EXTENDING CLASSROOMS TO THE MILITARY WORKPLACE

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ABSTRACT

This paper identifies an architecture and an educational program structure that would promote enhanced training effectiveness for military personnel by extending the traditional school classrooms to the military personnel's workplace and by providing a more flexible curriculum schedule. The Navy's surface ship and submarine forces responsible for sonar and weapons systems will be used to illustrate examples of how this architecture can be implemented to extend classes from the Navy's classrooms to ships, bases, offices, and remote locations. We illustrate how distance learning systems can be used as the backbone for this architecture and how the student workstations in this architecture also can be used to accomplish Computer-Based Training (CBT), Part Task Training (PTT), and operational training, among others. We will identify technologies, such as video and audio digital compression, that provide the capabilities for the two-way interactive participation between an instructor and students at separate locations. Finally, we will address how this architecture can help eliminate problems with student availability and costs for access to the traditional classrooms, as well as facilitate a student's natural progression through an established curriculum.

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INTRODUCTION

The Navy's training programs provide well established curriculum guides through a training continuum plan. The plan identifies the courses, course sequences, and course content for military career advancement. While the Navy has adequately trained its personnel under its training program, this paper addresses how to improve these training programs by taking advantage of advances in technology. First, we will look at problems with the Navy's training program as perceived by some of its own instructors. Then, we will identify a training program structure and a training system based on distance learning (DL) that can be blended into the current training program to address these problems and improve its overall effectiveness. Finally, we will discuss the components of the DL training system and the rôle of each.

Since cost is always a concern, it is important to note that the components identified are commercially available or have been developed for research projects or existing customers. Thus, the concepts are proven and in use today.

AREAS FOR IMPROVEMENT

A recent National Security Industrial Association (NSIA) study, the Detection and Classification Training Commonality Study[1], was conducted by the Training and Operability Subcommittee of the Anti-Submarine Warfare Committee. In this study, the Navy's surface ship, submarine, air, and Integrated Undersea Surveillance System (IUSS) training communities at schoolhouses across the United States were questioned about the training methods, tools, and aids used in their programs. The major areas of concern identified by the instructors during this study are outlined below:

1. It is difficult to match student and class schedules: Many factors make it difficult to place personnel into classes in the planned sequences. Obstacles include active sea duty for extended periods, the lack of budget for travel expenses to attend classes, assignments at remote locations, and job obligations conflicting with class schedules. As a result, students often are entered into classes without the prerequisites or are sent to active duty without attending the recommended classes.

2. Class length is limited to five days: A number of courses offered are limited to five days because of student availability. In particular, it is difficult to get officers away from their assignments for more than five days. As a result, the instructors have been forced to cut valuable course material.

3. Remote assignments interrupt training continuity: Active duty on surface ships, submarines, and remote installations interrupts the ability of military personnel to continue training in the standard classroom structure. Onboard training (OBT) programs have been started for surface ships and submarines, but they currently do not provide the level of education offered in the classroom.

4. Lack of common methods and course content: The NSIA study found that the four Navy groups did not use the same terminology and often did not teach the same concepts for anti-submarine detection and classification fundamentals. Even more revealing was that within a community there were differences in what was taught between the east and west coast classrooms.

5. Limited budgets for instructors: The current military school structure has a limited number of instructors and locations similar to a traditional university model. Budgets do not exist to build more centralized schools and employ more instructors. However, the problem of how to provide additional and better education to personnel without adding instructors or schools is still valid.

6. Few Training Aids: Most of the instructors indicated there were few training aids, such as models of engines, movies, and actual devices found in active duty available to use for *show and tell* during classes. Similarly, there were few automated classrooms to provide either CBT or instructor-controlled simulation training. Classes were typically traditional stand-up blackboard lectures, but in cases such as sonar training, the lectures were followed with team exercises on a large weapons system trainer.

7. Active duty without refresher classes allows skills to deteriorate: The current detection and classification classes introduce and build skills that prepare students to identify the various contacts they may encounter. However, during any active duty period, many of these contacts may not be encountered. As a result of not using (and thus reinforcing) some of the contact information taught in class, the associated skills of these personnel deteriorate or are totally lost. The ability to refresh or improve skills during active duty is important but is only partially met by today's OBT programs.

EXTENDING CLASSES TO THE OFFICE

The seven problems listed can be addressed by a combination of changes in the methods of education offered to military personnel and the equipment used to teach these personnel. Key to the methods and equipment described below is that they exist and are in use today in some form. Thus, the educational structure used by the military can be enhanced without major new development activities.

There are a few basic concepts that, when combined, address the seven problems with traditional classrooms described above and provide a flexible, yet powerful, training capability:

1. Schedule classes similar to universities. Scheduling 2 to 3 meetings per week, for 1 to 2 hours per meeting, will allow personnel to attend classes without being removed from their jobs for days. Between classes, students will have the time to reinforce the class material through out-of-class research and assignments. Companies successfully use this approach by allowing employees to take time from work to attend classes.

2. Integrate multimedia devices into classrooms. While there are a few classrooms in traditional military schools that contain a network of PCs connected to an instructor's PC, none contain the capabilities that multimedia PC devices bring to the classroom. Video lectures, written text, two-way interactive exercises between students and instructor, computer-based tests, automated student evaluations, and student statistics are but a few of the improvements that are possible. Since multimedia PCs can double as CBT, operational training, and normal office machines, classrooms with multimedia PCs are flexible and can be used for various activities. Incorporating training aids involving full motion video is facilitated with a multimedia-automated classroom.

3. Broadcast interactive classes to other military locations. DL is a natural extension of the automated classroom. It allows one instructor to reach more students simultaneously, reduces student travel costs, provides training using a common course with a common instructor, makes classes more accessible to personnel so they can attend classes in the proper sequences, and provides more flexibility in the scheduling of classes.

The multimedia capability to display full motion video (FMV) with audio and interactive text on the PC display provides the basis to extend the classroom from schoolhouses to other locations without sacrificing the visual and interactive environment of the traditional classroom. This allows classes to be broadcast from a central location, such as a school, to many government military locations.

Communications between sites is accomplished using satellite or terrestrial lines. Today, this educational structure is popular in metropolitan areas where companies have employees seeking advanced degrees. Local universities broadcast classes directly to company locations and other university campuses, where DL classrooms are established. Thus, student travel to the university campus is eliminated. Similarly, companies, such as IBM, transmit classes via satellite to their locations across the country thus providing common training to personnel at all locations. These classes permit two-way student and instructor communications. Effectively, DL expands any physical class size without bound. This permits personnel to attend classes from their base or ship while on duty, and permits the traditional university class schedule. DL also allows exercises (such as homework) to be mixed into classes to improve student retention. The DL and university scheduling changes can be viewed as additions to the current school structure. Receipt of DL broadcasts requires a network of remote classrooms at the bases, installations, onboard ships, or on moveable platforms such as semitrailers.

4. Record classes and deliver them to personnel, such as submarine crews. This provides delayed access to classes and continued training for personnel. With this concept, recorded lectures and assignments are supplied to personnel who would use multimedia PCs to view lectures and complete assignments, as well as execute computer-based or operational training exercises. This is already used within the submarine OBT program, but is limited to a library of video tapes for a specific set of information. The scope of the current OBT program expands dramatically with the use of a multimedia device. Class lectures, seminars, information, announcements, and more can be relayed to personnel without direct access to DL classrooms. Education can continue and skills can be strengthened while on duty.

5. Use a common classroom workstation for all types of training. This provides flexibility in the use of the training equipment and reduces the total cost of equipment to accomplish the various types of training due to the use of a common platform. The common workstation can be scheduled for in-house classes, DL classes, CBT, PTT, operational or any other training activity throughout the day. This also provides a portable, inexpensive platform for use in traditional schools, offices, ships, moveable platforms, or at remote locations.

6. Expand use of CBT to bring more training flexibility to remote sites, surface ships, and submarines. CBT can provide exercises that supplement recorded lectures. The use of CBT should, and can, be expanded to include more than just information learning. The power of PCs and workstations provides the ability to conduct operational training (for example, sonar operators) similar to that provided by the simulations contained in large weapon system team trainers. Real-time simulations of sonar displays exist on PCs and have been used as prototypes for large team trainer developments. The expansion of these prototypes to interactive operational training devices is feasible and portable.

7. Use portable classrooms at remote locations (for example, the desert). This is a natural extension for the DL, CBT, and Lecture Replay equipment, which is portable and can be transported anywhere on a moveable platform that can supply power, cooling, and communication link facilities. Platforms, such as semitrailers equipped with the training devices, power generation equipment, cooling equipment, and the communication transmit and receive equipment, are ideal. These portable classrooms can be moved to student locations whether they are permanent military personnel or reserves on a training weekend. A subset of this concept was contained in the Close Combat Tactical Trainer Request For Proposal for vehicle simulation modules. The idea is easily expanded to include the devices needed for general CBT, remote lecture review, and DL classrooms.

ARCHITECTURE AND TECHNOLOGY

The classroom system architecture supports a modular, building block approach for developing and enhancing classroom system training solutions. Modularity is accomplished by defining a standard interface between Commercial Off-The-Shelf (COTS) hardware and software products and complying with industry standards whenever possible. This modular concept allows system upgrades with minimal or no changes to existing hardware and software, thus resulting in reduced system upgrade costs. The architecture is targeted to classroom applications that require platforms to support self-paced and instructor-led lecture training.

Refer to Figure 1 for a block diagram representation of the classroom system architecture. Two architectures are presented: an overall architecture that supports DL and a workstation architecture. The architectures support a wide range of training applications from CBT to fully interactive DL and video conferencing.

Instructor-Led Lecture

DL is a form of instructor-led lecture where lessons are delivered to students at remote classrooms in addition to within the four walls of the conventional classroom. The receive sites can be connected via satellite, Local Area Network (LAN), or terrestrial interfaces. Figure 2 illustrates the connection elements from the classroom to any military facility whether it be another classroom, a remote location, a port, an air base, a surface ship, a portable transport platform, or even an office. The goal of the architecture is to provide a buffer between the application code and communication interface such that receive sites can be connected to the broadcast location over multiple, heterogeneous interfaces. Locations unable to receive broadcasts, such as submerged submarines, can use workstations for self-paced training. When the submarines are docked, these workstations can easily be configured as DL student stations.

DL System Functional Description

The DL systems manage sites connected to the LAN, terrestrial, and satellite interfaces. It supports FMV, text, graphics, and computer data transmissions. FMV is supplied from a camera, laser disc, document camera, or VCR. Computer data is in the form of text, graphics, or control commands. The instructor controls the entire environment from a single station. Transmissions over the LAN use an IBM device called the F-Coupler. This device sends analog video and data over a token ring cabling network. Students connected over the LAN receive the same video and audio information transmitted to remote locations. The information is displayed on the student's workstation monitor. Receive locations are configured as LAN-based workstations, single workstations, or as a classroom having a large screen projection system and student keypads. The broadcast system controls student workstations and keypads to allow the instructor to register students and ask questions. Students use the stations to answer instructor questions and to ask questions. Receive sites are monitored to check for students' questions and the status of satellite receive site equipment. The broadcast processor also controls the operation of video equipment at receive sites to record lectures for replay later.

Receive sites transmit question results, student audio, and computer status information back to the broadcast location over satellite, LAN, or terrestrial interfaces. Satellite transmissions are performed using a channel-sharing access method. The broadcast location sends transmit commands to every receive site to control backwards transmissions. This method is necessary because it would be very costly for every receive site to have its own satellite channel. LAN-connected receive sites use the LAN-communication protocol to control backward transmissions. Receive sites using the terrestrial lines do not need a communication controller since every site has an independent

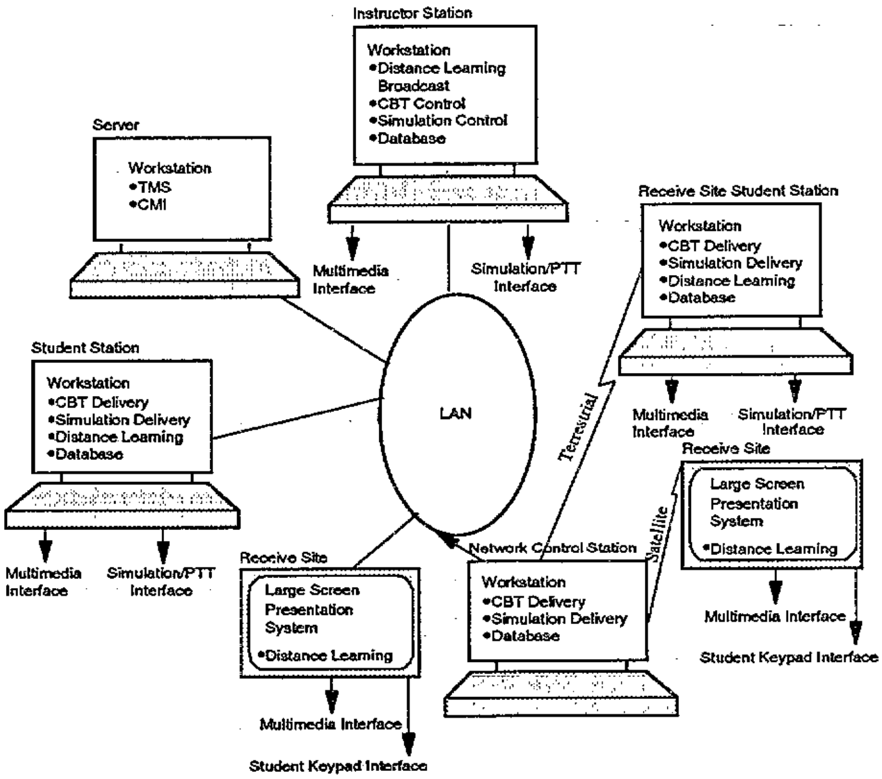

Figure 1. Classroom System Architecture 920037X5

transmission interface to the broadcast location.

DL Technologies

Advancements in digital transmission (DT) technologies have had a major impact on DL and video conferencing. Specifically, the evolution in digital compression techniques has resulted in the transmission of near-broadcast quality video within a T1 (1.54 mbps) bandwidth. Digital Coder/Decoders (CODEC) have been developed using compression algorithms such as Discrete Cosine Transforms (DCT) and Vector Quantization. These algorithms significantly reduce the amount of information being transmitted by filtering out redundant color information and by sending only changes in video scenes. The primary advantages of digital over analog transmission are:

- Requires less uplink power
- Satellite transponders accept multiple DTs
- Send computer data with video or audio
- Costly encryption devices are not needed; computer data can be used to develop access protection algorithms
- Lower life cycle costs (satellite costs).

Receive site satellite equipment also has been significantly reduced because of advancements in DT techniques. A receive site can consist of a small antenna (1.2 m), a block down converter, and a very inexpensive receiver. Of course, the actual configuration of a receive site depends on satellite position and transponder power. Very Small Aperture Terminals (VSAT) are commonly used to receive high-speed digital transmission. These VSATs can easily be installed at receive site classrooms, docks, and on ships.

Satellite transmission standards exist to ensure interoperability between different satellite equipment (described below) in areas such as video coding, communication, control,

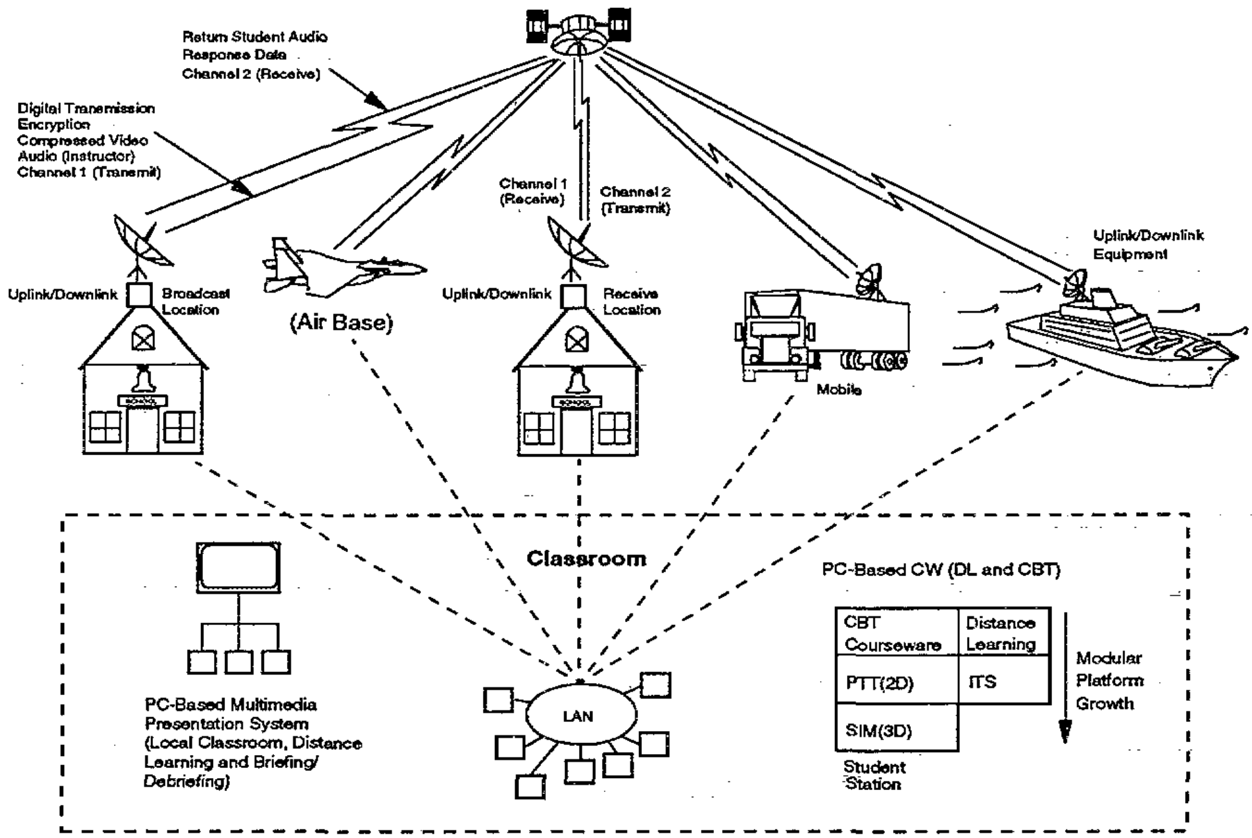

Figure 2. Distance Learning Network

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and audio compression. The most visible standard for CODEC is H.261, better known as Px64 and the Motion Picture Expert Group (MPEG)[2,3].

Satellite forward transmissions are sent using CODECs (compress audio, video, and data; digitize; multiplex), a modem (modulate; demodulate), and uplink equipment (up-converter, amplifier, and antenna) which use modulation access methods (Single Channel Per Carrier; Time Division Multiple Access). Remote sites use a low noise block down-converter (demodulate) and a receiver (demultiplex) to provide analog audio, video, and data at baseband levels.

Remote site backward transmissions use an audio data CODEC, a quick access modem and uplink equipment including a satellite antenna. Digital and analog transmissions can be supported, though analog transmissions require an expensive transmission device. Broadcast sites require a quick access demodulator (control receive sites), and a decoder (extract key pad and audio data). For terrestrial returns, equipment such as Digital Service Units and Channel Service Units are needed. Echo cancellation units are also needed to reduce the effects of satellite delays and audio feedback.

Classroom Workstation (CW) Architecture

The minimum configuration for a self-paced training device is a workstation that delivers lessons to students with various levels of fidelity. This CW also provides methods for testing the student and recording results. Student remediation is supported by controlling branching within the lesson. These capabilities satisfy the generic requirements for

CBT platforms. The architecture supports workstation capability enhancements beyond CBT by defining standard interfaces that allow upward migration of the platform to support PTT, 2D and 3D simulation, Intelligent Tutoring System (ITS) and DL.

CBT: CW Functional Capabilities

The CW is used as the interface to students for classroom training. At a minimum, the CW delivers CBT lessons to students in a stand-alone or networked environment. In a net-worked environment, a CW can access lessons from its internal hard drive, Compact Disc (CD) Read-Only Memory (ROM), Electrical Read/writable Optical Disc (EROD) or a central file server. The file server can perform as another workstation, print server, database server, or curriculum development station. The file server also can be used to implement a Training Management System (TMS) to maintain student rosters, lesson materials, access protection, and perform Computer Managed Instruction (CMI) tasks. The server is a modular upgrade to the student CW since it can perform as both a file server and student station. Also, since every CW can be configured with a database, the classroom easily can be upgraded to operate in a distributed database network. CWs having built-in databases are beneficial for training devices that are needed on surface ships and submarines to teach students while at sea. The devices could maintain security and retain CMI information for a large number of students taking lessons. The CW architecture also supports an easy method of enhancing the baseline workstation to support evolving multimedia technologies such as Digital Video Interactive (DVI), FMV (frame grabbers), digital audio, and digitized images (video capture).

These technologies can be used to enhance the CBT delivery. A major problem with using these technologies is the lack of standardized interfaces. This has resulted in vendors writing proprietary hardware drivers and developing internal data formats. IBM and Microsoft have jointly developed an industry-accepted interface to multimedia devices using multimedia extensions. These extensions serve as a buffer between the application and multimedia hardware, such as video disks and digital audio cards. The workstation is no longer tied to a specific vendor. The only limitation is vendors must comply with the established multimedia extension definitions to ensure product acceptance. Other government and private industry organizations such as the Interactive Multimedia Association (IMA) and National Institute of Standards and Technology (NIST) are working on multimedia data formats, data conversion, and hardware interface standards. If private industry has not adopted a standard interface to specific multimedia devices, the architecture will allow the military to establish a standard by defining Application Program Interfaces (APIs) and Dynamic Link Libraries (DLLs). DLLs allow applications to load drivers when the appropriate application executes. The DLL could be a driver or interface to a driver. When the application completes the execution, the DLL is removed from memory. The DLL can be shared between many applications. The API defines the software interface to DLLs and device drivers. APIs and DLLs can be used to develop an internal interface standard to ensure that existing platforms can take advantage of future technologies.

Other industry standards that will have an impact on the workstation configuration are MPEG and the Joint Photographic Expert Group (JPEG). These standards define digital compression algorithms for motion on digital storage media (DSM) and still pictures, respectively. This architecture, with the appropriate hardware, supports the development and integration of DLLs and APIs to allow existing workstations to use the new compression techniques.

DVI is another compression technique for digital storage media. However, it is not accepted as an industry standard; it is an internal compression algorithm developed by Intel and IBM. Intel and IBM market a DVI-based capture and playback card. With DVI, workstations can deliver FMV without using a laser disc or VHS, which is ideal for space-limited submarines and surface ships. The architecture will allow DVI to be integrated with the TMS and CMI using APIs and DLLs. DVI is integrated into a training system, versus standalone training, to enhance existing instructor-led lecture and self-paced training applications.

The migration of a CW into a PTT or simulation device is accomplished by integrating actual operational equipment with the CW or developing a front panel using graphics or digitized images on the CW. Both methods require the generation of courseware or simulation code. Courseware is code that is responsible for presenting material to the student, monitoring student progress, responding to instructor commands, and controlling simulation. The simulation code is responsible for presenting screens to the user, implementing scenario changes, or controlling operational or test equipment. A requirement (above those for conventional CBT) imposed on PTT and simulation training is the instructor's ability to monitor the student's progress. Specifically, the courseware responds to commands from an instructor station to control simulation scenarios or send student responses to the instructor. API and DLLs can be developed to interface between the courseware, instructor station, and simulation code. These interfaces define generic commands to be issued to the courseware and simulation code.

An ITS is an expert system that acts as a tutor during CBT applications. The ITS runs in the background and directs the courseware and simulation based on student responses. The ITS also implements different teaching strategies to adapt to student needs.

DL: CW Functional Capabilities

DL configured CWs, dependent on software/hardware components, support three functions:

- A station to allow the instructor to interact with receive site locations
- A platform to monitor and control the DL network
- A device to provide student inputs.

The instructor station controls video equipment, transmissions, and student interaction. The communication interface and driver software are identical to those used for CBT. The only difference is that commands are being issued by an instructor instead of by the CBT courseware. Examples of instructor commands used to control the network are:

- Configure receive sites into a network
- Enroll students
- Select receive site for student audio
- Ask students questions
- Display student responses.

The network control processor sends commands to receive sites and monitors the status of receive sites. All data packing and data validity checking are performed by this processor, as well as the control and monitoring of DL equipment.

The requirement for a student CW operating in a DL environment is to perform as an input device for answering and asking questions. The CW displays the transmitted video in a full, half, or quarter screen. Three video transmissions can be displayed on the CW with only one active. The instructor can send questions, graphics, and video to the CW. The instructor can enable CWs for question inputs and disable CWs not enrolled in the class. The DL software is activated when the CW is powered up and runs in the background until an execute command is detected. Upon detection, the software notifies the student of the start of a DL class and becomes the active task.

The CW architecture supports CBT and DL software running as separate tasks, with each being capable of becoming the active task upon requests from either the instructor or student. For example, when a student is performing a self-paced lesson, the instructor can issue a roster command, which causes the DL task to become active simultaneously and vice versa. Also, when a student is participating in a DL session, the student can start a CBT lesson, but still be part of the DL classroom. The DL software operates independently in a seamless environment with the CBT and other training applications. No restrictions are placed on other training applications when the DL software is running. Thus, a CW originally configured to support only CBT can easily be upgraded to support DL.

CW Hardware and Software Components

The hardware and software required to accomplish the CW extensions and capabilities previously discussed are either available commercially or have been developed and demonstrated as part of independent research and development projects conducted at IBM Federal Systems Company at the Manassas, Virginia facility. The following are required - 1. Hardware (minimum): 386 Processor; 120 MB hard drive; 8 MB RAM; VGA graphics; FMV Board; DVI Board; LAN Adapter; CD ROM or EROD; Digital Audio Board; NTDS Board, PTT equipment; Speakers; Amplifiers; Serial cards; F-Coupler; 2. Software: Multitasking Operating System; CBT Authoring/Delivery Program; Simulation Modules; Multimedia Device Drivers; Database; Database Interface; Security/Access Control; DVI Authoring/Delivery Program; Communication DLLs; DL; and TMS.

SUMMARY

The implementation of the proposed classroom system architecture will result in training systems that are capable of supporting CBT, simulation, and distance learning on one modular platform. This architecture resolves existing training problems such as instructor availability, lesson continuity, growth potential, training costs, and student availability, by providing methods for training at remote locations and providing powerful workstations with growth potential.

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