# Constructing Virtual Training Demonstrations

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## ABSTRACT

In modern warfare the changing tactics of asymmetric threats present an ongoing need to disseminate lessons learned straight from the battlefield to a wide audience of personnel. Interactive virtual environments have been shown to be effective for training, and distributed game-based architectures contribute an added benefit of wide accessibility. However, conveying new knowledge with interactive training requires either the development of new simulation behaviors or the availability of training personnel for role-playing functions. This presents a constraint on either the speed or breadth of concept dissemination, but one which can be circumvented with virtual training demonstrations. Demonstrations have been favored by the Army as a complement to more traditional training materials because they accelerate learning, stimulate interest, and communicate better than text. They also can be delivered on a wide variety of hardware platforms and accomplish almost instantaneous shared knowledge. Unfortunately, demonstrations have received little attention in the research literature and there is little consensus on what constitutes a good demonstration. We describe two parallel avenues of research towards the rapid construction of effective demonstrations. The first avenue's goals are to: clearly articulate the nature and purpose of demonstration; compare related areas of research (e.g., observational learning studies, behavioral modeling training) to identify factors influencing demonstration effectiveness; and define a set of component capabilities, guidelines and best practices for creating effective demonstrations. The results inform the second avenue's investigation of how a demonstration authoring toolset can be constructed from existing virtual training environments using 3-D multiplayer gaming technologies. We then outline four potential uses for our work, specifically geared toward authoring demonstrations for Army curricula.

## ABOUT THE AUTHORS

**Dan Fu** is a group manager at Stottler Henke Associates. He joined nine years ago and has worked on several artificial intelligence (AI) systems including AI authoring tools, wargaming toolsets, immersive training systems, and AI for simulations. Dan was principal investigator on an intelligent agents project to create AI middleware for simulations and videogames. The result was SimBionic®, which enables users to graphically author entity behavior for a simulation or videogame. Dan holds a B.S. from Cornell Univ. and a Ph.D. from the Univ. of Chicago, both in computer science.

**Randy Jensen** is a group manager at Stottler Henke Associates, Inc., working in training systems since 1993. He has developed numerous Intelligent Tutoring Systems for Stottler Henke, as well as authoring tools, simulation controls, after action review tools, and assessment logic routines. He is currently leading projects to develop automated after action review for Marine Corps combined arms training, a framework for ITS interoperability with distributed learning architectures for the Joint ADL Co-Lab, and an authoring tool for virtual training demonstrations for the Army. He holds a B.S. with honors in symbolic systems from Stanford University.

**Eduardo Salas** is Trustee Chair and Professor of Psychology at the University of Central Florida. He also holds an appointment as Program Director for Human Systems Integration Research Department at the Institute for Simulation & Training. Previously, he was a senior research psychologist and Head of the Training Technology

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**Don Lampton** has been a research psychologist for twenty-five years with the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). He began his career with ARI at the Fort Knox unit where he was involved with early Simulator Networking (SIMNET) research, and participated in the development of one of the first PC-based, networked armor unit training systems. In 1988, he transferred to ARI's unit in Orlando, FL where he is a member of the Virtual Training Environments Team. He is the co-developer of the Virtual Environments Performance Assessment Battery (VEPAB), the Fully Immersive Team Training (FITT) system, and the Dismounted Infantry Virtual After Action Review System (DIVAARS).

**Laura Kusumoto** is Vice President of Studios for Forterra Systems, Inc., where the OLIVE virtual worlds platform is being applied to a range of professional applications in defense, intelligence, healthcare, emergency preparedness, and distance and e-learning. She has spent more than a decade in virtual worlds and multimedia production, and before that she was a software engineer who received her MS in Computer Science from Santa Clara University in California.

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## INTRODUCTION

The use of demonstrations in Army training environments is pervasive. While live demonstrations are arguably the most effective way to disseminate information to warfighters (Kontogiannis & Shepherd, 1999), they suffer four drawbacks. The first is characterizing the efficacy of any given demonstration. This requires an instructional framework to measure a demonstration's effectiveness. Moreover, it would suggest how to create the most effective demonstration (Rosen, Salas, & Upshaw, 2007). The second is time: the spreading of innovative fighting concepts from the field requires that either personnel or reports make their way back to the classroom. The concepts must then be inserted into formal curricula before eventual demonstration and training. At a minimum there exist delays on concepts added to the doctrinal mindset. The third is the transmission of concepts. Reports written on AKO or in email are inferior methods to what should ideally be demonstrated face-to-face. The fourth is the non-trivial manpower and equipment necessary to enact a demonstration. This is especially true for team training situations.

In this paper we describe our efforts towards handling these problems. So far our work has proceeded along two avenues of research: organizational psychology and technology investigation. The psychology literature has established that virtual or constructive environments can accelerate the learning process by illustrating correct behaviors, establishing a shared mental model of team behavior, and supporting such advanced techniques as cross training (Salas & Cannon-Bowers, 2000). Despite its importance, demonstrations by themselves have received little attention with little to no agreement on what makes a demonstration effective. The psychology work informs our second avenue of technology investigation, which examines and evaluates approaches and platforms to be employed for demonstrations, such as film, video, and computer-based instructional aids. Modern simulation and game engine technology affords a variety of capabilities such as 3-D visualization, transparency, and multiple synthetic agents who can function as instructors, teammates, or adversaries. They afford great potential as demonstration platforms, although demonstration is a relatively new application for "serious games". The results of our investigations form the basis for a demonstration authoring system whose development is underway, called RADX: Rapid Authoring of Demonstrations for eXperience.

The rest of this paper is organized as follows. We describe the theoretical basis for demonstrations. This includes an analysis of the relevant literature with demonstration-oriented elements called out. We then characterize the space of technology solutions with a focus on 3-D game engines. With these two pieces of work in mind, we examine team training applications.

## THE NATURE OF DEMONSTRATION

In this section we summarize the nature and purpose of demonstration (see (Rosen, Salas, & Upshaw, 2007) for an expanded version). Training is the systematic acquisition of the knowledge, skill, and attitude (KSA) competencies targeted for acquisition. Generally training consists of five core elements: the provision of information (e.g., classroom lectures), demonstration (e.g., live demonstrations, video recorded examples of task performance), practice (e.g., simulation, guided on-the-job performance), feedback (e.g., results analysis), and remediation (i.e., the selection of future training (Salas et al., 2006)). This section forwards a conceptual definition of a demonstration and a review of the theoretical basis underlying the use of demonstrations for training. Guidelines for developing effective demonstrations are summarized.

Although an exact and widely accepted definition of a demonstration is currently lacking (Williams, Davids, & Williams, 1999), demonstration-based training can be understood as a learner's observation of task performance, components of task performance (i.e., part-task performance) either in real time or through some form of recorded or computer generated medium, or characteristics of the task environment that have

been targeted for acquisition. Demonstrations are often an example of task performance; however, demonstrations are rightfully thought of as engineered experiences where learners are prompted to actively process the informational content of the example, and to systematically and reliably acquire targeted KSA's and transfer them to the work environment. In this vein, we propose a working definition of demonstration: "A demonstration is a strategically crafted, dynamic example of partial or whole task performance or of characteristics of the task environment intended to increase the learner's performance by illustrating (with modeling, simulation, or any visualization approach) the enactment of knowledge, skills, and attitudes (KSA's) targeted for skill acquisition."

Demonstrations vary in terms of information, physical characteristics, and the learner's activities prior to, during and after the example of task performance. We distinguish between an example, which is the observational component of the demonstration, and the demonstration, which is the entirety of the example plus additional activities and information provided. In the following section we review the theoretical literature pertinent to designing effective demonstrations.

## Theoretical Basis for Demonstration-based Training

Learning through observation has been one of the fundamental means of acquiring knowledge and skills in both systematic and informal training. This section briefly reviews two of the research traditions in behavioral science that form the cornerstones of our understanding of demonstration-based training: observational learning and behavior modeling training.

### Observational Learning

Bandura (1986) describes four observational learning processes:

1. attention (whereby people must actively process what they are observing in order to learn),
2. retention (wherein what is observed must be stored symbolically in order to affect future behavior),
3. production (whereby the stored symbolic knowledge must be reconverted into overt actions), and
4. motivation (whereby the perceived consequences of performing the observed behavior must be favorable enough to strengthen the likelihood of future performance).

This theory has received much empirical attention with the majority of research conducted under the general observational learning heading tending to involve lower level motor tasks. Hence, the generalizability of the empirical findings from these studies to types of complex tasks trained by organizations is suspect. Still, Bandura's observational learning theory remains the most widely researched and applied.

### Behavioral Modeling Training

Behavioral modeling training (BMT) is one of the most extensively used training methods available to modern organizations (Taylor, Russ-Eft, & Chan, 2005). BMT is based on Bandura's social learning theory (Hogan, Hakel, & Decker, 1986). Utilizing the model provided by social learning theory, BMT includes processes such as modeling, a retention process, behavioral rehearsal, feedback, and methods of training transfer to encourage the greatest transfer of training possible (Doo, 2005; Kraut, 1976). Specifically, during BMT:

1. trainees are given a list of well-defined skills and facts to be learned during training,
2. during training models and visual aids are used to illustrate effective behaviors and skills,
3. trainees are provided ample opportunities to practice newly learned skills,
4. trainees are provided feedback and social reinforcement by trainers and other trainees, and
5. trainers and the organization utilize many methods to promote transfer of training (Decker & Nathan, 1985).

Using all these methods, behavioral modeling training has proven to be an effective training tool in developing skills, resulting in high transfer of training. Additionally, BMT has been tested and found effective in a number of scenarios including training technical and interpersonal skills.

## A Typology of Demonstrations

We have created a typology of demonstrations shown in Figure 1. It represents classes of features that can be included within a demonstration. Any one demonstration may (and likely will) have features from more than one category. This framework organizes the space of possibilities and provides a common language for discussing demonstrations.

There are two types of knowledge: procedural and strategic. Procedural knowledge is "how-to" knowledge; it involves knowledge about the sequences of actions involved in task performance. It is a rehearsed and static sequence of behaviors performed to reach a task goal, such as performing a "stack" as part of a forced entry sequence. Strategic knowledge is "how-to-know-when-to-do-what" knowledge (Kontogiannis & Shepherd, 1999) and is generally associated with problem solving. Strategic knowledge

involves learning aspects of the task that are not specific to one context, such as deciding when to initiate communication during an operation.

There are two high level categories concerning the types of activities and information provided in the demonstration. First, passive demonstrations do not require any activity on the part of the learner outside of the act of observing. These are by far the most frequently encountered demonstrations in day to day life and training programs. Passive demonstrations rely entirely on the content of the example and sometimes guiding information to focus the attention of the learner, but do not incorporate any directions that require action (behavioral or cognitive) on the part of the learner. Active demonstrations impose demands on the learners outside of passively observing an example of task performance. They require the learner to engage in activities designed to increase the retention of knowledge and transfer of skill. Table 1 summarizes the six categories of demonstrations. Other than guided vs. unguided, the types are not mutually exclusive, and so a demonstration can be both active-preparatory and active-retrospective for example.

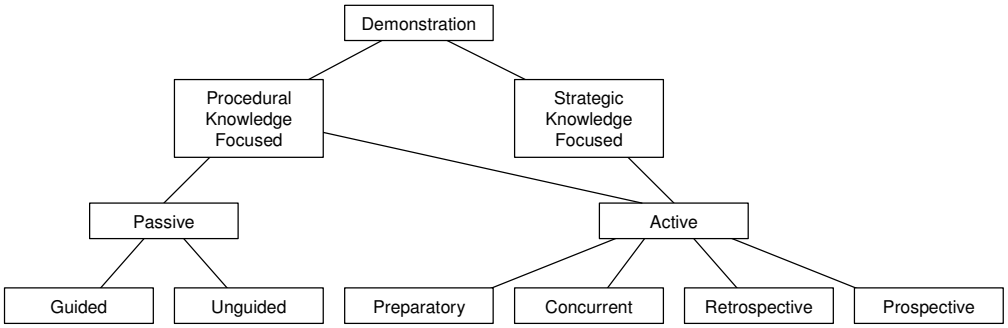


**Figure 1:** Typology of Demonstrations for Simulation-based Training (Salas et al., 2008)

**Table 1:** Description of demonstration types (adapted from Salas et al., 2008)

| Demonstration Type | Description | Example features | Citations |
|---|---|---|---|
| Passive-unguided | Learners given no requirements or information outside of that present in the example of task performance or task environment characteristics | N/A | (Austin & Laurence, 1992; Berry, 1991; Blandin & Proteau, 2000; Palmiter & Elkerton, 1993) |
| Passive-guided | Learners are given pre-demonstration information intended to increase learning | Attentional advice, provision of learning points | (Decker & Nathan, 1985; Jentsch et al., 2001) |
| Active-preparatory | Learners engage in activities (designed to orient and focus the learner) before viewing the example for the observation experience to come before viewing the example | instruction on self-regulatory skills for observation, goal setting, and perceived self-efficacy | (Cumming, Clark, Ste-Marie, McCullagh, & Hall, 2005; Hard & Lozano, 2006) |
| Active-concurrent | Learners engage in activities during observation of example | note taking, perspective taking | (Lozano, Hard, & Tversky, 2006) |
| Active-retrospective | Learners engage in activities after viewing the demonstration designed to focus attention on salient aspects of performance | symbolic mental rehearsal, learner-generated learning points | (Davis & Yi, 2004; Hogan, Hakel, & Decker, 1986) |
| Active-prospective | Learners engage in activities after observing the example that focus the learner on how it can be applied to other contexts | goal setting exercises, the generation of practice scenarios by the learners | (Lathan & Saari, 1979; Taylor et al., 2005) |

## PLATFORMS AND TECHNOLOGIES

In this section we examine the types of game technologies and link them to demonstration. Fu, Jensen, and Hinkelman (2007) categorize technologies along two dimensions: *depiction* and *plurality*. The most popular depiction is 3-D, which makes the visualization as realistic as possible, as opposed to 2-D. Plurality refers to the number of participants: single player, multiplayer, or massively multiplayer. Using

these two dimensions, we now outline the most popular combinations.

**2-D, Single Player Games** depict a point of view either from overhead or from the side. 2-D depictions could be most useful for "big picture" understanding, such as training coordination among teammates. 2-D game engines, compared to others, offer the lowest amount of fidelity. Their use for demonstration-based training is limited.

**3-D Single Player Games** display the virtual environment by rendering it from parameters and descriptions of 3-D objects. It assumes the player is the only person operating in the environment, and that anything else independently moving is controlled by artificial means. The engine may support many "cameras" or viewpoints within the environment, such as first person, tethered, overhead, or a user-controllable point of view. It may support display of several cameras simultaneously on one screen. There are three major genres: first-person shooter (FPS), real-time strategy (RTS), and role-playing game (RPG). Briefly, FPS depicts a first-person point of view. Emphasis is on real-time shooting ability. RTS depicts scenes from an overhead, angled perspective. The player will control several units from above. RPG is similar to RTS, but there is no real-time component.

**3-D Multiplayer Games** increase the number of human players involved. One might think of multi-player as the same as single player except that the control for avatars is supplanted by real human control.

**3-D Massively Multiplayer Online Games (MMOG)** are similar to 3-D multiplayer except on a bigger scale. They feature a huge virtual world, potentially as big as the earth, where one may explore and meet other avatars and objects. Unlike the multiplayer games whose participants assemble temporarily and then disperse when the game round concludes, MMOG's retain history in the virtual world: the world changes and so do the avatars in it.

**Guidelines for Developing Effective Demonstrations**

Much of the existing training research concerns tasks that are more abstract and simple rather than the types of tasks the Army generally choose to train. Still, we were able to gather general principles in the form of seven preliminary and empirically based guidelines as shown in Table 2 (Rosen, Salas, and Upshaw, 2007).

**Table 2:** Platform evaluation with guidelines

| Guideline | 2-D | 3-D | | |
|---|---|---|---|---|
| | | Single player | Multiplayer | Massive Multiplayer |
| 1. The KSA's targeted for demonstration-based training must be perceivable by the learner. | Operational | Tactical, Operational | Tactical, Operational | Tactical, Operational |
| 2. Direct the learner's attention to the cues relevant to learning. | Operational | Tactical, Operational | Tactical, Operational | Tactical, Operational |
| 3. Use instructional narratives to make covert aspects of performance accessible to learners. | Operational | Tactical, Operational | Tactical, Operational | Tactical, Operational |
| 4. Utilize mixed models, as opposed to positive-only models, to display both positive and negative behaviors and outcomes. | No | Tactical, Operational | Tactical, Operational | Tactical, Operational |
| 5. Show the consequences of behaviors. | No | Tactical | Tactical | Tactical |
| 6. Instruct learners to create their own scenarios in which to rehearse behaviors. | No | No | No | Tactical |
| 7. Instruct learners to symbolically or mentally rehearse behaviors and skills before rehearsing them. | No | Tactical | Tactical | Tactical |

As remarked earlier, 2-D views are most likely to be used in team training situations to improve situation awareness. Oftentimes it is helpful for teammates to understand the "why" and "where" of coordination. These were labeled as "operational" in the Table. 3-D views, especially FPS, are naturally suited for tactical understanding. These were labeled "tactical" in the Table.

Based on our platform investigation, we used Forterra's MMOG OLIVE as a basis for in-depth investigation. Its MMOG architecture was not deemed critical because

constructing a demonstration or exercising practice-based training methods demands repeatable experiences. Still, MMOG architectures afford advantages and efficiencies for potential distributed use cases and also scalability to scenarios populated by the avatars for large numbers of role-players or spectators.

## EXAMPLE USE CASES

In this section we review some existing curricula and training materials to develop Army training examples. While the following examples are not comprehensive, they explore a range of technology use cases, for different training topics, and sketch a reasonable instructional context for each. Our emphasis is on developing the authoring and playback capabilities that support the full virtual demonstration vision described in this cross section of use cases.

Similarly, the following examples do not address the development of other materials in a training package or instructional strategy in which the demonstrations are used. Although the consideration of the instructional context in this sense is an important driver for the design of demonstration authoring capabilities, the creation of other materials is treated as an implicit authoring step for which other tools and practices are used.

All of the following examples presume an authoring process which entails pre-production, execution, post-production, and delivery / distribution stages. In most cases the first three stages will have several common features, in that subject matter experts describe the desired actions and communications to be performed in execution, human role-players perform the scenario, and then in post-production the resulting execution log is played back and tailored to demonstrate objective concepts. The level of effort in these initial stages varies with the complexity of the scenario and the instructional goals. The delivery mechanism is one of the primary differentiators between use cases.

### Augment Existing Training Materials

| Example domain: | Stryker vehicle safety |
|---|---|
| Instructional context: | Accompanying IETMs provided with the basic Stryker driver training course |
| Demonstration type: | Standalone video, fully annotated and developed in detail by Army SMEs |
| Delivery mechanism: | Any media player, with content provided in compressed video file format or on digital media (eg, DVD) |

Basic Stryker driver training is a two week course, conducted as much as possible hands-on with actual vehicles (Army TC 7-21, 2006). It presently introduces an Interactive Electronic Technical Manual (IETM) for vehicle maintenance checks. While materials such as IETMs are useful references, they often do not make for compelling learning experiences. It is well-documented in training literature that the most effective methods are those that engage the training audience and provide them opportunities to practice skills. Scenario-based training (Salas, Priest, Wilson & Burke, 2006) embeds opportunities for practice and evaluation of desired performance within a rich context that mimics a realistic task setting. This allows trainees to develop the skills necessary for making complex decisions. However, given the vast space of military training domains, there simply are not the resources to provide scenario-based training for many subject areas and task areas. Within this space, virtual demonstrations can be a low-cost means to augment the most basic training materials such as manuals, and provide a more compelling learning experience.

For this example use case, the objective is to construct a training demonstration (or set of demonstrations) for Stryker safety procedures, focusing on the coordination of the vehicle with multiple team members and other aspects of the environment. The training objectives are primarily oriented toward procedural knowledge (see **Figure 1**). The demonstration would be made available in conjunction with other training materials such as IETMs, to specifically illustrate correct procedures and potentially negative examples as well, that is, to show what can go wrong if procedures are not followed. Training domains involving safety are likely to be compelling applications for negative demonstration examples, as they show the consequences of behaviors, which has been identified as helping retention (Jentsch et al., 2001). Seeing the negative outcome from failing to perform a safety procedure provides an insight and motivation that is absent when the procedure is shown independently with no such built-in lessons learned (see Guideline 4, **Table 2**). Some Stryker safety training concepts that could be conveyed effectively with virtual demonstration include:

1. Mounting/dismounting procedures
    a. Avoid path of weapons
    b. Inform driver of mounting/dismounting intentions
2. Evacuation drills

3. Use of ground guides (individuals on the ground who provide direction to the vehicle driver):
   a. Vehicle blind spots – driver needs assistance from ground guide or other team members
   b. Ground guide for navigation in narrow streets, crowded areas, cantonments, bivouac sites, parking areas, low clearance, limited visibility
   c. Ground guides stand by fender to talk to driver, not in front of running vehicle
   d. Ground guides walk 30 feet ahead and to left of vehicle; driver must be able to see guide's feet
   e. If a ground guide is required and Stryker moves in reverse, a second ground guide is required.
4. Refueling operations – require a full crew with various responsibilities, esp. under fire

**Figure 2:** Example OLIVE view from inside a vehicle, demonstrating driver visibility to dismount

The objective of the demonstration author(s) in this example is to construct a standalone demonstration with annotations and markup that make the Stryker safety concepts nearly self-explanatory. For example, with the safety procedures regarding the ground guides, the demonstration could be annotated to show the distance and offset to where the ground guide should stand. The demonstration could also show multiple points of view to illustrate how the guide sees the driver, and that the driver can see the guide's feet. Additionally, the demonstration would include synchronized playback of the spoken communications conducted in the virtual environment between drivers and other team members. This demonstration could be authored in a matter of hours and exported to digital media or compressed digital file formats for distribution with the driver's course. Like IETMs and other existing training materials, the demonstration would be available through the same channels for future reference and refreshers.

**Widely Disseminate Knowledge About New Enemy Tactics**

| | |
|---|---|
| Example domain: | Combating IEDs in convoy operations |
| Instructional context: | Army directive learning channels, such as the Center for Army Lessons Learned |
| Demonstration type: | Standalone video, developed by Army SMEs based on reports direct from the theater |
| Delivery mechanism: | Any media player, with content provided in compressed video file format or on digital media (eg, DVD) |

Modern asymmetric warfare conditions are increasingly characterized by an action and reaction cycle where the enemy is continually adapting tactics in response to measures employed by US forces. As new enemy tactics are encountered in theater, and as new countermeasures are developed in response, this cycle often functions at a far faster speed than the traditional process of updating doctrinal TTPs and distributing them accordingly. Although an individual demonstration in isolation may not achieve a comprehensive goal with respect to strategic knowledge (see **Figure 1**), demonstrations in this example collectively contribute to strategic knowledge in dealing with asymmetric threats.

For this example, we examine the domain of combating IEDs. The example below is sourced from http://www.blackwaterusa.com/btw2004/articles/ttp1.ppt. Consider an insurgent convoy ambush tactic involving a sequence as shown in **Figure 3** and **Figure 4**.

The function of the demonstration in this case would be not only to show a 2-D view that affords full situational awareness of the tactics carried out against the convoy, but also to show perspectives from individual vehicles where their knowledge of battlefield conditions is limited to first-hand observation and communication with other vehicles.

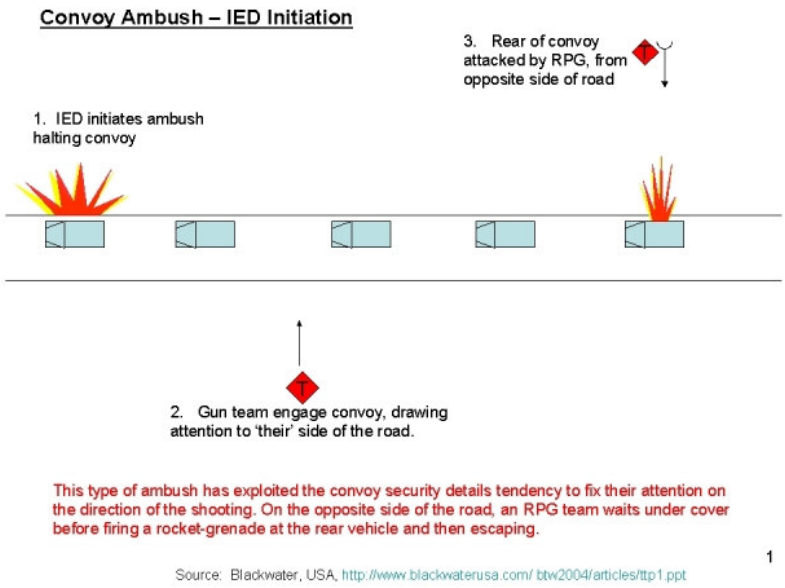


**Figure 3:** IED tactic against convoy

**Figure 4:** Alternate simultaneous 3-D views of IED tactic against convoy

The authoring process could involve two scenario executions—the first to demonstrate the enemy tactic carried out successfully, and the second to demonstrate a response that is effective against this tactic. For example, in the positive variant, a combination of advance assignments and communication can create 360 degree awareness, rendering the RPG attack unsuccessful.

The scenario is designed on geo-typical terrain based on descriptions from deployed Soldiers in theater. With a distributed server-based architecture for the virtual environment in which the scenario is executed, it may even be possible to involve deployed Soldiers in the execution of the scenario, either with active role-playing participation, or in an oversight role to verify that the tactics and events unfold as intended. Once again the human role-players make a valuable contribution to the effectiveness of the demonstration not only by controlling actions and movements, but also for the communications during the scenario, which play a key role in the situational awareness element of the IED scenario. After conducting the two executions with human role-players, the post-production stage can be carried out by a single author, who directs all switching between different viewpoints during playback and adds any markup or annotation. While the rapid creation and distribution of demonstrations may tend to reduce the amount of instructional framework included in the videos, the authors' choice of camera angles, zooms etc may serve to fulfill the requirement of making sure viewers' attention is directed in a manner that serves the author's instructional goals. The resulting content is

then exported to portable digital video formats and distributed.

The distribution goal in this use case would be to achieve playability on a wide variety of devices that the intended audience may have, from AAR theaters, to individual desktop or portable computers, to PDAs, and ultimately even cell-phones. For cell-phones, an option may be a wireless web page with links to an audio introduction and then small-format short video or a series of such. Thus the lag from battlefield experience to widely distributed knowledge is shortened not only by the ease of constructing example scenarios and then producing self-contained demonstrations in the same environment, but also by the ability to export to highly portable formats.

Note also that although the concept of rapid dissemination of content might seem to imply some kind of "push" or broadcast distribution method, there's an alternate possibility that is more like a future Youtube, wiki, or AKO. That is, a web-hosted archive of video, with community capabilities such as blogs or comment threads attached to posted video, and advanced indexing capability. This could further be supported by automated or user-driven metadata attached to video demonstrations. For example, because the authoring process takes an execution log as source material, it's possible to derive vehicle types, explosive types, and other content directly from the log automatically and use this to characterize the demonstration for indexing purposes.

**Augment Interactive Training**

| | |
|---|---|
| Example domain: | Cordon and search, in an asymmetric urban warfare setting with cultural implications |
| Instructional context: | CONUS home base classroom leadership training |
| Demonstration type: | Server driven playback with interactive POV control |
| Delivery mechanism: | Virtual environment client stations viewing slaved playback |

The example domain in this use case is a direct extension from a technology demonstration created at Army RDECOM for an Asymmetric Warfare ATO in 2005. RDECOM used Forterra's OLIVE platform in a search and cordon scenario in urban terrain typical of Iraq. Several role-players assumed the virtual avatars for the local characters, with Soldiers conducting the search and cordon mission in the virtual environment. The objective was to show how the virtual environment can be used to provide units with practice as part of a training program in preparation for deployment.

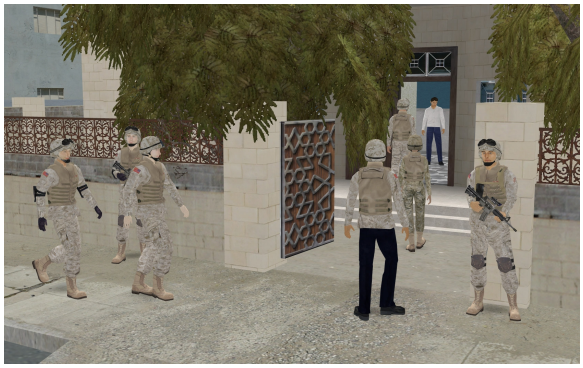

**Figure 5:** Search and Cordon Scenario in OLIVE

The mission execution sequence in the scenario involves a sequence of scenes, starting with a civil unrest situation outside an overwatch residence in the cordon area, continuing to the entry of a residence, and a hostage situation in the interior. The sequence ends with a virtual AAR—essentially a review conducted between avatars still in the virtual environment.

The RDECOM scenario presents a compelling training use case, showing not only how the virtual environment can give effective practice, but also how the architecture easily supports participation in a virtual co-located exercise from participants in distributed locations. There are several ways that virtual demonstration authoring capabilities could be integrated into an instructional strategy following the lead of RDECOM's use case. The line distinguishing AAR tools from demonstration authoring tools fades or disappears entirely when the target audience has synchronous access to playback clients, as in a classroom setting or even a distributed classroom. An instructor can conceivably drive a dynamic playback experience which also affords some individualized interactivity for the training audience, with little additional effort beyond "pushing the play button" on an already authored playback sequence. Consider the following instructional sequence in a home base leadership training classroom setting.

1. A virtual demonstration scenario is played for the class on client stations. Primary start/stop control is driven by an instructor, who also has demonstration authoring tools (annotation, markup, split panel) handy for directing attention during playback. Trainees can control their virtual viewpoints and positions, and jump to the perspective of different characters in the scenario.

2. The class performs an interactive exercise with the same clients, and the exercise is recorded.
3. The instructor plays back the exercise in after action review, once again making use of primary playback controls, but also directing students to specifically monitor specific character positions or actions in the scenario in order to see instructionally significant mistakes or successes.
4. Both playbacks are exported to a format that the training audience can take with them.

This example illustrates the beneficial synergy that results from using a common virtual environment both for immersive scenario based training and also for demonstration authoring and administration, two tasks that are related under the same training objectives as described in Guideline 4 in **Table 2**. In this classroom setting, client stations are configured to support either synchronous scenario execution or synchronous playback. Playback takes a wider meaning in this context, where it can refer to either after action review playback on the log of an exercise just conducted, or playback of a previous "reference" exercise in the sense that the playback functions as a demonstration. The demonstration authoring capabilities provided by the proposed toolset expand accordingly in this setting, enabling an instructor not only to direct classroom participants to interact with the demonstration scenario, but also to interact with the playback of their own exercise.

Whether used for demonstration authoring or for interactive training, a key component of the virtual environment in this example domain is the ability to present situations requiring both team coordination and communications with local characters, which includes the portrayal of cultural gestures and clothing. For this case, there may be several simultaneous dialogs carried out between avatars during playback, for which the demonstration author may make use of tools specifically aimed at sorting out communications and playing back those that are most relevant to a given portion of the playback at any time.

**Facilitate Asynchronous Embedded Learning**

| | |
|---|---|
| Example domain: | Cordon and search, in an asymmetric urban warfare setting with cultural implications |
| Instructional context: | Unit-motivated embedded refresher training |
| Demonstration type: | Standalone video, fully annotated and developed in detail by Army SMEs, with an emphasis on team coordination and cultural interaction tasks |
| Delivery mechanism: | Any media player, with content provided in compressed video file format or on digital media (eg, DVD) |

This use case is essentially a variation of preceding examples, but with different context and motivation. Embedded training holds an increasingly key role for keeping unit operational capabilities fresh while deployed, where the training resources of a home base are not available. Advanced forms of simulation-based embedded training are gradually becoming available to deployed Soldiers, and when available they can make for effective just-in-time training as well as mission rehearsal. However, resources are limited in theater, and as a result it is likely that lightweight forms of embedded training, such as virtual demonstrations, can offer significant training value in the deployed setting.
Embedded refresher training is especially useful in modern asymmetric warfare, where units are routinely assigned different kinds of duties, which they may have been trained on before deployment, but have not performed since that time. In this use case example, a unit has been tasked to begin conducting cordon and search activities on a regular basis. The unit leader wants to go through refresher training to bring his Soldiers back up to speed on not only the team coordination procedures involved in cordon and search, but also the cultural interactions that are required for these operations. This can be accomplished by reviewing a virtual demonstration of proper procedures, presented in an environment that is geo-typical not only of the terrain where operations will be conducted but also of the specific local cultural factors. Such a demonstration would be specifically prepared (as in other use cases above) for supportability on a wide variety of players, specifically for the restrictions of the embedded setting.

## CONCLUSION

This paper summarizes two threads of investigation: the nature of demonstration and potential technologies. We provided a working definition of demonstration and offered a typology of demonstrations with according guidelines. These results informed our review of available technologies. Platforms were then characterized using our typology, guidelines, and performance criteria. Finally, we summarized four example use cases that illustrate the potential of gaming technologies in particular.

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**REFERENCES**

Austin, S., & Laurence, M. (1992). An empirical study of the SyberVision golf videotape. *Perceptual and Motor Skills, 74*(3, pt 1), 875-881.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Rockville, MD: National Institutes of Mental Health.

Berry, D. C. (1991). The role of action in implicit learning. *The Quarterly journal of experimental psychology, 43*(4), 881-906.

Blandin, Y. & Proteau, L. (2000). On the cognitive basis of observational learning: Development of mechanisms for the detection and correction of errors. The Quarterly Journal of Experimental Psychology A, Volume 53, Number 3, 1 August 2000, 846-867.

Cumming, J., Clark, S.E., Ste-Marie, D.M., McCullagh, P., & Hall, C. (2005). The functions of observational learning questionnaire (FOLQ). *Psychology of sport and exercise, 6*, 517-537.

Davis, F.D., & Yi, M.Y. (2004). Improving computer skill training: behavior modeling, symbolic mental rehearsal, and the role of knowledge structures. Journal of Applied Psychology, 89(3), 509-523.

Decker, P. J. & Nathan, B. R. (1985). *Behavior modeling training: Principles and applications*. New York: Praeger.

Doo, M. Y. (2005). The effects of presentation format for behavior modeling of interpersonal skills in online instruction. *Journal of Educational Multimedia and Hypermedia, 14*(3), 213-235.

FM 7-1 (2003). Battle Focused Training. Washington, DC: Department of the Army.

Fu, D., Jensen, R., & Hinkelman, E. (2007). "Evaluating Game Technologies for Training," *Unpublished manuscript.*

Hard, B. M., Lozano, S. C., & Tversky, B. (2006). Hierarchical encoding: Translating perception into action. Journal of Experimental Psychology: General, 135, 588-608.

Hogan, P. M., Hakel, M.D., & Decker, P.J. (1986). Effects of trainee-generated versus trainer-provided rule codes on generalization in behavior-modeling training. *Journal of Applied Psychology, 71*(3), 469-473.

Jentsch, F., Bowers, C., & Salas, E. (2001). What determines whether observers recognize targeted behaviors in modeling displays? *Human Factors, 43*(3), 496-507.

Kontogiannis, T., & Shepherd, A. (1999). Training conditions and strategic aspects of skill transfer in a simulated process control task. *Human-Computer Interaction, 14*, 355-393.

Kraut, A. I. (1976). Developing managerial skills via modeling techniques: Some positive research findings- A symposium. *Personnel Psychology, 29*, 325-328.

Latham, G.P. & Saari, L.M. (1979). Importance of supportive relationships in goal-setting. Journal of Applied Psychology, 64(2), 151-156.

Lozano, S.C., Hard, B.M., & Tversky, B. (2006) Perspective-taking Promotes Action Understanding and Learning. Journal of Experimental Psychology: Human Perception and Performance, 32(6), 1405-1421.

Palmiter, S. & Elkerton, J. (1993). Animated demonstrations for learning procedural computer-based tasks. Human-Computer Interaction, 8(3), 193-216.

Rosen, M. A., Salas, E., & Upshaw, C. L. (2007). Understanding Demonstration-based Training: A Conceptual Framework, Some Principles and Guidelines. *Unpublished manuscript*.

Salas, E., & Cannon-Bowers, J.A. (2000). The anatomy of team training. In S. Tobias and J.D. Fletcher (Eds.), *Training & Retraining* (pp. 312-335). New York: Macmillan Reference.

Salas, E., Priest, H. A., Wilson, K. A., & Burke, C. S. (2006). Scenario-based training: Improving military mission performance and adaptability. In C. A. C. A.B. Adler, and T.W. Britt (Eds.), *Military life: The psychology of serving in peace and combat* (Vol. 2: Operational Stress, pp. 32-53). Westport, CT: Praeger Security International.

Salas, E., Rosen, M. A., Pavlas, D., Jensen, R., Fu, D., Ramachandran, S., Hinkelman, E. (2008). Understanding Demonstration-based Training: A Definition, Conceptual Framework, and Some Initial Guidelines. ARI Technical Report, to appear.

Taylor, P. J., Russ-Eft, D.F., & Chan, D.W.L,. (2005). A Meta-analytic Review of Behavior Modeling Training. *Journal of Applied Psychology, 90*(4), 692-709.

Williams, A. M., Davids, K., & Williams, J.G. (1999). *Visual perception and action in sport*. London: Spon.