on *when and how to provide Joint tactical training with desktop simulations* because few multi-team experiments have been conducted. Consequently, a technology gap exists between simulation implementation and the instructional support tools required for distributed team performance assessment, diagnosis and after action review. Therefore, a main OVF objective was to apply SBT to the design of Joint scenarios. OVF was not a true training evolution because it was fully scripted with all expected communications and simulator actions in order to remain within the 30-minute windows allotted for each scenario. Nevertheless, it served as a good case study to develop lessons learned. In this paper, we describe the approach used for simulation network and scenario development, and conducting OVF testing and demonstration. The guidelines describe resulting solutions to scaling the SBT approach to Joint training exercises. The conclusions describe how more questions were raised than were answered during OVF, including research requirements that should focus on measuring training return on investment.

APPROACH

Figure 1 depicts the SBT model as an instructional approach whereby the learning objectives and scenario development are based on mission critical competencies that are tied to mission essential task

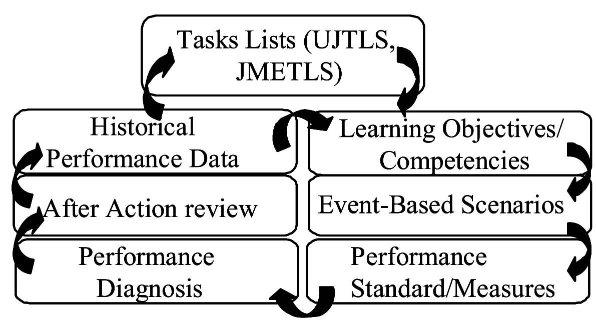

Figure 1. Scenario Based Training Model

lists. Mission critical competencies are used to identify team performance standards (Oser et al., 1999). Event-based scenario development is tied to team performance, and requires that valid and reliable performance measures (e.g., timing, accuracy, coordination, communications) are generated to support diagnosis and timely feedback in after action review. Training results maintained in a skill inventory database establish a team performance baseline that drives future training needs. SBT guidelines exist for multi-team training environments that were used to prepare us for developing OVF. Refer to Bergondy & Salas (1998), Clark et al. (2001), Crane et al., 2000; Dwyer et al. (1999), and Oser et al. (1997) for further details. However, we expected to find additional challenges during OVF development, and they included:

- How would simulation interoperability among the different levels of simulation fidelity affect training value across the Joint teams? For example, could laptop simulations enable valid interactions among teams provided with higher levels of functional fidelity?

- How would the members of the Joint Service working group achieve consensus in developing Joint training objectives?

- How should Joint competencies and performance measures be developed and assessed?

- What measurement, diagnosis, and after action review tools should be employed?

- What collaboration tools are necessary to support distributed exercises?

Simulation Network Development

An OVF exercise management team was stood up ten months prior to the demonstration. Within this team were separate, but closely coordinating working groups responsible for developing simulation network interoperability and scenarios. OVF planning involved identifying overarching Joint learning objectives and appropriate scenario events. The process began by reviewing the Universal Joint Task List dated 1 July 2002 to identify Joint Tactical Tasks that could be achieved given the constraints of available simulations and tools that could be configured in an unclassified environment. For example, scenario actions by Red forces had to be compatible with available Blue force models and simulations. Therefore, early planning resulted in a general scenario story line that involved a downed aircraft and terrorist hostilities surrounding the aircraft and crew so that simulations could be evaluated to be part of the OVF.

A survey of potential simulation participants revealed both Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) systems were available. About 80% were DIS, with the remainder using a variety of HLA Run Time Infrastructures (RTIs) and Federation Object Models (FOMs). The majority of systems were DIS, so each HLA system had to provide a gateway to convert back and forth from native HLA RTIs and FOMs to the IEEE 1278.1 standard for DIS. Many systems committed early for OVF, with some added or removed from the list of participants throughout the months leading up to OVF in order to fully support the Joint scenarios. Participant simulations represented were:

- Navy and USMC:
  - Expeditionary Strike Group comprised of an LHD, AEGIS Cruiser, and Landing Craft Air Cushion vehicles
  - Expeditionary Fighting Vehicles
  - Company sized Marine Air Ground Task Force
  - SH-60B helicopters (2)
  - Marine Corps AH-1W Cobra

- Air Force: F-16's, A-10's, and AWACS

- Army: AH-64 Apache attack helicopter and Special Operations unit

- Opposing forces military equipment were Ex-Soviet Bloc
  - KILO class submarine
  - 3 OSA class patrol boats
  - Wheeled BMP vehicles

Specific interoperability guidelines were established in a web-based data repository to ensure the working group had up-to-date information. Several shared documents had daily updates. The shared documents proved invaluable for ensuring that representatives of each system knew exactly what data to expect from other systems. The Simulation Network document consisted of a master list of network IP addresses for each participating system. It contained general network infrastructure information, including: DIS port number, DIS exercise number, network subnet masks, center of gaming area coordinates, frequencies used for simulated radio communications, and important location coordinates within the scenarios. An Entity List document contained IEEE 1278.1 DIS Enumerations for each of the participating entities, including: assigned DIS Site, Application, and Entity Numbers to uniquely identify entities on the simulation network, as well as to specify which simulation systems were responsible for generating each different entity. A video switching document contained information used to determine which display screens would be tied into the video splitter and displayed at any given moment within the OVF exercises for presentation to an audience on multiple projected screens.

Scenario Development

Scenario development proceeded in parallel to simulation network development. A shared spreadsheet was employed to develop and maintain ground truth for scenario event timelines, simulation sources, communications sources, and communications scripts.

Significant training events were developed to challenge a unit or units. The development of a story line to link various training events required several major considerations. First, events had to be incorporated into a timeline with a complete understanding of what happened previously and what events would follow. Second, each event had to comply with geopolitical considerations and established rules-of-engagement. Third, inter-dependencies had to be considered, for example, friendly and enemy forces had to be in the right place at the right time to interact. Finally, the story line had to provide learning opportunities for various engaged forces without significant dead time which might de-motivate uninvolved participants. The geopolitical background description included:

- An Expeditionary Strike Group is participating in a Joint live-fire training exercise with the allied country of Kioland. The Expeditionary Strike Group is an LHD with a company-sized Marine Air Ground Task Force, a destroyer and AEGIS cruiser with two embarked SH-60B helicopters.

- The Joint Task Force Commander responsible for command and control of the exercise is embarked on the LHD.

- While transporting ordnance to support the exercise, the pilot of a C-17 transmits a call that he is making an emergency landing in the adjoining coastal country of Badland.

- The Badland government had recently made overtures to improve relations with western governments, which was unpopular with the general populace of Badland.

The final four Joint scenarios were designed to take place in chronological order following the initial storyline: 1) Terrorist Action Response/Attack Assessment; 2) Special Operations Rescue of Aircrew; 3) Joint Close Air Support; and 4) Battlespace Maneuver & Integration of Firepower. Time and resources required limiting the scope of SBT efforts to Scenario 1. Scenario 1 event details were:

1: The C-17 pilot transmits a MAYDAY that the aircraft is under attack by unidentified ground forces and is boarded by armed militia in a well-coordinated attack.

2: The militia takes the C-17 pilot hostage and moves him to a remote airfield. They also commandeer weapons and vehicles from the C-17 and injuries are incurred.

3: The Joint Task Force Commander aboard the LHD establishes command and control of the rescue operation. Tactical aviation assets consisting of F-16's, and A-10's are put into position. AH-1W Cobra and AH-64 Apache helicopters are positioned to provide reconnaissance;

4: An amphibious assault is launched from the LHD consisting of a Landing Craft Air Cushion and eight Expeditionary Fighting Vehicles.

5: A Forward Observer is strategically moved into position from the Kioland live-fire training exercise down the coast to Badland.

6: Naval gun fire support is provided to ensure safe access by the Expeditionary Fighting Vehicles from the beach to the airfield;

7: A MEDEVAC operation is performed to evacuate an injured infantryman; and

8: An SH-60B initiates an anti-submarine warfare operation when a submarine periscope is sighted.

Identifying Training Objectives

The working group started the process of detailing Joint tasks and training objectives with the Universal Joint Task List dated 1 July 2002. Tasks are grouped into four levels: Strategic National, Strategic Theater, Operational, and Tactical. For Scenario 1, the working group started with the Strategic level for tasks required of the Joint Task Force. For example the Strategic, Operational, and Tactical Tasks that were related to Events 5 and 6 were:

- Strategic Theater Task: ST3 Employ Theater Strategic Firepower

- Operational Task: OP3 Employ Operational Firepower

- Tactical Task: TA3 Employ Firepower

Next, Service-specific tasks supporting TA 3 Employ Firepower were examined. For example:

- Universal Naval Task List - NTA 3.2.2: Attack Enemy Land Targets

- Air Force Task List - AFT 4.2.1: Perform Counterland Functions

- Army Universal Task List - ART 3.3: Employ Fires to Influence the Will, Destroy, Neutralize or Suppress Enemy Forces

As one proceeds from the Strategic to the Tactical level, the tasks are identified in greater detail. For example, at the Strategic Theater level, Task ST 3.2.1 reads: "Conduct Attack on Theater Strategic Targets/Target Sets using Lethal Means – To engage strategic targets (other than air defense or defensive counter air targets) with available Service, Joint and allied/coalition delivery systems, delivering lethal ordnance." Next, the Navy Task requirements embedded in Events 5 and 6 were identified. For example, Navy Task, NTA 3.2.8 supporting ST 3.2.1 is: "Conduct Fire Support - employ lethal fires against hostile targets which are in close proximity to friendly forces to assist land and amphibious forces to maneuver and control territory, populations, and key waters."

Finally, Service specific Mission Essential Tasks must be referenced in order to establish performance standards for each of the participants in the Joint tactical exercise. The Navy Mission Essential Task List (NMETL) was selected to illustrate how performance standards could be developed for the Naval Gunfire Support events 5 and 6 in Scenario 1. The NMETL has associated with it a set of conditions and standards that must be applied and describe a desired outcome. The standards and conditions define the training objective. For example, Events 5 and 6 tasks involved: Communicate with Force Recon, Locate Target, and Conduct Fire. An example of a specific NMETL training objective (related to NTA 3.2.8.), might be: "strike the target while avoiding damage or injury to friendly forces within 100 meters of the target (conditions) and within 5 minutes from Call For Fire (standards)." The conditions and standards associated with each task can be adjusted based on consideration for level of unit readiness. For example, a less expert team might have a training objective set with more time to respond and friendly forces at a greater range.

Assessment, Diagnosis, and After Action Review

Although the NMETL to training objectives approach is effective, it is limited to providing information about what happened, but offers nothing about the processes the team used to perform the task. Team research has shown that identifying the range of mission critical competencies underlying METLs significantly improves training scenario design and development of diagnostic performance measurement tools (Acton et al., 2001; Brewer et al., 2001; Cannon-Bowers & Salas, 1998; Cannon-Bowers et al, 1995; Castillo et al., 2002; Smith-Jentsch, Johnston, & Payne, 1998). Team performance measures are more effective in providing diagnostic information for after action review when both *team performance processes and outcomes* are assessed, thereby optimizing training resources and training participant time. The scenario working group identified a few of the mission critical competencies for OVF as:

- Understanding the operational plan;
- Sharing the operational picture via tactical links;
- Communicating via voice and electronic networks;
- Coordinating and de-conflicting various force elements; and
- Evaluating preplanned responses.

The working group agreed that the competencies applied to single Services, but they were particularly important in Joint Service exercises. The act of studying documents, conducting dialog during planning and preparation, and identifying Joint lessons learned in executing the scenario all serve to establish a common basis for *understanding other Services' doctrines*, *tactics, techniques, procedures and unique vocabularies*. For example, Scenario 1 events require the Theater Commander to satisfy a requirement for fire support. Furthermore, the intermediate Joint Force Operational Commanders would be making decisions about what forces to employ, when and where to employ them, and how to support them in accomplishing the mission essential task. Finally, the Commanding Officer of the cruiser would be tasked to provide the necessary fire support.

A high priority in all of these activities involves developing a shared understanding of how the Services need to operate through communications. Therefore, the working group identified the Team Dimensional Training (TDT) measurement tool for demonstration during OVF. It can be used as a paper-based tool, but in this case the Handheld PC-Based version on the Shipboard Mobile Aid for Training and Evaluation (ShipMATE) was employed. For a more detailed description of TDT and ShipMATE refer to Smith-Jentsch, Zeisig, Acton, & McPherson (1998), Hession et al. (2001), and Giebenrath et al. (2003). The ShipMATE TDT was designed to ease the distributed training problem of coordination among exercise evaluators and controllers. It enables rapid synchronized assessment of team task and teamwork performance via voice communications. An authoring tool allows the developer to create mission essential task checklists with associated conditions and standards. The teamwork assessment tool enables measurement of the four dimensions of proper communication, initiative/leadership, supporting behavior, and information exchange.

To illustrate ShipMATE TDT, Table 1 presents an example of teamwork assessment for Scenario 1, Event 6: Naval Gunfire Support (NGFS). It begins with the USMC Forward Observer requesting Naval Gunfire Support, or Call-For-Fire. The Forward Observer (FO)

Table 1. Example Teamwork Assessment for Scenario Naval Gunfire, Event 6: Naval Gunfire Support (NGFS).

Observed Communications	Assessment
TAO: GLO – TAO, Check fire, check fire Target 2016. SH-60, track 7013, fouling gun target line. Break. Air Control, Direct Blazer One to clear to the north ASAP. AC: TAO – Air Control, Roger, clearing Blazer One to the North, going buster.	*TAO Used All Available Resources to Monitor the Task (Information Exchange)* *TAO Provided Direction (Initiative/Leadership)* *TAO used complete report and avoided excess chatter (Communication Delivery)*
GLO: TAO-GLO, Roger, Check fire Target 2016. GLO: Mike Five November this is VICKSBURG, check fire in effect Target 2016. Gun target line foul – expected clear in six zero seconds. Will advise. Over.	*GLO provided a big picture summary (Information Exchange) and avoided excess chatter (Communication Delivery)*
FO: VICKSBURG – Mike Five November, Roger, Check fire Target 2016. Out.	*FO used complete report and avoided excess chatter (Communication Delivery)*

communicates position information of hostile targets to the Tactical Action Officer (TAO) located onboard the AEGIS Cruiser. At the same time, a Navy SH-60B helicopter is conducting operations along the coast, and entered an unsafe zone (fouls the gun target line) where rounds from the cruiser were crossing. Having access to the greater operational picture, the TAO begins to de-conflict the area with the Gunnery Liason Officer (GLO) and Air Controller (AC) before resuming gunfire support. Assessment of only the outcome of the event (timing and accuracy) may not have revealed how the team was successful. Table 1 shows how proper use of available information resources, providing direction and complete reports, and avoiding excess chatter enabled the team to mitigate a potentially catastrophic outcome. An after action review that includes these details about performance processes, as well as outcomes will ensure the team has the proper feedback and dialog concerning how they can improve their performance.

To this end, the ShipMATE TDT was designed to support an evaluator in summarizing mission essential tasks accomplished, as well as selecting and summarizing assessments for each of the teamwork dimensions. This enables a quick look across each dimension to rapidly diagnose where team performance strengths and weaknesses exist. Research has shown that this strategy reduces the need to address each and every performance data point, as well as mitigates the possibility of overlooking the most critical team issues (Smith-Jentsch, Zeisig, Acton, & McPherson, 1998). It improves the efficiency of conducting after action reviews because it summarizes performance strengths, supports selecting the most critical performance issues for discussions among team members, and provides detailed guidance to instructors for facilitating team self-correction. In addition to ShipMATE, the OVF demonstration exhibited examples of other electronic and web-based planning, assessment, and after action review capabilities that could support distributed simulation based training. For example, the Forward Observer Training System is instrumented to record and automatically assess the Forward Observer's use of proper terminology when transmitting a call for fire support.

Skill Inventory and Historical Data

The final element of the SBT model is to maintain an historical database of individual and team performance in order to analyze current and future trends. It also allows measurement of the benefit of conducting training exercises and allows the Services to build and optimize future exercises, concentrating on areas of highest payoff. It might also reveal areas where differences in Service doctrines need to be revised or strengthened as more Joint exercises are conducted.

Testing and Demonstration

As OVF drew near, simulation and scenario developers conducted testing one week prior to the event to work out remaining interoperability issues. An open invitation was sent to participants to stage and test their systems within NAVAIR ORL TSD. Nearly every system was brought together for testing. Even with all participants using a common set of documents, minor interoperability issues occurred. Three days prior to OVF, simulations were set up and tested on the exhibit floor. Most demonstration participants and subject matter experts arrived two days in advance for final team-in-the-loop testing and familiarization training. Final communications script problems and simulation network interoperability issues were worked on until the first demonstration of Scenario 1.

At Demonstration start with Scenario 1, the training participants followed their pre-scripted communications and pre-determined interactions with their simulations. Independent observers monitored simulations and operators to identify and troubleshoot system problems. A lead exercise controller monitored all communications circuits (air-to-air, air-to-ground, ship-to-shore, ground-to-ground, etc.) to ensure that actions during each scenario segment were completed prior to starting the next segment. For example, before the amphibious forces could land safely on the beach, the access roads had to be cleared by way of the Naval Gunfire Support. The controller had to ensure that actions linked sequentially were completed. An exercise evaluator tested the ability to record teamwork observations on ShipMATE. At scenario completion, team members spontaneously discussed their processes and perceived outcomes. An after action review at the Scenario Control site was conducted to correct coordination and technical problems that arose during the exercise. The system at Scenario Control had captured unit location and visual inputs from various simulators and this permitted the Lead Controller to replay selected significant events. The birds-eye view display of forces and their interactions permitted all units to see what actually happened. This was an opportunity for team members and observers/controllers to correct any misperceived outcomes and ask how they might have happened.

SUMMARY

In summary, many of the tasks performed and lessons learned by the exercise management team throughout OVF development and demonstration have been typical of single Service and Joint Service exercise requirements, and have been reported elsewhere for live exercises (e.g., Bell et al., 1996; Crane et al., 2000). However, the DoD TT vision has raised the bar for Joint training: it is expected to be a combination of live, virtual, and constructive systems connected via wide area networks and spanning geographical distances and time zones. In contrast, throughout OVF development many of the Exercise Controllers were face-to-face and in close contact with the simulations. During the demonstration most of the simulations, participants and Controllers were just a few feet to several yards away from each other. Problem resolution was facilitated by close proximity of people and systems. Therefore, the many issues addressed in OVF have the potential for even greater challenges (e.g., time delays, individual schedules, training schedules, long haul networking) given the Joint training vision. Learning is likely to be greatly hindered without training management support embedded in such systems (Walwanis et al., 2003). Therefore, the following guidelines are written to facilitate learning in a geographically and physically distributed training environment.

GUIDELINES

Guideline 1. Establish a web-based Support System for Training Management Teams (S2T2) (Walwanis et al., 2003). This support system should enable collaboration for both simulation and scenario development. For example, it should:

- Provide templates for single sources of documentation to track information.
- Update participants with alerts and guidance on how to engage technical personnel during the scenario and simulation planning.
- Provide guidance and support for interoperability testing. For example, simulation integration and test should be conducted within the context of the scenario. Scenario timing should be assessed to ensure the event timeline is synchronized with the expectations of the training management team (e.g., instructors, role players, scenario monitors, lead evaluators, etc.).

Guideline 2. The S2T2 should provide shared electronic tools and templates for supporting SBT tasks. For example, it should:

- Provide database capabilities (Stretton et al., 2001) that relate the training audience requirements (e.g., strategic, operations, and tactical tasks) to mission critical competencies and scenario events.
- Provide capabilities for developing and distributing team measurement tools, diagnostic assessments, and after action review.
- Provide database capabilities for storage and use of historical performance data collected during scenario run.

Guideline 3. The S2T2 should provide web-based guidance on how to conduct Joint service SBT. It should include how to:

- Establish technical leads for scenario and simulation planning and testing. For example, assign one scenario writer from each Service, designate one as the lead, and use a single source shared scenario document.
- Establish a single lead for Exercise Controller.

- Provide guidance to help training managers gain consensus for each sequence of events in the scenario to resolve differences early.

- Develop a communications plan for the participants and allow time to integrate disparate communications devices or virtual radios. For example, communication tools should enable capturing and correcting missed communications among participants so that ensuing events in an exercise can continue. Variability in Interoperability standards and encoding formats exist for virtual radios and integration is typically not seamless.

Guideline 4. Establish performance assessment, diagnosis, and after action review capabilities in local simulations for individuals, as well as teams. A great advantage of such systems is that intelligent tutoring systems can supplement feedback at the individual level. The capabilities should:

- Consolidate automated performance assessment with instructor observations and maintain in a database for diagnosis and development of after action review (Bolton et al., 2001).

- Coordinate local performance assessments with a central Scenario Control site for adequate assessment and feedback of cross-Service training objectives (Walwanis et al., 2003).

- Support a database for historical information to be used for identifying future training objectives.

CONCLUSIONS

Efficient use of training resources requires getting the right information, to the right people, at the right time. Physically distributed Joint tactical training poses significant challenges for providing adequate time to review, replay key events, and listen to communications for insight and awareness of what happened and how to improve. OVF demonstrated how low cost, PC-based simulations could support Joint scenario-based training in order to rehearse tactics, decision-making, and team coordination. Frequent training with low cost, PC-based simulations using the SBT approach can make the high dollar and opportunity costs of virtual and live training more efficient and effective. Guidelines in this paper have provided insight on merely a few of the challenges faced by Joint tactical training in distributed environments. Finally, OVF raised many more questions than it answered. For example,

- How early in the readiness cycle should individuals participate in these exercises?

- What processes and tools are required to enable individuals to participate in distributed training without cutting into time to accomplish other task requirements?

- How will responsibilities be coordinated for establishing Joint performance criteria?

- What is the return on investment of Joint tactical training exercises?

These questions should be addressed with research in order to validate and further extend the value of SBT capabilities to Joint tactical exercises.

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