Ammunition Multimedia Encyclopedia (AME): A Case Study

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Abstract

Many organizations are using Distance Learning (DL) technology to expedite training. The military in particular is implementing DL because technology is transforming warfighting which means training loads are increasing. The demographics of the military are changing, with the Digital (D) Generation being the majority of new recruits. DL has been successful with the D Generation because they are very technology savvy and very comfortable using computers. This paper presents a theory-based description of how a comprehensive web-based application known as the Ammunition Multimedia Encyclopedia (AME) was developed that provides a wide range of information for ammunition handling and transportation.

1. Introduction

Practitioners and academics agree that in today’s global work environment, organizations need to train employees quickly [1]. According to Schank [2] time is the enemy of successful training. He argues that without proper time to repeat or practice training exercises, effective learning does not take place. With ever increasing requirements for job-related skills, organizations have been turning to web-based distance learning (DL) technology to help speed up the training process [3]. DL is beneficial to organizations because it provides convenience, efficiency and cost savings [3], [4].

Due to its many benefits, DL is also gaining acceptance within the US military. Emerging technology is revolutionizing warfighting which means training loads are increasing. This is resulting in an additional demand for new training methods [5], [6]. Because of the increased complexity of modern warfare, military services are looking to transform operational capabilities by being more “responsive, deployable, agile, versatile, lethal, survivable, and sustainable” [5], [6]. For that reason, DL is now becoming a higher priority for the military [7].

In addition to technology changes in the US military, the demographics are also changing. The baby boomers account for most of the senior officers and many are preparing to retire [5]. The “Gen Xers” are coming into leadership positions and the “D Generation” (digital generation) are the new recruits. The D Generation is computer savvy and is accustomed to using automation and computer networks. The new leaders need to use innovative technology to effectively lead and inspire the new D Generation recruits. The leaders in the US military are increasingly compelled to transform into a more flexible and effective operation [8]. In order to accomplish these goals all personnel will need a wide range of skills and experience. Innovative DL tools will play a key role in achieving those goals.

The Defense Ammunition Center (DAC), a Department of Defense (DoD) organization, located in McAlester, OK, has a need to provide training in ammunition technology for its Quality Assurance Specialist (Ammunition Surveillance) (QASAS) personnel in order to produce highly qualified munition professionals. Like many other organizations, DAC is faced with both shortened classroom time and reduced On the Job Training (OJT) for its personnel. This structure becomes problematic when new munitions and variants of munitions are introduced and sent to the field for use under very short development times—much like the current situation. Presently, there are situations where QASAS members are servicing munitions for which they have not received training. The option to provide existing QASAS members with refresher classroom training is too expensive; thus another solution that can provide a similar level of practical munition knowledge must be identified.
DAC challenged an Information System (IS) team from a large southwestern university to develop a tool to help with this problem. Initially a proof of concept prototype based on Computer Supported Collaborative Learning requiring Immersive Presence (CSCLIP) was developed [9], [10], [11]. CSCLIP technology was empirically tested and demonstrated that cognitive, affective and psychomotor learning CSCLIP concepts in a completely different domain with a specific plan for further empirical testing. Based on this new application, CSCLIP technology shows much potential. For example, hands-on, realistic technology could be used to train first responders on emergency equipment to help prepare for situations such as 9-11, Hurricane Katrina, or the recent Gulf oil spill. Another useful application would be just-in-time training. Organizations could employ the same technology on an as-needed basis as new situations arise. Novices could study the information prior to coming into the classroom resulting in shortened training time.

Once demonstrated to be viable, a comprehensive web-based application that provides a wide range of information relevant to QASAS personnel was developed. The project, known as the Ammunition Multimedia Encyclopedia (AME), is in its third year of funding. (Figure 1.)

Since the IS community is both users and developers of DL technology, new and innovative applications are always of interest. A review of the literature reveals very little research that focused on experiential learning at a distance. Vankipuram et al [12] used VR training in a surgical environment and found the experimental group performed significantly better than the traditional control group in both time and the number of errors during a surgical procedure. The limitation of this study, however, was that only 13 participants were tested. Bruelly [13] used asynchronous collaboration and video to help improve the skills of physical therapists. Cote et al [14] found that a simulator for scoliosis surgery training could be tested by using collaboration in an immersive environment. While these systems show great potential, they remain largely untested and evidence of their success is usually anecdotal at best. There is clearly a gap in this area of research. This paper helps to bridge this gap by presenting is a case study that describes a unique IS application that is being used to aid ammo handlers with the safe handling, packaging and transportation of ammunition as well as a plan for empirical testing. In Section 2 a brief background about DAC is provided along with a discussion of the theory-based design used to develop AME. Section 3 gives a detailed description of how the design was implemented. Finally, a plan for future research is presented.

2. Why AME?

2.1 Background

For DAC, developing well qualified QASAS is critical for success. QASAS personnel need to be capable of using information from a wide range of sources to make good, safe, actionable decisions. How DL trainers design, develop, organize, make discoverable, and deliver content has a significant impact on effectiveness [15], [16].

Safety is always another paramount concern at DAC. Handling live ammunition is a dangerous task and some of DAC’s interns have limited or no previous experience. With reduced training time, they are often quickly deployed to Iraq and Afghanistan. This lack of training can put the warfighter at additional risk. Another concern is that the ammunition domain is dynamic and ever-changing. New ammunition technologies come to the warfighter at a rapid pace. Unfortunately, traditional forms of DAC education are hard pressed to keep up with the rapid changes in technology. Further, many QASAS professionals attend their initial training, but there is very limited reach-back training availability.

AME was developed for both the desktop and handheld PDA devices in remote locations, with the focus of this paper being the desktop version. The web-based mode supports personal computers with internet access and the mobile mode (Mobile AME). Within the DAC, there resides a schoolhouse dedicated to instructing DoD civilian and military members in the storage, handling, transport, maintenance, and inspection of military munitions of all kinds—both national and foreign. The curriculum structure for the classes within the schoolhouse is designed to provide one-time instruction in a
classroom supplemented with reference materials and training manuals to provide refresh instruction.

No single theory sufficiently explains complex technology-supported learning like AME. Hamada [17], therefore, recommends an integrated approach. The AME development team used both learning and technology theories to guide them. They are discussed below.

2.2 Learning theories

According to Meyers and Jones [18] active learning takes place when students are doing rather than listening. Their research shows greater learning takes place when learners are involved in discovering, processing, and applying information. Researchers across a range of disciplines agree that incorporating active learning theory helps learners by using higher order thinking skills such as analysis, synthesis, and evaluation [19], [20], [21], [22]. According to Oberlinger and Oberlinger [23], integrating active learning strategies is considered more pertinent to D generation learners.

A related theory, experiential learning theory, developed by Kolb [24] is considered by academics, teachers, and trainers as influential work. Kolb explains that experiential learning is a cycle of experience reflecting, reflecting, thinking and acting. Immediate experiences lead to observations and reflection. Reflections are transformed into abstract concepts that lead to informed actions. Borsheim et al [25] argue that realistic and relevant technical application has great potential for D generation learners across a wide range of disciplines used to support experiential an active learning goals.

According to Mackey and Livsey [26] there are a number of benefits to experiential learning including increased learning, increased motivation to learn, increase skill proficiency, increased independent thinking and decision making based on direct evidence and increased perception and creativity. In addition to learning theories, technology theories also played an important role in designing AME.

2.3 Technology theories

Daft and Lengel’s [27] seminal media richness theory asserts that a rich medium aids in a more rapid clarification of vague issues than a lean medium. A lean medium requires a longer time to improve understanding because users have a mix of information requirements. A range of media richness is helpful in the learning process. Another technology-related theory is Davis’[28] Technology Acceptance Model (TAM). TAM contends that perceived usefulness and ease of use are the two main criteria to predict attitudes toward an IS (i.e., the easier a system is to use, the more useful it is perceived to be). Steur [29] argues that the more profound level of involvement between humans and computers in terms of human senses creates a sense of “immersive presence”. More recently, Borsheim, Merritt, and Reed [30] maintain that implementing meaningful technical applications have potential to be effective in a broad range of disciplines. To summarize, based on learning theory, learning objectives of AME were developed leading to decisions on what objects to include in AME. Based on technology theory, systems should be useful and easy to use which influenced both hardware and software decisions. These informed decisions led to the development of AME including feedback from QASAS users. Figure 2 provides a theoretical schematic for AME outcomes.

![Figure 2. Theoretical Schematic](image)

While AME was under development, the authors consulted DL experts from the university’s College of Education. They advised that combing learning theory and technology theory would help to create a useful web-based learning tool. A very realistic/hands-on environment was created to facilitate learning. A rich medium was developed that includes 2D images, 3D images, video, and PDF documents. The DL experts deemed the web site to be very easy and intuitive to use. After an early proof of concept prototype was developed, DAC officials provided feedback about the system and some adjustments were made. In the next section a detailed description of how AME was implemented is provided.

3. How AME was implemented

3.1 Artifact collection

Using theory to guide the design of AME, a central repository of munition information accessible by the internet was developed. The goal of this website is to provide a comprehensive surveillance facility to
support personnel handling munitions. It provides an encyclopedia of currently used munitions which can be used for identification and refresher training on munition storage, transport, and inspection procedures.

Initially DAC personnel identified 90 different munitions identified by Department of Defense Identification Code (DODIC). The first task was to collect the required artifacts in formats to support web-based functionality for the 90 identified DODICs. The artifacts collected were:

a. Thumbnail (index picture). A reference photograph of the munition that captures a visual distinction between the specific DODIC and other munitions. These distinctions can include shape and coloration.

b. Ruler Picture with identified hotspots. A photograph of the munition with scale indicator and hotspots showing the visual inspection areas.

c. General munition data (nomenclature/use/description for Ammo Datasheets)

d. Specifications and characteristics of each munition (per Ammo Datasheets)

e. Munition inspection checklist (per Supply Bulletin (SB) 742-1)

f. Packaging/Shipping Inspection checklists.

The above four artifacts are created as a compilation from government furnished information. The sources of this information include:

I. SB Inspection of Supplies and Equipment Ammunition Surveillance Procedures

II. Hazard Classification of United States Military Explosives and Munitions

g. 2D images and photograph album of munition inspection points. Each inspection area on a munition has one or more close-up photographs of the area. These photographs are accessed either individually though the inspection point hotspot or collectively through the album link.

h. 2D images and photograph album of packaging materials. Photographs of the material used to package the munitions are sequentially displayed, from pallet to outer container to inner container, through the packaging link within the album link.

i. Immersive views. For each munition type, there is a horizontal and vertical view of the munition that can be rotated to view from any angle. This immersive view can also be zoomed in to provide a close-up detail of a specific area.

j. Inspection videos. For each munition type, there is a video with sound and text that displays the inspection areas and identifies through text and visual examples the critical, major, and minor defects associated with that inspection area.

The process of collecting artifact information has undergone some revision. Steps have been added to improve quality control and prepare AME to be hosted on a DAC-approved DoD web server.

3.2 Photo capturing and editing

Capturing of photographic content on the requested munitions was obtained on-site at the DAC ammunition inspection warehouse in McAlester, OK. A Magellan Object Rig was used to allow a live munition to be photographed in a 360 degree environment. Lighting was controlled using a portable fabric enclosure (Figure 3.)

Figure 3. Ammunition Box on Magellan Rig

This technique was used to capture a majority of the images needed for the artifacts. Once the raw photographs are taken they are edited using Photoshop to remove all background material (Figure 4 and Figure 5).
In these Figures, images from a 40 mm High Explosive Dual Purpose grenade are captured and refined in the process to create the immersive view.

3.3 Collection to publication methodology

Once the artifacts were developed, the second tasks was to submit them to the AME database, organize them using XML format, and make them available on a DoD web server. In order to ensure the integrity of the information presented on AME a five-step methodology was employed for collecting, editing, verifying, and publishing. These stages are as follows:

Step 1: All non-multimedia data are collected from DAC approved sources and converted into AME and Mobile AME formats.

Step 2a: Once the non-multimedia data have been collected and formatted for AME, they are sent to DAC approved Subject Matter Experts (SMEs) for integrity quality check (QC).

Step 2b: As the non-multimedia data are being QC’d by SMEs, the multimedia (e.g., ammo photos and inspection videos) are captured and processed.

Step 3: Once the non-multimedia data have been quality checked and the multimedia data have been obtained, they are compiled into a single unit at the development web application.

Step 4: After an internal check, the data are converted into XML data store and made available to DAC for approval.

Step 5: The final phase of the methodology is to push the compiled DODICs to DAC’s web server.

3.4 Review of the AME website features

The home page has the same form but without the authentication requirement previously shown in Figure 1. The Search feature and links to primary munition categories remain unchanged. Starting clockwise from the upper right corner, the Ammo Help link provides an external link to DAC’s Ammo Help: frequently asked questions. The Defense Ammunition Center (DAC) link connects the user to the DAC Home Page.

Finally, in an effort to improve ease of use, the Technical Support link was created as a means to diagnose viewing issues and, if needed, provide links to DoD-approved software needed to view site features.

To assist the user in verifying that they have all the browser resources needed to fully use the site, the Test My System link creates a popup window and runs various JavaScript commands to verify resources. In the attached system test (Figure 6), it is shown that the web browser meets all of the requirements (shown as true) except for the Quick Time support (shown as false). This means that, while using this browser, the user can see all of the AME features except for those needing Quick Time, which are the immersive views. In order to see the immersive views, the user should download and install the software from the support page link.
In order to help identify areas with content, colored highlighting around each munition type and the word color shows the degree of content within each link (Figure 7).

For the AME site, the highlighting scheme is as follows:

- Green highlighting identifies munitions by DODIC that have complete information.
- Blue highlighting identifies munitions by DODIC that have all information except the corresponding inspection video.
- Red highlighting identifies munitions that have additional missing information.

The munition home page contains the Experience, Read, and Discuss link categories, a search feature, munition use and description, and a picture of the munition with scale and hotspots identifying the inspection locations (Figure 8). The Experience and Read Link categories have been updated with content, while the Discuss link category remains currently inactive. Work is currently underway to identify technology that would provide collaborative functionality. All other features on the munition home page are enabled.

Within the Experience link categories, the 2D Images/Album link provides a popup window showing the links for the munition, packaging, and weapon pictures (Figure 9).

Within each link are a set of pictures that can be viewed manually or sequentially displayed in album mode (Figure 10).
The Immersive View link retains the same features enabled from the last contract year. Munitions are shown in a horizontal and vertical view that can be rotated (Figure 11).

The Videos/Animations link provides all associated video links related to the particular munition. For the 90 munition content requested to be delivered this contract year, each munition has a visual inspection video associated with it. These videos identify and give visual examples of critical, major, and minor defects to be found at each inspection area. These videos begin by highlighting the inspection areas (Figure 12) then illustrate the defects that could be found the video concludes with a listing of the inspection and defect information source.

The Read Link category provides munition specifications, inspection checklists, and packaging and shipping information in PDF format (Figure 13). This content is taken directly from and referenced to the DoD source documents.

The hotspots on the ruler image on the primary munition page identify areas requiring visual inspection of the munition to assess its viability. When users mouse over the hotspot, a popup window appears providing a link to a close-up of that specific inspection area (Figure 14).
3.5 Lessons learned

While AME has not been empirically tested, QASAS personnel have been using AME and providing feedback on an ongoing basis. Below is description of some of the lessons learned and a brief description of how the system was improved.

Though AME was designed to use commonly available software, occasionally some computers were unable to use all of AME's features because they lacked particular programs. "Test My System" quickly identified tools for display needed and already on a given computer and provides links to download any needed programs. Also, a "Contact Us" feature was added for the user to report problems (Figure 6).

Originally it was impossible to distinguish between which items were complete from those that were incomplete. The solution was either to not display incomplete items at all, but thereby depriving the user of potential useful information, or color code items to indicate a general level of completion (Figure 7).

Originally no ruler was included in the photo, making it difficult to compare disparately sized munitions. A scale was added so the user would have an exact impression of the length of the munition. To give the user further context a link to the weapon(s) used to fire the munition was also included (Figures 8 and 9). It was also determined that navigation needed to be improved so a Search feature was added that enables the user to go straight to an item rather than having to navigate through the munition hierarchy.

In order to provide the user with additional resources, links to external sources were added (Figure 13). This feature allows the user to easily access a greater amount of data than is possible to host and maintain on a single website. Hotspots were added so that the user could easily identify key inspection points on the munition (Figure 14). The next section provides a description of future research to empirically access AME.

4. AME evaluation considerations

In order to determine if AME is an effective just-in-time training tool or job performance support aid, a necessary usability evaluation is currently being conducted. Usability testing is a method for evaluating the ease of use, ease of learning, satisfaction, frustration, and potentially a few other measures of a device, software, web site, or other system [25].

In the case of evaluating the usability of the AME we are concerned with the usability of the software application. The test participants need to be representative of the expected users in terms of variables such as demographic characteristics, previous experience, the types of tasks to be performed, and the context of their performance. The evaluation can be accomplished through laboratory testing and/or field testing. In both cases, it is important to use a thoroughly pre-tested standardized data collection procedure, explain the purpose of the study to the participants, obtain background information that can help interpret the results, and obtain participant's consent.

4.1 Laboratory testing

Laboratory testing is performed under controlled conditions and environments, such as a formal usability lab. Although evaluating the usability of a device using a software emulator on a PC is possible and may yield preliminary usability data, the user's interactions should be recorded with the device itself, using a camera focused on the device and the resulting video captured digitally. A second camera may be used to record the user's facial expressions. Facial expressions can be very useful in determining how comfortable the user is with the system.

The user's interactions can be recorded either by setting up a camera behind the user and getting an over-the-shoulder. The test can be recorded and analyzed by using specialized software, such as TechSmith’s Morae 2 commercial usability testing program [31].

The recording procedure should follow the high level steps listed below, which are detailed at the TechSmith web site http://www.techsmith.com/.

- Create a study configuration
- Define the test scenario
- Define the tasks
- Define markers
- Define surveys
- Save Study details
- Configure recording details
- Complete test setup.

The actual testing should be performed using a human facilitator and the test participant seated at a
comfortable workspace. Between 5 – 8 test participants are usually recommended to obtain reliable data. Little new usability information is typically gleaned using more than this number of participants [32]. The facilitator’s role is to explain the procedure to the participant and answer questions before the actual testing begins. During the testing, the facilitator may probe for additional information or ask what the participant would do next at a particular point in the test. The participant should be given several representative tasks to perform using the device and application. In the case of evaluating AME, the tasks should include but not necessarily be limited to:

- Selecting a particular type of ammunition
- Drilling down the menu hierarchy to find characteristics of the ammunition
- Accessing and using the 3D immersive views of the ammunition, both vertical and horizontal views.

Experience suggests that the maximum length of a testing session is about 45 minutes, after which the participants are likely to become fatigued, resulting in low reliability of the data.

The performance variables to be assessed should include, but not necessarily be limited to:

- Time on task
- Number of errors committed
- Speed and accuracy of task completion
- Number of times the participant had to backtrack during navigation

At the completion of testing, the participant should be administered a survey or questionnaire to assess subjective reactions. An example is the System Usability Scale (SUS) [31], which consists of approximately 10 questions on general usability criteria (e.g., How easy was it to navigate through the program? Would you recommend this device/application to good friend?)

4.1 Field testing

Ideally, in addition to laboratory testing, applications should be tested in the environments or settings in which they will be actually used, to take into account factors such as distractions, environmental variables, and multitasking demands. Because it is often not practical to carry elaborate filming and recording equipment to the field, this type of testing will usually involve direct observation, recording of behaviors on a predetermined checklist, and post task surveys. Many of the same issues addressed in the Laboratory Testing section will apply in field testing.

5. Conclusions

Changing technologies and changing demographics with the DoD are creating a need for new DL functionality. AME was developed to create a hands-on environment to enable QASAS personnel throughout the world to access over 200 DODICs. This theory-based, realistic, and easy to use application helps in the safe inspection, storage, and transportation of live ammunition.

To further improve AME an empirical evaluation is under way. Initially laboratory testing in a controlled environment will be conducted. The information gained from that study will be used to improve AME. After lab testing is completed, actual field testing is planned that will take into account a variety of environmental variables that will help further improve AME.

AME is currently being used by QASAS throughout the world to implement good, safe, actionable decisions. AME can be accessed online via computer anytime, anywhere meeting the needs of QASAS everywhere. In addition to internet access, AME can be downloaded to a mobile PDA that can be used in remote locations, possibly in hostile situations, without internet access. Blackberry, iPhone, and Android applications are also under development. AME is beneficial to DAC because it meets the needs of both new and more experienced QASAS, reduces training time, and thereby reducing cost.

6. References