# ADVANCED DISTRIBUTED LEARNING (ADL) TECHNOLOGIES AND NIGHT VISION DEVICE TRAINING

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## ABSTRACT

Recent technological advances in night vision devices (NVDs), such as night vision goggles (NVGs) and thermal imaging systems, have greatly increased their potential for improving warfighter readiness, effectiveness, and safety in night operations. However, it is unlikely that this potential will be fully achieved without a systematic, integrated approach to training. Research findings and operational experience suggest that the majority of the problems that NVG users experience can be attributed to: (1) a limited understanding of their limitations and (2) perceptual problems encountered when using the devices. In addition, there is evidence that NVG knowledge and skills are highly perishable and require frequent practice for sustainment. In the past, NVG training consisted of a mix of training technologies, such as classroom instruction, hands-on training, simulation, and vehicle/aircraft training. A mix of technologies is required because NVG knowledge and skills requirements are heterogeneous and complex. Advances in Advanced Distributed Learning (ADL) technologies, such as computer-based training (CBT) and web-based training (WBT), make these attractive additions to the NVG training mix by providing high quality training to warfighters at the time and place it is needed the most, and which is suited to learner needs and learning styles. In this paper we discuss efforts to develop and implement CBT/WBT for NVG training and provide examples and illustrations in the dismounted and mounted warfighter environments. We cite lessons learned and discuss the issues involved in systematically integrating ADL technologies with other NVG training technologies. Finally, we provide recommendations for future research and development.

## ABOUT THE AUTHORS

Dr. John Ruffner is a Human Factors Engineering Psychologist with DCS Corporation in Alexandria, Virginia. He received a Ph.D. in Industrial/Organizational Psychology, with a specialization in Human Factors and an M.S. in Experimental Psychology from Iowa State University. He has over 26 years experience in human factors research and development and test and evaluation (RDT&E) in the areas of night vision systems, training development, and crew station design for aviation and ground systems. He was a research psychologist at the U.S. Army Aviation Center where he conducted RDT&E on night vision devices, pilot training, and skill sustainment. He served as an Assistant Professor of Psychology at the University of Missouri. He has published over 75 technical reports, conference papers, and journal articles.

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## INTRODUCTION

### Background

Recent technological advances in night vision devices (NVDs), such as night vision goggles (NVGs) and thermal imaging systems, have greatly increased their potential for improving warfighter readiness, effectiveness, and safety in night operations. However, it is unlikely that this potential will be fully achieved without a systematic, integrated approach to training (Berkley, Antonio, and Joralmon, 1998; Ciaverelli, Kishore, and Baer, 1994; Dyer and Young, 1998).

The overreliance on NVG technology without a solid understanding of NVG limitations may result in what McNulty (1992) described as "a poorly conceived application of a technological innovation." Furthermore, Dyer and Young (1998) caution that training support materials have not kept up with modernization of the night vision equipment. Thus, without adequate training, the use of NVGs may serve as a detractor rather than a contributor to warfighter readiness.

Findings from mishap and accident analyses, field operations, and subject matter expert (SME) interviews suggest the majority of the problems NVG users experience can be attributed to two factors. First, users may have an insufficient understanding of NVG limitations. Second, the users may experience perceptual problems, such as the inability to judge the distances to obstacles, the distance between terrain features, and closure rates between aircraft or vehicles. In addition, it is widely held that NVG knowledge and skills are perishable and need to be practiced frequently.

The primary reasons for using NVGs are to increase safety, operational effectiveness, and situational awareness (SA) at night, yet their use may increase workload. Performing tasks at night the way one performs them in the day, coupled with the NVG limitations, requires more work and extra perceptual and cognitive resources that are not normally required. There is a need to provide the opportunity for safe, realistic training with sufficient frequency so that good "night" habits can be formed (Ruffner, Antonio, Joralmon, and Martin, 2001).

### Organization of This Paper

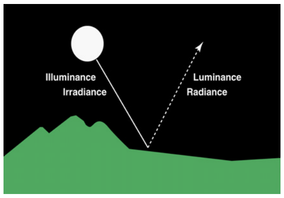
In this paper, we address the application of Advanced Distributed Learning (ADL) technologies to NVD training, and in particular, to NVG training. First, we provide a brief overview of NVG training. We then discuss our efforts to implement ADL concepts and technologies for NVG training and provide examples of computer-based training (CBT) and Web-based training (WBT) applications in the mounted (driving) and dismounted warfighter environments. Following this, we cite lessons learned from our efforts to develop NVG CBT/WBT that can be applied to other training domains. Finally, we discuss the issues involved in systematically integrating ADL technologies with other NVG training technologies and provide recommendations for future research and development.

## NIGHT VISION GOGGLE TRAINING

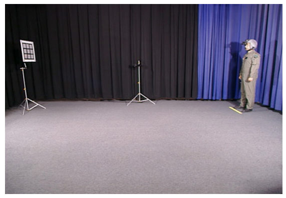
The purpose of NVG training is to provide the student with an understanding of the basic operation of NVGs, an appreciation for the conditions that affect the imagery obtained with the device, and techniques for operational employment. NVG training focuses on what Dyer and Young (1998) describe as knowledge of the technology (e.g., adjusting the device to get the best image) and visual cognition (e.g., understanding the visual elements in the image and how various conditions affect the imagery). Thus, it is important that NVG training be visually intensive and use high fidelity imagery.

NVG training can be organized into introductory training and operational training (Ruffner, Antonio, Joralmon, and Martin, 2001). NVG introductory training, which is the focus of this paper, is conducted prior to operational training. It provides the student with an understanding of, and an appreciation for, the capabilities and limitations of the device. The primary goals of introductory NVG training are to expose students to a wide range of variables affecting NVG performance, to instill an appreciation of NVG limitations, and to increase the effectiveness of operational training. In comparison, operational training is conducted in the tactical area, in the vehicle, or in the aircraft, and is usually mission-oriented.

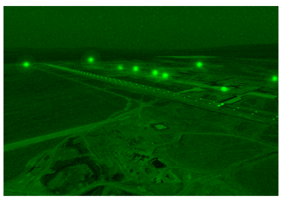
In the past, NVG introductory training technologies have included classroom instruction, hands-on training (i.e., using an eye lane or a terrain model board), and simulation (see Figure 1A , 1B, and 1C).



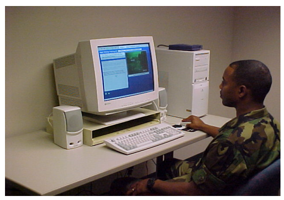

A. Classroom



B. Hands-on



C. Simulation



D. CBT/WBT

Figure 1. NVG introductory training technologies.

For example, training for NVG driving in the Army follows a "crawl, walk, and run" strategy which combines classroom instruction and hands-on familiarization with the NVGs, followed by driving a course during the daytime, at night with headlights, and at night with NVGs (Department of the Army, 1990, 1993). NVG training for dismounted warfighters is typically less structured than for drivers. NVG training for dismounted and mounted warfighters is considered a unit training responsibility and only a brief familiarization is provided during formal schoolhouse (institutional) training. In addition, there is a great deal of variability in unit NVG training programs (Ruffner, Piccione, and Woodward, 1997).

Army aviation NVG training is accomplished during schoolhouse training using a combination of classroom instruction, hands-on exercises with NVG equipment and a terrain model board, and exercises in an NVG-compatible simulator (U.S. Army Aviation Training Brigade, 1998). The training program follows a sequence of progressively more difficult tasks, starting with daytime training of maneuvers followed by unaided night and NVG training. Mission-specific training is accomplished at the individual aviator's unit.

An example of a systematic approach to introductory NVG training is the Night Vision Goggle Training Course developed by the U.S. Air Force Research Lab (AFRL) Warfighter Training Research Division. This program is the result of a joint Marine Corps, Navy, and Air Force collaborative effort. The night vision training course combines classroom instruction with supplemental videos, eye lane training, terrain model board training, and NVG simulator training (Berkeley, Antonio, and Joralmon, 1998).

NVG knowledge and skill requirements are complex and heterogeneous. Therefore, no single instructional approach or training technology is sufficient to train the myriad of knowledge and skills required to employ the device safely and effectively. Each technology has its strengths and shortcomings. Therefore, effective NVG training requires a systematic, integrated combination of training technologies to take advantage of the strengths of the technologies and to mitigate the effects of their shortcomings (Ruffner, Antonio, Joralmon, & Martin, 2001).

## ADVANCED DISTRIBUTED LEARNING TRAINING TECHNOLOGIES

The overall goal of the ADL initiative is to ensure that learners have access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required (Morris, Weisenford, and Boland, 1999). ADL technologies, such as CBT and WBT, have the potential to provide high quality training to warfighters tailored to their needs at the time and place needed. Advances in the capabilities afforded by ADL technologies make these attractive additions to the overall NVG training mix, as illustrated in Figure 1D. The following sections discuss the advantages and disadvantages of CBT and WBT for NVG training.

### Computer-Based Training

The primary advantages of CBT for NVG training are that it provides the opportunity for interactive self-paced instruction, exploits the advantages of multimedia, can utilize a variety of learning strategies, can automate the measurement of student performance, and can provide feedback and remedial instruction within the program. In comparison to the other NVG training technologies, CBT is relatively inexpensive, does not require travel, can be done on one's own time schedule (thereby minimizing scheduling constraints), and can be reviewed as many times as needed.

The primary disadvantages of CBT for NVG training are that there is somewhat limited opportunity for hands-on experience and one-on-one feedback from an experienced NVG instructor, and limited interactivity with the warfighter's mission profiles. CBTs may be more difficult to update than a written program of instruction used in either academic or hands-on training.

CBT can be delivered by means of a variety of media. These include, but are not limited to, CD-ROM, local area or wide area networks, and the internet in the form of distance learning, distributed training, or Web-based training. In addition, advanced CBT techniques have been developed for providing intelligent training or adaptive training that adjust the difficulty and content according to student performance and learning needs.

**Web-Based Training**

Web-based training is an innovative approach to distance learning in which computer-based training is transformed and extended by the technologies and methodologies of the World Wide Web, the Internet, and intranets. WBT presents live content, which is easily modified, in a structure allowing self-directed, self-paced instruction in a wide variety of topics (Able, 2001; Kirby, 2001).

Like other training technologies, WBT has several advantages and disadvantages for NVG training. The primary advantages are that it provides for easy delivery of training to users, it has instant multi-platform capabilities, and it provides for easy updating of content and quicker turnaround of prototypes and finished products. In addition, it can be linked with other training systems, its access is controllable, and it can be installed on private networks for security or greater bandwidth.

The primary disadvantages of WBT are that it has limited formatting of content in current browsers, bandwidth/browser limitations may restrict usable instructional methodologies, and limited bandwidth can result in slower performance for sound, video, and intense graphics.

## CBT AND WBT FOR NIGHT VISION DEVICES

In this section, we discuss our recent efforts to develop CBT and WBT for image intensification systems, such as NVGs, for the U.S. Army. We briefly discuss the results of our efforts to develop two NVG CBTs - the Night Driving Training Aid (NDTA) and the Monocular Night Vision Device (MNVD) Operation and Maintenance (O&M) Training Aid - as examples of how CBT/WBT techniques can be applied to NVG training. In addition, we provide examples from the training aids that illustrate the application of instructional strategies and media consistent with the ADL initiative.

**Night Driving Training Aid**

We developed the Night Driving Training Aid (NDTA) in response to a need to provide a low-cost and effective means of providing drivers of Army vehicles with an understanding and appreciation of the factors that affect driving while using NVGs. The NDTA was developed as part of an Army Small Business Innovation Research (SBIR) project sponsored by the U.S. Army Dismounted BattleSpace Battle Lab (DBBL) and managed by the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM).

During Phase I of the SBIR, we conducted a comprehensive front-end analysis and analyzed ten years of Army vehicle mishap and accident data involving NVDs to identify critical training needs and areas requiring emphasis in the training aid. In addition, we surveyed existing NVG training programs to identify relevant content and potential delivery options. We identified NVG driver training requirements, assessed available training technologies, and made recommendations for the structure and functionality for the NDTA to be developed in Phase II.

The Phase I findings indicated that a night driving training aid should: (1) provide instruction on the capabilities and limitations of NVGs for driving; (2) train drivers to understand the procedures for, as well as the impact of, not properly preparing, adjusting, and focusing the NVGs; and (3) train drivers to appreciate the effect of environmental conditions on the performance of NVGs and the resultant image quality. The Phase I findings also indicated that the computer-based training aid should provide a variety of scenes and scenarios in an interactive setting, and should be a viable means of conducting low cost training at the unit level where time, money, and instructional resources are scarce (Ruffner, Piccione, and Woodward, 1997).

We developed four sample lessons on CD-ROM to illustrate to the project sponsor the "look and feel" of the prototype to be developed in Phase II. Furthermore, we identified a set of training requirements (what knowledge and skills the student should acquire) and functional requirements (what the training aid should be able to do). During Phase II, we validated the training requirements and functional requirements developed in Phase I, produced a fully functional prototype CBT, and conducted an assessment of user acceptability (Ruffner and Woodward, 2000).

Reflecting the training needs identified during Phase I, the NDTA provides instruction and quizzes on night vision, AN/PVS-7B/D NVG device characteristics, NVG limitations and capabilities, adjustment and focusing techniques, planning for driving with NVGs, techniques for driving with NVGs, and hazards to driving. We drew upon instructional materials and media developed by the three military services (e.g., Berkley, Antonio, and Joralmon, 1998; Department of the Army, 1990; U.S. Army Aviation Training Brigade, 1998; U.S. Marine Corps; 1999) as well as from original training material developed specifically for the target audience.

The NDTA includes several features that research has shown to be desirable for effective CBT and WBT: an on-line orientation/help system, an on-line navigator (course map), pop-up definitions, hyperlinks, text or graphic overlays, full motion videos, audio narration to accompany text or video, lesson completion status indication, end-of-lesson quizzes, and tracking of student performance (see Ruffner and Woodward, 2000; 2001). The seven modules and the respective lessons within the modules comprising the NDTA are shown in Table 1. As part of a Phase II *Plus* enhancement to the NDTA, we developed a version that includes the AN/PVS-14 Monocular Night Driving Device (MNVD) for the U.S. Army Project Manager Night Vision/Reconnaissance, Surveillance, and Target Acquisition (PM NV/RSTA).

We developed the NDTA through extension of an internally developed proprietary software architecture, known as *flex*CBT™, that meets several instructional goals of the ADL initiative. Specifically, the architecture was designed for: (1) modular development, (2) rapid prototyping capability, (3) an alterable menu hierarchy, (4) alterable tutorial functions and sequencing, (5) separately implemented specialty software, and (6) separation of the instructional content from the software code. These features facilitate prototype development and review, reusability of software and instructional content, as well as the extensibility of instructional content to related training areas. The *flex*CBT™ tutorial engine was developed using Click2Learn's Toolbook II Instructor™.

Figure 2 presents sample NDTA screens from an instructional sequence designed to provide the student with an understanding of the effects of incompatible interior lights on the NVG image. In the first screen, the student is provided with instruction on incompatible lights and their negative impact on an NVG image. In the second screen, the student is given the opportunity to interactively start and stop a video to examine this effect.

Table 1. NDTA Modules and Lessons

Module I: Introduction
- Lesson 1: Introduction to the NDTA
- Lesson 2: Why We Use Night Vision Devices
- Lesson 3: Image Intensification vs. Thermal NVGs
- Lesson 4: Types of Image Intensification Devices
- Lesson 5: Need for Training and Practice

Module II: Image Intensification Concepts
- Lesson 1: How Image Intensification Systems Work
- Lesson 2: Human Vision and NVGs
- Lesson 3: Effects in Image Intensification Systems

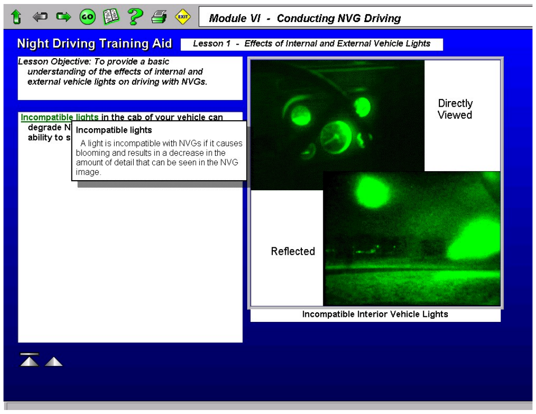
Module III: NVG Hardware and Adjustments
- Lesson 1: Major Components and Controls
- Lesson 2: Adjustment Controls
- Lesson 3: Mount Assemblies
- Lesson 4: Optical Functions
- Lesson 5: Adjustments

Module IV: Conditions that Affect NVG Operations
- Lesson 1: Natural Light
- Lesson 2: Cloud Cover
- Lesson 3: Artificial Light
- Lesson 4: Obscurants

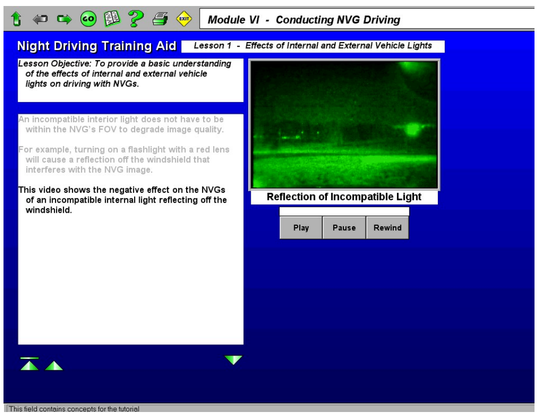
Module V: Preparing for NVG Driving
- Lesson 1: Equipment Check/Image Assessment
- Lesson 2: Vehicle and Route Checks
- Lesson 3: Environmental Checks
- Lesson 4: Crew Briefings

Module VI: Conducting NVG Driving
- Lesson 1: Internal and External Vehicle Lights
- Lesson 2: Vehicle Speed and Road Conditions
- Lesson 3: Single Vehicle Mission Techniques
- Lesson 4: Crew Coordination Techniques
- Lesson 5: NVG Emergency Procedures
- Lesson 6: Convoy Mission Techniques

Module VII: Driving Hazards
- Lesson 1: Drop-offs and Ditches
- Lesson 2: Steep Grades and Rises in Terrain
- Lesson 3: Vehicles On or Near the Roadway
- Lesson 4: Personnel
- Lesson 5: Large Objects in the Vehicle Path




A. Tutorial screen.



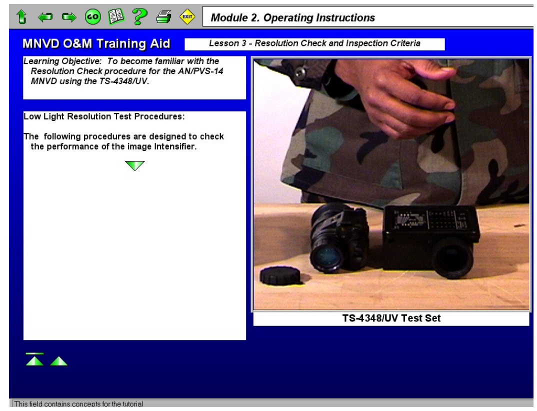

B. Full-motion video

Figure 2. Sample screens from the NDTA CBT.

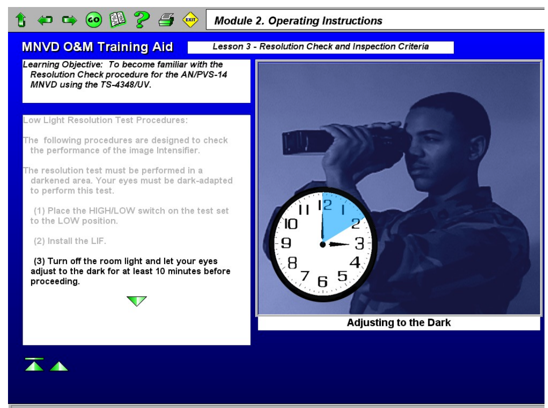
**Monocular Night Vision Device Training Aid**

As part of the Phase II *Plus* effort, we developed the MNVD O&M Training Aid for the Army PM NV/RSTA. This training aid was developed to meet a critical Army need for training on operation and maintenance procedures for the AN/PVS-14 NVG. The organization of the CBT (see Ruffner and Woodward, 2001) closely follows that of the AN/PVS-14 Operator's Manual (Department of the Army, 2000a) and Unit/Direct Support Maintenance Manual (Department of the Army, 2000b).

Figure 3 presents sample screens from an instructional sequence from the MNVD O&M CBT that illustrates the steps an operator would take to perform a resolution check of the MNVD. The first screen provides instruction on the proper equipment for performing the resolution check. The second screen illustrates how the operator should look through the MNVD and the test set to check the resolution pattern after waiting 10 minutes to allow for an adequate level of dark adaptation.




A. MNVD with test set.



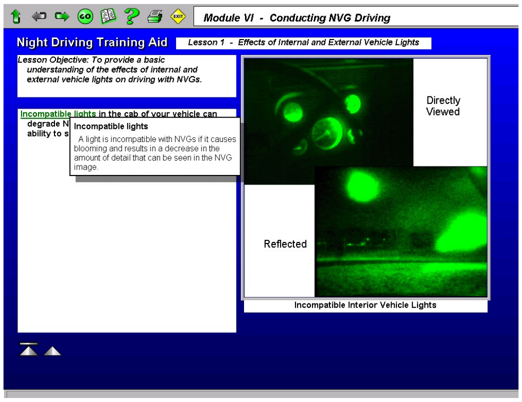

B. Procedure for checking resolution.

Figure 3. Sample screens from the MNVD O&M CBT.

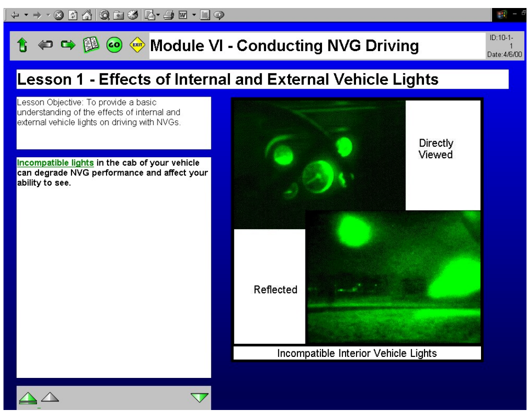
**Extension of CBT to WBT for NVG Training**

During the SBIR project, we developed Web-based versions of the NDTA and MNVD O&M training aids as extensions of the CBT versions. These were used by the project sponsor, SMEs, and representatives from the target audience for remote reviews. This capability is useful for providing training developers with a means of obtaining reviewer comments during the development process prior to a formal review. The Web-based versions of the NDTA and MNVD O&M CBTs contain most of the "look and feel" and functionality of the CD-ROM versions. For example, Figure 4 shows corresponding screens from the CBT and WBT versions of the NDTA.

In addition to aiding CBT evaluation and revision, developing a Web-based version of an NVG training aid makes it possible for soldiers to access instructional information and be trained from any location at which they can gain access to the Internet and at the time they would benefit most from the training. This is consistent with ADL objectives (Morris, Weisenford, and Boland, 1999; Weisenford, Jesukiewicz, and Brown, 2000) for providing training suitable for the individual's needs at the place and time training is required.




A. NDTA CBT Screen




B. NDTA WBT Screen

Figure 4. NDTA CBT and WBT screens.

## LESSONS LEARNED

Throughout the SBIR project we identified several lessons learned about training NVG knowledge and skills in a CBT and WBT environment that are relevant to the application of ADL technologies to NVG, as well as other training applications (Ruffner, Piccione, and Woodward, 1999; Ruffner and Woodward, 2000). These are discussed in the following paragraphs.

(1) First and foremost, it is critical to obtain customer and end-user involvement early on to obtain their buy-in (input and participation). This helps ensure their requirements, needs, and expectations are determined soon enough in the development process to influence design decisions and content development.

(2) CBT/WBT development is greatly enhanced by the ability to use rapid prototyping to obtain frequent and timely user input. We were successful in setting up a website so users and SMEs could access the training products as they were being developed. Such "distant" reviews saved time and developmental costs, and proved to be invaluable throughout the developmental process. This situation had an unexpected benefit in that web-based reviews established higher confidence levels for the users, expert evaluators, and developers that the products being developed met all standards for content and usability.

(3) The ubiquitous nature of the software architecture and instructional content provides the ability to readily shift small and large blocks of information (text and imagery) between different night training products. This is consistent with the ADL objectives of developing courseware content in units that are relatively self-contained and reusable.

(4) It is important to recognize the capabilities and limitations of the instructional technology, software/hardware, delivery technology, and their implications for meeting the instructional objectives. Examples include resolution limitations when displaying videotaped NVG imagery on a CRT screen and bandwidth limitations affecting the download speed and visual quality of embedded full-motion videos.

(5) Training material from one NVG user domain (e.g., aviation) may be applicable to another domain (e.g., driving). However, the material must be carefully reviewed and edited to be suitable for the target audience. For example, the technical level and vocabulary of material developed for training military aviators is not necessarily appropriate for military drivers. Similarly, media (e.g., full-motion video) used for NVG training for one user group (e.g., aviators) may illustrate an important concept (e.g., the effects of an incompatible light in a helicopter cockpit on NVG image quality) but needs to be modified to reflect the perspective of the target audience (e.g., effect of an incompatible light in a truck cab). In short, any time lesson content is lifted from one product and inserted into another product, greater attention to detail is necessary to ensure the content is appropriate.

(6) Likewise, It is essential to use the appropriate vocabulary level and terminology throughout the training aid. For example, terms like "terrain albedo" and "situation awareness" may be commonly understood in the aviation NVG context, but meaningless or interpreted differently in a driving context.

(7) The multimedia capabilities of the CBT or WBT should be selected to support the instructional objectives, and not the other way around. For example, video presentations are essential for demonstrating certain dynamic NVG visual effects, such as the changing appearance of terrain with varying light levels and environmental conditions.

(8) With so many options for sophisticated multimedia available, instructional developers must learn to be practical and judicious in choosing which combinations of text, images, videos, etc. are most effective in meeting training objectives. In other words, it's very easy to exceed or overdo the instructional content.

(9) Effective CBT/WBT products require a mix of instructional designers, software engineers, graphic artists, and multimedia specialists, which can increase production costs considerably. Before ADL technologies, training programs were typically produced by as little as a single SME using presentation software at low cost. Therefore, agencies that fund training product development must recognize that higher costs and time to develop may be required. Cost effectiveness can be enhanced when training segments can be reused in other products with similar content.

(10) ADL developers must keep in mind user experience and confidence in using the Internet and computers. All CBT/WBT products must be as user-oriented as possible. Course designers must keep both CBT and WBT applications in mind as products are developed. Instructional development must include basic and advanced topics for intended users, allowing them to "push the training envelope." ADL developers must keep in mind that WBT has advantages over CBT when user computer memory limitations and update flexibility are critical issues. On the other hand, CBT has advantages over WBT when Internet access and bandwidth limitations are critical issues.

Clearly, our experience demonstrates great potential for ADL technologies while recognizing that there are limitations in their applications.

## FUTURE DIRECTIONS

In this section, we discuss future directions for research and development in the area of NVG CBT/WBT training. We also discuss the need to integrate ADL technologies with traditional NVG training technologies to produce an effective, systematic approach to training, and issues involved in meeting this need.

### Future NVG CBT/WBT Applications

Our interactions with NVG training personnel and various user groups throughout the SBIR project indicate a critical need for, as well as a high level of interest in, CBT and WBT delivery of NVG instructional material to supplement the traditional training approaches. Two user groups expressing a strong interest are dismounted warfighters and aviators. Figure 5 presents examples of topics and visual media relevant to these user groups.

A. Dismounted: Distances to light sources.

B. Aviation: Effects of low-level moon.

Figure 5. Future NVG CBT/WBT topics and media.

We are currently collaborating with the Fly By Night Training Team at AFRL to develop NVG CBT/WBT for USAF security police, whose mission contains elements of dismounted and mounted warfighter NVG operations. This course will draw from instructional content, media, and architecture developed for the NDTA and MNVD O&M CBTs, as well as content that AFRL is developing for an instructor-led version of the NVG course.

As an example, Figure 6 shows two screens from an instructional sequence on the effects of a low angle moon on image quality for a hypothetical aviator NVG CBT/WBT being considered for development. The top panel shows a screen that explains the general effect of a low angle moon and contains a pop-up definition of "blooming," which is an increase in the brightness around the light source and a decrease in the level of detail. This is a common effect with the current generation of NVGs that is best demonstrated using both a static and dynamic visual presentation. The bottom panel shows a screen containing a full-motion video that illustrates how NVG image detail decreases as two helicopters fly in the direction of the moon.

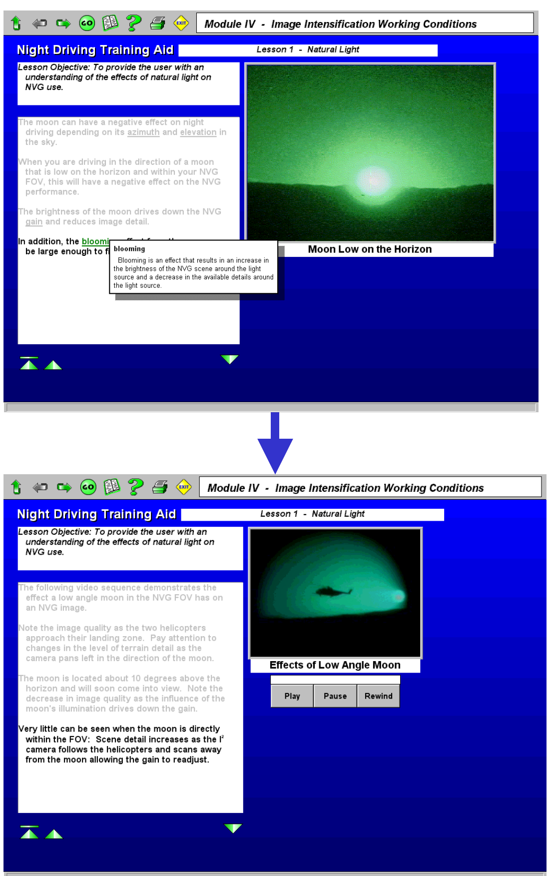



Figure 6. Sequence showing effects of low angle moon.

The text, photograph, and video shown in Figure 6 are adapted from the AFRL NVG Training Course (Berkley, Antonio, and Joralmon, 1998). This course is a valuable repository of aviation NVG instructional objects for an aviation NVG CBT/WBT. Furthermore, the course was a valuable source of instructional content and media for the NDTA development effort, and provided the opportunity for industry-government collaboration. Our experience working with AFRL supports the notion that applying ADL technologies to NVG training is an area in which industry-government collaboration will result in a productive approach. This is fully consistent with the ADL Joint Co-Lab initiative (Joint ADL Co-Lab, 2001b).

**Integrating ADL Technologies with NVG Training**

In the preceding sections, we identified ways in which ADL technologies, particularly CBT and WBT, can be applied to NVG training. We also noted that, because of the complexity of knowledge and skills required for their operational employment, NVG training requires a systematic, integrated combination of training technologies, including those contained in the ADL initiative. Therefore, the success of efforts to apply ADL technologies to NVG training will depend on not only how ADL technologies per se are applied, but also on how effectively they are integrated with traditional NVG training technologies. Techniques and procedures for accomplishing this are still in their infancy. In this section we offer suggestions to facilitate this integration.

There are a number of ways in which CBT/WBT, as examples of ADL technologies, can be used in NVG training. One way is to use CBT/WBT as an economical means of introducing concepts and exposure to imagery. This is later augmented in the classroom or in hands-on practical exercises with a qualified NVG instructor (whose availability and time is limited), or in an NVG simulator (which is expensive to operate). CBT/WBT can also be used to reinforce topical instructional points made during previous NVG classroom training, hands-on training, and simulator training. Most likely, some combination of the introductory and reinforcing functions of CBT/WBT will be most effective. In addition, because NVG knowledge and skills are perishable, NVG CBT/WBT is useful for conducting refresher training after an extended period of nonuse. In any event, it is critical that CBT/WBT content be carefully developed as a collaborative effort between an instructional designer and a qualified NVG instructor/SME (Ruffner, Antonio, Joralmon, and Martin, 2001).

A key operational capability of the ADL initiative, as stated in the Sharable Content Object Reference Model (SCORM) (Joint ADL Co-Lab, 2001a), and one that sets it apart from traditional CBT and WBT delivery concepts, is being able to construct a "piece" of instruction as needed that is suitable for a specific student's learning needs and learning style at a given time. This capability has numerous prerequisites. It requires that course developers and training personnel be able to identify required knowledge and skills, to identify and locate appropriate training content, and to obtain and assemble reusable information objects (RIOs) and reusable learning objects (RLOs) from instructional resources that may be distributed across different physical locations. In addition, the student(s) and the instructor/facilitator(s) may be in different locations.

The following training scenario illustrates a preliminary conception how NVG training might be developed and delivered using ADL technologies (Joint ADL Co-Lab, 2001a, 2001b). An example of a core "lesson" (i.e., one that is common across a variety of NVGs and operational applications, and that has been found to be a critical performance deficiency) is the proper NVG focusing technique. The instructional designer, with the help of the NVG SME, develops a brief lesson (a learning object) to meet a specific learning objective (being able to focus the NVGs in the field). The lesson consists of a combination of text, graphics, photographs, animations, videos, and voice narrations that provide multimedia explanations and demonstrations of focusing technique and how it affects the NVG imagery.

This lesson, as a learning object, is constructed as a single, self-contained unit of instruction and is designed to be a reusable shared content object (SCO). The SCO has several associated assets including a text file, a graphics file, an audio file, and a video file. These assets may reside at different locations. The SCO is "tagged" with metadata attributes, such as searchable keywords for text and imagery. Likewise, there will be a number of SCOs (e.g., a lesson on the effect of incompatible lights) developed for NVG training that may reside at different locations (e.g., training support center, government research lab, private corporation), and which may have different ownership.

During a unit's scheduled NVG training class conducted at the digital training facility, the NVG training NCO uses an intelligent search engine and the metadata developed by the training developer and NVG SME to identify the SCOs required to meet the training objectives for the soldiers attending the class. The specific SCOs are delivered to the soldiers at their computer workstations as a supplement to the NCO's prepared lecture and preceeding a hands-on class on focusing and adjustment techniques. In addition, the students have the option of calling up additional SCOs to enhance their understanding of focusing differences between different NVG models. Later that week, students review the lessons via the NVG training Web site just prior to a night field training exercise (FTX) to refresh their understanding of the imagery effects.

## CONCLUSIONS AND RECOMMENDATIONS

In this paper, we discussed our efforts to develop CBT and WBT, as ADL technologies, for NVD training and particularly for NVG training. These efforts are guided by the ADL objectives of developing training that is available at the time and place it is needed, tailored to the student's specific learning needs. We are conducting internal R&D to move our proprietary architecture toward ADL SCORM compliance and encourage similar efforts by others in the training community.

The successful application of ADL technologies to NVG training will benefit a variety of military and civilian users. In particular, it will have a sizable payoff and return on investment for individuals in the National Guard and Reserve as well as those in law enforcement and civil aviation. In these cases, learners are engaged in full time jobs, have limited time for NVG training, and may not be able to travel to a location with NVG instructors, specialized fixed facilities, and simulators.

In the future, NVD training developers need to construct products for CBT/WBT applications consistent with ADL technologies and guidelines. The successful application of ADL technologies, and their integration with traditional NVG training technologies, will greatly enhance training effectiveness. Since NVG training involves difficult concepts, non-intuitive aspects, highly perishable skills, and higher operational risks, successful ADL implementation is of paramount importance.

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