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Computer-Based Instructional Technology in the AEGIS Training Program

by

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ABSTRACT

The purpose of this thesis is to examine how the AEGIS Training Program is utilizing Computer-Based Instructional Technology (CBIT) to increase efficiency and effectiveness in a period of declining budgets and increasing technology. The AEGIS Training Program is faced with a variety of logistical, educational, and manpower-related issues that are not adequately addressed by traditional methods of training and instruction. In response, the AEGIS Training Center (ATC), Dahlgren, Virginia, is testing an electronic "Classroom of the Future" concept. This thesis provides an overview of the background, development, and early testing of the AEGIS "Classroom of the Future" and the associated Interactive Electronic Technical Manual (IETM) project. Problems encountered, expected benefits, and early testing results are discussed as well as recommendations for further analysis.

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I. INTRODUCTION

This ship is built to fight, you had better know.

ADM Arleigh Burke

Referring to USS ARLEIGH BURKE (DDG-51), ADM Burke recognized the complex and intense nature of modern warfare which led to the development of his highly technological namesake. When this warship was designed, the U.S. and the Soviet Union were the preeminent "super-powers" of the Cold War. For over forty years, potential conflict drove the production of ever increasingly high-tech weaponry. The threat of global warfare virtually disappeared with the official breakup of the Soviet Union in December of 1991. The U.S. had become the sole surviving "super-power" of the Cold War by literally outspending the Soviets in terms of defense dollars and technology. However this victory was not without cost in terms of the U.S. economy.

To achieve the world's most technologically advanced military force, deficit spending was used in the 1980s to rebuild the "hollow force" of the post-Vietnam era. Other deficits covered the increased costs for entitlements and other discretionary programs. The failure of many of the nation's savings and loan institutions caused a marked increase in the national debt. With interest payments, the national debt will approach the four trillion dollar mark in fiscal 1992 (Academic American Encyclopedia, 1992). These events, coupled with the recessionary economy of the late 1980s and early 1990s, have caused the United States to substantially reduce its level of defense spending. Secretary of Defense Chaney reported in testimony before the House and Senate Armed Services Committees in February and March of 1992 that the Department of Defense budget, excluding Desert Shield/Desert Storm costs, had a cumulative real decline of 29 percent from fiscal 1985 to fiscal 1993 and was expected to be 37 percent by 1997 (Office of the Assistant Secretary of Defense (Public Affairs), 1992). In order to afford these cuts, the U.S. Navy and the other military services are being forced to downsize. As a result, fewer dollars are available for training expenditures. However, the need for training has not diminished. The global responsibilities of the United States require the Navy to be prepared for any eventuality. The acquisition of sophisticated weaponry by Third World countries continues unabated. The increased complexity of modern, high-tech warships designed to counter such threats requires continuous and innovative training. The issue becomes how to accomplish this training rapidly and effectively, but in an efficient and economic manner.

The Navy typically conducts its warfare training at a shore based facility where traditional methods of instruction are employed. However, as warships have become more technologically advanced, the associated training material has become voluminous and expensive to update. At the same time, budget cutbacks may shorten classes forcing this material to be condensed. Personnel may be required to learn the material in a shorter time frame, yet students learn at different rates. In shorter classes, instructors may be unable to assist those students who require extra help.

Budget cutbacks may also impact personnel training from a logistical standpoint. Travel expenses to and from a training site are normally funded from training budgets. With fewer dollars available, commands may be unable to send personnel away from the job to schools for necessary training.

Maintenance of curriculum materials could be affected by personnel reductions. Extensive technical libraries require knowledgeable staff to operate and maintain such facilities. Support for training must occur if knowledge and skill levels are to be maintained at the fleet level. An alternative to traditional methods of training is required if these problems are to be resolved.

Computer-based instructional technology (CBIT) offers access to large data storage capacity, delivery of instruction, monitoring of student progress, and allows instructors more time with students. In network form, it can provide training without the student actually being present at the facility. Additionally, advances in microprocessing have made this technology more affordable.

In testimony before the Subcommittee on Technology and Competitiveness of the U.S. House of Representatives Committee on Science, Space, and Technology, Dr. Ronald F. Fortune summarized computer-based instruction (CBI) as a solution to many problems in education.

> The U.S. has invested a great deal of research, development, and high expectations in computer-based instruction (CBI) during the past 25 years. CBI is an application of technology to a collection of teaching methods and has generated much excitement among educators who recognize the computer's potential as an instructional delivery medium. Research to date shows that well-designed CBI can markedly improve student performance and motivation. Recent cost-benefit analyses show that CBI can be a low-cost, effective resource for providing instruction. CBI also offers benefits that the more traditional classroom teaching methods cannot provide. It can support individualized learning so that students can proceed at their own pace regardless of their ability level. Along with instruction, CBI configurations can provide access to information databases and serve as media for long-distance communication. In some applications, a combination of instruction, information access, and communication capabilities can provide unique and stimulating learning experiences that cannot be duplicated by any other teaching methods. (Fortune, 1991)

Recognizing the computer's potential benefits in engineering and education, the Department of Defense (DOD) developed the Computer-aided Acquisition and Logistic Support (CALS) strategy. This initiative is designed to "improve the timeliness of weapon systems development, reduce costs, and improve the quality of weapon systems and their supporting technical data" through the use of computer technology (CALS Resource and Implementation Cooperative (RIC), 1992).

These objectives will be realized by:

- establishing the infrastructure within DOD to create, receive, store, and manage digital technical data.
- requiring weapon system data to be created, managed, and used in digital format.
- creating data once and accessing and using it many times.

(CALS Resource and Implementation Cooperative (RIC), 1992) CALS defines standards the technology must meet in order to be utilized within DOD. This includes hardware, software, and connectivity.

In compliance with the implementation policies, the AEGIS Program is investigating state-of-the-art CALS technology as it can be applied to complex modern warships within the AEGIS community. Existing CALS applications such as two and three dimensional computer-aided design (2D/3D CAD) for hip construction are being implemented. In areas within AEGIS where no Navy sponsored initiatives exist, new CALS technology is being developed, tested, and evaluated for application.

Under this charter, the AEGIS Training Center, Dahlgren, Virginia, has developed a "Classroom of the Future" concept. This effort by the AEGIS program to apply computer-based instructional technology in the training environment is unlike anything existing in the Navy today. "It is the forerunner of tomorrow's training techniques and will allow AEGIS sailors to take full advantage of (this) technology." (CALS Resource and Implementation Cooperative (RIC), 1992)

The purpose of this thesis is to examine how the AEGIS training program is utilizing CALS technology in the classroom. Research questions include: What benefits are expected from the implementation? What problems are experienced? Is technology in training enabling the AEGIS program to meet its goals of increased efficiency and effectiveness?

Chapter I has introduced the problem to the reader. Chapter II provides background on the development of AEGIS and its training programs. Chapter III examines training and education literature and discusses how traditional methods are insufficient in addressing the training problems created by increased technology. Civilian applications of computer-based instructional technology are also examined. Chapter IV discusses the AEGIS Training Center's "Classroom of the Future" concept and its components. Chapter V looks at CBIT implementation in the AEGIS program; the problems encountered, future developments, and expected benefits. Chapter VI examines the early indications of effectiveness of CBIT within the AEGIS program. Chapter VII presents the summary and conclusions.

This research looks at a program unlike any other in the Navy today. The application of CBIT in the AEGIS program is in its infancy and offers the opportunity to follow the development of a program that has a potential for revolutionizing the way the Navy trains.

II. BACKGROUND

> We thought we had made the world safer, but it remained deeply unsettled. In the war's aftermath, as our navy radically reduced its size, its ships had to be driven harder than ever before. Crews spent more time at sea and had less time for upkeep for their ships or, in a manner of speaking, for themselves. The pressures of exercises increased, and, because of rapidly changing technology, so did the demands of proficiency. (Beach, 1986)

These sentiments reflect the author's view at the end of the Second World War. They could easily reflect the view of a sailor in 1992 looking back on the Cold War. The only difference between the times is the level of technology. Today, the demands for proficiency are as important as they were fifty years ago. However, increased technology has led to training issues that are not sufficiently addressed by traditional methods of instruction. Before addressing those issues within the AEGIS community, it is important to understand the history and technological background leading to the development of the AEGIS weapon system and the AEGIS training program.

A. NAVAL STRATEGY AND TECHNOLOGY

In the years between the World Wars, the advancement of the submarine and the development of the aircraft carrier signaled the need for significant changes in naval tactics. This did not occur. Beach (1986) wrote, "the minds of the men in control were not attuned to the changes being wrought by advancing technology." The strategy of the day was influenced by the writings of Alfred Thayer Mahan and involved the concentration of firepower from massed battle fleets with the battleship as the centerpiece. Mahan believed the fleet should be concentrated so as to attack in force, destroying the enemy, and gaining the strategic objective of control of the sea. All other ships would operate in support of the battle line. Mahan died in 1914. He never had the opportunity to consider what aircraft, submarines, and radar might mean to the fleet in it's mission of sea control (Beach, 1986). Others did have this opportunity, but "Mahan's nearly mystical pronouncements had taken the place of reality for men who truly did not understand (technology) but were comfortable in not understanding" (Beach, 1986). Hughes (1986) wrote, "strategies as well as tactics are influenced by weapons made by man." The battleship remained the preeminent ship of the line.

B. WEAPON DEVELOPMENTS

Prior to World War II, the primary mission of the surface combatant was to engage and destroy other surface combatants. Air defense was considered secondary. Although recognized as a threat in some corners of the Navy, air power was not given credence until the Japanese attack on Pearl Harbor on December 7, 1941. With the great Pacific battleships out of action, the mission of carrying the offense to the enemy was given to the aircraft carrier. The vast majority of sea battles in World War II occurred between carrier forces and their air wings. To protect the vulnerable carriers from air attack, surface combatants were given much-needed anti-aircraft weaponry. Battleships, cruisers, and destroyers now bristled with additional five inch 38 caliber (5/38), 40 mm, and 20 mm guns. To illustrate the change, the battleship USS TENNESSEE (BB-43) had eight 5/25 anti-aircraft guns in the mid 1920s. By May 1943, she carried eight twin 5/38 gun mounts, ten quadruple 40 mm gun mounts, and forty-three 20 mm guns for a total of 99 anti-aircraft guns. (Utley, 1991)

The principles of defense in depth were built as radar became more available. The new technology gave task forces the ability to detect enemy aircraft before visual range and provide early warning to ships to prepare for action. Combat Air Patrols (CAP) were positioned along the threat axis in order to attack the enemy before he got close to the fleet. The CAP fighter planes would attempt to destroy as many enemy aircraft as possible. Those that survived were left alone to run the gauntlet of anti-aircraft fire from the task force. Not all attackers were destroyed, but the majority did not reach the fleet. This process was complicated in late 1944 by the advent of the "Kamikaze" suicide-plane and the "Oka," a jet-propelled, human bomb. The birth of the "guided missile" required new tactics. Since massed anti-aircraft fire was no longer a deterrent, the "Kamikaze" had to be destroyed earlier and further away from the fleet. The limited range of radar was overcome by the concept of "picket" ships. These radar-equipped destroyers were placed away from the task force in a ring surrounding the main body of ships in order to provide earlier warning of inbound enemy aircraft. Since the enemy would theoretically be detected farther out, the CAP could intercept sooner and have more time to shoot down the attackers. But not all "Kamikazes" were destroyed. Those pilots that got through the inner zone of anti-aircraft defense used their bodies as guidance systems crashing their bomb-laden aircraft into the warships. Roscoe (1953) wrote, "the Kamikaze-Oka onslaught gave the U.S. Navy what many consider its worst hour in World War II."

After the war, the U.S. Navy continued to develop systems and tactics to protect against air attacks. In the intervening years, the anti-ship missile (ASM) emerged as the primary air threat. The unmanned ASM could attack without the human element of hesitation. The determination of a "Kamikaze" was no longer required. The AS-1 "Kennel" was probably the Soviet Union's first fully operational air-to-surface missile (Polmar, 1986). Developed in 1946, it was the forerunner of many longer-range variants such as the AS-4 "Kitchen" and AS-6 "Kingfish." The surface-to-surface SS-N-1 "Scrubber" was deployed at sea in 1959 by the Soviets (Polmar, 1986). The following SS-N-2 "Styx" was designed for small combatants in coastal defense roles. It was ideal for Third World navies. Until the French "Exocet" and U.S. "Harpoon" became operational in 1973 and 1977 respectively, the "Styx" was the most widely used ASM in the world (Polmar, 1986). The "Styx" gained notoriety on 21 October 1967 when Egyptian "Komar" boats, from within Alexandria harbor, used it to sink the Israeli destroyer ELATH steaming twelve miles offshore (Polmar, 1986). The ELATH had the dubious distinction of being the first surface combatant to be sunk by an anti-ship missile.

C. AEGIS DEVELOPMENT

The anti-ship missile threat has since been demonstrated in the Falkland Islands War, in the Gulf of Sidra, and the Persian Gulf. The U.S. Navy's defense against this threat is still the defense in depth concept. Missiles began to replace guns as the weapon of choice in anti-air warfare (AAW) in the late 1950s. As technology increased, the level of threat increased and the area of engagement grew further and further out. ASMs attained greater range and speed and greater accuracy though improved guidance systems. By the late 1960s, it was recognized that the Navy's reaction time, firepower, and operational availability in all environments did not match the threat. To counter this problem, an operational requirement for an Advanced Surface Missile System (ASMS) was issued and a program of comprehensive engineering development was started (Assistant Chief of Naval Operations, Surface Warfare (Public Affairs), 1989). In December 1969, the ASMS program was renamed AEGIS after the mythological shield of Zeus. The AEGIS system was designed to be a total weapon system capable of handling target detection, tracking, and missile guidance simultaneously in a multi-threat environment. In 1973, the system was successfully tested onboard USS NORTON SOUND (AVM-1) and demonstrated the capability of engaging targets in a variety of anti-air warfare scenarios. In 1983, the lead ship USS TICONDEROGA (CG-47) was commissioned.

The TICONDEROGA (CG-47) class cruisers and ARLEIGH BURKE (DDG-51) class destroyers are currently the only U.S. warships incorporating the AEGIS combat system. The CG-47 class is composed of 27 ships authorized and funded with the last ship joining the fleet in 1994 (Jane's Fighting Ships 1992-1993, 1992). The Navy plans to acquire at least 29 ships of the DDG-51 class (Jane's Fighting Ships 1992-1993, 1992). Twenty-two are authorized and funded (Navy News Service, 1992). The lead ship USS ARLEIGH BURKE (DDG-51) was commissioned in 1991.

D. AEGIS TRAINING CENTER

The AEGIS system is the U.S. Navy's state-of-the-art combat weapon system.

> It can defeat an extremely wide range of targets from wave top to directly overhead. AEGIS is extremely capable against anti-ship cruise missiles and manned aircraft flying in all speed ranges from subsonic to supersonic. The AEGIS system is effective in all environmental conditions having both all-weather capability and demonstrated outstanding abilities in chaff and jamming environments. The computer-based command and decision element is the core of the AEGIS combat system. It is this interface that makes the system capable of simultaneous operations against a multi-mission threat: anti-air, anti-surface, and anti-subsurface warfare. The combat system also has the capability for overall force coordination. AEGIS brings a revolutionary...combat capability to the U.S. Navy. (Assistant Chief of Naval Operations, Surface Warfare (Public Affairs), 1989)

As an evolving technology, the integration of the AEGIS combat system with ship acquisition required unique management and planning. In 1977, the AEGIS shipbuilding project (PMS-400) was established at Naval Sea Systems Command.

> The special management treatment combine and structure hull, mechanical, and electrical systems, combat systems, computer systems, repair parts, personnel maintenance documentation, and tactical operation documentation in one unified organization....For the first time in the history of surface combatants, PMS-400 introduced an organization that has both responsibility and authority to simultaneously manage development, acquisition, combat systems integration and life time support. (Assistant Chief of Naval Operations, Surface Warfare (Public Affairs), 1989)

Under the PMS-400 charter, the AEGIS Training Center (ATC) was formally commissioned in October of 1985 and is headquartered at the Naval Surface Warfare Center (NAVSWC), Dahlgren, Virginia.

> The mission of the AEGIS Training Center is to train AEGIS combat system officers and enlisted personnel in the knowledge and skills required to maintain competency and proficiency in operating and maintaining the AEGIS combat system, combat systems management, decision making, and communications, and to perform such other functions as may be directed by the AEGIS Program Manager (PMS-400) (ATC Instruction 5400.1B, 1991).

The ATC is a composite command with 12 subordinate AEGIS Training Units and Training Support Groups in the United States and overseas. Primary instructional and administrative facilities are located at the AEGIS Education Center (AEC) in Dahlgren. Additional instruction is conducted by the AEGIS Support Units (ATU) located at the Combat Systems Engineering Development Site, Moorestown, New Jersey and at the AEGIS Combat Systems Center, Wallops Island, Virginia. AEGIS Training Support Groups (ATSG) provide training and lifetime engineering support to AEGIS ships and shore facilities. These ATSGs are located in Norfolk, Virginia, San Diego, California, Mayport, Florida, Philadelphia, Pennsylvania, Long Beach, California, St. Inigoes, Maryland, Pascagoula, Mississippi, Bath, Maine, Pearl Harbor, Hawaii, and Yokosuka, Japan (ATC Instruction 5400.1B, 1991).

Depending on the training, courses range from 1 to 25 weeks in length (ATC Course Description Catalog, 1991). Currently, over 7000 students per year receive training at one or more of the AEGIS Training Center sites (Sine, 1992). Officers in the AEGIS training pipeline receive training as prospective Commanding Officers/Executive Officers (PCO/PXO), Combat Systems Officers (CSO), and AEGIS Officer Console Operators (AOCO). Senior enlisted personnel and certain officers are trained to operate and maintain the AEGIS Weapon System (AWS) and/or the AEGIS Combat System (ACS). After completion of Navy technical schooling, junior enlisted personnel in the AEGIS pipeline receive training on the operation and maintenance of specific equipment within their rating. Team training to simulate Combat Information Center (CIC) operations is provided to all precommissioning crews.

1. AEGIS Education Center

The AEGIS Education Center (AEC), Dahlgren, Virginia, is composed of the Cruiser and Destroyer Education Facilities. The 61,500 square foot Cruiser Education building contains 23 classrooms, 21 equipment laboratories, two technical libraries, offices, and support areas (ATC Public Affairs Office, 1991). The adjoining Destroyer Education building has 78,000 square feet with 24 classrooms, seven equipment laboratories, one technical library, and related support areas (ATC Public Affairs Office, 1991). Laboratories include radar, computer, display, console, and shipboard support equipment installed similarly to the actual equipment onboard ship. Classrooms are in the traditional style with erasable-marker board, tables, and overflow storage for curriculum-related materials. Class size ranges from two to two dozen personnel depending on the course. There are 300 instructors at AEC (Johnson, 1992) of which 42 are contracted civilians and the remainder military (Sine, 1992). The instructor staff is organized in three eight-hour shifts and conducts classes 24 hours a day from Sunday midnight to Saturday noon.

The classes taught at the AEC are listed to illustrate the magnitude of the AEGIS curriculum:

- AEGIS Prospective Commanding Officer/Prospective Executive Officer, CG-47 to 64, 5 weeks.
- AEGIS Prospective Commanding Officer/Prospective Executive Officer, CG-65 to DDG, 5 weeks.
- AEGIS Combat Systems Officer, CG-47 to 64, 5 weeks.
- AEGIS Combat Systems Officer, CG-65 to DDG, 5 weeks.
- AEGIS Weapons System Operation and Maintenance, CG-47 to 64, 17 weeks.
- AEGIS Weapons System Operation and Maintenance, CG-65 to DDG, 17 weeks.
- AEGIS Fundamentals, CG-47 to DDG, 2 weeks.
- Radar System AN/SPY-1A Operation and Maintenance, CG-47 to 58, 24 weeks.
- Radar System AN/SPY-1B/1D Operation and Maintenance, CG-59 to DDG, 23 weeks.
- AEGIS Fire Control System/Operational Readiness Test System Operation and Maintenance, CG-47 to 64, 24 weeks.

- AEGIS Fire Control System/Operational Readiness Test System Operation and Maintenance, CG-65 to DDG, 20 weeks.
- AEGIS Display System Operation and Maintenance, CG-47 to 59, 25 weeks.
- AEGIS Display System Operation and Maintenance, CG-60 to DDG, 23 weeks.
- AEGIS Computer System Operation and Maintenance, CG-47 to 64, 24 weeks.
- AEGIS Computer System Operation and Maintenance, CG-65 to DDG, 20 weeks.

(ATC Course Description Catalog, 1991)

2. AEGIS Training Units

The AEGIS Training Units (ATU) provide specific training at remote locations where operational equipment is required (ATC Instruction 5400.1B, 1991). The Combat Systems Engineering Development Site, Moorestown, New Jersey, conducts training for new AEGIS equipment in conjunction with engineering development (Sine, 1992). A full scale arrangement of the AEGIS Combat System within a duplication of a ship's superstructure allows realistic team training.

The following officer and enlisted training is conducted at Moorestown:

- AEGIS Combat Systems Maintenance Manager, CG-65 to DDG, 7 weeks
- AEGIS Combat Information Center Team (Precommissioning), CG-47 to DDG, 2 weeks.
- AEGIS Training Supervisor, CG-47 to DDG, 1 week.

(ATC Course Description Catalog, 1991)

The Combat System Center, Wallops Island, Virginia, conducts officer and enlisted operator training for AEGIS fleet units and support commands (ATC Instruction 5400.1B, 1991). This training includes:

- AEGIS Officer Console Operator (AOCO), CG-47 to 64, 4 weeks.
- AEGIS Officer Console Operator (AOCO), CG-65 to DDG, 4 weeks.
- AEGIS Combat Information Center Supervisor, CG-47 to DDG, 4 weeks.
- AEGIS Combat Systems Maintenance Manager, CG-47 to 64, 7 weeks.
- AEGIS Combat Systems Maintenance Manager, CG-65 to DDG, 7 weeks.

(ATC Course Description Catalog, 1991)

3. AEGIS Training Support Groups

The ATSGs in Norfolk, Virginia, San Diego, California, Mayport, Florida, Bath, Maine, Pascagoula, Mississippi, Long Beach, California, Pearl Harbor, Hawaii, and Yokosuka, Japan provide logistic support for training, implementation, integration and engineering development of:

- Fleet introduction of AEGIS ships.
- Battle Readiness (excludes ATSG Bath and Pascagoula).
- AEGIS Combat System Maintenance.
- Training Appraisals for Type Commanders (excludes ATSG Bath and Pascagoula).
- Pre-Commissioning Training (ATSG Bath and Pascagoula only).

(ATC Instruction 5400.1B, 1991 ; ATC Course Description Catalog, 1991)

In accomplishing these missions, the ATSGs conduct the following training:

- AEGIS Combat System Maintenance Team, CG-47 to 64, 1 week (ATSG Norfolk and San Diego only)
- AEGIS Combat System Maintenance Team, CG-65 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Embarked Staff, CG-47 to 64, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Embarked Staff, CG-65 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).

- AEGIS Training Supervisor, CG-47 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS AN/SPS-49(V) Air Search Radar System Operator, CG-47 to 73, 2 days (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Combat Information Center Team (Shipboard), CG-47 to DDG, 1 week, (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).

(ATC Course Description Catalog, 1991)

Training, implementation, integration, and engineering development of radio communications is conducted by ATSG, Naval Electronics Systems Engineering Activity (NESEA), St. Inigoes, Maryland. The ATC Course Description Catalog (1991) lists these courses taught by ATSG:

- AEGIS Radio Communications System Team, CG-47 to DDG, 3 weeks.
- Interrogator System AN/UPX-29(V) Maintenance, CG-47 to DDG, 4 weeks.

AEGIS Training Support Group Long Beach provides additional logistic support and training in Engineering Development Models (EDM), Underway Replenishment (UNREP), and testing weapons systems. ATSG Philadelphia provides logistical support and training in Waste Heat Recovery Systems (WHRS), Low Pressure Air Compressor (LPAC), Rankine Cycle Energy Recovery System (RACER), and the Reversible Reduction Gear (RRG). (ATC Instruction 5400.1B, 1991)

The highly sophisticated and complex AEGIS warship is the result of lessons learned in wartime and peacetime. It is not a simple weapon. As demonstrated in this chapter, the technology involved requires a great deal of training to understand and operate. The AEGIS training program is designed to accomplish that training. However, as technology advances and budgets decrease, the training necessary to operate such ships has become more difficult to accomplish using traditional methods of instruction. Those issues affecting AEGIS training will be examined and discussed in the following chapter.

III. TRADITIONAL TRAINING VS. INCREASING TECHNOLOGY

Since its introduction to the fleet in 1983, technology for the AEGIS Combat System has continually developed and become increasingly complex. The AEGIS Program Manager (PMS-400) planned ship construction in four baselines which allowed "incorporation of technological advances during construction or 'forward-fitting' technology rather than very expensive technology backfitting during scheduled overhauls" (Assistant Chief of Naval Operations, Surface Warfare (Public Affairs), 1989). Five baselines actually developed.

The lead ship, USS TICONDEROGA (CG-47), represents Baseline 0. Elements of her configuration included the AN/SPY-1A phased array radar, twin Mk 26 missile launchers, and two SH-2F LAMPS I helicopters. Baseline I was marked by USS VINCENNES (CG-49) receiving the SH-60B LAMPS III helicopters, helicopter haul-down system, and SM-2MR Block II Standard missiles. Baseline II, beginning with USS BUNKER HILL (CG-52), saw the replacement of the Mk 26 missile launchers with the Mk 41 Vertical Launch System (VLS) and the addition of the Tomahawk cruise missile. Baseline III started with the addition of the SQQ-89 (V)3 ASW system to USS SAN JACINTO (CG-56). Baseline IV, beginning with USS PRINCETON

(CG-59), incorporated the AN/SPY-1B radar with upgraded computers and displays. (JANE'S FIGHTING SHIPS, 1992-1993, 1992)

The AEGIS destroyers are also planned in baselines or "flights." Beginning with USS ARLEIGH BURKE (DDG-51), the Flight I configuration includes the AN/SPY-1D radar, the SQQ-89 (V)6 ASW system, and SM-2MR Block IV Standard missiles. (JANE'S FIGHTING SHIPS, 1992-1993, 1992)

A. ATC TRAINING PROBLEMS

The AEGIS Combat System is rapidly evolving and expanding as demonstrated by the baseline upgrades. However, with "declining budgets, increasing weapon systems complexity, and increasing volume of supporting data, the AEGIS commitment to deliver the most modern, capable, war-ready ships and maintain these (ships) in the highest state of readiness is increasingly at risk" (CALS Resource and Implementation Cooperative (RIC), 1992).

The AEGIS Training Center has used traditional methods of instruction to train officers and enlisted personnel to operate and maintain AEGIS warships. This method of training and management now appears to be inadequate in addressing the aforementioned problems and the specific logistical, educational, and manpower related issues that result from them. These issues must be resolved in order to increase the efficiency and effectiveness of AEGIS training.

1. Logistical Issues

a. Volume of Supporting Data

A complete set of AEGIS weapon system technical manuals for USS ARLEIGH BURKE has approximately 13 million pages of information after complete distribution to users afloat and ashore and costs $4,075,000 to produce, distribute, and maintain (CALS Resource and Implementation Cooperative (RIC), 1992).

> Current management of AEGIS technical manuals requires significant time and resources to ensure that the instructor and students are working with the latest technical manual revision. The ATC library contains approximately 50,000 different AEGIS technical manuals, with multiple copies made to train the technicians and operators on the many different AEGIS systems. (CALS Resource and Implementation Cooperative (RIC), 1992)

In an interview with the author, an ATC instructor stated he had 2,400 publications checked out for teaching one course to a class of ten students (Solow, 1992).

b. Maintenance Costs of Supporting Data

As publication updates occur, new pages are produced and tedious page changes are made by hand. This process is time consuming and very expensive. The Deputy Chief of Naval Operations, Logistics, (OP-04) estimated that, throughout the Navy, "22.5 million pages are changed and inserted per year into paper documents at a cost of $400 million per year" (Naval Electronic Systems Engineering Activity, 1992).

c. Storage of Supporting Data

The extensive technical library at ATC requires a vast amount of space to maintain the supporting data used as curriculum material. Certain publications are maintained in three vault storage areas totaling 41,280 cubic feet (Johnson, 1992). The remaining curriculum materials are stored in classrooms.

d. Classroom Utilization

Publications relevant to a particular course are stored in one classroom and that room becomes dedicated to that particular class. Consequently, classrooms at ATC are no longer multi-purpose and are restrictive in their usage. Although instruction occurs 24 hours a day, a single class day is composed of four hours of lecture and four hours of lab work (Johnson, 1992). As a result, these dedicated classrooms are utilized for instruction less than 17 percent ($4 \div 24 = .16667$) of the time. Given the expected growth of the AEGIS training program, the ATC will run out of space in 1996 requiring additional military construction (MILCON) dollars for new classrooms (Sine, 1992).

2. Educational Issues

a. Shorter Classes

Shorter classes offer budget savings, but the amount of information taught may have to be condensed to fit the shorter timeframe. If curriculum material is condensed, the question arises of whether or not the training is adequate in preparing a sailor to perform on the job. On the other hand, presenting the full amount of material in a shorter period could place inordinate pressure on the instructor and students.

b. Student Learning Rates

The ability to learn and the rate at which learning occurs is different in every student. A number of studies have shown that differences in abilities, motivation level, interests, and prior history will affect performance and attrition in training programs (Wexley and Latham, 1991). In traditional settings, finding the optimum class pace is necessary. If too fast, slower students can become lost and may struggle to keep up. If the class is slow, faster students can become bored and lose interest in the topic.

c. Knowledge Retention and Transfer

Training is ineffective if a student is unable to retain the knowledge gained during training and use it on the job. Traditional training often relies on memorization and recitation. Student must "pump" enough information into their memory so they can successfully "dump" the correct answer into a test. If this knowledge is short term, then it may not be remembered long enough to be applied on the job.

> As long as the Services must depend on first-enlistment (personnel) for operating and maintaining their high-technology devices, there will be pressures to make

> military training more effective within fixed time constants....The problem is...that (these) personnel are available for only that period for training and subsequent service in a technician capacity. The Services receive some return on their investment in training only during the period of on-the-job performance, and then only after the technician has learned to function with a sufficient degree of proficiency. Under these time constraints, rate of acquisition of knowledge becomes a parameter of primary importance in training. (Munro and Rigney, 1981)

d. *Student Literacy*

Knowledge acquisition is hampered by the apparent declining aptitudes of the potential military recruit population. Cohen (1991) noted that "sixty percent of U. S. high-school seniors can't read or draw accurate conclusions from standard text." The military screens and selects recruits through skills and aptitude testing. As of fiscal year 1990, "approximately 20,000 Navy enlistees annually, most of whom are high school graduates, read below the ninth-grade level" (Spendley, 1990). This is roughly 25 percent of the annually recruited population. For the AEGIS program, the question becomes how to "offset the perceived decrease in student ability to assimilate the information being taught" (CALS Resource and Implementation Cooperative (RIC), 1992).

e. *Audio-Visual Material*

The use of audio-visual material has been proven worthwhile. "A film, slide show, or even a sea story embellished with actual pictures goes far in capturing the attention of the class" (AEGIS Training Center, 1992). Unfortunately, this tool is not always available.

> Occasionally, it is too troublesome for the instructor to obtain necessary materials and equipment to provide such motivation....The instructor does his best to overcome these obstacles by using a drawing or verbal explanation to generate student interest. (AEGIS Training Center, 1992)

f. Supporting Data Access

Due to the volume of technical manuals and supporting data used in the AEGIS training program, it can be difficult to readily access information. If the instructor finds that students need to review certain information, he cannot always quickly refer to the necessary publication. The flow of the class may be disrupted and slowed as time and effort must be expended locating the data and the advantage of immediate feedback and reinforcement is lost. This can be particularly burdensome if class time is at a premium.

g. Varied Audience

Although learning about the same equipment, the type of training necessary for Commanding Officers, Executive Officers, Tactical Action Officers, Operations Officers, Combat Systems Officers, and maintenance technicians is very different. The capability to more efficiently and effectively conduct such varied audience training is required.

h. Remote Site Training

As technology increases and updates occur, it may be necessary to conduct time-sensitive training to students in remote locations. Such a capability must be able to convey the necessary training in such a manner that knowledge is easily acquired, retained, and applied correctly during job performance.

3. Manpower Issues

a. Billet Reductions

The AEGIS Training Center currently has 300 instructors to conduct training (Johnson, 1992) and additional support personnel to maintain technical publications. The growth of the AEGIS program indicates more personnel may be necessary to conduct training under the present system. If billets could be reduced by improving training techniques and reducing the volume and maintenance of publications, addition cost savings might be realized and applied to budget reduction.

b. Instructor Productivity

Instructors spend a great deal of time preparing lessons, locating reference material, inserting publication corrections, and obtaining audio-visual equipment for class use (AEGIS Training Center, 1992). If these and other related activities were reduced or eliminated, instructors could use that time for more productive activities such as additional student assistance or teaching an additional class.

c. Direct Costs

O'Neil and Paris (1981) point out that "most of the direct costs in education and training are associated with instructor and administrator salaries and benefits." In the military, students are paid similarly and may receive additional funding, or "per diem", to offset expenses. The direct relationship between time and costs could be reduced "to the extent that reductions in instructional time can be achieved" (O'Neil and Paris, 1981).

B. COMPUTER-BASED INSTRUCTIONAL TECHNOLOGY

As discussed in Chapter I, the AEGIS Program Manager has directed the evaluation of promising CALS technology and its implementation where cost effective. The AEGIS Training Center developed the "Classroom of the Future" concept to address the logistical, educational and manpower related problems it faces. The project's use of computer-based instructional technology (CBIT) will be examined in later chapters. It is important to first understand how this technology can enhance a training system.

1. Definitions

In reviewing literature on this subject, a variety of definitions and acronyms were encountered describing the use of computers in education and training. Many are synonymous and used interchangeably. To simplify the descriptive process in this research, the following acronyms and definitions are used:

- Computer-Based Instructional Technology (CBIT) is an inclusive term referring to any computer technology used to aid education and training.
- Computer-Based Instruction (CBI) refers to "any use of a computer to present instructional material, provide for active participation of the student, and respond to student action" (Criswell, 1990). CBI has two major components: Computer-Aided Instruction and Computer-Managed Instruction.
- Computer-Aided Instruction (CAI) refers to the "delivery of instruction, the monitoring of student performance, and other activities directly related to the instructional aspect of training" (Hays and Singer, 1989).
- Computer-Managed Instruction (CMI) refers to the "use of computers for student and instructor record keeping and instructional scheduling" (Hays and Singer, 1989).
- Interactive Courseware (ICW) refers to "computer-controlled courseware that relies on trainee input to determine the pace, sequence, and content of training delivery" (DOD Instruction 1322.20, 1991).

2. Benefits of Application

The application of CBIT is generally driven by "the need to improve the efficiency or effectiveness of a particular training system or situation" (Kearsley, 1983). However, not all instruction is appropriate for CBI (Montague and Wulfeck, 1984). Evaluation guidelines must be examined to determine if a particular training system is suited for CBI applications. Kearsley (1983) developed a checklist (Table 3-1) for assessing training situations and determining if CBI offers any potential benefits.

TABLE 3-1 CBI BENEFITS CHECKLIST

		Yes	No
1.	<u>Increased Control</u>		
	Are existing materials poorly used?	[ ]	[ ]
	Are existing training programs taught inconsistently?	[ ]	[ ]
	Is standardization of training important?	[ ]	[ ]
	Is detailed tracking of learning needed?	[ ]	[ ]
2.	<u>Reduced Resource Requirements</u>		
	Is decentralized (field-based) training possible?	[ ]	[ ]
	Is higher student throughput desired?	[ ]	[ ]
	Is a higher student-to-instructor ratio desired?	[ ]	[ ]
	Is expensive equipment needed for training?	[ ]	[ ]
3.	<u>Individualization</u>		
	Is there considerable variation in student backgrounds?	[ ]	[ ]
	Is there considerable variation in student abilities?	[ ]	[ ]
	Is there likely to be considerable student variation in terms of learning progress?	[ ]	[ ]
	Does the instruction have to stand alone (e.g., self-study)?	[ ]	[ ]
4.	<u>Timeliness and Availability</u>		
	Is it necessary to provide training to many students as quickly as possible?	[ ]	[ ]
	Is it desirable to provide training "on demand," i.e., whenever and wherever a student needs it?	[ ]	[ ]
	Is there a problem with students forgetting due to premature training?	[ ]	[ ]
	Is there a problem with a shortage of qualified instructors?	[ ]	[ ]
5.	<u>Reduced Training Time</u>		
	Would time savings in training be worthwhile?	[ ]	[ ]
	Can the training system and organization be changed to capitalize on time savings?	[ ]	[ ]

TABLE 3-1 CBI BENEFITS CHECKLIST (continued)

		Yes	No
6.	<u>Improved Job Performance</u>		
	Is the quality of job performance a critical training concern?	[ ]	[ ]
	Are there job performance problems that improved training can address?	[ ]	[ ]
7.	<u>Convenience</u>		
	Do employees already use a computer system for their jobs?	[ ]	[ ]
	Could CBI be integrated into existing jobs or equipment?	[ ]	[ ]
8.	<u>Change Agent</u>		
	Is there a need for new training approaches or methods?	[ ]	[ ]
	Could CBI lead to improved personal or organizational productivity?	[ ]	[ ]
9.	<u>Increased Learning Satisfaction</u>		
	Is attrition or failure rate high?	[ ]	[ ]
	Is there a problem with student motivation?	[ ]	[ ]
10.	<u>Reduced Development Time</u>		
	Is the large-scale development of training materials and program involved?	[ ]	[ ]
	Is immediate revision/update of training materials important?	[ ]	[ ]
	Is instruction developed in terms of a competency-based framework?	[ ]	[ ]

Source: Computer-Based Training, G. Kearsley, 1983
Reproduced with permission, (Kearsley, 1992)

If the evaluation produces mostly negative responses, CBI may not fit training needs and therefore other approaches should be considered. More positive responses indicate CBI may successfully address training system needs and should be examined further. The checklist provides a convenient framework for discussion of specific benefits derived from computer-based instruction and technology.

a. Increased Control

Uniformly high quality instruction is possible using computers (O'Neil and Paris, 1981). Standardized courses can eliminate variability in different instructors and ensure each student receives the same training regardless of when or where he was trained. When training is packaged and is less dependent on individual instructors, there is greater standardization and control over the quality of the instruction and its delivery (Wetzel, Kekerix, and Wulfeck, 1987). From the administrative viewpoint, students can be tracked by CMI allowing easier and more accurate monitoring of their performance (Dean and Whitlock, 1983).

b. Reduced Resource Requirements

Computer-based instructional technology can reduce resource requirements in a variety of ways. Depending on the training requirements, a computer-based course can be sent out on disc to any remote site with computer access. In network form, the course is transmitted electronically to a number of receivers. Exporting training in such a fashion could reduce the number of instructors and central training facilities required because one instructor could teach more than one class simultaneously. Student travel costs and expenses are reduced as well. In 1988, Federal Express integrated CAI into its training program by replaced some of their traditional classroom programs with a system that utilized interactive video on computer workstations.

> Federal Express has made a huge investment in interactive training resources: more than $40 million in 1,200 systems in 800 field locations. Each is stocked with 30 interactive videodisc programs, which have been used to train many of Federal's 23,000 couriers and 2,100 customer service employees....By offering training at the workplace, Federal cuts the travel costs of sending employees to regional training courses....Amortized over three years, it is estimated that each workstation will provide training for about $25 per day, compared with the $400 (per day) cost of sending an employee to regional headquarters for instructor-led training. (Heathman and Kleiner, 1991)

Transferring training materials to electronic storage could drastically reduce the amount of paper resources required in the conventional classroom. Electronic data storage allows large amounts of data to be maintained on hard drives or the more recent compact disc-read only memory (CD-ROM). The capacity of a single 4.72 inch CD-ROM is over 550Mb or equivalent to 250,000 pages of text (Long and Long, 1990). Such storage media provides easier data access, incorporation of updates, and portability of data bases.

c. Individualization

The computer is sensitive to individual differences in learning rates among trainees (Latham and Wexley, 1991). Allowing each student to learn at a speed and in a fashion most suited to his or her particular learning style has always been at the heart of CBI (Kearsley, 1983).

> The self-paced nature of (CBI) and the use of pre- and post-tests, means that students with a higher level of initial knowledge can complete the course faster than those with less knowledge or those who are slow learners, but each should eventually complete the course satisfactorily if they are capable of doing so. This is motivating for the students as it gives the opportunity for the better ones to become productive sooner, yet the less able do not return to the job with gaps in their knowledge. (Dean and Whitlock, 1983)

d. Timeliness and Availability

Computer training can be available at any time of the day as long as a computer is available. Time-sensitive training is possible by network or by sending the training program to the remote site. "A (CBI) course can be taken by the students as and when they are ready, without any delay, resulting in more rapid productivity" (Dean and Whitlock, 1983).

e. Reduced Training Time and Increased Learning

Increases in learning and retention have been observed under CBI methods (Heathman and Kleiner, 1991). Orlansky and String (1981) reviewed 48 studies and found that, compared to conventional training, CBI produced the same level of achievement in 32 cases and higher results in 15 cases. They also found that students completed the CBI courses an average of 30 percent faster than conventional training.

More recent evaluations of CBI by Kulik and Kulik (1987) found computer-based instruction positively influenced student outcomes. In four separate analyses of CBI classroom use, a total of 199 comparative studies were made. Based on the results of the analyses, Kulik and Kulik (1987) made the following observations regarding CBI.

- Higher examination scores indicated students learned more using computers.
- Students learned faster as evidenced by reduced instructional time.
- Student attitudes toward instruction and technology improved.
- Student attitudes toward subject matter, however, were not improved significantly by computer usage.

Under CBI, classes could become shorter without affecting student achievement levels. This equates to a shorter overall time in training pipelines and a faster return on the training investment. The expense of sending a sailor to school should decrease. The sailor could reach his command and have the opportunity to apply the training to his job sooner. As a result, his training could receive faster reinforcement which would theoretically aid in developing long term skill retention.

f. Improved Job Performance

Computer-Based Instruction is an active mode of learning which is participatory in design.

> The capability of (CBI) to provide interactive individualized instruction means it inherently has the potential to improve the quality of training. It has been shown that instructional approaches based on passive presentation methods (i.e., classroom lectures, videotape) result in very little actual learning. Most of the time the student is not attending to the instruction. In interactive individualized instruction, the student spends a very high percentage of the time attending, and, hence, learning. (Kearsley, 1983)

In 1982, Weyerhaeuser lost $355,200 in lost work potential to employee injuries on woodpulp digester equipment. The company invested in ICW to provide digester operation and safety training to its employees. Training began in the first quarter of 1983. By the end of the quarter, lost work potential was down to $21,000. Shortly after all employees completed the training, the loss potential due to injuries dropped to zero and remained there from April through December of 1983. Although injuries did occur after this time, the rate was much lower than before. The cost of implementing ICW was 39 percent below the cost of internal company classroom training and 51 percent below outside training. (Niemi, 1991)

g. Convenience of Embedded Training

Computer presence in the work place is continually growing. Depending on the type of system present, training can occur on existing devices. Referred to as "embedded training," this type of training can be built into the system and is tutorial in design. The system itself can teach personnel how to operate the device. Such training can be an initial exposure for new personnel or refresher training for experienced operators.

This capability can be used three ways. First, computers can be used to present straight computer-based training on device operation and usage. Second, the computer can be used to stimulate an operational device's equipment and provide a simulation of an actual event for purposes of training. Finally, computers can do both of the above simultaneously. (Fletcher and Rockway, 1986)

The Navy Tactical Data System used the Lesson Translator (L-TRAN) project for embedded training (Fletcher and Rockway, 1986). A more current example is the AEGIS Combat Trainer System (ACTS) which can provide individual or team training on actual shipboard equipment (Guarracino, 1992).

h. Agent for Change

Computer-based instructional technology can be used to bring about educational change as demonstrated in the Weyerhaeuser example. However, many trainers believe that older personnel who are not accustomed to interacting with CBIT will be somewhat resistant to technological training (Heathman and Kleiner, 1991). When introducing the

Intelligent Video Learning System in 1989, Ford Motor Company found just the opposite.

> Ford's trainers have observed that older technicians are sometimes afraid to ask questions in classroom situations, often shrinking into the background. IVLS gives trainees the chance to learn without embarrassment, and the technicians have really taken to it. (Heathman and Kleiner, 1991)

By taking advantage of the non-threatening nature of CBIT and its increasingly user-friendly interfaces, organizations can successfully institute change in the workplace.

i. Increased Learning Satisfaction

Studies have shown that CBI can be more efficient than traditional classroom teaching. Learning time is reduced, students enjoy class more, and attitudes toward the subject matter improve. One school in Johnston County, North Carolina, achieved a 57 percent gain in student reading skills after a CBI system was installed there (Houlihan, 1991). A student was asked about his success with the computer. He replied "It's fun to learn this way, but most of all the computer don't talk back and tell me I'm dumb" (Houlihan, 1991).

Many nationally known companies have implemented CBI with remarkable results. Weber Metals of Los Angeles uses CBI to conduct basic skills training in math, reading, and English as a second language. Workers' average grades have increased 19 to 37 percent. Other companies report reduced absenteeism, measurable saving resulting from increased production efficiency, higher quality, and improved workforce attitudes. (Fortune, 1991)

j. Reduced Development Time

Development of computer-based training materials has often been time consuming. In the past, "CBI generally required extensive development time and high levels of expertise exceeding that of most instructional developers" (Wetzel and Wulfeck, 1991). Other problems included "the proliferation of nontransportable machine specific CBI software over incompatible hardware systems (Wetzel and Wulfeck, 1991). Efforts have been made to standardize development systems and make instruction easier to produce. These new "authoring" tools allow the lesson developer to easily enter content and presentation options into complex databases. By standardizing training lesson development, incompatible and nonexportable programs can prevented. The Navy's Computer Based Educational Software System (CBESS) is one example of this emerging technology.

k. Cost

There has been dramatic change in the power, portability, and affordability of small computers in the last 15 years.

> In 1981, when IBM introduced its first PC, Big Blue charged $2,655 (or $3950 in 1991 dollars) for a machine that had 64 kilobytes (KB) of memory and 160 KB of floppy disk storage, which was about 50 single spaced typewritten pages. It used the Intel Corp. 8088 chip, which had speed of 4.77 megahertz....Today the same configuration of hardware sells for $3695...[and] has 50 times the speed (50 megahertz chip), 1,000 times the memory (64 megabytes), and 10,000 times the storage capacity (1.6 gigabytes) of the original machine. (Rosenthal, 1992)

Long and Long (1990) claim that if the automobile industry had experienced similar progress, a new car would now cost less than a gallon of gasoline. The trend is toward smaller faster computers, such as the laptop PC, that are easily moved about and are capable of communicating with other computer systems.

3. Hindrances to Application

The implementation of CBI has not grown at the same rate as the accompanying technology. Funaro and Lane (1987) point out that "the 'growing pains' associated with technology expansion have to a large extent inhibited the routine use of CBI as a solution to military training problems."

a. Lack of Standardization

The rapid development of the computer industry has brought about a variety of programming languages, architectures, authoring systems, data storage media, data communications, and connectivity. In the past, because of the lack of standardization, "consumers have difficulty in resolving the claims, counterclaims, strengths and weaknesses of the different approaches, and are reluctant to make decisions without a clearer grasp of the technology" (Funaro and Lane, 1987). Interestingly, this problem has generated a sub industry where companies have developed technologies that can bridge the gaps between proprietary systems and allow interoperability. The overall industry trend is slowly toward standardization, but only because the customer has demanded it.

b. Technology Obsolescence

The rate of innovation and change in the computer industry is very rapid. Hardware technology purchased a few years ago may be obsolete and unable to run newer instruction software. Budget problems can make it difficult to justify large investments in updating hardware every few years. (Fortune, 1991)

Some computer manufacturers are beginning to build systems with upgrades in mind. By allowing a chip or a circuit board to be replaced instead of the entire machine, they are keeping customers in the market at a fraction of the cost of losing them to obsolescence.

c. *Flawed Planning by Management*

Management and organizational concerns are a primary factor in the success of any CBI project. Seidel and Wagner (1981) examined the "frequently overlooked...management aspects of a variety of projects that have involved the use of the computer for instructional purposes." Kearsley (1983) based the following CBI management principles on the findings of Seidel and Wagner.

- There must be an unambiguous understanding of the purpose and nature of the project.
- All participants must be actively involved.
- Conduct training and orientation for all users involved.
- Establish and maintain adequate controls over project resources and programs.
- Establish explicit and objective criteria to assess system and courseware acceptability.
- Assign project tasks according to skills needed.

- An appropriate evaluation model and plan must be developed.

- Establish a stable system before developing courseware.

- Prepare everyone for the iterative nature of the project.

d. Perceptions of CBI

While students have been found to enjoy CBI, teachers are more likely to resist such technology.

> Teachers have been increasingly been made accountable for raising their student's scores on standardized tests. They are reluctant to introduce CBI into the classroom unless they are assured that it addresses the school's established curricular goals and can improve student performance on tests. Most teachers recognize that the computer is an important teaching tool and that computer literacy is an essential set of skills for their students to develop. Yet many are not convinced that CBI is the best way to spend precious classroom time. (Fortune, 1991)

These attitudes must be addressed by significant training and involvement of the teachers in the implementation process if CBI is to be successful.

IV. AEGIS CLASSROOM OF THE FUTURE CONCEPT

A. BACKGROUND

In 1986, the Naval Electronic Systems Engineering Activity (NESEA), St. Inigoes, Maryland, began to explore the use of optical media for providing interactive AEGIS technical manuals (Naval Electronic Systems Engineering Activity, 1992). The results of these efforts were favorable and provided the basis for further experimentation.

In March of 1990, the AEGIS Interactive Electronic Technical Manual (IETM) Project was established as a CALS initiative. It would "provide leadership and management for all aspects of optical technology within the AEGIS program as it relates to the management, use, and presentation of technical manual data in the 'paperless' ship environment" (CALS Resource and Implementation Cooperative (RIC), 1992). Specific goals included:

- Establishing a critical experiment for the development of IETMs to be used on AEGIS ships.
- Validate the concept of the IETMs through user feedback and other measures of success.
- Decreasing time to execute critical repairs (achieved by having faster and more complete access to the needed maintenance documentation and diagrams via IETM on CD-ROM) thereby increasing efficiency and effectiveness.

- Reducing the weight of paper on each ship (accomplished by reducing the amount of paper, estimated at 23 tons on a typical AEGIS ship).

- Achieve significant cost reduction/cost avoidance in production and life cycle maintenance of core AEGIS technical manuals on ships (and ashore).

(Naval Electronic Systems Engineering Activity, 1992).

In August 1991, NESEA completed the Navy's first IETM for the AEGIS program. The AEGIS Radio Communications System (RCS) IETM was the first step toward achieving the ultimate goal of transitioning complex combat systems technical documentation, such as the AEGIS Weapon System, to electronic format. (CALS Resource and Implementation Cooperative (RIC), 1992)

Concurrent with the IETM project, the AEGIS Training Center developed a computer-based "Classroom of the Future" concept. This continuing effort was designed to improve the traditional methods of teaching AEGIS Combat System operation and maintenance and to reduce costs. Specific goals of the project included:

- decrease the time required by instructors to prepare lessons.

- decrease the time required to teach a course.

- decrease the number of instructors required to teach a course.

- eliminate planned military construction by more efficient use of the present facilities.

- use technology to offset the perceived decrease in student ability to assimilate the information being taught in the various courses.
- couple the efforts of the AEGIS IETM Project into a cohesive approach for use by training activities.
- reduce production, distribution, and maintenance costs of curriculum materials by taking advantage of a paperless classroom.

(AEGIS Training Center, 1992 ; AEGIS Training Center, 1992c)

In October 1991, ATSG, St. Inigoes, Maryland, used the "Classroom of the Future" and the Radio Communications System IETM for the first time to conduct the Radio Communications System Team Training course for USS ANZIO (CG-68).

B. INTERACTIVE ELECTRONIC TECHNICAL MANUAL PROJECT

The Interactive Electronic Technical Manual project involved two related initiatives; the development of the IETM and the AEGIS Documentation Optical Production System (ADOPS).

1. Interactive Electronic Technical Manual

An IETM is an electronic data base accessed by computer. The Radio Communications System IETM, which is stored on CD-ROM, can be used at either the systems level or individual system component level to accomplish diagnostics, maintenance, or operator/technician training (Naval Electronic Systems Engineering Activity, 1992).

> The information in an IETM does not differ from that in a paper technical manual. What is different, however, is simply how the data is presented to the user. In a paper manual, the data is formatted for presentation on pages of

> paper. In an IETM, the information is 'pageless.' That is to say, the information is synthesized, formatted and linked specifically for retrieval and presentation by a PC system. This allows all information relevant to a given problem or task to be displayed without other irrelevant or unwanted information. Combined with an appropriate graphical user interface the information in an IETM can be used much more easily and more effectively than information found in paper manuals. (CALS Resource and Implementation Cooperative (RIC), 1992)

Other information not normally found in traditional manuals can be imported into the IETM. Operators and technicians could access data such as the Planned Maintenance System (PMS), the Consolidated Shipboard Allowance List (COSAL), the Allowance Parts List (APL), and ship's configuration. (Naval Electronic Systems Engineering Activity, 1992)

The project was expanded to include development of a maintenance-oriented (MO) IETM to complement the Operator RCS IETM and an (MO) IETM for an element of the AEGIS Weapon System. These IETMs should be more specific in nature with amplified technical maintenance information needed by electronics technicians and tailored for specific equipment (Naval Electronic Systems Engineering Activity, 1992). Further demonstrations of both the operator's IETM and the technician's maintenance-oriented IETM are necessary in order to validate the ability to produce IETMs for the much larger and complex AEGIS Weapon System (CALS Resource and Implementation Cooperative (RIC), 1992).

2. AEGIS Documentation Optical Production System

The AEGIS Documentation Optical Production System (ADOPS) is an initiative to formalize the process of IETM production.

> The (ADOPS initiative) was for the development of a cost-effective production capability for additional IETMs using a government-owned system of integrated hardware and software. This production system...provides an in-house capability for converting text and graphics to the required formats for screen-oriented displays, developing interactive retrieval software, optimizing document organization, assessing mass storage devices, and formatting data for production of optical storage media. This capability can be used to develop additional IETMs for other AEGIS systems in the future. (Naval Electronic Systems Engineering Activity, 1992).

C. CLASSROOM OF THE FUTURE COMPONENTS

The main objective of the AEGIS "Classroom of the Future" concept is to improve training received by technicians and operators. By providing classroom instruction with the same devices and fidelity of material as the student will encounter onboard ship, training can be positively enhanced and the student should be better prepared to perform on the job.

A diagram of the prototype AEGIS "Classroom of the Future" is provided in Figure 4-1.

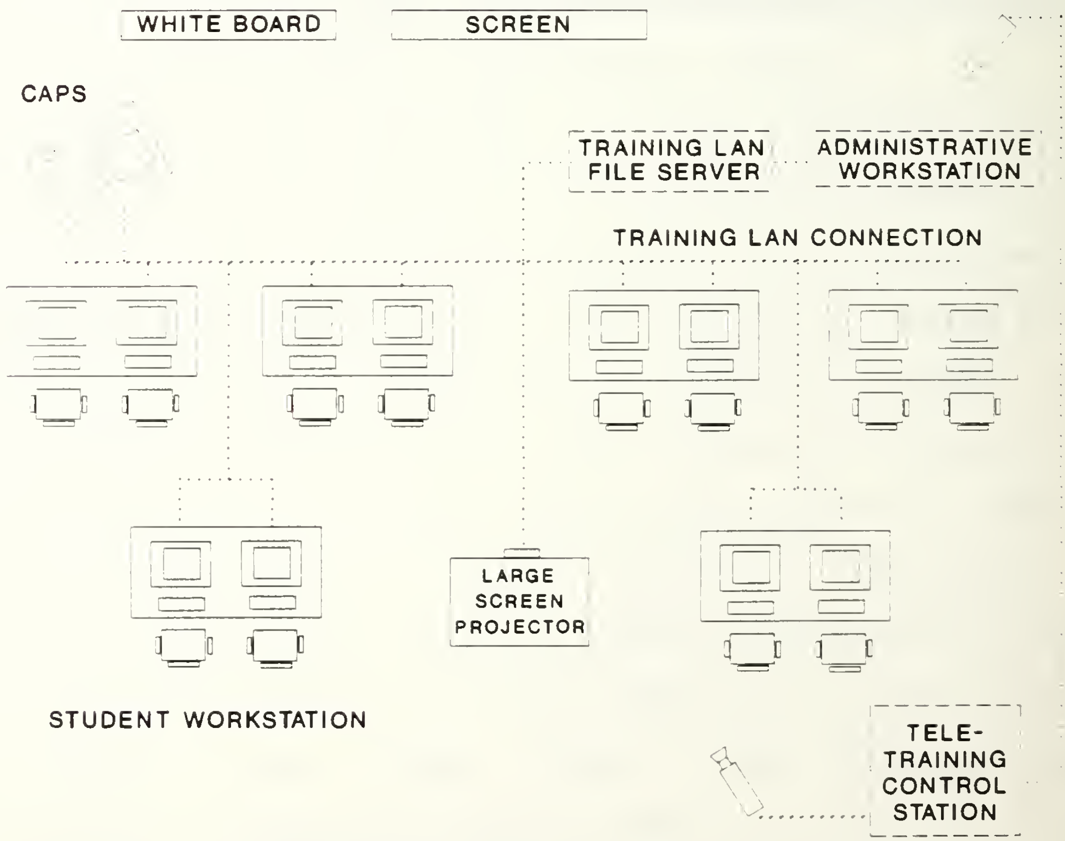

Figure 4-1 AEGIS Classroom of the Future
(AEGIS Training Center, 1992a)

1. Computer Aided Presentation Station

A Computer Aided Presentation Station (CAPS) is used by the instructor to present the topics. The CAPS system is comprised of a 386/486 micro-computer housed in a podium configured with a CD-ROM drive, dual VGA display monitors, a pointing device such as a mouse or light-pen, a keyboard, output connects for external displays, and a student workstation control panel. The CD-ROM permits the instructor to access digitized interactive information in the same manner as shipboard IETMs. The automated Instructor's Guide is accessed from the training Local Area Network (LAN) file server and is displayed on one monitor. Instructor controlled material from the file server or IETM is presented on the other screen and displayed on student workstations.

The material displayed to the students can also be shown on a large screen display. The student workstation control panel allows the instructor to control the presentation process as he feels necessary. For example, student video screens can be blanked if the instructor wants students to concentrate on the large display screen for an important point. Conversely, the instructor can unlock the workstations permitting students to explore and experiment with the data base. Notetaking and electronic illustration is possible through the keyboard, mouse, or light pen. The addition of a remote control device permits the instructor to move about and not feel "tied to the podium." (Frerichs, 1992)

2. Student Workstations

An individual workstation consists of a 386 desktop PC, keyboard, mouse, and VGA color monitor linked by local area network connection to the CAPS and the file server. The 386 Laptop PC provides similar capabilities in laboratory environments. The workstation is identical to the systems being installed onboard AEGIS warships as part of the "paperless" Navy concept. Such early familiarity with the exact ship's equipment should aid the student in applying what he has learned to the job.

The workstation provides the opportunity for enhanced student/instructor interaction. During class, the instructor can access a student's station from the CAPS to assist in answering questions. Because of connectivity, the instructor can easily walk the student through his questions and gain feedback from the student. This process can be applied classwide in answering a particularly relevant question. This is an important capability, especially in remote site training where the student and instructor could be in separate locations.

The interactive capability can also aid in various administrative functions. By using computer-managed instruction to track student progress, data bases can be created for comparing and analyzing student and class performance rates. This will be of particular importance in evaluating the effectiveness of the program.

3. Training Local Area Network

The training Local Area Network (LAN) will link the CAPS, student workstations, and administrative workstations with the training LAN file server. The file server is the central repository for all instructional material and network software. The Curriculum and Instructional Standards Office is responsible for the evaluation, approval, and loading of all instructional material. This will ensure that only the latest approved version of a curriculum is available for use. (AEGIS Training Center, 1992)

4. Administrative Workstation

The administrative workstation provides instructors with a management tool for computer instruction. CMI and lesson planning will be possible via the local area network. Instructors can access curriculum files in the central LAN file server from workstations at their desks. Using the Authoring Instructional Materials (AIM) system, the instructor can personalize curriculum files for presentation in class. This might involve using digitized multimedia, such as full motion video, for illustrations or making simple notes. The AIM authoring system could will allow the instructor to select the different levels of detail necessary for varied audiences. (AEGIS Training Center, 1992 ; Johnson, 1992)

5. Tele-Training Control Station

The Tele-Training Control Station provides the capability to conduct remote site training. Information transmitted to the remote location will have the same quality of presentation as seen in the transmitting classroom. Video cameras can provide live interaction between the instructor and students at the remote site. The electronic link will provide a CMI capability allowing the instructor to test and evaluate students. Videotaping allows presentations to be retained for reference material at school or shipboard use. (Johnson, 1992 ; PRC Inc., 1991)

D. AEGIS COMBAT SYSTEM INTERACTIVE TRAINER

The AEGIS Combat System Interactive Trainer (ACSIT) is an older, interactive training system in place at the AEGIS Education Center and various ATSGs. Although not specifically part of the AEGIS "Classroom of the Future" outlined earlier in this chapter, ACSIT does represent the early interest in CBIT by the AEGIS training program.

ACSIT is a video disc-based, audio-visual system composed of off-the-shelf hardware. The system is used to "produce and display dynamic visuals, augment tactical training equipment, and to enhance student attainment of specified objectives within the ACS courses of instruction" (ATC Instruction 5510.3, 1989). ACSIT is composed of two main elements: an Instructor Control Station, and 12 Student Workstations.

A student workstation is a movable desk housing a computer, keyboard, two touch-screen color monitors, video-disc player, and headphones.

The ACSIT system can be used as a laboratory to supplement course instruction or act as a library for additional on-line student study. The system functions in the following modes:

- Instructor control of all student lessons.
- Student workstations networked with the ICS allowing student progress to be monitored by the instructor.
- ICS operating in stand-alone configuration frees instructor for curriculum development while students continue lessons independently.
- Diagnostics.

(ATC Instruction 5510.3, 1989 ; Guarracino, 1992)
ACSIT labs are located at the AEGIS Education Center, Dahlgren, Virginia, and at four ATSGs; Bath, Maine, Wallops Island, Virginia, Norfolk, Virginia, and San Diego, California.

The AEGIS "Classroom of the Future" concept is designed to address the logistical, educational, and manpower related problems the ATC has encountered. By combining technology with tradition training, the AEGIS Training Center intends to "create a total atmosphere which will enhance the actual learning process" and reduce training costs as well (AEGIS Training Center, 1992).

V. IMPLEMENTATION OF THE AEGIS CLASSROOM OF THE FUTURE

The AEGIS "Classroom of the Future" concept started in 1990 in conjunction with other initiatives including the AEGIS Paperless Ship Program and the Interactive Electronic Technical Manual (IETM) Project (AEGIS Training Center, 1992c). The goals of the "Classroom of the Future" were to improve efficiency and effectiveness in training and to reduce costs. The Computer Aided Presentation Station (CAPS) was developed with these goals in mind. Using off-the-shelf hardware and software, the AEGIS Education Center, Dahlgren, Virginia, designed CAPS to better "manage and present instructor guide information to the instructor, and present required graphics to the students" (Aegis Training Center, 1992c). The system received high interest and praise when demonstrated at the 1990 and 1991 CALS Expo and the 1991 Surface Warfare Symposium (Guarracino, 1992).

Similarly, the AEGIS Training Support Group at Naval Electronic Systems Engineering Activity (ATSG, NESEA) St. Inigoes, Maryland, developed the Radio Communication System (RCS) IETM and the accompanying system workstations. Using a 386 PC workstation with CD-ROM capability and Windows 3.0, operators and technicians can search the IETM by topic, key word, graphics, or subsystems for desired information (AEGIS Training Center, 1991 ; Naval Electronic Systems

Engineering Activity, 1992). The RCS IETM system received wide support among potential users and plans for operational testing onboard AEGIS ships have been developed.

> Proper fleet introduction of IETMs...dictates they first be introduced to AEGIS operators and technicians in the classroom training environment before being placed aboard ship, ergo, computer aided training techniques must also be developed and implemented within the AEGIS training hierarchy to support the proper introduction of IETMs aboard AEGIS combatants (Naval Electronic Systems Engineering Activity, 1992)

The ships selected for testing will receive the following support for RCS IETM fleet introduction:

- Radio Communications System Team course at ATSG, St. Inigoes using the IETM and CAPS.
- Refresher courses at the shipyards.
- Complete installation and checkout of RCS IETM workstations, training, and logistical services prior to ship's commissioning.
- Full operational capability prior to ship's commission.

(Naval Electronic Systems Engineering Activity, 1992)

A. AEGIS RADIO COMMUNICATIONS SYSTEM TEAM COURSE

In October 1991, the AEC and ATSG, St. Inigoes brought their respective projects together in a prototype training environment. The CAPS and IETM system were used at St. Inigoes to conduct the Radio Communications System (RCS) Team course for USS ANZIO (CG-68). USS ANZIO was to be the first AEGIS ship to receive the RCS IETM system for operational testing. In 1992, prototype "Classroom of the Future" training continued with the RCS Team course being taught to USS SHILOH (CG-67), USS VICKSBURG (CG-69) and USS JOHN BARRY (DDG-52). These ships were also selected for RCS IETM operational testing. The Naval Personnel Research and Development Center (NPRDC), San Diego, California, and the ATC evaluated the prototype "Classroom of the Future" to have achieved satisfactory results (AEGIS Training Center, 1991 ; Johnson, 1992 ; Johnson, 1992a ; Sine, 1992).

B. PROBLEMS ENCOUNTERED DURING PROTOTYPE TESTING

Few problems were encountered during the prototype testing of the "Classroom of the Future" (AEGIS Training Center, 1991; Guarracino, 1992 ; Johnson, 1992 ; Sine, 1992). Those problems that were discovered were generally technical in nature or due to the initial lack of experience with the total system. Formal and informal feedback procedures between instructors, students, technicians, and evaluators ensured that the concerns were noted. Most solutions were in place in time for the next ship's class.

1. Technical Problems

a. CAPS and IETM Not Connected

The instructor's CAPS and the Radio Communications System IETM system were not connected when the first class at St. Inigoes was conducted (AEGIS Training Center, 1991). Instructors could not control from CAPS what was seen on the students' workstations. Consequently, students could be browsing the system and possibly miss an important point emphasized by the instructor. This problem was easily resolved.

A classroom Local Area Network (LAN) was established thereby connecting the CAPS and the IETM workstations. A control box was installed by the instructor's station from which the workstations could be controlled as a group or individually. The LAN greatly enhanced the instructor's control over what was presented and increased instructor confidence in the system (Frerichs, 1992). During a visit to the facility, the networked class was demonstrated to the author by an instructor. The system seemed to be very functional and, in terms of control, unobtrusive from a student's perspective.

b. Visibility of Large Screen Display

The Large Screen Display used in the first class was reported to be difficult to see from the student workstations. The screen also did not display the same color highlights as indicated in verbal information from the instructor (AEGIS Training Center, 1992). The screen in place during the author's visit was sharp, bright, and clearly visible from any of the student workstations.

c. Instructor Mobility

In early classes, the instructors reported they felt "tied to the podium" while operating the CAPS (AEGIS Training Center, 1991 ; Frerichs, 1992). The introduction of an infra-red remote control device to interface with CAPS, similar to television remote controllers, allowed the instructor to retain system control and gain freedom of movement (Frerichs, 1992).

2. Instructor Perceptions

The instructors' initial perceptions of the "Classroom of the Future" appeared to be neutral to negative. Specific concerns included a perceived lack of eye contact with the students, uncertainty of what students were seeing on the workstation, and lack of system control. The technical changes previously discussed provided positive system control to the instructors. Student monitors could be "blanked-out" when the students' direct attention was required by the instructor. Instructors became certain that what was seen on the student workstations was the desired material. (AEGIS Training Center, 1991 ; Frerichs, 1992 ; Johnson, 1992)

C. AEGIS CLASSROOM OF THE FUTURE DEVELOPMENT PLAN

As part of the continuing evolution of the "Classroom of the Future," a joint effort between the ATC and NPRDC has been underway to develop a CALS-compliant open systems version of the "Classroom of the Future." This system is similar to the

prototype in design, but with a different authoring tool and operating system. NPRDC has developed a CAPS that uses the Navy's Authoring Instructional Materials (AIM) program.
The AIM program is a POSIX/UNIX-based authoring tool for design, development, and maintenance of training materials. The POSIX/UNIX operating system is used to control the multi-user microcomputer network. (Dickieson, 1992)

Testing of the ATC/NPRDC version of the "Classroom of the Future" will occur in three phases. Phase I will use the new CAPS and electronic instructor guide to conduct the two-week AEGIS Fundamentals course in September 1992. Phase II is planned for the February 1993 AEGIS Fundamentals course and will include CAPS, the electronic instructor guide, AIM integration, student workstations, student testing, student course critiques and the IETM (AEGIS Training Center, 1992 ; AEGIS Training Center , 1992b ; Johnson, 1992a).

Phase III is expected to occur in fiscal year 1994. Illustrated in Figure 5-1, this phase of the "Classroom of the Future" development will involve expanding the system to additional classrooms (Figure 5-1) and conducting the AEGIS Computer System Operation and Maintenance Course using IETMs and self-paced instructional modules (AEGIS Training Center, 1992a).

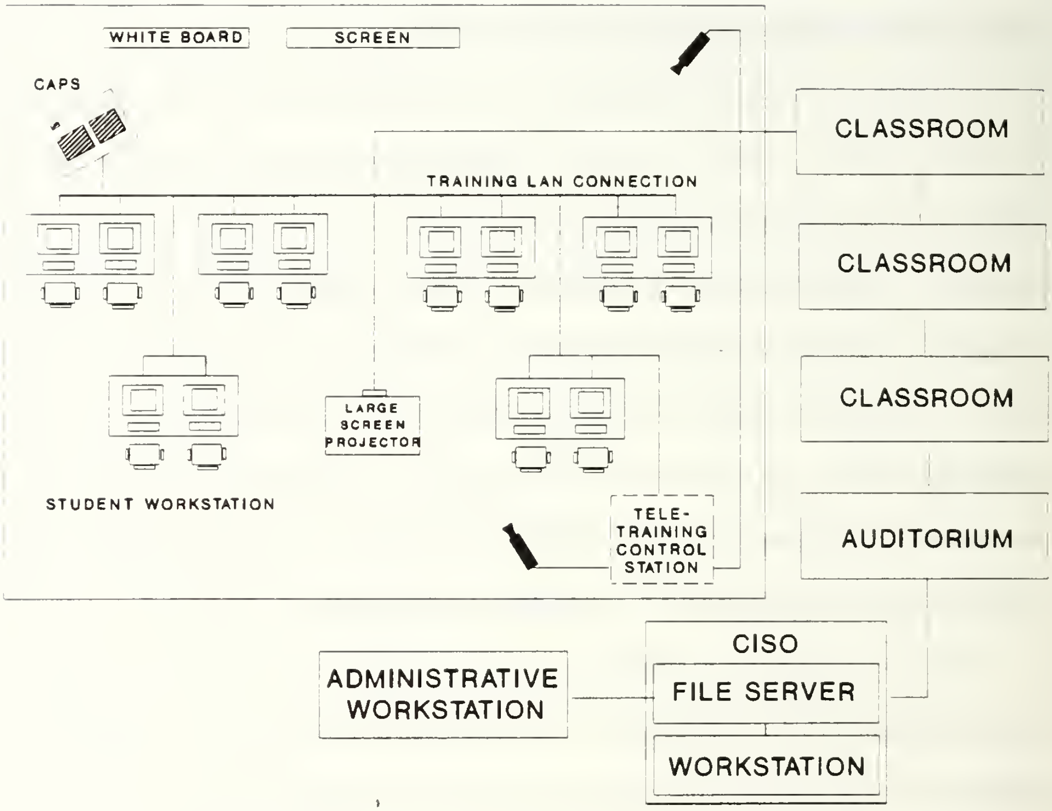

Figure 5-5 PHASE III
AEGIS Classroom of the Future
(AEGIS Training Center, 1992)

Funding for the "Classroom of the Future" involves an investment of $2,000,000 over four years by the AEGIS Training Center and the use of 6.2 funds by the Naval Personnel Research and Development Center for additional research and development. Technology based classrooms could save the ATC an estimated $2-4 million annually in staff reduction, reduced attrition, and reduction in basic skills tutoring. (AEGIS Training Center, 1992)

D. EXPECTED BENEFITS OF IMPLEMENTATION

The AEGIS program expects to achieve logistical, educational, and manpower-related benefits through the use of computer technology in training. Some benefits are quantifiable now and others should be realized as the "Classroom of the Future" matures.

1. Logistical Benefits

a. Reduced Volume and Cost of Supporting Data

Long and Long (1990) stated that the CD-ROM can store 250,000 pages of standard text. When the AEGIS Weapon System manuals for a single ARLEIGH BURKE destroyer are transitioned to IETM format, the 13 million pages normally distributed to users afloat and shore (CALS Resource and Implementation Cooperative, (RIC), 1992) could be stored on roughly 52 CD-ROMs (13m÷250k). This figure is only an approximation of the reduced volume of a single set of AEGIS Weapon System manuals. The actual number of AEGIS CD-ROMs that might be generated by the AEGIS Documentation Optical Production System was unavailable because the AEGIS Weapon System IETM project is still under development.

Transitioning support data to IETM format also offers substantial cost savings.

> The cost of the production, distribution, and maintenance of AEGIS Weapon System manuals) is $4,075,000. The cost of producing, distributing, and maintaining the same information in an optical-based IETM is $958,000...and

translates into a savings of $3,117,000 per new construction DDG-51 class destroyer. (CALS Resource and Implementation Cooperative (RIC), 1992)

Of the planned 29 ARLEIGH BURKE-class destroyers, the first eight ships are to be delivered with paper manuals since IETMs will still be under development. Therefore, by multiplying the cost difference figure of $3,117,000 by the remaining 21 ships, a gross savings of $65,457,000 is realized. The nonrecurring costs for the AEGIS Weapon System IETM transition will be $24,550,000. By subtracting the nonrecurring costs from the gross savings, a total net savings of $40,907,000 in cost avoidance is realized for the entire class of ships. (CALS Resource and Implementation Cooperative, (RIC), 1992)

The ATC technical library currently maintains 50,000 different AEGIS manuals with multiple copies made for curriculum use (CALS Resource and Implementation Cooperative, (RIC), 1992). When these manuals are replaced by IETMs, the AEGIS Training Center should see significant savings through reduced reproduction, maintenance, and storage costs.

b. Reduced Maintenance Costs of Supporting Data

Updates and changes to paper-based technical manuals cost the Navy $400 million per year (Naval Electronic Systems Engineering Activity, 1992). The production and distribution costs of paper changes should be reduced by use of electronic data storage. Other savings could be found in personnel reductions. Fewer people should be necessary to maintain supporting data as updates would be computer-generated and may be as simple as a disc exchange.

c. Reduced Storage Requirements

The large amount of storage space required by paper manuals can easily be reclaimed by electronic data storage. For example, two copies of paper Radio Communications System technical manuals occupy an estimated 104 cubic feet onboard ship (Naval Electronic Systems Engineering Activity, 1992). A single RCS IETM CD-ROM jewel box (storage case) measures only 10.05 cubic inches (5.5" x 4.875" x .375").

Electronic data storage should allow the ATC Technical Library to reclaim a very significant portion of the total vault storage area (41,280 cubic feet [Johnson, 1992]) currently filled with paper manuals.

d. Increased Classroom Utilization

The "Classroom of the Future" at ATC will access instructional material and technical documentation from the central file server and IETMs via the CAPS and student workstations. Since paper materials would not be required, the need to maintain dedicated support documentation in the classroom could be eliminated. As a result, classroom utilization at ATC would greatly improve. Any class could be taught in any room utilizing CAPS and the student workstations to access the appropriate lesson. As a result of increased utilization of the present facilities, the ATC estimates $13.8

million in proposed military construction costs for additional classrooms could be avoided (Sine, 1992 ; AEGIS Training Center, 1992c).

2. Educational Issues

The AEGIS "Classroom of the Future" is expected to provide many education benefits. The AEGIS Training Center expects to achieve shorter classes, increased student learning rates, and greater knowledge retention and transfer as a result of introducing CBI into the AEGIS training program. The RCS Team course results in these educational areas will be discussed in Chapter Six. Other benefits are also expected.

a. Student Literacy

Computer-based Instruction has been demonstrated to be a challenging, but non-threating, method for effectively enhancing student literacy (Fortune, 1991 ; Houlihan, 1991).

> In an environment where scholastic scores are steadily decreasing, it will become necessary for ATC to train technicians to maintain sophisticated electronic equipment to the present level. Given the lower reading and comprehension scores, ATC will be required to enhance the training experiences to compensate for these deficiencies, and do so in approximately the same time frame. Technology will aid in this endeavor. (AEGIS Training Center, 1992c)

b. Multi-media Presentation

"Capturing training material in digital format increases the availability of this information in a readily usable format" (AEGIS Training Center, 1992). By accessing photographs, digitized video, and audio through the instructional database, instructors can make quick and effective illustrations to students. Instructor preparation time is reduced because the need for obtaining video cassette recorders, projectors, or other audio-visual equipment before class is eliminated.

c. Increased Data Base Access

The availability of technical data in electronic data bases should allow ATC instructors and students to access information rapidly and efficiently. The Radio Communications System IETM provides such an example.

> Unlike conventional paper documentation, which requires you to cross-reference information among multiple, bulky technical manuals and cumbersome foldouts and schematic diagrams, the RCS IETM offers a wealth of interrelated text and graphics information available with a click of a mouse or a keystroke. All cross-references are handled by the computer: when you have found one kind of information about a subject, all related information is automatically available to you. (Naval Electronic Systems Engineering Activity, 1992)

d. Training Tailored to Audience

Instructors should be able to access instructor guides and tailor a presentation for varied audiences. The lesson could specifically focused on a need or particular level of training. The capability to customize lesson plans electronically eliminates the need for multiple copies of curriculum material designed for a particular audience. Cost savings should be seen in lower reproduction costs and increased instructor efficiency.

e. Remote Site Training

The "Classroom of the Future" should enhance the ability of ATC to export training. Standardized lessons can be produced from the instructional data base and sent to remote sites possibly on disc or by Video-TeleTraining. Cost savings could be achieved through reduced student travel expenses and lost manhours in transit to and from training. By transferring some training to computer-based instructional facilities onboard ship, even greater savings might be realized.

3. Manpower Issues

a. Billet Reductions

Through shorter classes and increased instructor productivity, ATC desires to reduce costs by decreasing the number on instructors necessary to teach a course. The implementation of CBIT is designed to aid in achieving the reduced costs.

Additional cost savings should be realized as a result of supporting data moving to electronic format. The number of personnel necessary to maintain the large paper data base should decrease as well.

b. Increased Productivity

The "Classroom of the Future" concept should increase an instructor's productive time by reducing time spent in lesson development, locating references, correcting publications, or searching for audio-visual material. By automating lesson planning, the instructor needs merely to download course material to the classroom. The need to find and reproduce material is eliminated by the electronic databases. As a result, instructors should be able to provide more student assistance or even conduct additional classes.

VI. EVALUATION OF THE AEGIS CLASSROOM OF THE FUTURE

A training program's effectiveness can be evaluated by four criteria: reaction, learning, behavioral, and results (Kirkpatrick, 1976).

Reaction criteria are simply the participants' reaction to the training. Surveys are generally used to determine this information.

> Reaction criteria measures how well the participants liked the program, including its content, the trainer, the methods used, and the surroundings in which the training to place. (Latham and Wexley, 1990)

Learning criteria evaluates how much the student learned. This evaluation could involve a test in which a student must correctly answer a certain number of questions or complete certain tasks within a given timeframe.

Behavioral criteria examine students' behavioral changes on the job as the result of training. In the Weyerhaeuser example in Chapter Three, the lost potential due to injuries dropped because the training caused behavioral changes in personnel safety awareness.

Results criteria are the overall value of the training program in helping a business or military command reach its goals.

A. RESULTS

The AEGIS "Classroom of the Future" is currently in the development and testing stage. Phase I testing of the joint ATC/Naval Personnel Research and Development Center electronic podium and AEGIS Fundamentals electronic Instructor's Guide began 21 September 1992.

The earlier Radio Communications System Team classes provided the opportunity to implement and evaluate the prototype CAPS and the RCS IETM system in an actual training environment. The goal of this experiment was twofold:

- determine what student and instructor reactions would be to the introduction of technology to the classroom.
- provide RCS IETM exposure and training to the operators and technicians of ships selected for RCS IETM operational testing.

(AEGIS Training Center, 1991)

Radiomen and technicians from USS ANZIO (CG-68), USS SHILOH (CG-67), USS VICKSBURG (CG-69), and USS JOHN BARRY (DDG-52) received Radio Communications System Team training in four separate classes tailored to their ship. Classes were composed of 18 to 22 students and were taught by five instructors. Training consisted of two weeks of lecture and one week of lab. Student reactions to CBI were measured in pre- and post-course surveys. Instructor reactions were surveyed in the same manner.

Reaction surveys showed a split response to the technology used in the classroom. Students were generally enthusiastic while instructors were neutral to negative about the system (AEGIS Training Center, 1991). Much of the instructors' reactions were attributable to the technical problems discussed in the previous chapter. Frustration with the system caused a negative reaction. As time spent with the system increased and experience was gained, instructor reactions improved (Johnson, 1992a).

Learning criteria indicated no significant increase or decrease in student achievement. However, these classes should not be compared to previous traditional courses nor to each other. There is not enough data available yet to compare the CBI courses to previous traditional courses and expect statistically significant numbers. The CBI courses should not be compared to each other either. The initial technical problems present in the first course could have affected student outcomes. Students in later courses should not have been affected because the problem was corrected.

Behavioral criteria are unavailable. Not all the test ships are in commission yet. Those ships that are commissioned are in training exercises for later overseas deployment. Behavioral information will be collected through feedback at the conclusion of deployments.

Results criteria such as cost savings from shorter classes cannot be determined so early in the program's development.

As discussed in Chapter III, many studies have shown that students can complete a CBI courses in a shorter period than in a traditional course (Kulik and Kulik, 1987 ; Orlansky and String, 1981). The four three-week Radio Communications System Team courses taught using CAPS and the RCS IETM system did not see a reduction in training time. However, because of the developmental nature of the program, a reduction was not expected (AEGIS Training Center, 1991 ; Johnson, 1992). As the "Classroom of the Future" matures, duration of training will be an important factor in determining the efficiency of the program.

B. RECOMMENDATIONS

Although the "Classroom of the Future" is still in development and testing, long-range planning for the evaluation of the program should be developed.

1. CBI Effectiveness in the AEGIS Training Program

A large amount of data from traditional instruction already exists. The traditional data base should be collected, examined for accuracy and completeness, and made ready for statistical comparison to CBI data. As more data from the AEGIS "Classroom of the Future" becomes available, the information should be collected, examined for accuracy, and compared to the clean traditional data base to determine CBI effectiveness. Areas that should be examined are achievement, attitude, attrition, and training duration.

2. AEGIS CBI in Long-Term Job Performance

Some studies have shown that CBI increases skill retention and job performance (Hassett and Dukes, 1986). A difficult evaluation involves determining the effectiveness of CBI in long-term job performance. In order to accomplish this evaluation, conventional job performance factors must be measured first so that later, when CBIT is affecting job accomplishment, the two types of performance can be compared. At a minimum, skill retention should be tested at several points in time to assess skill decay from CBIT. Learning how long skills stay in place as a result of CBI is essential information in planning refresher training. This knowledge could allow AEGIS Training Support Groups to schedule refresher training to occur at the optimum point in time for maximum benefit.

VII. SUMMARY AND CONCLUSIONS

A. SUMMARY

The purpose of this thesis was to examine how the AEGIS training program is utilizing CBIT to increase efficiency and effectiveness in a period of declining budgets and increasing technology. The primary area of interest was the AEGIS "Classroom of the Future," and the benefits and problems with its implementation. Primary sources of information were literature on the subject of CBIT, archival data from the AEGIS Training Center, interviews with AEGIS personnel involved in the implementation process, and observations based on two visits to the AEGIS Training Center.

B. CONCLUSIONS

Computer-Based Instructional Technology (CBIT) offers many benefits in terms of increasing efficiency and effectiveness and reducing training costs. The "Classroom of the Future" project should allow the AEGIS Training Center to take advantage of these benefits.

By transitioning paper-based manuals to CD-ROM-based Interactive Electronic Technical Manuals (IETM), the AEGIS program can realize significant cost reductions in the production, distribution, storage, and maintenance of technical data. The Computer-Aided Presentation Station

(CAPS) and student workstations will allow data from IETMs and central file servers to be accessed from any classroom allowing more efficient use of class space. CBIT provides significant remote site training capabilities which can further reduce training costs and increase efficiency.

Development and testing of the AEGIS "Classroom of the Future" is still in the early stages and therefore significant changes in training effectiveness have not been noted. Reaction surveys do show positive attitude responses by students and improving attitude responses by instructors (Johnson, 1992a). Results of previous CBIT studies show that classes can be shortened and student achievement levels increased as a result of computer based instruction. Such results are expected at the AEGIS Training Center, but must be confirmed through analysis. Data must be collected and compared to data from traditional methods of instruction to determine the effectiveness of the "Classroom of the Future".

The implementation of the "Classroom of the Future" is well-planned as evidenced by the few problems experienced during the prototype evaluation at AEGIS Training Support Group, Naval Electronic Systems Engineering Activity, St. Inigoes, Maryland. The quick resolution of the problems encountered demonstrates good management reaction and cooperation by the developers and trainers. The AEGIS Training Center's co-location at the Naval Surface Warfare Center with the engineers, technicians, and equipment necessary to solve problems offers the ATC a distinct advantage over other training locations.

There is still much to learn about computer-based instruction and how technology can affect the human learning process. The AEGIS Training Center recognizes the need for continued study and has provided the Naval Postgraduate School, Monterey, California, with several research topics relating to technology and training.

The "Classroom of the Future" project represents a vehicle for analysis and evaluation of CBI for years to come. This thesis has examined the background and early development of the program and provides a foundation for further research.

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