Lessons Learned From Integrating Commercial Gaming Technology into an ADL Environment

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ABSTRACT

The CSTT is a government funded program that is currently being used to demonstrate the effective use of ADL technologies for the military. It provides training and simulated practice to help our National Guard Bureau's Civil Support Teams – Weapons of Mass Destruction (CST-WMD) train in their mission to support local and state authorities at domestic Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) incident sites. The CSTT program uses distributed simulations and instructionally sound courseware to help keep their skills current for individuals and teams with regard to interagency operations and decision-making. This training improves the essential aspects of civil-military interoperability and mission planning

The Joint Advanced Distributed Learning (JADL) Co-Laboratory, in partnership with the US Army Research, Development and Engineering Command (RDECOM), the National Guard Bureau (NGB) and the US Army Program Executive Office for Simulation, Training and Instrumentation (PEOSTRI), has funded the development of the CSTT prototype and its associated technology to allow it to reach large numbers of people quickly and to provide simulated experiences that transfer efficiently into high levels of performance in an actual emergency. . Skillful management of these technologies has proven to be an important element in the teaching and learning process.

To ensure the quality of instruction, an in-depth instructional systems design was performed to develop the instructional specifications for the CSTT. This paper will look in detail at the changing requirements in the architecture and design of the CSTT from initial research, through the prototype development process and into the foreseeable challenges associated with production. It will discuss the role that Advanced Distributed Learning technologies and commercial gaming technologies have played in the development of this application and will identify the current state of these technologies in supporting this role, as well as lessons learned on working with and integrating these technologies.

ABOUT THE AUTHORS

Ms. Cindy Carlisle is a NAVAIR Orlando, Training Systems Division employee serving as the Deputy Director of the Joint Advanced Distributed Learning (JADL) Co-Lab. The mission of the JADL Co-Lab is to integrate instruction and technology to meet the military's training requirements. The Co-Lab promotes the implementation of ADL through research, development and consulting services for the Department of Defense (DoD). Ms. Carlisle participates on many DoD Joint Boards, Integrated Product Teams, and Working Groups, often serving as principal advisor. Ms. Carlisle's work has been recognized with many awards, articles published in the Government Computer News, and frequent invitations to speak at conferences.

Mr. Brent Smith has served as Chief Technology Officer, Vice-President, Director of Development and Project Manager for ECS, Inc since 1997. While at ECS, he has performed extensive research in the areas of collaborative distributed learning architectures, distributed simulations, and the use of commercial gaming technologies as educational tools for the US military. He is currently developing distributed courseware simulations for the National Guard and the Army Medical Department Center and School. He has proven skills in building strategic affiliations to manage and solve complex training issues for a variety of clients. His professional focus is on the research and development of new technologies to enable new learning methods and tools to improve effectiveness. Mr. Smith is a frequent speaker on the topic of simulation and training development and as an adjunct professor at the University of Central Florida, designed a course on game engine development. He has testified before Congress and spoken at the e-learning Guild's Annual Conference, TechLearn, I/ITSEC and the MORS Training Transformation Conference. He is a member of the Association of the US Army (AUSA), the Military Operations Research Society, the National Defense Industry Association, and the I/ITSEC Subcommittee for Education.

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INTRODUCTION

The vision of the Department of Defense's Advanced Distributed Learning Initiative is to harness the power of the Internet and other virtual or private wide area networks to deliver high quality learning. It brings together intelligent tutors, distributed subject matter experts, real time in-depth learning management and a diverse array of support tools to ensure a responsive, high quality "learner centric" system[1].

The Joint ADL Co-Laboratory, in partnership with the US Army Research, Development and Engineering Command – Simulation & Training Technology Center and the National Guard Bureau's Civil Support Teams for Weapons of Mass Destruction has been developing the Civil Support Team Trainer (CSTT) prototype to provide the training and simulated practice necessary to support our Weapons of Mass Destruction – Civil Support Teams (WMD-CST) in their mission to support local and state authorities at domestic WMD/NBC incident sites.

The CSTT prototype demonstrates the effective use of distance learning technologies to provide the Army National Guard with a low-cost, highly effective, distributive training platform. It incorporates state-of-the-art DL technologies with doctrinally accurate courseware to produce a SCORM-conformant training application. Technically, the CSTT prototype uses a modular architecture to support web-based, 3-D, immersive training simulations that allows integration with many instructional approaches and learning content. Instructionally, the CSTT prototype immerses participants in a realistic, virtual training scenario that provides cues and conditions designed to provoke the sequence of tasks required for effective individual and collective mission performance.

This paper will discuss the many lessons learned in developing and implementing interactive instruction within a simulated environment using commercial gaming technologies. It will also discuss the various technologies used to develop the CSTT and how they were implemented to maintain a focus on the overall instructional integrity of the application.

BACKGROUND

The Advanced Distributed Learning (ADL) Initiative is a collaborative effort to harness the power of information technologies to modernize structured learning. It sets forth a new paradigm to provide access to the highest quality education and training that can be tailored to individual needs and delivered cost-effectively, whenever and wherever it is required. The ADL Initiative employs a structured, adaptive, collaborative effort between the public and private sectors to develop the standards, tools and learning content for the future-learning environment.

The ADL Initiative created a network of four ADL Co-Laboratories to advance the initiative and to serve distinct areas of operational responsibility. The ADL Co-Lab network serves as the focal point and catalyst for the large-scale cooperative research, development, implementation and assessment of ADL technologies and related products. As a member of that ADL Co-Lab network, the Joint ADL Co-Lab integrates instruction and technology to meet the military's training requirements. It actively pursues research interests to advance the state of distributed learning within the Department of Defense[2].

The Joint ADL Co-Lab is interested in those technologies, methodologies and techniques which can be demonstrated and shared throughout the Department of Defense. It supports cooperative research, development, demonstrations and assessments of ADL technologies, tools and prototypes by facilitating partnerships, research and sharing among the military services. The Joint ADL Co-lab facilitates the following activities

- Serving as the primary support activity for the Office of the Under secretary of Defense (OUSD) for Personnel and Readiness ADL Incentive Program
- Conducting research in support of the Military Services to meet ADL's vision of adaptive learning by studying, compiling and distributing research on ADL related issues.

- Fostering cooperation in the development and procurement of ADL tools and course content for training systems across the DoD.
- Developing guidelines for ADL users and developers with information on the principles of design, development, procurement, implementation, evaluation, cost and effectiveness of ADL technologies
- Advancing the use of the Sharable Content Object Reference Model (SCORM®) to promote reuse and interoperability by testing, evaluating and implementing SCORM specifications, guidelines and tools.

The Joint ADL Co-Lab has a prototype program that supports the mission of the ADL Initiative by overseeing the development and delivery of pilot R&D efforts among the military and Joint Services. The aim is to advance the state-of-the-art in web-based training by optimizing the use of technology to provide enhanced learning experiences and environments to our service members. The Civil Support Team Trainer is one of the successful prototypes developed through this program that has been transitioned into production.

CSTT OVERVIEW

The CSTT is being developed to help prepare our National Guard Civil Support Teams - Weapons of Mass Destruction. The Civil Support Team (CST) mission is to support civil authorities at a domestic chemical, biological, radiological, nuclear or high-yield explosives (CBRNE) incident site by identifying CBRNE agents/substances, assessing current and projected consequences, advising on response measures and assisting with appropriate requests for additional support. Civil Support Team members work in a high-risk and high-stress environment where attention to detail is paramount to the team's success and survival. Safety is of the utmost importance during CST operations where one minor mistake could cause not only team casualties but could also further spread CBRNE materials.

Each CST consists of 22 highly skilled, full-time members of the Army and Air National Guard. Team members spend 800-1,200 hours learning the standards of the Occupational Safety and Health Agency (OSHA), the National Fire Academy, and the Environmental Protection Agency (EPA); they also train extensively with civilian subject-matter experts. A high level of proficiency in each individual's military specialty must be maintained. In addition to individual training requirements, the collective training requirement is of utmost importance. Fifteen months of rigorous initial unit training is required before operational certification. Training and coursework are also provided by the Army Chemical School, the Defense Nuclear Weapons School, the Army Medical Department, the U.S. Army Medical Research Institute for Infections Diseases, and the Department of Justice's Center for domestic Preparedness.

The teams are divided into six sections — command and control, operations, survey and reconnaissance, logistics and administration, communications, and medical. All have been given state-of-the- art equipment that can make them a tremendous asset to on-scene commanders. The units have two major pieces of equipment: a mobile analytical lab and a mobile communications facility. The first allows the teams to identify and assess particular chemical and biological agents in the field. The second allows the team to coordinate communications among the first responders and all other areas.

Instructional Objectives

The CSTT builds upon traditional methods of WMD training to deliver complex information to a diverse, geographically dispersed audience in a short period of time. It also provides an opportunity to provide practical, hands-on experience in situations that can not easily be practiced using real scenarios while ensuring the essential skills are sustained once they are attained by an individual or team.

The CSTT uses a "*Structured Training Approach"* to interactively navigate the student through a series of principles while communicating the student's input decisions to the simulated environment. Structured training provides a deliberate focus on training objectives by immersing participants in a realistic scenario, with cues and conditions set up to support a planned sequence of task performance. The structured training approach allows us to incorporate the principles of battle-focused training with instructional principles and learning theories that guide the framework of the training.

The CSTT teaches facts, concepts and operational procedures relevant to the CST mission. Skills include identifying agents and substances, assessing current and projected consequences, advising on response measures, and assisting with requests for additional military support. The CSTT program uses distributed simulations and instructionally sound courseware to help keep these skills current for individuals and teams with regard to interagency operations and battle staff decision-making skills. This training also attempts to improve the essential aspects of civil-military interoperability and mission planning for responding to WMD terrorist acts involving CBRNE related devices. The key to success of the CSTT rests with standardization, interoperability, and interconnectivity.

The Civil Support Team Trainer follows a Competency model of instruction, allowing for a customized learning experience based on the needs of an individual learner. The customized Web-based training program presented to each learner will be determined by pre-assessing the learner's knowledge base. In the same manner, a customized learning plan will be developed for the skills Simulation portion of the course. The behaviors of the CSTT are as follows:

- The learner is first presented with the CSTT introduction and navigation Sharable Content Objects (SCOs).
- The learner is then presented with a knowledge assessment SCO that internally evaluates the learner's mastery of each of the lesson objectives. The assessment SCO reports satisfaction status of the lesson objectives through the SCORM Run-time Data Model
- The learner is presented with the instructional material related to unsatisfied objectives
- After the learner has completed all of the required instructional material, if any, an exam is presented that re-tests the objectives the learner has not satisfied
- Once the knowledge-based objectives are satisfied, the learner is presented with a simulation assessment that internally evaluates the learner's mastery of skills in a real-life scenario.
- Once completed, the skills assessment simulation SCO reports satisfaction status of the skill objectives through the SCORM Run-time Data Model
- The learner is directed to a guided practice simulation if skill-based objectives are unsatisfied, otherwise, the learner may choose a Guided Practice Simulation, a Managed practice simulation or proceed directly to the Final Assessment simulation.
- To complete the root aggregation, the learner must pass the both the Knowledge Assessment Post Test and the Skills Assessment Post Test.

System Description

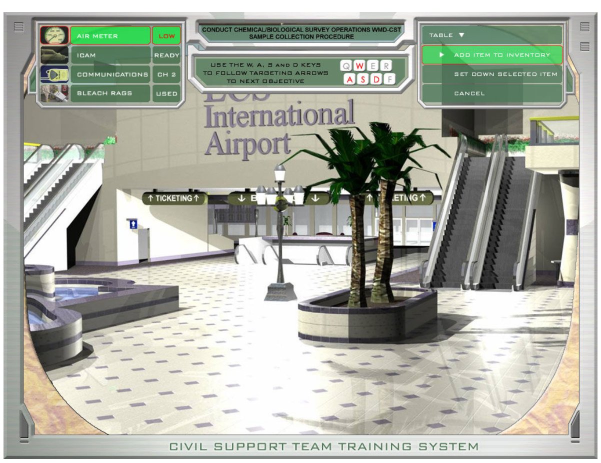
The CSTT is built upon a reusable; component based architecture that was designed to promote reusability and allow for faster development times, lower development costs and increased performance on modestly powered personal computers. An important requirement in this development was to allow our Armed Forces to train jointly while training objectives are evaluated independently against service-specific doctrine. The modularity allows for the development of an unlimited number of threat scenarios in an unlimited number of new 3D environments by reusing assets, behaviors and training objectives. It also facilitates the integration of other distance learning technologies such as Intelligent Tutoring systems to immediately provide feedback inside the simulation based upon that performance.

In the CSTT, each training exercise is designed to train individuals and groups to execute and practice established techniques, tactics and procedures within a "*scenario*" relevant to the WMD-CST. A scenario is a short, goal-oriented training exercise that provides the means to train a group of closely related tasks within the context of a specific mission. Within each scenario, task steps are mapped to performance measures that must be accomplished to correctly perform the task step. These actions are stated in terms of student performance that will be communicated to a Learning Management System (LMS) for evaluating training proficiency. A LMS will control the presentation of courseware from four different components: web-based instruction, guided practice simulations, managed practice simulations and assessment simulations.

The web-based instruction component was developed to incorporate an explanation of the skills being trained, the rationale behind the skills and the fundamentals of how they are to be used. This portion of courseware is completed individually by each student and may include any web technologies used today or in the future. Once completed, the students go into an individual or team-based guided practice where students may put these skills to practical use. This component attempts to build the core fundamentals of each training objective by breaking each task down into its basic elements. This allows the student to build proficiency in the subtasks that add up to the whole. The managed practice component delivers game-like exercises in which students may practice elements of those skills while receiving appropriate and immediate feedback on their performance before entering the assessment module. The assessment module contains a number of objectives. Upon completion of the simulation, each objective is either “satisfied” or “not satisfied”. In this fashion, individual performance may be monitored, evaluated and communicated to the LMS.

CSTT DEVELOPMENT PHASES

The CSTT has been developed with support from many different funding sources. Almost all funding to date has focused on the core architecture and the development of a prototype application. The CSTT has primarily been developed under the umbrella of the Joint ADL Co-Laboratory. However, the initial development effort began in 2002 through an ADL research initiative within the Program Executive Office for Simulation, Training and Instrumentation. This work led to a proof-of-concept application that was leveraged in the Joint ADL Co-Laboratory’s 2003 prototype program with funding from multiple partners to include the US Army RDECOM, the National Guard Bureau and the Joint ADL Co-Laboratory. Finally, in 2004, additional work was funded by the Joint ADL Co-Laboratory to add new capabilities to the core architecture and to improve the instructional quality



Proof-of-Concept - Program Executive Office for Simulation, Training and Instrumentation

In 2002, PEOSTRI funded the initial exploration of commercial gaming technologies to determine the applicability of these technologies towards the development of distributed simulations and training applications. This effort involved the evaluation of different gaming technologies as they applied to modeling and simulation within the military. The results of this evaluation were published in a “Game Engine Evaluation Report”. Once this report was completed, the NetImmerse game engine from Numeric Designs Ltd. was selected to develop a proof-of-concept application.

The NetImmerse engine was selected for three reasons:

- The ability to natively import databases that have been built in the OpenFlight file format, a commonly used format for legacy DoD synthetic environments.
- Portability – The company that developed the NetImmerse engine had also developed a version of this engine, called the Hurricane 3D engine that ran on a Pocket PC.
- Cost and Customer Support – The NetImmerse engine had a license fee of 50K, as compared to other engines evaluated that cost anywhere from 5 to 10 times more. Customer support with NDL proved to be very helpful as well.

The development of the proof-of-concept application involved taking the core NetImmerse engine and adding networking capabilities, audio, and a synthetic environment to create a limited training scenario that centered on the security checkpoint at a generic airport. The application had the capability to import customized models and behaviors into an immersive and networked training environment.

2003 Technical Prototype Development – Integration of Technologies

The 2003 prototype effort for the CSTT leveraged the proof-of-concept application to develop the core infrastructure for an initial training scenario. The prototype facilitated the development of technology that integrated an immersive 3D simulation with a SCORM conformant LMS and web-based instruction to allow CST members to train simultaneously in the same environment from geographically dispersed locations. The development of this prototype met three research objectives. These objectives dictated many of the development decisions that are outlined within this document. The objectives were:

- Develop a Communications Layer to allow communications between a game-based simulation and any SCORM conformant LMS, and
- To develop a Launch Mechanism to allow any SCORM conformant LMS to launch a game-based simulation,
- Apply Meta-data to a representative sample of assets, content objects and content aggregations to describe them in a consistent fashion such that they can be searched for and discovered across other systems.

In achieving these objectives, middleware was developed to allow any SCORM conformant LMS to launch the prototype, monitor and assess students and report this data back to the LMS. The prototype application uses the "Gamebryo" game engine to render the virtual environments used in the CSTT courseware scenarios. This engine was based on the "NetImmerse" engine and was also developed by NDL. In the prototype application, the simulation is comprised of three single scenarios that could be launched from a SCO. Upon completion of each scenario, student performance data is collected and assessed against pre-established evaluation criteria to determine whether training objectives were "satisfied" or "not-satisfied".

Communications via SCORM

Conformance to the Sharable Content Object Reference Model (SCORM™) 2004 promotes reusable and interoperable learning resources across multiple Learning Management Systems. At its simplest, SCORM 2004 is a model that references a set of interrelated technical specifications designed to meet DOD's high-level requirements for Web-based learning content. SCORM has evolved over the last four-plus years to include a variety of features and capabilities. It focuses on key interface points between content and LMS environments and is silent about the capabilities provided within a particular LMS. Within the SCORM context, the term LMS implies a server-based environment in which the intelligence resides for controlling the delivery of learning content to students. This involves gathering student profile information, delivering content to the learner, monitoring key interactions and performance within the content and then determining what the student should next experience.

In SCORM, simulation content currently can be treated and processed (e.g., described, sequenced, tracked, delivered) like all other content. Simulators often have more complex requirements for data tracking, in particular, state management. Simulation requirements vary, and different approaches and models for use of simulation will result in different solution approaches[3]. A mechanism for assessment needed to be developed that allowed student performance data to be extracted from the CSTT and communicated to the LMS. A LMS is very limited in how it is able to interact with a SCO; consequently, the LMS is not able to "watch" what is happening inside a SCO and take action.

Within the SCORM context, a course structure format (CSF) defines all of the course elements, the course structure, and all external references necessary to represent a course and its intended behavior. This CSF is intended to promote reuse of entire courses and encourage the reuse of course components by exposing all the details of each course element. The CSF describes a course using three groups of information. The first group, called Global Properties, is the data about the overall course. The second, called block, defines the structure of the course, and the third group, objectives, defines a separate structure for learning objectives with references to course elements within the assignment structure[4].

SCORM presently provides a rules-based "learning strategy" that enables Sharable Content Objects (SCOs) to set the state of global records called objectives. These records can store the learner's degree of mastery in the form of a score or a pass/fail state, or they may store the progress of the learner in terms of completion. However, SCORM's CMI data model and restriction on SCO-to-SCO communications limit the design of simulation content. SCORM uses the CMI data model to provide data for content and to capture result and tracking data used to control content delivery. The CMI model is weak in representing many attributes necessary for a simulation, including tracking results, learner attributes, assessment data and content state.

The CSTT is able to aggregate the learner's actions into learning objectives and report them using the objectives data model. Sequencing rules can be created to map these to global variables so that these values can be used by sequencing rules for other SCOs. However, these global variables can only be written to once; therefore, a global variable cannot be used to aggregate data over a set of lessons. Additionally, the existing sequencing rules can only inspect three aspects of a global variable: score, completion and satisfaction. This limited set of data may not be sufficient to support all the types of data required for the simulation.

The Launch Mechanism

One key piece of software that was developed to facilitate this capability was a Java Applet. The applet acted as a proxy between the SCO, which is written in JavaScript, and the launched application. The steps for the process for launching an application from a SCO and writing the results back to the LMS are as follows.

- SCO launches the Java Applet
- SCO calls Java Applet method using LiveConnect.
- Java Applet opens a socket to wait for results from application launched in the next step.
- Java Applet method launches the CSTT executable with command line arguments that configure it to run the proper scenario.
- CSTT application executes the scenario
- Upon completion of the scenario, the application sends the training results back to the applet via the socket the applet was listening on.
- The Applet returns the results it received
- The SCO processes the results returned from the Applet and writes the results return to the LMS.

While this approach met the objectives outlined for the prototype application, it has many drawbacks. First, it requires that a java applet get permission to launch an executable on the client machine. It also requires that the correct instance of the CSTT application necessary to execute the scenario resides on the client machine.

A better approach would be to develop a browser plug-in that would provide a wrapper around the CSTT application. This would also have the ability to be embedded within a SCO, thus eliminating the Java Applet requirement that the CSTT application reside on the client machine. As the CSTT is updated, the new version would only need to be updated through the LMS, whereas the former method would require all applications be updated on the client machines prior to launch. Another advantage of this approach would be that it simplifies the mechanism for transferring performance data to and from the SCORM.

Application of Meta-data

The SCORM metadata specifications have several tags that are useful for simulation assets. These include the Format, Type, and Name tags. The Format tag was used to describe the type of asset. Values included model, animation, terrain database, audio/wav (for sounds), image/Targa (for textures), font, and movie/AVI (for movies).

The Format tag was expanded to include types that are not MIME. The Type and Name tags are related in use. The Type tag is used to describe the type of technology associated with this asset. The Type tag can specify that this resource is used with simulations. So, its value would be "simulation." The Name tag is used to describe the specific name of a technology that is associated with this asset. Name tag can specify "CSTT" or "Gamebryo" signifying that the Gamebryo engine will be needed for this asset.

For the CSTT prototype, we tagged a representative sample of the simulation assets. In our research, there was no mechanism in the SCORM Run-Time-Environment for transferring assets to the file system on a client machine to be used by an application. This is inherent in the web-based architecture of the SCORM RTE. For this reason, Meta-data tags are only useful for storing the content in SCORM repositories for search capabilities. On the other hand, if the architecture of the SCORM RTE was modified to support such applications, it would be a powerful tool for using simulation applications in the classroom.

The approach taken to meta-tagging the content for the CSTT could be useful for other simulations. Some of the content, such as three-dimensional models and animations, are proprietary to applications built on the Gamebryo engine. This means these assets are only reusable for applications built using the Gamebryo engine. On the other hand, the approach taken for tagging these assets could be useful for simulation and training applications that use similar types of assets.

The following subsections discuss the approach taken to meta-tagging the simulation assets of the CSTT:

- Models - Polygonal models must be constructed to be compatible with animations. A tag must be used to designate the animation sets that are compatible with this model. In the Relation section, the Resource tag could be used to list the animations that this model is compatible.
- Animations - Animations are composed of key frames. Models must be specifically constructed to use the key frames. The animations need to specify a unique tag that can be used by models to determine if the models construction will be compatible with the key frames. The Relation tag in the Relation section can be used to designate a name for models to use to show that they can play a particular animation.

Scenario Development

In developing courseware and a scenario for the CSTT prototype, the National Guard Bureau provided Subject Matter Expertise. The 1st Civil Support Team from the Massachusetts National Guard, the 44th Civil Support Team from the Florida National Guard and the National Guard Bureau's Readiness Center worked to identify and define the requirements that would be used in the CSTT prototype. Documents used to help define these requirements include:

- TRADOC Regulation 350-70-1 as described in the ARTEP 3-627-35-MTP (Mission Training Plan for the WMD-CSTs)
- Multi-Service Tactics, Techniques and Procedures for Nuclear, Biological and Chemical (NBC) Protection
- The 1st CST-WMD Survey Team Standard Operating Procedure
- The Certification of WMD Civil Support Teams O&O Concept and ARTEO
- Employing National Guard WMD Civil Support Teams Course Book.

The scenario developed for the CSTT prototype is a derivation of a scenario outlined in the ARTEP 3-627-335-MTP entitled "Terrorism Incident Scenario introducing a persistent chemical nerve agent, O-Ethyl S-(2-Diisopropylaminoethyl) Methylphosphonothioate (VX) or a Non-persistent chemical nerve agent, Isopropylmethylphosphonofluoridate (GB)

This scenario specifies the context of a chemical terrorism incident situation requiring CST response to conduct NBC Survey operations. The scenario is intended to portray the notional features of a chemical terrorism incident. These conditions are met when:

- Terrorist acts involving WMD are threatened or have occurred
- Chemical or biological contamination is suspected in the incident area.
- A reconnaissance or survey of the area and a collection of samples is required.
- The WMD-CST operations center has conducted survey-mission planning
- The Survey Team receives the mission from the operations center, and
- An emergency decontamination line has been established.

The prototype scenario was developed in accordance with the CST Training & Evaluation Outline (T&EO) listed in the ARTEP 3-627-35-MTP. T&EOs are the foundation of the Mission Training Plan and the collective training of the Civil Support Team units. They are the training objectives that support the critical operations of the unit. The premise behind the CSTT prototype is to link these T&EOS together to form a logical scenario to form a training exercise.

The prototype scenario is based on the T&EO entitled "Conduct Chemical/Biological Survey Operations". This T&EO can further be broken into eighteen individual task steps and performance measures as outline in the "Certification of WMD Civil Support Teams (CST) O&O Concept and ARTEP" The prototype effort allowed all of the events that comprised this T&EO to be completed and assessed. However, no formal instructional design was completed for the 2003 prototype effort.

2004 Operational Prototype

While the 2003 prototype effort showed the potential of using simulations with web-based instruction, it primarily provided a framework of technological integration. The 2004 effort worked to increase quality of instruction for the CSTT, as well as the technical capabilities of the application by developing realistic behaviors to allow individualized instruction and feedback. This effort included the following objectives:

- Systematically develop the instructional specifications for the CSTT using sound ISD principles
- Design and integrate intelligent tutoring capabilities into the CSTT managed practice.

- Evaluate third party Artificial Intelligence solutions to create behaviors for team members, other emergency responders and crowd / civilians.

Defining Instructional Requirements

CST training management is an integrated system that ensures each CST is trained and ready to operate in response to a domestic terrorist attack and that training is sustained after certification. The collective training sustainment plan requires that exercises be conducted with first responders and encourages joint and interagency training. The CSTT is being developed to help satisfy that requirement from geographically dispersed locations. This opens up possibilities for inter-agency training within the context of a WMD event response.

From a learning sciences perspective, cognition is based on the interactions that take place in the social and material world. Through participation, an individual comes to understand the world from the perspective of that, which is around them. The CSTT requires a level of "fidelity" to ensure that learning occurs in a sufficiently real-world context. The CSTT is designed to present the student with a problem, provide the student with the tools to solve the problem and offer customized suggestions as a resource to solve the problem. In this fashion, the student will produce a solution, receive consequences based on their solution and be guided to suggested areas for review before beginning another scenario.

While simulations offer the opportunity to undergo informative interactive experiences, they do not, by themselves, constitute training or instruction. One of the greatest challenges in this development is the creation of a framework or model of collaborative learning that allows problem-solving and analytic skills to be tested individually and collectively within the simulation. The assessment component monitors individual and team performance on task steps and training objectives. As an exercise unfolds, each task step may be "satisfied" or "not satisfied". If all task steps within a training objective are satisfied, then the training objective will be "completed".

Meaningful and accurate measures of performance will be crucial to ensure valid metrics of proficiency. Understanding the dynamics of digital performance and how it can be quantified across different tasks, echelons and situations is a fundamental requirement. Such understanding will generate critical building blocks for the CSTT curriculum. The challenge is to develop more accurate and insightful methods for measuring student performance, both individually and collectively against changing tactics, techniques and procedures.

The prototype CSTT courseware is being designed for Survey Team Operations Sample Collection Emergency Response Teams. These highly specialized teams consist of people primarily responsible for detection, identification, containment, control and decontamination of hazardous materials within the Hot Zone. Team members have completed basic training with the National Guard and have had some training in WMD/NBC incidents. Over time, the CSTT will be open to other audiences from similar backgrounds. The courseware will successfully accommodate these audiences, whether they use portions or all of the CSTT courseware.

A good training approach is to build the core fundamentals of each task separately and then gradually incorporate additional tasks. As individual and collective proficiency increases, the pace of training should accelerate. In most cases, that means the conditions for task performance are made more difficult. Another approach for obtaining higher levels of proficiency is to frequently introduce "elements of the unknown" into this training. This focuses on critical thinking skills and adaptability.

The first step in the development process for the prototype CSTT was to specify the constructs of each training objective to be measured within the prototype scenario. Once performance measures were determined for each training objective, they were mapped to events within the simulation. In the prototype CSTT, these events were applied to a model of the training objective and a pass/fail determination was communicated to the LMS.

One difficulty that arose during this process was attributed to the inherent structure of how the CSTs are organized. Each CST is controlled by their resident state. While the National component for the NGB is striving to standardize methods and procedures across states, different funding levels, available equipment and sample collection methodologies create variances in how the sample collection process occurs across state lines.

The solution to this problem is fairly straightforward. While not part of the 2004 effort, we will address this issue by incorporating models for the range of equipment that could be used for this type of event; we can allow team members to equip themselves following their state-specific Standard Operating Procedures. Part of the 2004 effort included the integration of Macromedia's Flash into the game-based simulation. With this functionality, we will have the Survey Team doing equipment checks and site preparation using only the equipment that they will typically use during the "Arrival" lesson in the continued 2005 production effort.

Intelligent Tutoring Capabilities

Intelligent Tutoring Systems (ITS) provide feedback to students. The current version of SCORM precludes the model-tracing types of tutors that allow an LMS to observe a learner trying to solve a problem and immediately stop a lesson and send the learner to remedial materials. Therefore, the CSTT uses an internal model tracing framework for Intelligent Tutoring Capabilities that evaluates student actions and determine whether those actions are appropriate. If actions are deemed inappropriate, remediation to the students is inserted and executed inside the simulation.

From an assessment viewpoint, the CSTT waits for the student to complete the proper task and then moves to the next set of instructions. Building upon lessons learned from the FY03 prototype effort, the assessment module was enhanced with logic to analyze a student's performance to ensure that the objectives of the knowledge domain are being mastered. This information is now compared to the inherent evaluation criteria of the expert model within the training objective's instruction scenario to determine if there are any student misconceptions or missing conceptions. When the system finds a missing concept or a misconception, it will make a diagnosis and prescribe instructional remediation. ITS capabilities may immediately insert and trigger behaviors that will inform the student of why his action is incorrect and reassert what the proper action is. Taking this a step further, upon failure of the module, SCORM sequencing may be applied to send the student back to the web-based instruction module corresponding to the training objective being taught.

Artificial Intelligence

To be effective, the CSTT must present the training audience with realistic and unpredictable challenges. To accurately depict the threat, computer controlled characters and models must be able to realistically execute events. An important function of the execution process is the ability of the simulated threat to react to changes in the environment and respond to student input. Simulations can supplement traditional training methods by providing challenges and experiences that closely approximate an actual event in the field. The course of events in these simulations is determined by the decisions and actions of the participants as well as by computer generated events and behaviors built into the scenario.

Training against or with an artificially intelligent entity is only valuable if the entity acts and reacts in the same way as the people with which the trainee is going to be working with in the real world. Nearly all modern games control their characters through a finite state machine. Each character in the game is in a state that corresponds to some goal or attitude (kill, run away, etc) When in that state, their actions are programmed through a sequence such as "find nearest enemy, point at it, shoot, repeat" Transitions from one goal to another are conditioned by queries to internal properties and the external environment. Complexity is achieved by refining the decision process for switching between states, improving the behavior within each of the states, and increasing the number of states and thereby the complexity of the logic to jump between them.

The capabilities of the CSTT were extended to allow all team members to be controlled by Artificial Intelligence (AI). This allows the student to have an immersive individual or team training experience that will continually be enhanced as additional strategies, AI types and equipment types are added. Prior to implementing any AI capabilities, an in-depth review of different middleware solutions was performed. The different AI technologies evaluated included:

- SOAR
- SimBionic
- DirectIA
- Renderware's AI component
- AI-Implant

Evaluation of these technologies included a detailed review of a variety of criteria to include the overall architecture, availability of predefined behaviors, support for the Gamebryo engine, animation support, the availability of editing tools, extensibility, total cost (including the cost of integration) and support. As a result of this evaluation process, it was determined that AI-Implant seemed to be the best fit for the long-term goals of the CSTT for the following reasons:

- The AI-Implant architecture allows an easier integration with the CSTT architecture through the Gamebryo engine
- AI-Implant facilitates the development of all the necessary behaviors to realistically depict all CST members
- An editor allows non-programmers to build

behaviors

- AI-Implant includes many pre-defined behaviors that allow the development team to focus on the development of behaviors that are specific to the CSTT.
- The Core functionality may be extended through an API. For example, this would allow the future integration with SOAR if more complex behaviors are needed.

For the prototype, three different AI scripts were created for each scenario in order to model the behaviors for each of the three team member roles. Although each of the CSTT roles required a different AI script, the core behaviors that are utilized by these scripts are the same, only the logic is different. The core AI behaviors that are necessary in order to simulate the various team members are the ability to use CSTT equipment, the ability to interact with other teammates, and the ability to communicate with other teammates (either computer or student controlled). Finally, the AI is being used in both the managed practice and the assessment module

The Road Ahead

The CSTT is currently in production to develop additional courseware and simulations for the National Guard Bureau's WMD-CSTs. The National Guard continues to express interest in the CSTT and has directed that the CSTT also accommodate the training requirements for their newly set up CBRNE Enhanced Response Force Package (CERFP). The CERFP units consist of traditional National Guard personnel who would be recalled from their homes or workplaces in order to respond to an incident. While they are receiving a high level of initial training, the challenge is how to sustain these highly perishable skills. By leveraging the courseware and assets already being developed for the CSTT, the NG CERFP teams can quickly and effectively use immersive simulations to provide distributed training to each team member anytime, anywhere.

The NG CERFPs augment the existing capabilities of the NG WMD CST and are located in each of FEMA's 12 regional districts. The mission of the NG CERFP is to provide the capability to locate and extract victims from a contaminated environment, perform mass casualty/patient decontamination, and medical triage and treatment in response to a WMD event. The NG CERFP will operate within the Incident Command System and will be in a supporting role when requested. Operations will be organized and supported using a tiered response of Local, State, and Federal responders. The task force will work in coordination with NORTHCOM/PACOM and other military forces and commands as part of the overall national response of Local, State and Federal assets.

CONCLUSION

The modularity of the CSTT architecture allows for the development of an unlimited number of threat scenarios in an unlimited number of new 3D environments. It also facilitates the integration of other distance learning technologies to continuously monitor individual performance and provide feedback based upon that performance. After action reviews may be customized for each simulation. This fantastic range of possibilities has required far reaching technological innovation to make this a reality: innovation that is already well underway under the guidance of the Joint ADL Co-Laboratory.

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