Innovate: Journal of Online Education

Volume 2
Issue 2 *December 2005/January 2006*

Article 3

1-1-2006

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Gaming and simulation may be two of the most powerful tools available to those who design online instruction because they engage and challenge the learner in a very personal way. In order to succeed in simulation and gaming, the learner must work at a higher cognitive level than the recognition and recall that often succeeds in the traditional classroom. Instead, the learner must become immersed in the situation and apply both new knowledge and old skills to outwit the forces and obstacles thrown in their path. Not all gaming and simulation is instructional, but instruction that can apply the techniques of gaming and simulation has a good chance of capturing the learner's attention for extended periods of time. When the U.S. Army Armor School at Ft. Knox, KY contracted with the University of Louisville and its partner Northrop Grumman Mission Systems to design and develop an online course for Army captains, they requested that the course include as many gaming and simulation techniques as possible so as to engage online learners in military problem solving and decision making. Because this course is Web-based, the major challenge was to apply gaming and simulation techniques while still respecting the rigorous connectivity and software limitations of the far-flung learner group. This article discusses the instructional design and programming solutions developed during Phase 1 of the Army Captain's Career Course-Distance Learning (AC3-DL) course that balanced the goals of gaming and immersive simulation with the strict limitations imposed by some military users' access to the Internet and computer technology. Many of the solutions presented have broader applications to the design of online instruction.

Neither Game Nor Simulation

The game-like features of this course include scenario-based challenges, scoring based on good decision making, and learner-controlled timing. The simulation features include detailed screen displays, photos, and animations; lifelike audio and sound effects; and realistic maps, overlays, and orders that can be viewed, downloaded, saved, and printed. Although the instructional design for AC3-DL incorporates both gaming and simulation techniques, it is neither a game nor a simulation.

It is not a game because it provides formal training to prepare young officers for actual combat situations. The audience for the course is active duty National Guard and reserve officers, including some who are serving overseas in remote locations. Generally, officers taking this course have four to ten years of military service. They have attended the Armor Officer Basic Course, performed duties as a platoon leader, and led troops in tactical situations. This course is a requirement for advancement to the rank of captain.

It is not a true simulation because the learners' actions are limited to a few specific, albeit complex, choices rather than the wide range of choices typical of most computer- and video-based simulations for training and entertainment (Gredler 2004). Indeed, technical specifications included using no more than 56K bandwidth, 150K file size for quick downloads, and no special software other than no-cost downloads such as Flash Player and Adobe Acrobat Reader. The technical specifications may seem restrictive to recreational game developers, but they were created by the Army specifically to make this (and other) courses accessible to military personnel regardless of the technology infrastructure present where they were stationed.

AC3-DL Course Design

The course includes three units (volumes), all set in the same broad scenario in Kosovo. Each unit includes several related lessons built around unique vignettes that present complex problems. The Kosovo scenario includes many elements that the Army calls the Contemporary Operating Environment (COE), such as

working with non-governmental organizations (NGOs) and respect for civilian infrastructure and culture. The generic enemy is the "Gordian insurgency." The lesson-specific vignettes are subsets of this overall scenario and present complex problems (missions), such as planning a convoy route through a populated area where an insurgency is already present. The problem can only be solved when the learner masters a set of actions taken directly from Army training doctrine and applies them to the situation in a way that accounts for the specific features of a particular region. To ensure the transferability of knowledge, the problem remains the same in the pretest, lesson, and posttest, but in each case, the terrain and obstacles are changed. The learner's role is also defined for each pretest, lesson, and posttest. In some cases the learner must execute a group task by commanding, and in some cases, the learner must execute an individual task.

A successful learner must be able to adapt Army training principles to new, complex situations. For example, in the vignette shown in Figure 1, the learner is notified that a U.S. infantry team is planning to attack a small enemy group that has fortified itself in a Kosovo village, and the team needs support from the captain's armored unit. In Army terms, the captain has the task of providing support by fire (SBF). On any given terrain, there are often several reasonably good positions from which armored vehicles could provide SBF for the infantry unit. However, in order to select the *optimum* position, the learner must consider multiple factors such as the positions of other friendly forces, the speed at which friendly forces can move toward the objective, and the location of the civilian infrastructure to be preserved. What looks like a straightforward decision actually requires careful consideration. In this case, we see two similar hills in the northeast quadrant. The smaller hill provides a good observation point. However, not only is the smaller hill too close to the enemy position (that is, within the range of fire), but it is also too small to maneuver the armored vehicles. The smaller hill is *not* the optimum position from which to provide SBF.

In most cases, a lesson vignette begins with real maps and photos of the area but moves quickly to the simulation animations. As the learner moves from concrete to more abstract representations, the transition is eased by the integration of increased visual cues. For example, in the actual photos of towns in Kosovo, the course setting, almost all rural buildings have dark red tile roofs (Figure 2). Likewise, in the animations (such as seen in Figure 1), almost all buildings have dark red tile roofs. The animated terrain matches the actual map terrain as closely as possible without adding details irrelevant to the instruction. Moreover, within the animations themselves, variation in image size and detail helps to ease the learner's transition from one vantage point to the next. Finally, throughout the Web-based course, the screen designs remain consistent with the narrative text on the left, navigation buttons at the bottom, and 790 X 450 pixel action window on the right. In terms of visual design, the objective is to promote continuity while keeping the learner's attention focused on the content rather than on the level of abstraction in the graphics.

Replicating the Work Environment

Clark and Mayer (2003) recommend that because online instruction or training is already an abstraction of the actual application of knowledge, we must "keep in mind the important physical features and psychological requirements of the work environment" (154). To simulate the actual work environment, AC3-DL presents information to learners in formats that replicate Army communications. For example, each lesson not only simulates realistic situations but also keeps the learners immersed in specific Army protocols such as interpreting a Situation Report (SITREP). The SITREP provides the learners with details about the terrain; the location, strength, and intentions of the enemy force; and the intention of their own commander. As Army officers, learners are already trained in these protocols, so this course builds on prior learning by applying it to a new and complex situation.

Similarly, directions from the commander such as operational orders (OPORDs) and fragmentary orders (FRAGOs) are linked to the program as real documents that learners can open, save, and print out (Exhibit 1). An OPORD is a directive issued by the commander to subordinate commanders for the purpose of affecting the coordinated execution of an operation. It is a large, inclusive document including five standard elements: the situation, the mission, the execution, service and support, and command and signal. The situation is a broad overview of the battlefield; the mission provides detail of the unit’s purpose and task;

execution includes the "how to" information needed to complete the mission; service and support includes details of assistance available such as medical evacuation (MEDEVAC), transportation, and supplies; and command and signal includes information related to the commander and communication details such as code names and recognition signals. A FRAGO is an abbreviated form of an operation order, usually issued on a day-to-day basis, which eliminates the need for restating information contained in a basic operation order, and it is often issued in sections. In Army parlance, learners can create a realistic *battlebook* from the resource materials embedded in the course site. All maps include elevations and the correct terrain symbols, supporting photos are of actual terrain and events, and audio messages are scripted as actual radio transmissions and delivered with the appropriate level of urgency in the speaker's voice. Although not interactive, text messages from the commander and other team members are presented on screens that simulate the "free text" screen of an FBCB2 (Force XXI Battle Command, Brigade-and-Below), which is an elaborate wireless laptop computer that can transmit and receive text messages, coordinates, and map overlays to solders in the field (see Figure 3).

Learners must use all of these available resources to create their own METT-TC for each situation. METT-TC is a military acronym that stands for the process of assessing components of a situation including mission, enemy, terrain and weather, troops and support available, time available, and civilian considerations. Some soldiers think of METT-TC as a checklist to help them organize all available information related to a mission before making a decision.

Since all learners are Army officers, they are very familiar with this process. Every learner's development of the METT-TC is assessed indirectly. Just as in actual combat, if officers wisely apply all information and resources at their disposal, then their chances of good decision-making are greatly enhanced. If they overlook critical information, their chances of success are reduced. An officer's ability to assess and use METT-TC is gauged throughout the course and built into the lessons. Inability to accurately assess the mission, enemy, troops, time, or civilians may result in a less than optimal performance in each scenario.

Feedback in AC3-DL

The instructional design principle of *consequential feedback* is applied to help learners differentiate between several reasonable courses of action and the optimal course of action (Responsive Management Systems 2003). This feedback is integrated into AC3-DL's course design by using scores, offering scenario outcomes, and providing demonstrations.

For the pretest and posttest, automatic feedback is provided in the form of a score. Scoring is done automatically by a program that runs behind the secured course section of the Army Knowledge Online (AKO) Web site. If a learner scores 100% on the pretest, completion of the lesson or posttest is not required. If a learner scores less that 70% on the posttest, one more opportunity is provided to review content and retest. If a learner does not pass the posttest on the second attempt, a live instructor will contact the learner for an instructional intervention. Learners must successfully pass the posttest before continuing on to the next lesson.

During lesson activities—where learners are allowed more than one attempt—the feedback includes text and animation that describe the consequences of the learner's action. Again, using Figure 1 as an example, a learner could select the optimal position for SBF but then call for a smoke screen and mortar fire on the objective in the wrong order. The consequential feedback serves as an instructional moment by reminding the learner that the smoke precedes the mortar so as to provide cover for friendly forces as they advance toward the objective. The consequence of using smoke and mortar in the wrong order would be harmful to the friendly force. The differences in possible responses are subtle, and the intricacies learned are intentionally complex. As Prensky (2001) reminds us, designers must work to avoid "just a series of mini-role plays in which you are being openly directed to a 'right' answer" (216). By allowing the learner to see the consequences of tactical decisions, the lesson design compels critical reassessment of these decisions on the part of the learner rather than directing the learner to the optimal strategy.

Demonstration and rehearsal are critical components of consequential feedback, and in this online course, a DEMO button is available within each lesson. One of the more innovative demonstrations makes use of an animated terrain table (see Figure 4) that replicates an actual terrain table used in military training and strategy sessions. This terrain table animation shows the learner the optimal solution to a problem presented in one of the lessons but presents it on neutral terrain. Since the learner must still transfer and apply the principles to the lesson scenario and terrain to be successful, the demonstration does not provide a simple "answer" to the situation so much as a further prompt for the learner's active decision making.

Adapting the Course Environment to the Limitations

Creating animations for the situational vignettes while still respecting the specified technical limitations was possibly the greatest design challenge.

At first glance, the best solution to designing the AC3-DL course would have been to use CD-ROM. That format could have overcome almost all of the technical considerations and allowed for 3-D modeling and simulation such as seen in *Full Spectrum Warrior*, the commercially successful game that was originally developed as a tactical command simulation under a U.S. Army contract. There were, however, several good reasons why CD-ROM was not an option. First, the instructional content of AC3-DL is extremely complex and is constantly being updated so the CD-ROMs would have been outdated within 12 to 24 months. Second, it is almost impossible to track the ownership of a CD-ROM, and although the instructional content in AC3-DL is not classified, it is proprietary and requires some control. Finally, AC3-DL is actually a large instructional program comprised of many volumes. This project involved updating only three, with the next three falling in the following contract year. It was not practical to scatter the content between online and CD-ROM delivery.

In order to immerse the learner in a seemingly realistic situation, therefore, a balance needed to be established within the technological constraints. On the one hand, the graphics had to be designed to scale; use military color conventions, symbols, and icons; and appear as realistic as possible. On the other hand, the graphics could not be three-dimensional because 3-D images required more bandwidth than the technical specifications allowed. The resolution to the 3-D problem was to place the learner's point of view as either top down or bird's eye. This allowed map elements, such as topography lines, to be combined with illustration elements, such as varied buildings, varied foliage, water, roads, railroads, and bridges. In order to add necessary detail to these illustrations and animations while maintaining a bird's eye view, shadows served to define objects. For example, when looking closely at the center of the town illustration of Figure 5, the round top of a water tower could easily be mistaken for any round structure. However, the shadow of a water tower is distinctive, especially to a trained military officer. This is important information because a water tower is a civilian infrastructure object to be preserved. The file size of the Flash animations was controlled by building the screens in layers and using as much compression as possible without distortion.

Assessing the Current Version of AC3-DL

As of this publication, the course has passed the Army's internal evaluation and the external evaluation is underway. The resultant comments are extremely positive and often include remarks on the interactive nature and game-like appearance. As one Army reviewer put it, "This is awesome teaching. All the media, radio communications, graphics, etc. fused together as a lesson is great."

Although the Armor School's reaction to the course development has been very positive, several lessons have been learned that could apply to future course development. In order to maximize the overall video gaming look and feel, multiple ways for learners to react and make selections must be provided. For example, the response mechanism can be varied by mixing multiple choice, drag and drop, highlighting, and labeling. More than 8 cognitive processes can be tested using variations of "drag and drop" options. We are researching other applications of multiple choice, matching, and rank ordering responses as well.

A more predictable instructional scaffold can be built. This instructional predictability equates to consistent

rules throughout a game. It is unfair to the learner if the game emphasizes simple issues early on but then leaps quickly to complex problem solving. Good instructional design requires that information be scaffolded so the problem solving becomes increasingly but predictably more complex (Bill 1999). One possible solution is adaptive testing that individualizes the questions learners must answer based on their mastery level during previous testing.

Once the collection of topographies, buildings, and environmental components is built in Flash, less time will be needed for graphics development, and more time will be devoted to building challenging lesson situations. The goal is not to make this course *fun* in the sense of entertainment but to create an engaging environment where learners can envision themselves in control of their options while testing their own command decision-making. It is a safe way for the learners not only to apply what they know but also to identify what they do not know and to take control of their own learning.

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