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AD-A226 734

A Two-point Videoteletraining System: Design, Development, and Evaluation

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September 1990

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Dist	Avail and/or Special
A-1	

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Navy Personnel Research and Development Center
San Diego, California 92152-6800

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 1990		3. REPORT TYPE AND DATE COVERED Interim	
4. TITLE AND SUBTITLE A Two-point Videoteletraining System: Design, Development, and Evaluation				5. FUNDING NUMBERS Program Element 0602233N Work Unit RM33T23.02	
6. AUTHOR(S) H. Simpson, H. L. Pugh, S. W. Parchman					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Navy Personnel Research and Development Center San Diego, California 92152-6800				8. PERFORMING ORGANIZATION NPRDC-TR-90-	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Technology (Code 222) 800 N. Quincy, Ballston Towers #1 Arlington, VA 22217-5000				10. SPONSORING/MONITORING	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The objective of the work was to design, develop, and evaluate an experimental two-point videoteletraining (VTT) system consisting of two classrooms equipped with audio and video equipment and communication links to enable two-way communication between the classrooms. The approach involved a survey of VTT systems; development of system design guidelines; definition of personnel, training, and logistics requirements; system design and development; and system evaluation. Findings were that student attitudes and performance on examinations were comparable in originating and receiving classrooms. Students at the remote site were more likely to comment on deficiencies of the VTT system and were particularly sensitive to audio problems. Instructor acceptance of the VTT system was high. Several types of technical difficulties occurred during the field test. Most of these problems were resolved, through audio quality was never fully satisfactory. A preliminary cost analysis indicated that conducting training with a T1-based, two-way VTT system is more costly than sending an instructor to a remote site but that VTT can be less costly than having students travel to the instructor.					
14. SUBJECT TERMS Distance training, distance education, teletraining, instructional television				15. NUMBER OF PAGES 55	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UNLIMITED		

FOREWORD

This technical report describes work conducted as part of the Navy Personnel Research and Development Center's Communication Networks in Training (CNIT) project in the general area of remote-site training. The CNIT project is one part of the Schoolhouse Training product line and falls under the Personnel and Training Technology (NP2A) Block of the 6.2 Mission Support Technology Program Element 0602233N (Work Unit RM33T23.02). The work was performed under the sponsorship of the Office of Naval Technology.

The objective of the project is to find more cost-effective ways to train personnel who are geographically remote from training resources. The project has been exploring the use of new communication technologies to export classroom training to geographically-remote students. Among these technologies are two-way video, computer networking, facsimile, and other media. This technical report describes the west coast videoteletraining demonstration project, which was conducted during FY89 and FY90. The report documents work performed and provides a sketch of the videoteletraining system that was designed, developed, and evaluated.

The recommendations in this technical report are intended for use by the Chief of Naval Education and Training and Chief of Naval Operations (OP-11) in developing policy for the application of advanced communication technology to Navy training.

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ACKNOWLEDGEMENTS

The West Coast videoteletraining demonstration project was a joint effort involving personnel from five different commands. The authors gratefully acknowledge the help of the various participants in the conduct of the research reported in this document. CDR Brad Winsted, training officer, and LCDR Shelley Cruze, videoteletraining action officer, from Commander Training Command, U.S. Pacific Fleet, played key leadership roles. Fleet Combat Training Center, Pacific, provided engineering support and originating facilities for conducting the project, under the management of CDR Larry Willits, engineering officer, Dale Turner, engineer, and Kyle Matzke, engineer. Fleet Training Center, San Diego, provided instructors and adapted instructional materials for delivery in the videoteletraining classroom. We are indebted to education specialists Brad Simos and Linnette Pace, and to instructors MMC Raymond Sugel, BT1 Richard Deressen, ENC Dale Cruse, and EN1 Chiu-Kin Yu. Naval Technical Training Center, Treasure Island, made its facilities available as the receiving site, where Victoria Baugh, education specialist, coordinated the project.

SUMMARY

Problem and Background

Because of the wide geographic dispersal of home ports, fleet units, and Navy Reserve detachments, it is very expensive to bring Navy personnel to a few facilities for classroom training. The costs not only involve transportation and travel expenses, but also the time lost from duty. New communications technologies have the potential to reduce the cost of geography on training. For example, Videoteletraining (VTT) can be used to deliver instruction with two-way instructional television and may link students and instructor across great distances. The solution to the Navy's remote-site training problem lies in the proper selection and use of new communication technologies such as VTT.

Objective

The overall objective of the project is to explore technologically cost-effective ways to train personnel who are geographically remote from training resources. The objective of the work described in this report was to design, develop, and evaluate an experimental two-point VTT system. The system consisted of two classrooms equipped with audio and video equipment, interfaces, and communication links to enable fully-interactive two-way video between the classrooms.

Approach

The approach involved a survey of VTT systems; development of system design guidelines; definition of personnel, training, and logistics requirements; system design and development; and system evaluation.

Findings

Student performance on examinations was comparable in originating and receiving classrooms. Student attitudes were similar at originating and receiving sites. However, students at the remote site did not feel that they had as much access to the instructor as students at the originating site; possibly because of this, they gave the instructor a lower overall performance rating. Students at the remote site were more likely to comment on deficiencies of the VTT system; they were particularly sensitive to audio problems.

Students at both locations indicated that they wanted to see their cohorts at the other site. This is an expressed attitude which supports the use of two-way video.

Instructor acceptance of the VTT system was high. However, only two instructors participated in the field test and this finding needs further verification.

Several types of technical difficulties occurred during the field test, particularly at the beginning. Most of these problems were resolved as the bugs were gradually worked out of the system. However, audio quality was never fully satisfactory and remained a problem throughout the field test.

A preliminary cost analysis indicates that conducting training with a T1-based, two-way VTT system is more costly than sending an instructor to a remote site but that VTT can be less costly than having students travel to the instructor.

Recommendations

1. The Chief of Naval Education and Training (CNET) should conduct cost analyses using a variety of real-world scenarios to determine cost break-even points for multi-point, satellite-based VTT systems using simplex and fully-duplexed transmission modes.
2. VTT instructor training methods and materials developed by Navy Personnel Research and Development Center (NPRDC) should be refined into a VTT instructor training course that includes learning objectives and tests, course outline, instructional strategies, learning activities and resources, and other essential curriculum elements. Upon completion, CNET and Chief of Naval Technical Training (CNTT) should consider this material for inclusion in curriculum development and delivery guidance, such as the forthcoming Naval Education and Training (NAVEDTRA) 130-series publications.
3. Research should be conducted to determine the relative costs and effectiveness in meeting training objectives of live instruction, one-way video, two-way video, multi-channel two-way video, videotape instruction with on-line instructor access, and videotape instruction without instructor access.
4. Research should be conducted to determine the most effective instructional methods, strategies, and instructional materials to use in the VTT classroom. The research should explore the applicability of VTT to a range of different types of courses, and include laboratory as well as lecture-based instruction.

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INTRODUCTION

Problem and Background

A requirement exists to train Navy personnel who are geographically remote from training resources. This requirement exists throughout the Navy, but is perhaps most obvious for personnel aboard ships at sea. Shipboard training is limited by available training resources and the skills of shipboard trainers. By necessity, personnel are periodically assigned to formal schools to receive training they cannot receive aboard ship. Strategic Homeporting is causing the dispersal of Navy ships over a greater number of smaller, more geographically isolated ports. As training resources and personnel tend to concentrate near larger ports, strategic homeporting can be expected to accentuate the training problem. Even through strategic homeporting appears to be reduced in scope, the locations of existing training facilities often require fleet personnel to travel away from their home duty station to complete required training. The remote-site training requirement also exists in the Navy reserves. Reservists typically belong to small detachments, widely dispersed geographically, with limited training resources, few qualified trainers, and little time to train. The requirement to overcome geographic distance in training delivery is a generic problem that exists in the civilian public education and industrial world as well as in the military world.

Evolving technologies have the potential to reduce the impact of geography on training. For example, two-way interactive television can link together instructors and students across distance and permit travel to occur electronically rather than physically. Other technologies, which can provide training at sites without instructors, include electronic mail, audio conferencing, computer-aided instruction, videotapes, interactive videodisks, and remotely-controlled videographics systems. These technologies are widely used in the civilian world, but are only beginning to have an impact in the military world.

The solution to the Navy's remote-site training problem lies in the proper selection and use of new communication technologies. In general, these technologies are costly and constantly changing; new technologies appear regularly. Proponents of one technology or another proclaim the virtues of their favorite. Many technologies are being used on a regular basis, others in demonstration projects. Investigators are exploring strengths and limitations, cost-effectiveness, and other dimensions governing suitability for different applications. Unfortunately, there is no media selection model to follow to determine which technology will be "best" in a particular application. The Communication Networks in Training (CNIT) project is exploring different technologies, research and development projects, and the Navy's training problems in order to gain a better understanding of which technologies hold the greatest potential for future use in the Navy.

Objective

The primary objective of the CNIT project is to develop more cost-effective technological approaches to train personnel who are geographically remote from training resources. This objective is being addressed along four different tracks:

1. Assess the applicability of new communication technologies to the solution of Navy training problems.

2. Design, develop, and evaluate an experimental, computer-based instructional support network.
3. Design, develop, and evaluate an experimental, two-way videoteletraining system.
4. Determine optimal alternative equipment configurations and training protocols to enhance training effectiveness in a videoteletraining laboratory.

This technical report describes the work performed on track 3 during FY89 and early FY90. The track 3 work concerned the design, development, and evaluation of a two-way, interactive videoteletraining system using compressed, digital television technology to link, via T1 land, an originating classroom at Fleet Combat Training Center, Pacific (FCTCPAC), in San Diego, to a receiving classroom at Naval Technical Training Center (NTTC), San Francisco. This system was intended for use by Navy instructors with little or no television experience. Other project documentation describes work performed on project track 1 (see Simpson, 1990) and track 2 (see Simpson & Pugh, in press). The work performed on track 4 will be reported in the future.

Track 3 Origins

Early in 1989, Navy Personnel Research and Development Center (NPRDC) personnel began working with Chief of Naval Education and Training (CNET) personnel in support of the Naval Education and Training Command's (NAVEDTRACOM) teletraining demonstration project. This project was being conducted at Fleet Combat Training Center, Atlantic, and its operational objective was to link five different east coast training sites via satellite to conduct fully interactive VTT. In support of the NAVEDTRACOM effort and CNIT project research, NPRDC began working with personnel in the San Diego naval training community to conduct a west coast VTT demonstration project. Project resources consisted of a small amount of funding; willingness of personnel at NPRDC, Commander, Training Command, Pacific (COMTRAPAC), FCTCPAC, and Fleet Training Center (FTC) to commit time and personnel to the project without reimbursement; and a T1 land line linking FCTCPAC to Treasure Island whose bandwidth was made available to the project without cost. Essentially, the project was a grass-roots effort involving five interested commands who decided, under the leadership of COMTRAPAC, to make the project happen. Project participants met weekly to coordinate the work throughout the initial planning, implementation, and field testing phases. Project responsibilities were distributed among participants as follows:

COMTRAPAC: Project planning, oversight, and logistics support.

NPRDC: Research design, system design, human factors, and instructor training.

FCTCPAC: Engineering and facilities support.

FTC: Training adaptation and delivery.

NTTC: Logistics support at receiving site.

The west coast project, like that on the east coast, would demonstrate the feasibility of delivering training remotely. However, the west coast project differed, in the following respects, from the east coast project:

1. Technologies used: Experimental video technology (UVC VP-2000 codec) was tested.
2. Human Factors/Training analyses: Systematic analyses provided the bases for equipment selections, classroom layouts, and training materials used.
3. Communication medium: T1 land line was used (not satellite).
4. System complexity: The two-point system was much simpler (and less costly) than the east coast system.

The ways in which these four factors influenced system design are described in greater detail later.

APPROACH

Overview

The approach included a survey of videoteletraining systems; development of system design guidelines; definition of personnel, training, and logistics requirements; system design and development; and system evaluation. These steps are described in greater detail below.

Survey of Videoteletraining Systems

As a prelude to designing and developing the west coast system, a survey was conducted of existing instructional TV systems. The purpose of this survey was to familiarize project personnel with the technologies employed, instructional procedures, logistics management issues, and problems typically faced in the use of such systems for instructional delivery. This survey covered systems in use in the military and several public education and commercial teleconferencing systems. (The initial survey was extended with an in-depth survey reported in Pugh, Parchman, and Simpson (in press)).

Videoteletraining, as defined in this document, is the use of TV to conduct training. It encompasses both conventional one-way, standard bandwidth, analog video; and two-way, narrow bandwidth, digital video. Depending upon the particular system, video may be one- or two-way and audio may be one- or two-way. Conventional systems are less likely than narrow-bandwidth systems to employ two-way video or audio. Teleconferencing uses the same technology as teletraining but has the objective of linking its participants in a two-way conference rather than in delivering training.

Conventional video has been used in educational institutions for more than 40 years, primarily as a way of extending instruction to a larger audience. More recently, it has linked different institutions via satellite, land line, or microwave relay.

Distance education for K-12 and college-level students has increased dramatically in recent years. According to a recent survey, the number of states promoting this technology has gone from

fewer than 10 in 1987 to virtually all states in late 1989 (U.S. Congress, Office of Technology Assessment, 1989). The design of intra-state TV-based distance education systems varies, but in the main, these systems employ one-way video and two-way audio (return audio via telephone). Their primary use is to meet instructional needs at remote locations that lack available resources (e.g., offer a course in calculus or French in a remote school district). Typical of these systems are those of the states of Maine and Vermont. The University of Maine has a state-wide instructional TV system that ties together six main sites (nodes) via land line and in turn is extended to many additional sites via ITFS (instructional television fixed service). The system enables university-level instruction to be distributed to most of the sparsely-populated state. The system's main site is Augusta, but instruction can be originated from other sites. Most of the instruction is via one-way video and two-way audio (telephone dialup). Instructors receive little training and facilities are rudimentary but formal evaluation indicates that instruction is effective. Consistent with most findings of research in this area, students prefer live instruction to instruction via TV, but performance is not significantly affected by instructional mode.

The University of Vermont has a system similar to that of Maine--five nodes tying together various campuses--but permits two-way video among the nodes. Any node can select video from any other node at will; thus, video control is greater than in the Maine model. In other respects, the systems are quite similar (i.e., basically low-cost operations using regular instructors and with rudimentary facilities). Evaluation of system effectiveness is currently underway. At both Maine and Vermont, each site is equipped with an engineering facility with a full-time operator who controls cameras and audio remotely; the instructor does not have to operate any video equipment. Both systems use compressed digital TV and broadcast unencrypted signals.

The U.S. Army Satellite Education Network (SEN) at Ft. Lee, Virginia, has been in operation since 1985 and in major respects resembles a commercial broadcasting facility. Conventional technology is used, i.e., unencrypted, analog, one-way video and two-way audio (return audio via telephone). Fully equipped studios are provided with professional quality cameras, sound, lighting, special effects, etc., and manned by trained, full-time personnel. The Logistics Management College has developed a 2-week course to train instructors and their presentations are very professional. (Personnel at both Fleet Combat Training Center, Atlantic [FCTCLANT] and NPRDC are currently planning similar courses for Navy instructors and could benefit from the Army's lengthy experience in this area.) The SEN has a single uplink (Ft. Lee) and 58 downlinks throughout the continental U.S. The system broadcasts approximately 4 hours per day, 30 weeks per year. During 1989, 24 classes were conducted for 5,000 students. Downlink sites purchase capital equipment at a cost of about \$10,000 and subscribe to the SEN service for about \$400 per month. Signals are unscrambled. Because of its low operating costs for users, the SEN has proved to be highly cost-effective (Brockwell, 1989).

The Naval Education and Training Command's VTT demonstration project, based at FCTCLANT, uses encrypted, digital, two-way video and audio and is a good example of the use of newer teletraining technology. The system links five different sites, each capable of originating and receiving video and audio, and so is more ambitious in its system design than most conventional instructional TV systems. Teletraining was used to reduce the significant travel and per diem costs FCTCLANT expends each year delivering training to the fleet. Teletraining was used to deliver 12 different courses to several hundred different students. Analyses conducted by

the Center for Naval Analyses indicate that performance and attitudes of students at remote sites are comparable to those at the originating site, and that training costs can be reduced by using teletraining. The project has received funding for FY90 and is expected to continue, with further development, in the future (Snowdon, 1989; Mahnke, 1989).

Several firms currently offer teleconferencing services and will, for a fee, install video equipment, satellite links, and set up studios at the customer's site. The facility, once established, may be used to communicate between sites in real time with video, audio, and other media. As in present-day commercial broadcasting, the primary communication link is satellite. Typically, these facilities are used to support televised two-way meetings or conferences. Small-scale teleconferences usually involve business executives who meet electronically rather than travel cross-country to meet physically (Cushman & Derounian, 1988). On a larger scale, video teleconferencing has come into widespread use for special interest conferences, many of which involve a significant educational component. In the usual arrangement, conference speakers meet at a central site, their presentations are transmitted by satellite relay to ground stations having receiving antennas, and the signal is presented by large-screen TV to the on-site audience. A two-way audio link enables the audience to direct questions at speakers and participate in discussion. The arrangement just described is common and is used, for example, by the PROFNET network via a node at San Diego State University. The same configuration is used to conduct electronic classes. For example, within the San Diego area, PROFNET currently offers 15 electronic courses at the graduate level.

The Defense Commercial Telecommunications Network (DCTN) has more than 100 sites throughout the U.S., primarily at Army and Air Force bases and at Naval Air Systems Command (NAVAIR) and Navy Regional Data Automation Command (NARDAC) locations. On the west coast, sites currently exist at San Francisco, Pt. Mugu, and China Lake. The NARDAC at North Island is currently planning a site. Each of these sites is fully equipped to permit teleconferencing via satellite with other DCTN sites. The Pt. Mugu site is administered by NAVAIR personnel, operated by a contractor, and was installed and is maintained by American Telephone and Telegraph (AT&T). It is primarily used by high level civilian and military personnel and has received some use by contractors. Users are charged at a rate of \$300 per hour to use the site. The Pt. Mugu site, which is probably fairly representative, is impressive when compared to operations using the same technologies for remote-site instruction: the rooms are well designed (by AT&T), acoustically isolated, have comfortable seats, good sound, several high-quality video monitors, seamless communication, and all the other amenities. The DCTN uses compressed, digital TV technology and employs encryption on all broadcasts.

Most instructional TV systems use one-way video. These one-way systems have been operating successfully for many years. Two-way systems have only recently begun to be used. They have the potential to permit better instructor-student interaction than one-way systems, but they are much more expensive than one-way systems. It remains to be seen whether the benefits of two-way TV outweigh its costs.

System Design Guidelines

System design guidelines were developed by consensus of the west coast VTT working group, which consisted of representatives of the five commands participating in the project

(COMTRAPAC, NPRDC, FCTCPAC, FTC, NTTC). The guidelines, their underlying rationale, and practical implications for system design are discussed below.

System Transparency to Users

During early discussions, it was decided that the system should be designed for ease of use by ordinary Navy instructors who had received little training in details of the technology, video presentation techniques, or other aspects of the medium. The notion was to build a system that would allow a competent Navy instructor to enter a VTT classroom and, with minimal adjustments to his presentation techniques, deliver effective training using the new medium. For this to work, the system had to be designed so that it was very easy to use and imposed little burden on the instructor. Moreover, the VTT classroom had to resemble and operate like a live classroom. This guideline is reflected in the design in that the equipment is operated by technical support personnel rather than the instructor, the VTT classroom is arranged like a standard classroom and contains students, and the instructor lectures and presents his material in a manner similar to a live classroom. The resulting design is discussed in detail in the VTT System Design and Development section.

Signal Encryption

U.S. Navy policy requires that videoteleconferencing and VTT systems in use in the Navy employ encryption. Open transmission is not permitted except by exemption. This policy applies even to the transmission of unclassified information. This policy has two main implications for system design: (1) digital transmission must be used and (2) KG-type encryption equipment must be employed at transmission and receiving sites.

Transmission Medium

It was determined early that the transmission medium to employ in the system would be a T1 land line (i.e., a cable providing a bandwidth of 1.544 megabits per second (mbps) that is equivalent to 24 commercial telephone lines). This transmission medium offered a contrast to the satellite medium used with the NAVEDTRACOM project.

Communication Technology

The communication technology, compressed digital TV, was dictated by the signal encryption requirement. However, even without this requirement, this technology would have been used. The reason is that compressed digital TV permits TV signals to be transmitted in a fraction of the bandwidth of analog TV, is less expensive, and allows TV to be transmitted over telephone lines. Digital TV appeared in the mid-1980s and was made possible by the development of a device called a codec (coder-decoder). The codec is essentially a high-speed minicomputer that samples an incoming TV signal, digitizes it, and uses an algorithm to compress the amount of information in the signal and thereby reduce signal transmission bandwidth. Compression algorithms have improved steadily over the years, reducing the bandwidth requirements by an order of magnitude. We determined to explore both established and new codec compression algorithms during the field test.

Training Network Design

Three different training network designs were considered:

1. San Diego-Treasure Island (NTTC) via T1 link.
2. San Diego (FCTCPAC)-Naval Station North Island (Naval Reserve Center) via infrared or microwave link.
3. San Diego (FCTCPAC)-Anchored ship (e.g., USS CONSTELLATION at North Island via infrared or microwave link).

Options 2 and 3 were eventually rejected due to time and cost constraints. The first option envisioned an originating classroom at FCTCPAC and a receiving classroom at NTTC. Students would be present at both sites and the same equipment suite would be available at both sites, enabling site role (originating or receiving) to be reversed.

Communication Directionality

Options available included one- or two-way audio and one- or two-way video. The technology being used and the bandwidth available made two-way video and two-way audio possible and hence this option, the richest possible, was selected.

Human Factors Considerations

The design of the VTT system raised a host of human factors issues:

1. Selection and placement of video equipment (cameras, video monitors, facsimile machines).
2. Selection and placement of audio equipment (audio mixers, microphones, loudspeakers, intercoms).
3. Classroom sound conditioning.
4. Classroom lighting, glare, and color.
5. Selection and arrangement of furniture (tables, chairs).
6. System user interface.

Each of these issues was addressed separately to arrive at a suitable design. Methods used included analyses, application of audio visual/human factors guidelines, informal trial, or some combination of all three. The methods used and resulting system design are discussed in greater detail in the section titled VTT System Design and Development.

Personnel, Training, and Remote-site Logistics Requirements

Instructional delivery via VTT imposed requirements in addition to those of live instruction. The list of requirements was determined by consensus of the west coast VTT working group. The requirements are sketched below and described in greater detail in the section titled VTT Training Design and Development.

Personnel Requirements

The basic premise underlying the use of VTT is that it reduces training delivery costs. Proponents of the technology contend that travel costs of instructors and students will be reduced because both will not have to be present at the same location for training to occur. Another contention is that the number of training personnel will be reduced as a single instructor is able to teach multiple classrooms. It follows from this line of reasoning that costs incurred via the use of VTT undercut its claimed efficiencies. Hence, these costs should be minimized. It was clear during the planning phase of the project that several different types of support personnel would be required, although the amount of their time was uncertain. As a minimum, personnel requirements were expected to include an instructor and on-call engineer at FCTCPAC and a facilitator and on-call engineer at NTTC. Contingency planning imposed additional personnel requirements, but these would be expected to vanish with a more mature system. It had to be possible to deliver training to students at the remote site even if the VTT system became inoperative. The required insurance was provided by making a backup instructor available on site to continue training in a live classroom if the VTT system failed. This contingency plan was essential for a field trial, to assure that no instruction was lost, but would be impractical with an operational VTT system for reasons of cost.

Training Requirements

Instructional delivery via VTT imposed requirements in addition to those of live instruction. It was anticipated that changes would have to be made to training materials and instructional delivery procedures to meet the needs of students at the remote site. In addition, it was expected that classroom activities (e.g., testing, laboratories, question and answer procedures, etc.) would need modifications. Each of these requirements was addressed separately to arrive at an effective solution. Methods used included analyses and informal trial.

Instructors had to be trained to operate in the VTT classroom. The content of instructor training had to be determined, a training syllabus developed, and training had to be delivered.

Remote-site Logistics Requirements

Procedures had to be developed to support training at the remote site. The support requirements included the following:

1. Deliver training and testing materials to remote site.
2. Recover training and testing materials from remote site at conclusion of training.
3. Develop secure method for remote-site test storage, administration, scoring, and retrieval.

4. Provide remote-site equipment operation and maintenance support.
5. Provide remote-site administrative support.
6. Provide remote-site instructional support for classroom activities.
7. Manage all of the foregoing (1-6).

Design and Develop VTT System

The VTT system was designed and developed based on the system design guidelines described earlier. The design and development process consisted of the following major activities:

1. Establish communication channel and interfaces--link the two sites electronically, and at each site, interface the channel to classroom audio/video equipment.
2. Establish communication ground rules--decide who shall be able to communicate with whom, in what form, and under what controls.
3. Conduct training analysis--observe live training and determine what audio/video is required to enable its delivery via VTT.
4. Select classroom video/audio equipment.
5. Design classroom.
6. Test and refine design.

The design and development process is described in detail in the section VTT System Design and Development.

Test and Evaluate VTT System

The VTT system was installed and made operational. Data were collected and analyzed concerning student performance and attitudes, instructor attitudes, instructor-student interaction, personnel requirements, technical problems, and VTT costs. Test and evaluation are described in detail in the sections VTT Field Test and Findings.

VTT SYSTEM DESIGN AND DEVELOPMENT

Overview

This section describes VTT system design and development in terms of system architecture, communication ground rules, the training analysis that led to the design, equipment selection, and classroom design.

Overview

This section describes VTT system design and development in terms of system architecture, communication ground rules, the training analysis that led to the design, equipment selection, and classroom design.

VTT System Architecture

VTT system architecture is shown in Figure 1. Essentially, the system consists of two symmetrical halves separated by a T1 line which serves as a communication channel. Each half--one at San Diego and the other at Treasure Island--consists of audio/video equipment in a classroom (not shown) and the signal processing equipment. Consider the San Diego site first. Audio/video equipment is connected to the VTC 300 codec,¹ which in turn is connected to a Newbridge 3600 bandwidth manager,¹ which is a device for allocating the available T1 bandwidth (1.544 Mbps) to the communication resources. Facsimile machine and intercom (telephone handset) are connected directly to the Newbridge where they were each allocated bandwidth equivalent to one commercial telephone line (64 kbps). In most communication, the classroom audio/video (i.e., the codec) was allocated one-half of the T1's bandwidth (768 kbps). Other portions of the available bandwidth were used for control signals. (Because the codec operated effectively at one-half T1 bandwidth, it would have been possible to run two channels of video simultaneously with the amount of bandwidth available.) Both the codec itself and the Newbridge permit bandwidth to be set; hence, the system has some flexibility in how these settings are made. The Newbridge is connected to a Cylink encryption device,¹ which is linked to a Kentrox Channel Service Unit (CSU), which provides interface to the T1 line. The T1 line runs to the top of Yerba Buena island, where it is connected to another CSU, and then routed through an extension to the classroom on Treasure Island. The equipment there is identical to that at FCTCP.

Two different types of codecs were used during the demonstration project. Virtually all of the system's actual "on air" time was obtained with the VideoTelcomm (VTC) System 300, which is the same codec used in the NAVEDTRACOM teletraining project in Damneck, VA. The System 300 is an established product in fairly wide use and with a proven track record. It is advertised as a "teleconferencing" system, and includes, in addition to codec, a controller, an inexpensive camera with zoom lens, two Sony 26" video monitors, two-channel audio mixer, and two microphones. The audio/video equipment provided is adequate for videoteleconferencing but, for reasons described later, is inadequate for videoteletraining. The codec operates at bandwidths ranging from 56 to 768 kbps. Video resolution is 256 by 240 pixels. Still frame images with a resolution of 512 by 480 pixels can be captured, stored on disk, retrieved, and transmitted. In operation, the VTC 300 proved to be reliable and fairly easy to operate.

The second codec used was Universal Video Corporation's (UVC) VP-2000.¹ (The UVC device is shown in Figure 1, connected to the Newbridge 3600 in the same manner as the VTC 300.) The VP-2000 is inexpensive but its specification claims significant capabilities; it was used on an experimental basis. Video resolution is rated at 480 by 400 pixels and picture quality is claimed to be superior to that of more expensive codecs. Unfortunately, the system provided to us was a prototype that never operated successfully over the T1 line due to interface problems. In closed circuit tests, video quality appeared inferior to that of the VTC 300.

¹Mention of specific manufacturers or brands of equipment does not constitute endorsement by the Department of the Navy.

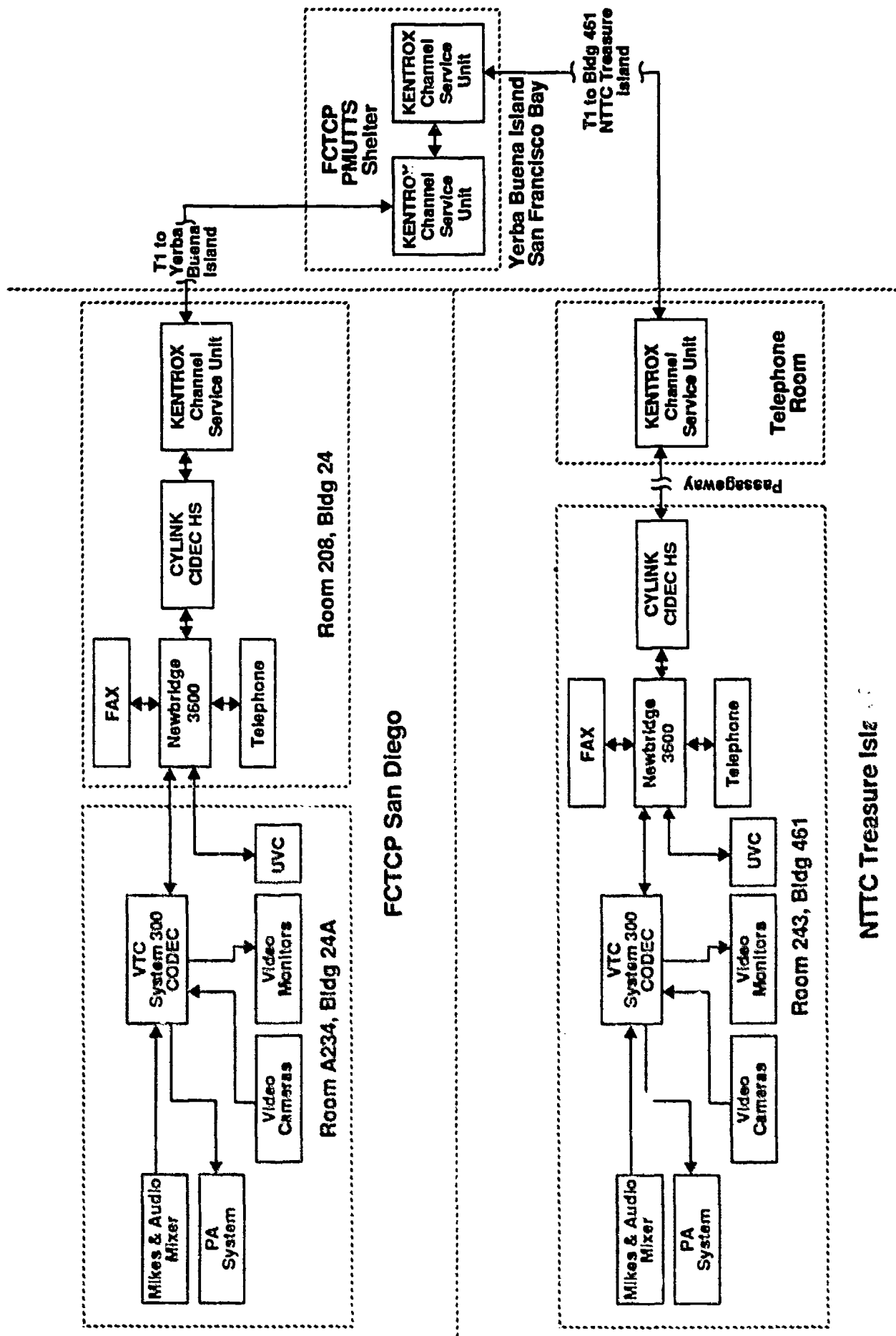


Figure 1. VTT system architecture.

Establish Communication: Ground Rules

In a given classroom, a person can see and hear, live, everything that goes on in the room. In addition, a monitor may be provided to show those in the room their picture as sent to the other classroom. Students in the originating classroom can see and hear the instructor, live, but those in the receiving classroom cannot and must be provided with instructor video and audio. Students do not necessarily need to see or hear students in the other classroom; providing this capability is costly and has other implications. Table 1 shows the default viewing/hearing options made available in the VTT classrooms at the beginning of the field trial.

Table 1

Default Viewing/Hearing Options in VTT Classroom at
Beginning of Field Trial

	Originating Classroom				Receiving Classroom	
	Students		Instructor		Students	
	Viewing	Hearing	Viewing	Hearing	Viewing	Hearing
Instructor	Live	Live	Live/VTT	Live	VTT	VTT
Students (Originating)	Live	Live	Live	Live	---	VTT
Students (Receiving)	---	VTT	VTT	VTT	Live/VTT	Live

The instructor was able to see and hear, live, students in the originating classroom as well as himself; he was also provided with a monitor to view the outgoing VTT picture of himself. He was provided with a second monitor showing the incoming picture of students in the receiving classroom; audio from the receiving classroom was fed to the entire originating classroom. Students in the originating classroom had options similar to the instructor, but could not see students in the receiving classroom. Likewise, students in the receiving classroom could not see students in the originating classroom, but could hear them. They could see and hear the instructor and they could see and hear themselves and, unlike students in the originating classroom, they could see the outgoing picture of themselves.

The main reason students were not able to see their cohorts in the other classroom is that only a single video channel was available and that was reserved for the instructor. It was possible to use this channel to send student pictures back and forth; this was done with increasing frequency as the field trial went on.

We made the decision to follow an "open microphone" policy. Microphones were provided to the instructor and to all students and were always live. Students could speak at anytime.

Training Analysis

As a prelude to selecting VTT equipment and designing VTT classrooms, we observed live classes at FTC and discussed training procedures with FTC personnel. We concluded that the courses we planned to deliver via VTT involved several standard processes and that these processes had implications for VTT equipment selection and classroom design. The processes and their design implications are:

1. **Instructor lectures to class:** A camera is needed to show instructor and a microphone is needed to pick up his voice.
2. **Instructor asks student question and student answers, speaking to class:** Microphones are needed to pick up student voices.
3. **Instructor observes students and maintains order in class:** Camera is needed in remote class to pick up students for instructor.
4. **Instructor leads student discussion:** Cameras and microphones are needed to pick up instructor and students in both classrooms, and instructor needs to be able to allow students to see each other.
5. **Instructor shows overhead projections to class:** An easel-type camera must be provided to instructor and the instructor must be able to select it instead of the main camera.
6. **Instructor shows (and may pass around) 3-dimensional object to class:** A zoomable, close-focusing camera must be provided to show objects.
7. **Instructor writes on whiteboard:** A third camera, with switch, must be provided to show whiteboard or instructor must use easel camera instead of whiteboard.
8. **Students complete written laboratory exercise while instructor strolls around class, looking over shoulders, and answering questions:** The instructor could not physically stroll the remote class, but its students could present their work to him if they were provided with an easel camera like that in the originating classroom. A facsimile machine is also needed to transmit student work from the remote classroom to the instructor.
9. **Students complete written tests: during testing, a student may ask the instructor a question that is not to be broadcast to the entire class.** An intercom (telephone handset) is needed to enable private conversation between instructor and a single student at the receiving classroom.

The training analysis led us to conclude that everyone in both classrooms needed access to a microphone and that the following additional capabilities were required: camera on instructor (originating classroom only), camera on class, easel camera, video switch, facsimile machine, and intercom.

The foregoing analysis reveals why a basic videoteleconferencing system, with a single camera, pair of microphones, and two monitors, would be inadequate for videoteletraining. More

processes occur in a classroom than in a conference, more people participate, and more capabilities are required.

Selecting Equipment

We began with a videoteleconferencing system and had to expand it to a videoteletraining system by obtaining additional video cameras, video display monitors, and an audio system.

Video Cameras

An inexpensive single-chip CCD video camera with zoom lens came with each VTC 300 system. In the originating classroom, this camera was mounted on a tripod and used as the instructor camera; in the receiving classroom, this camera was mounted in the ceiling to pick up students. During conferencing and class discussions, the instructor's camera was rotated and pointed at students.² The quality of this camera was marginal, but it was adequate to pick up the instructor and students and did not inhibit the transfer of information, which was mainly conveyed by the audio channel and via the visual aids presented on the easel camera.

We considered two different ways to meet the requirement for an easel camera: (1) mount a video camera on a copy stand and (2) use a dedicated easel camera. We chose the second option because the easel cameras we examined had adequate performance for our needs and would be easier for the instructor to operate. The Elmo easel camera we chose had approximately twice the resolution of the codec being used. It resembles and operates much like an overhead projector, has pushbutton zoom and focus control, and is reasonably compact.

Video Display Monitors

Video display monitors were required for two main purposes:

1. Display incoming and outgoing pictures to instructor.
2. Display instructor and his graphics to class.

The same monitors cannot be used by both instructor and students because they face different directions. We provided the instructor with three 12" Sony monitors on a table facing him, showing:

1. Picture of self (instructor camera).
2. Incoming picture from other classroom.
3. Elmo easel camera (for alignment of graphics).

Small monitors were provided up close rather than large monitors farther away.

²This camera was flimsy, had marginal resolution, and was a source of video noise; in revising the design, for a related project, we have selected a high-quality single-chip CCD camera for the instructor (Panasonic WV-D5100) with 12:1 zoom lens and a single-chip CCD surveillance camera with wide angle lens to pick up the class (Panasonic WV-CL110).

It was more difficult to select appropriate monitors for the class. A key question that had to be answered before a selection could be made was what size monitor to use. Answering this question was difficult and we are still not sure that we have a good way to answer it in the future. The existing guidelines are conflicting and do not necessarily apply to the world of VTT. What follows is our analysis and the conclusion regarding monitor size. JANAIR (1972) recommends that the viewing angle between the line of sight and information on a display screen should be at least 60 degrees, if possible, and never less than 45 degrees. Following the more liberal recommendation yields a 90 degree arc extending out from the center of a monitor, which may be regarded as encompassing an area in which the monitor can be adequately viewed (Figure 2). Within the arc, visibility is adequate between minimum and maximum viewing distances. JANAIR further recommends a minimum viewing distance of between one and two times the display width. Determining the maximum viewing distance is not as straightforward. A rule of thumb commonly followed in the audio-visual world is to limit the maximum viewing distance to about four times the screen diagonal ("rule of four"). More liberal recommendations are common. One guideline is the "inch per person" rule (i.e., a 19" diagonal monitor is adequate for 19 people, a 25" monitor for 25 people, etc.). A recent review of the literature recommended using one monitor for fewer than 15 persons, two monitors for 15 to 50, and another monitor for every additional 25 (Bailey, Sheppe, Hodak, Kruger, & Smith, 1989). This guideline is more stringent than the first but still seems questionable. Most of the references underlying it deal with videoteleconferencing rather than videoteletraining; one reference deals with conventional instructional television. The guideline is probably adequate if viewers are packed very tightly (e.g., in an amphitheater), are conferencing, or learning in a "talking heads" environment. We believe that the guideline is inadequate for videoteletraining with compressed digital television with its poorer resolution and reliance on graphics. Hence, we selected monitors that would satisfy the "rule of four" in the classrooms we were using. This led to the choice of 35" Mitsubishi monitors. Empirically, this rule seems reasonable, for in practice we found that, at the receiving site, viewing the monitor at distances beyond four times the screen diagonal made graphics difficult to see. (On the other hand, a smaller monitor would have been adequate for presenting the instructor's picture)

Microphones and Audio Mixer

The primary method of instructional delivery in the VTT classroom is the lecture. Audio quality is critically important. The instructor must be equipped with a microphone to be heard. Students need microphones so that they can ask or respond to questions or engage in discussion. Yet, because of the number of students there is a good chance of sound interference. Multiple microphones are required, and there must be a way to prevent unwanted sounds from being picked up. The approach we took was to use Shure AMS-8000³ eight-channel audio mixers with sound-activated microphones. Low-profile table microphones (Shure AMS-22) were provided to each pair of students and the instructor was provided with a clip-on lapel microphone (Shure AMS-26).

Other Equipment

Various other pieces of equipment were obtained to complete the classroom. These included video monitor racks, facsimile machines, loudspeakers, tables and chairs, camera mounts, etc. The VTC 300 system included an infrared remote control that served as a video switch.

³See footnote 1.

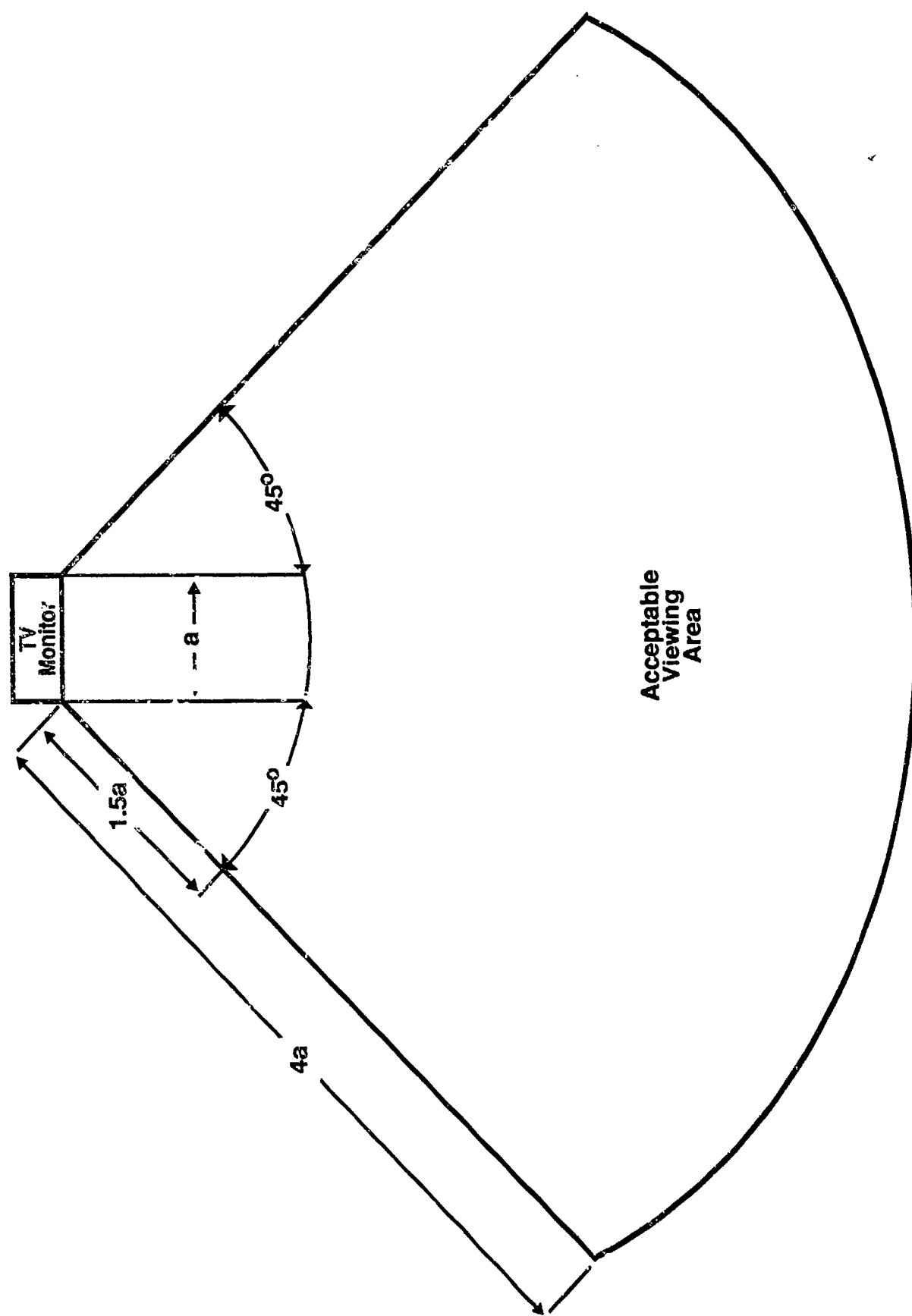


Figure 2. Recommended acceptable viewing area for video monitor.

Design Classrooms

Classroom design is discussed below in terms of lighting, sound conditioning, and classroom layouts.

Lighting

Both classrooms were equipped with overhead fluorescent lights. These were modified by adding a dimmer switch and using tubes balanced for a color temperature of 3200 degrees Kelvin to assure that flesh tones would look natural on camera. No special lighting was used beyond the fluorescent. Cameras were sensitive enough to pick up both instructor and students.

The front of the originating classroom was painted pale blue ("video blue") to provide a suitable background for the instructor. The wall behind the instructor was cleared to avoid distractions on camera.

Sound Conditioning

Both classrooms were carpeted to reduce echoes and reverberation. In addition, the receiving classroom was equipped with six foot free-standing panels along both walls. Both rooms came with suspended acoustic ceilings.

Classroom Layouts

Classroom layouts were governed by the spaces provided and the type of furniture required. Students sat at 60" X 30" tables, with two chairs per table, in accordance with standard practice in Navy schools. Minimum spacing between rows was 30", in accordance with human factors recommendations (JANAIR, 1972). Each table was equipped with a low profile microphone.

Figure 3 shows the layout of the originating classroom. The instructor stood at the front of the room behind a lectern. On the table before him were three monitors facing him showing outgoing picture to other classroom, incoming picture from other classroom, and Elmo easel camera.⁴ A 35" Mitsubishi monitor,⁴ to the instructor's right and raised to a height of 5', faced the class. This monitor was remotely controlled by the instructor and could present either incoming or outgoing picture. During presentations, it usually showed the output of the Elmo easel camera. The facsimile machine and intercom were located on a table behind the instructor.

Figure 4 shows the layout of the receiving classroom. A 35" Mitsubishi monitor at the front of the classroom takes the place of the instructor. A 26" Sony monitor⁴ located against the wall shows the outgoing picture of the class. Tables at the back of the classroom hold an Elmo easel camera, 12" Sony monitor for alignment of graphics, facsimile machine, and intercom. Four free-standing panels are located on each side of the tables.

⁴See footnote 1.

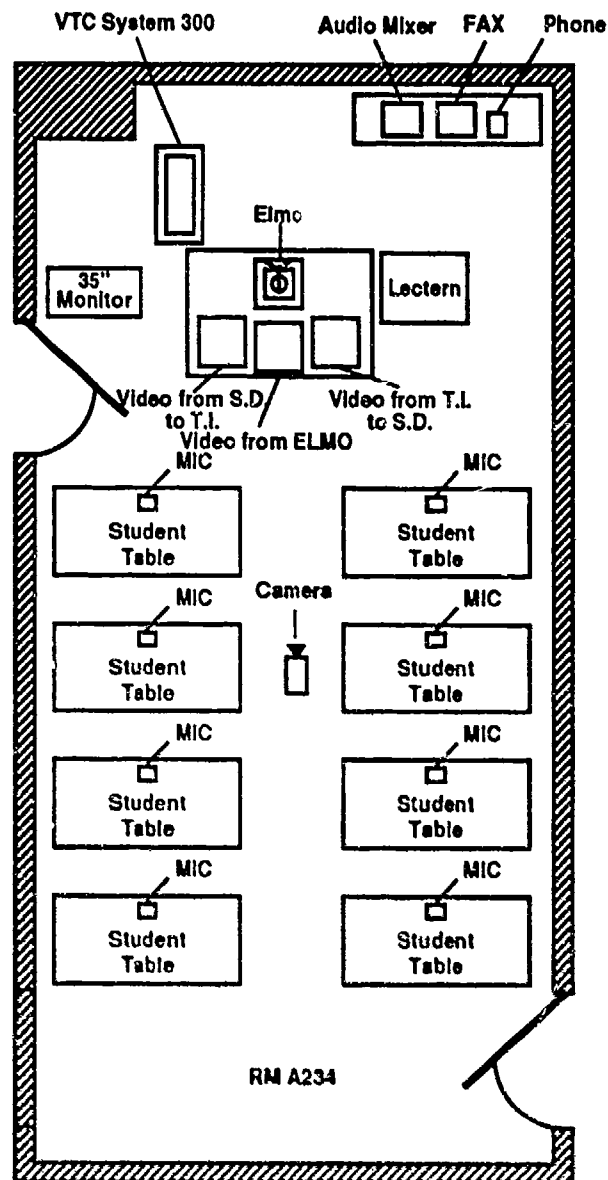


Figure 3. Layout of originating classroom.

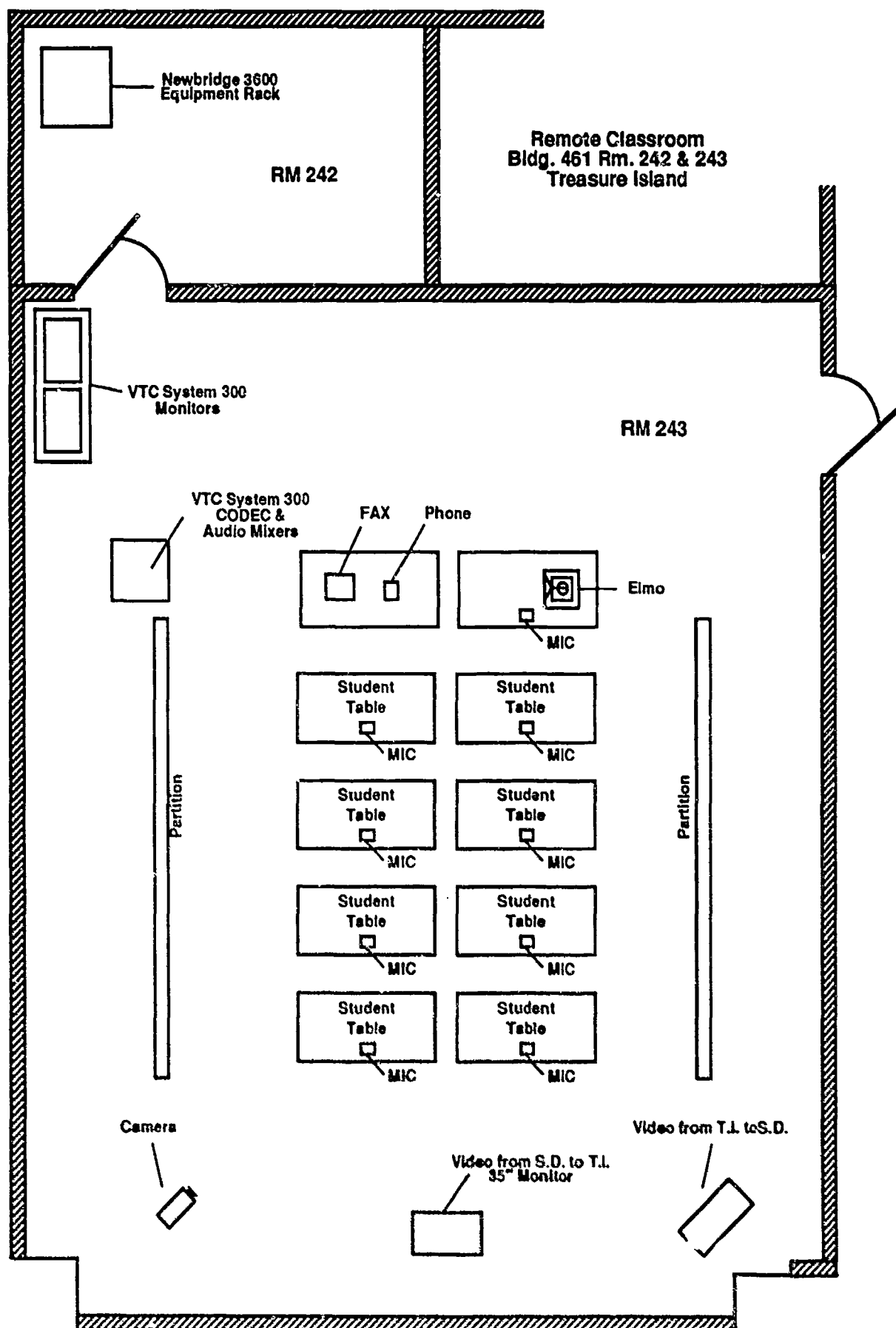


Figure 4. Layout of receiving classroom.

VTT TRAINING DESIGN

Overview

This section describes VTT training design in terms of VTT versus live instruction, VTT training course selection, classroom procedures, live course translation for VTT delivery, and instructor training.

VTT Versus Live Instruction

A decision was made to make VTT training as similar to live training as possible. The rationale was that this would simplify adaptation to the new medium by instructors and students, would provide a live audience for the instructor to play against, and would increase the total number of students taking a course. Moreover, this would be the least costly way to go. This decision had several implications: (1) regular Navy instructors, without extensive training in the TV medium, could be used; (2) students would be present in the originating classroom; (3) visual aids would be identical or very similar to those used in a live classroom; and (4) video production values would be secondary to simplicity and economy.

Training Course Selection

FTC provided us with a list of candidate courses for VTT delivery. Criteria for appearance on the list were (1) courses convened frequently and had significant class sizes, (2) were taught at both sites, (3) the need for special equipment for labs and demonstrations was nil, and (4) could be taught in less than a week. Courses on the list were Ammo Administration, 3M Administration, Safety Petty Officer, and Damage Control Petty Officer. NPRDC personnel visited FTC, observed several hours of each course, and conducted a training analysis, as described in the VTT Design and Development section of this report. The training analysis indicated that the 3M course was the richest in terms of the training processes it required and would be the most difficult course to deliver via VTT. It followed that if 3M could be successfully delivered via VTT, the other courses should also be possible. The 3M course is 4 days long, is delivered to more than 4,000 students yearly on the west coast, and consistently has a high backlog. The Safety Petty Officer course was chosen for delivery during gaps in the 3M schedule.

The decision criteria used in selecting courses for the demonstration project would apply only partially to the selection of courses for more extensive VTT delivery. The first and second criteria (volume and multiple-site training requirements) certainly do apply. In general, yearly training quotas should be a prime factor in selecting a course for VTT. A VTT course should have relatively high annual throughput at the originating site and sufficient trainee quotas at remote sites to justify VTT delivery. (In addition, some courses have unique training requirements or limited quotas and are nonetheless appropriate for VTT delivery. An example is a course with high training priority that covers a particular piece of equipment or class of ship.) Whether or not the third criterion (minimal lab and demonstration requirements) should apply is a research question; one of the truisms of VTT, often heard and of questionable validity, is that the medium is suitable only for lecture-based courses, though little research has been conducted to determine the limits to which non-lecture courses can be taught. The fourth criterion (course length) should not apply. There is

no reason VTT cannot be used for multiple-week courses, although it was more convenient, for the demonstration project, to restrict length.

Classroom Procedures

Lectures

The primary means of instructional delivery was the lecture. We determined that VTT lectures could be identical to those of a live class. However, because the VTT classroom had a single, fixed instructor camera, focused on the instructor in a small area around the podium, it would not have been practical for the instructor to illustrate a lecture by writing on a whiteboard on the wall behind. Instead, instructors were directed to write on paper at the base of the easel camera and to make the output of the easel camera visible to both classes. The fixed instructor camera also restricted instructor movement left and right (to remain in the field of view) and in depth (to maintain focus). Further, because compressed video was being used, with a slower frame rate than conventional video, instructors had to restrict the speed of their movements to prevent them from appearing as a series of rapidly changing still frames at the remote site. Making this change took some adaptation by the instructor, but did not seem to compromise the delivery.

Presentation of Graphics

The limitations of the fixed camera also contributed to our decision not to use an overhead projector with standard 8-1/2" by 11" transparencies projected on a screen. This would be affected by the depth of field problem but, more importantly, it did not appear that projected images would have sufficient contrast to produce a good quality image when picked up by a camera and transmitted to the remote site. Thus, a decision was made to use an easel camera and to adapt all transparencies used in a live class into hardcopy form for use with the camera. (Transparencies could be picked up by the camera, and were used on occasion in class, but produced an image of poorer quality than their hardcopy equivalents.)

Presentation of Three-dimensional Objects

The Safety Petty Officer course required presentation of small, three-dimensional objects. In a live class, they could be seen when in the instructor's hand or passed around the class but neither was possible for the remote class. Hence, the easel camera was a requirement, as well, for presenting such objects. The instructor placed the object on the easel, zoomed the camera in, and pointed out and described pertinent features of each object as its picture was presented to both classes on TV monitors.

Videotapes

Videotapes were used in both courses. They were played live to the originating classroom and transmitted to the remote classroom. We did not experience serious degradation of video quality at the remote site, although quality was inferior to that at the originating site.

Instructor-student Interaction

Instructor-student interaction conventions had to be modified for VTT. In live classes, instructors would generally call on students by name periodically to maintain alertness and get feedback on learning. With a VTT class, occurring in two separate classrooms simultaneously, the instructor had to alternate student-by-name calls between classrooms. The procedure followed was to make seating charts at the beginning of the class and to pause during lectures, determine which classroom was due for a "hit," check the chart, and then call on a student by name. As experience with the class increased, the instructor no longer had to check the chart for names, but still had to be attentive to which class and person was due for a question.

The procedure for students to ask questions had to be modified to assure that the person asking the question could be accurately identified. This was not a problem within a particular classroom, but was between classrooms. During most instruction, students could not see students in the other classroom and even if they could, identifying which student was speaking by the movement of a compressed video image and a voice coming from a loudspeaker would be difficult. For this reason, the procedure followed was for the questioner to identify self by name, pause, and then ask the question. The instructor would generally repeat the question for the class and then answer it.

Laboratories

Laboratories in both classes consisted of filling out written forms and then presenting the results to an instructor. In the live class, the instructor would stroll the room, look over shoulders, and provide individual help to students. This was impossible with the remote class so the instructor selected students in that class to present their work by TV to both classes. Students at the remote site used an easel camera to transmit their work back to the originating classroom. The instructor guided students through focusing and zooming procedures and critiqued their work as he went. Similar methods were followed at the originating classroom except the instructor operated the equipment. A facsimile machine could have been used to transmit work back and forth.

Testing Procedure

Multiple-choice paper and pencil tests were administered at the remote site by a facilitator. They were scored with a template and the results were transmitted back to the instructor in the originating classroom after students had left at the end of testing. A facsimile machine could have been used for this purpose.

Remote-site Logistics

Training on site was coordinated by an education specialist on the staff of Naval Technical Training Center, Treasure Island. This person worked with project staff in seeing to students' needs. All training materials were hand carried to the remote site, and retrieved from the remote site in the same manner. Test scores were computed on site by a facilitator and transmitted electronically to the originating site; a facsimile machine could have been used for this purpose. It is estimated that all remote site logistics could be handled by a single person on a part-time (one-quarter time) basis, provided the class contains a class leader with sufficient seniority to maintain class order.

Training Course Translation

No modifications were made to the content of lectures, classroom exercises, tests, or other classroom materials. VTT and live course length were identical.

Viewgraphs used in the live class were cleaned up and converted to hardcopy form to improve their appearance on video monitors. Viewgraphs could have been used on the easel camera, but were difficult to focus on and reflected light that showed as bright spots on video monitors. The easel camera could zoom in on the visual aids, which gave it greater flexibility than a standard overhead projector (i.e., the instructor could provide a close-up view of a part of the visual aid).

Instructor Training

All instructors were selected by FTC. Each was qualified to teach the topic, had the available time, and none was regarded by FTC as a "star." Three instructors underwent informal training over a period of 1 week with a total training time of approximately 8 hours each. Most of this time was spent practicing instructional delivery with VTT equipment in front of a classroom that contained no students. The general topics covered during training were as follows:

1. VTT System Operation
 - VTT System Overview
 - Classroom Layouts
 - VTT Equipment Operation
 - Easel camera
 - Microphone
 - Monitors
 - Video switching
2. Instructional Delivery
 - Maintaining Instructor/Student Dialogue
 - Conducting Laboratories
 - Administering Tests
 - Debriefing Procedures
3. Practice Teaching

The first hour or so of training covered topic 1. This training was intended to familiarize the instructor with VTT equipment, classrooms, and equipment operation. The instructor was shown how to operate VTT equipment and was given a little hands-on practice; he used the easel camera, switched from the instructor camera to the easel, learned how to wear and speak into a microphone, and learned about the other equipment in the room.

Topic 2 was not fully defined when instructor training occurred and, in fact, the instructors helped define how the issues under this topic would be handled in an actual class.

Most of the remaining time was spent by the instructor practicing instructional delivery and the use of the VTT equipment in front of the classroom (topic 3). During most of this time, NPRDC personnel and a senior instructor from FTC were present to help the practicing instructor improve his instructional delivery. Each instructor practiced for about 6 hours spread over several days. At times, this was very difficult because equipment was being installed, modified, or malfunctioning. The training was quite loosely structured, but enabled instructors to develop the basic skills necessary to stand in front of a camera and work in the VTT classroom.

VTT FIELD TEST

Overview

This section describes the VTT field test; results of the field test are discussed in the Findings section. Topics covered in this section are field test objectives, schedule, research design, subjects, and data collection.

Field Test Objectives

The VTT evaluation had four main objectives:

1. Determine the impact of VTT upon student performance and attitudes.
2. Assess VTT usability by instructors and students.
3. Document the support requirements and problems associated with installing and maintaining a VTT system.
4. Assess VTT cost-effectiveness.

The context of the evaluation was a series of Navy training courses delivered by Navy instructors using the VTT system. Students were Navy active duty and reserve personnel.

Schedule

The project schedule is shown below.

6/1-8/30--System setup.
8/25-9/25--System testing.
9/11-9/22--Instructor training.
9/25-9/28--Conduct 3M course.
10/2-10/6--Test UVC equipment.
10/10-10/12--Conduct safety petty officer course.
10/14-10/15--Conduct 3M course for reservists (part 1).
10/16-10/17--Conduct 3M course (interrupted).
10/17--Earthquake.
10/23-10/25--Safety petty officer course (cancelled).
10/30--11/3--Open house.

11/4-11/5--Conduct 3M course for reservists (part 2).

11/9--Conduct contracting conference.

The VTT system was installed over an approximately 3 month period starting in June 1989. System testing occurred from late August through September. Instructor training began in early September, before the system was fully operational, and was completed shortly before all tests were complete. Four training courses were delivered with the VTT system. Three of these were 3M courses and one was a Safety Petty Officer course. The first 3M course lasted four sequential days (25-28 September). The second 3M course was delivered on two separate weekends (14, 15 October and 4, 5 November) to naval reservists. The third 3M course commenced on 16 October but was cancelled on 18 October because of the San Francisco earthquake, which cut off power and physical access to the remote classroom on Treasure Island. The Safety Petty Officer course was conducted 10-12 October; a second course, scheduled for 23-25 October, was canceled because of the earthquake.

In addition to being used for training delivery, the VTT system was used for a two-point "open house" (i.e., a video conference between the two classrooms during which approximately 100 members of the Navy community visited the classrooms to see the VTT system in operation). The system was also used for a contracting conference on 9 November.

Research Design

A conventional two-group design was used:

Group 1: Experimental group (remote site).

Group 2: Control group (live class).

Subjects in the experimental group received training via interactive TV, with no live instructor present. Subjects in the control group received live instruction, although within the context of a VTT system.

Subjects

Subjects were Navy active duty and reservist personnel undergoing training required by their duty position.

Data Collection

Several different types of data were collected during training delivery:

Student performance: Tests were administered to students in each class. Test scores were obtained.

Student course evaluations: Attitude measures were obtained using a five-point Likert scale on a series of questions relating to the instructor, audio-visual aids, tests/homework, overall assessment, and instructor-student interaction. Student comments on the class were also gathered in a series of open-ended questions.

Observations: NPRDC observers were present in both classrooms throughout training and maintained logs describing what happened in each room on a minute by minute basis (e.g., instructor-student interactions, instructor's use of video equipment, technical difficulties).

FINDINGS

Overview

This section describes the VTT field test findings in terms of student performance, student attitudes, instructor attitudes, VTT support requirements and problems, and VTT cost-effectiveness.

Student Performance

Three courses were delivered to completion with the VTT system. Of these courses, student test grades were obtained for the first two. The maximum possible score on each test was 100 and the passing score was 70.

The first course completed was 3M, which lasted 4 days. Five students were present in the originating classroom and 8 in the remote classroom. A test was administered on the final day. The test score mean and standard deviation for the originating classroom were 86.5 and 2.9, respectively. Comparable scores for the remote classroom were 86.8 and 6.2. These scores indicate that the difference was not statistically significant.

The second course completed was Safety Petty Officer, which lasted 3 days. Nine students were present in the originating classroom and 6 in the remote classroom. Tests were administered on the second and third days. The results are shown in Table 2. Scores on the first test were higher in the originating classroom than in the remote classroom; the difference diminished to one-half point on the second test. Overall, scores were slightly higher in the originating classroom, although this difference was not statistically significant. One possible explanation for the pattern is that students in the remote classroom took a while to get used to receiving training via TV and this handicapped them slightly at the start of training. The handicap disappeared by the end of the course.

Table 2
Means and Standard Deviations of Test Scores for
Safety Petty Officer Course

	Originating Classroom		Receiving Classroom	
	Mean	S.D.	Mean	S.D.
Test 1	88.0	6.3	80.7	5.9
Test 2	84.0	5.0	84.5	7.7
Overall	86.0	4.4	82.6	4.9

Student Attitudes

Student attitudes were measured with a post-course questionnaire (Appendix), which contained 21 statements to be rated on a five-point Likert scale, eight multiple-choice questions, and three open-ended questions. This questionnaire was administered to all students taking courses at both originating and remote classrooms. For purposes of analysis, questionnaire data were combined across three classes and a total of 48 students (21 in originating classroom, 27 remote). Most students responded to all questions.

Student Ratings

The 21 statements to be rated fell into four categories:

1-6: Instructor.

7-14: Audio-visual aids.

15-19: Tests and homework.

20 and 21: Overall assessment of instructor and course.

The lowest point on the rating scale was 1, the highest point was 5, and the midpoint was 3. Mean ratings were computed for originating and receiving classrooms, differences were computed, and an unpaired t-test (2-tailed) was performed to compare ratings in the two classrooms. The majority of ratings on all items fell in the range between 4 and 5. Hence, in most cases, most students--regardless of which classroom they were in--gave positive ratings to the dimension being measured. To assess statistical significance, the questions were grouped as indicated above, and the Bonferroni method was used to determine an appropriate level of significance for each of the questions within its particular category. Beginning with a .05 level as the significance criterion for each category of questions, this results in the following required p levels for each question within a group:

1-6: $p = .0085$.

7-14: $p = .0065$.

15-19: $p = .01$.

20 and 21: $p = .025$.

In most cases, the differences in ratings between classrooms were slight and not statistically significant. However, there were a few cases in which classroom did make a difference, as described below.

Table 3 shows student attitude measures on statements relating to the instructor. A statistically significant difference was found for statement 5 ($t(46) = 10.87$, $p < .001$), which relates to instructor assistance outside of class. Students in the remote classroom, for obvious reasons, felt that the instructor was not available.

Table 3
Student Attitude Measures on Statements Relating to Instructor
(Scale 1-5)

	Originating	Remote	Remote-Original
1. Instructor prepared for class	4.4	4.3	-.1
2. Instructor presented lessons clearly	4.6	4.0	-.6
3. Instructor answered student questions	4.6	4.5	.1
4. Instructor encouraged class participation	4.7	4.5	-.2
5. Instructor was available for individual assistance outside of class	4.8	1.7	-3.1*
6. Instructor treated students fairly	4.8	4.4	-.4

* $p < .0085$.

Table 4 shows student attitude measures on statements relating to audio-visual aids. Statistically significant differences were found for statement 10 ($t(45) = 2.991$, $p < .005$) and statement 11 ($t(44) = 3.461$, $p < .001$). Both statements concern audio, with students at the remote site rating audio loudness and clarity lower than students at the originating site. On questions concerning video and graphics (7, 8, 9, 12, 13), both classrooms responded about equally. The conclusion is that students in VTT training were more concerned about audio than video. This is not as surprising as it seems, for the instructor teaches more through what he says than what he shows. On site, breakups in audio transmission had a much more serious impact on the instructor's presentation than temporary loss of video. Video images during training were generally still frames (e.g., viewgraphs), and not time dependent. However, for audio to be understood properly, transmission had to be uninterrupted. Thus, effective audio is much more vulnerable to poor transmission than video.

Table 5 shows student attitude measures on statements relating to tests and homework. Scores on all were high and did not differ significantly between classrooms.

Table 6 shows student attitude measures on statements relating to overall assessment of instructor and course. There was a small but statistically significant difference on statement 20 ($t(44) = 2.40$, $p < .02$). The most likely explanation for this difference is degree of availability of the instructor at the remote classroom, which students there gave low ratings to on statement 5. The difference on statement 21, though not statistically significant, is probably real. It is consistent with the findings of many other studies of distance education (i.e., given a choice, students generally prefer live instruction to instruction by electronic means).

Table 4

**Student Attitude Measures on Statements Relating to Audiovisual Aids
(Scale 1-5)**

	Originating	Remote	Remote-Original
7. Video screen was large enough to be seen	4.6	4.7	.1
8. Video screen was close enough to be seen	4.6	3.7	.1
9. Image on video screen was clear	4.3	3.9	-.4
10. Audio transmission was loud enough to hear instructor's voice	4.6	3.7	-.9*
11. Audio transmission was clear enough to hear	4.6	3.6	-1.0*
12. Graphics/slides/transparencies on TV	4.0	4.2	.2
13. Television was in working order	4.0	4.2	.2
14. Your microphone was in working order	4.4	4.4	0

*p < .0065.

Table 5

**Student Attitude Measures on Statements Relating to Tests and Homework
(Scale 1-5)**

	Originating	Remote	Remote-Original
15. Test questions were clearly written	4.4	4.5	.1
16. Test questions were related to course work	4.6	4.7	.1
17. Test answers were graded fairly	4.8	4.7	-.1
18. Homework assignments were understandable	4.7	4.5	-.2
19. Homework assignments were related to course	4.8	4.6	-.2

Table 6

**Student Attitude Measures on Statements Relating to Overall Assessment of
Instructor and Course
(Scale 1-5)**

	Originating	Remote	Remote- Original
20. Comparison of this instructor to other Navy instructors that have taught you in the past	4.5	3.9	-.6*
21. Comparison of this course to other Navy courses that you have taken in the past	4.1	3.6	-.5

*p < .025.

Instructor-student Interaction

Questions 22-28 were multiple-choice items focusing on various dimensions of instructor-student interaction.

22. Did you talk to the instructor or ask any questions during the regular hours of this course? All students in both classrooms responded "yes" to this question. (This result was guaranteed by the questioning procedure followed by the instructor. Classroom logs indicated that instructor questions were directed at students in originating and receiving classrooms in close proportion to the number of students in each classroom.)

23. How did the video teletraining method of instruction affect your opportunities to talk to the instructor or ask questions, as compared to traditional methods of instruction? The result is shown in Table 7. The majority of students in both classes felt that VTT had no effect on opportunities to interact with the instructor. Slightly more students in the remote classroom felt that VTT diminished opportunities, but the actual percentage was still small (11%).

24. Were there adequate opportunities for remedial instruction outside of the regular hours of this course? The result is shown in Table 8. The majority of students in both classes felt that remedial instruction was not necessary for the class. Of those who felt otherwise, the majority of those in the originating class felt opportunities for remediation were adequate, and the majority of those in the remote class felt opportunities were inadequate.

25. Did you attend any remedial instruction periods? All students in both classrooms responded "no" to this question. Questions 26 and 27 were follow-ups to 25 and so these questions were not answered by students.

Table 7**Student Responses to Question 23**

How did the video tele-training method of instruction affect your opportunities to talk to the instructor or ask questions, as compared to traditional methods of instruction?

	Originating	Remote
More opportunities	17	7
No effect on opportunities	78	82
Fewer opportunities	5	11

Note. Numbers are percentages based on 18 students at the originating site and 28 students at the remote site.

Table 8**Student Responses to Question 24**

Were there adequate opportunities for remedial instruction outside of the regular hours of this course?

	Originating	Remote
Yes	21	13
No	11	29
Remedial instructor not necessary	68	58

Note. Numbers are percentages based on 19 students at the originating site and 27 students at the remote site.

28. Which method of instruction would you have preferred for this course? The result is shown in Table 9. Responses of the two classes were very similar. Slightly more than half of the students in each class selected the last option, expressing indifference to the method of instruction. Of those who had a preference, it was for traditional rather than VTT by a margin of two or three to one. This result is not surprising, for it is consistent with the findings of many studies of distance education; in general, when students have a choice, they prefer live instruction. However, apparently the preference is not overwhelming. Viewed in a positive light, roughly two-thirds of students were either indifferent to method of instruction or preferred VTT.

Table 9**Student Responses to Question 28****Which method of instruction would you have preferred for this course?**

	Originating	Remote
Video teletraining where instructor is on TV	11	15
Traditional methods of instructor where instructor is physically present in the classroom	37	31
Indifferent between video teletraining and traditional methods of instruction	52	54

Note. Numbers are percentages based on 18 students at the originating site and 28 students at the remote site.

29. How much did the participation of students at other site(s) affect your learning during the course? The result is shown in Table 10. Very few students in either class felt that the presence of students in the other class had reduced their learning. Most thought there had been no effect. Many thought learning had been improved. This opinion was supported by the test performance data.

Table 10**Student Responses to Question 29****How did the participation of students at other site(s) affect your learning during this course?**

	Originating	Remote
Improved learning	32	18
No effect on learning	63	75
Reduced learning	5	7

Note. Numbers are percentages based on 19 students at the originating site and 28 students at the remote site.

Student Comments

Student comments were solicited with three open-ended questions (30, 31, 32).

30. What did you like most about this course? The breakdown of comments by medium relatedness is shown in Table 11. The percentages of "no comments" in both classrooms were comparable. The percentage of medium-related comments was approximately three times as great in the remote classroom as in the local classroom. The nature of the comments reflects the fact that remote students were more conscious of the medium than those in the originating classroom. The comments varied but were generally positive.

Table 11

Student Responses to Question 30

What did you like most about this course?

	Originating	Remote
Medium-related comment	14	41
Non medium-related	62	28
No comment	24	31

Note. Numbers are percentages based on 21 students at the originating site and 29 students at the remote site.

31. What did you like least about this course? The breakdown of comments by medium relatedness is shown in Table 12. As with the responses to question 30, the percentages of medium-related comments were greater in the remote than in the local classroom. In general, students in the originating classroom were more likely to criticize a non-medium related aspect of the course while those in the remote classroom were more likely to criticize a medium-related aspect. However, in this case, most of these comments reflected negatively on the medium.

Table 12

Student Responses to Question 31

What did you like least about this course?

	Originating	Remote
Medium-related comment	25	43
Non medium-related	45	32
No comment	30	25

Note. Numbers are percentages based on 20 students at the originating site and 28 students at the remote site.

32. Discuss any suggestions that you have for improving how video teletraining is used in this course. The breakdown of comments by category is shown in Table 13. Most suggestions were medium related. The comments of students who responded to this question tended to fall into three main categories. First, in both classrooms, students expressed a desire to see their cohorts in the other classroom. (This wish became apparent during training, and resulted in some changes to the way the system was configured, as described in the VTT System Design section.) Second, students wanted improved audio and, third, improved video. The remaining comments showed no pattern.

Table 13
Student Responses to Question 32

Discuss any suggestions that you have for improving how videoteletraining is used in this course.

	Originating	Remote
See other students	6	3
Improve audio	1	4
Improve video	1	4
Other	3	3
No comment	9	11

Note. Numbers are frequency counts.

Instructor Attitudes

Instructor attitudes were measured with a post-course questionnaire, which was designed to obtain instructor background information and attitudes toward audio-visual aids, students, and VTT itself. Only two instructors completed questionnaires and so the data are inconclusive. What follows is a composite of the responses of the two instructors. Both instructors were male, E-6, with EN rating and approximately 21 months of experience as instructors.

Both instructors gave high ratings (between 4 and 5) on questions relating to audio-visual aids. These indicate that they were satisfied with the quality and usability of the video and audio equipment used in the VTT system.

On questions relating to students, instructors disagreed on a question relating to student attentiveness; one instructor felt that students were equally attentive at both sites and the other felt that students at the originating site were more attentive. They agreed on all other questions, however, with the consensus being that student participation at both sites was equal, student performance was equal, and presence of students at remote site did not inhibit instructional delivery.

On questions relating to VTT, both instructors indicated that they felt comfortable with VTT, that it was as effective as live instruction, required no special preparation, did not require them to change their teaching style, and that they were satisfied with their training to use the system.

During informal discussions, both instructors expressed their positive attitudes about the VTT system and willingness to use it in the future.

VTT Personnel Support Requirements

Support requirements at the originating site consisted of one technician, who operated and maintained VTT equipment. The amount of the technician's time varied, but on average amounted to about 2 hours per 8-hour day (i.e., approximately one-quarter time).

Support requirements at the receiving site consisted of a technician and facilitator. Due to the nature of the field trial, both were present 100 percent of the time, but were generally idle. It is estimated that both roles could have been performed by a single person on a one-quarter time basis.

VTT Technical Problems

VTT equipment operated reliably throughout the field trial. There were no failures of classroom equipment (cameras, monitors, microphones, mixer, switches, or lighting).

The T1 link was initially very noisy and resulted in several system crashes during the first weeks of the field trial. The telephone company was contacted and eventually resolved the problems. Subsequently, clean communication between sites was maintained, with only one dropout. Audio quality remained a serious problem throughout the field trial. Quality was marginal, at best, and when noise or cross talk occurred on the T1 line, audio suffered, often becoming incomprehensible. Audio quality was also influenced by the sound level and voice quality of the speaker; some students spoke too softly to be understood properly and had to repeat themselves several times. During the weekend of 14 and 15 October, the communication link was particularly noisy, resulting in audio breakups on an average of six times per hour. The line problems were resolved before the class on 16 October.

On the evening of 17 October 1989, an earthquake occurred, which severed T1 communication and resulted in termination of the field trial until communication was re-established approximately 2 weeks later.

Our experience suggests that from a learning standpoint, audio quality is more important than video quality. It is also more difficult to design classrooms that provide good audio than good video. The requirements for good video include acceptable lighting and a camera pointed at and focused on the subject. The requirements for good audio include room sound conditioning (to control echoes and reverberation), selecting an appropriate sound system, microphone placement, controlling feedback and sound levels, and teaching personnel microphone procedures.

VTT Cost Analysis

The VTT field test was conducted to demonstrate the feasibility of delivering instruction via T1 land line and we did not expect it to demonstrate VTT cost-effectiveness. Nonetheless, it

allowed us to determine the approximate cost of implementing VTT with a fully-duplexed, T1-based VTT system.

VTT Cost Factors (VCF)

VTT cost factors consist of the following:

Audio-visual Equipment (AV): Cameras, monitors, audio mixers, microphones, lighting, switches and other audio-video equipment; also classroom modifications (e.g., carpeting, painting). Capital cost of approximately \$25,000 per classroom; equivalent to a monthly lease cost of approximately \$500 per classroom or \$1,000 for two classrooms.

Communications Equipment (CE): Codecs, encryption equipment, multiplexers, bandwidth managers, and communication interfaces. Actual cost to the project was about \$3,500 per month.

T1 Service (T1): Lease of T1 line. This cost is commonly about \$38 per mile per month, which for a T1 of the length used would be about \$15,000 per month. Actual cost was \$13,000 per month.

On-site Facilitator/Operator (F/O): An operational system of the type implemented would require at least one full-time person on site at an estimated cost of \$5,000 per month.

The total VTT cost factor may be described mathematically as:

$$\text{VCF} = \text{AV} + \text{CE} + \text{T1} + \text{F/O}.$$

Using the cost estimates just given, VCF works out to be approximately \$22,500 per month.

Training Costs Averted (TCA)

Training costs averted are the cost savings resulting from remote delivery of instruction rather than having students or instructor travel to be in the same classroom. There are two ways to compute these costs, based on different training scenarios:

1. Instructor travels to students (e.g., in Treasure Island).
2. Students travel to instructor (e.g., in San Diego).

In the first case, one person travels; in the second, several.

Unit Travel Cost (UTC): Unit travel cost is the travel cost per traveler; it depends upon distance, locations, and several other factors. Actual round-trip travel cost between the locations in the field trial was approximately \$100. These are much-traveled locations and fare is lower than for this distance between many locations. A more representative cost for this distance is about \$150 (approximately the cost between San Diego and Monterey).

Per Diem (PD): Cost of per diem while traveling. The assumption is made that travelers will stay in the BEQ at approximately \$8 per day and will receive per diem of \$36 per day for a total daily per diem cost of \$44 per person per day.

Scenario 1: Instructors Travel

Having the instructor travel to site has the implication that an additional instructor is required at the traveling instructor's home base to deliver training (i.e., if the traveling instructor instead used VTT, two classes could be taught simultaneously). With live instruction, two instructors are required to teach two classes. This results in an additional cost of approximately \$5,000 per month.

Assume that instructors travel to site, spend 2 weeks, and then are rotated. This requires two round trips at a total cost of \$300 and 30 days of per diem at a cost of \$1,320 for a travel and per diem cost of \$1,620 per month. Total cost is the sum of this and the \$5,000 per month for the additional instructor for a total cost of \$6,320. The difference between this and the VCF cost factor of \$22,500 is -\$16,180, for a net loss of this amount. It is less costly to send the instructor to students than to deliver training via VTT; this assumes that instructors are available to travel to site.

Scenario 2: Students Travel

Travel costs averted depend upon number of students and average course length. Assume that the average class contains 20 students and that course length is distributed as follows on a monthly basis:

5 days: 1
4 days: 1
2 days: 4
1 day: 2

The total number of courses is 9. This distribution allows usage of the classroom 5 days per week throughout the month with a mixture of courses of different lengths. Travel costs are the product of the number of students (20), number of courses (9), and round trip air fare (\$150); this works out to \$27,000.

Per diem is the product of number of students (20), instructional days (22), and per diem rate (\$42); this works out to \$18,480.

Total travel costs averted are \$45,480. The difference between this and the VCF cost factor of \$22,500 is \$22,900, for a net savings of this amount.

DISCUSSION

The findings indicate that student performance was comparable in originating and receiving classrooms. On most measures, student attitudes were very similar at originating and receiving sites. However, students at the remote site did not feel that they had as much access to the instructor as students at the originating site; possibly because of this, they gave the instructor a lower overall performance rating. Students at the remote site were more likely to comment on medium-related

deficiencies of the VTT system; they were particularly sensitive to audio problems. Students at both locations wanted to see their cohorts at the other site. Instructor acceptance of the VTT system was high. However, only two instructors participated in the field test and this finding needs further verification. The system experienced several technical difficulties during the field test, particularly at the beginning. Most of these problems were resolved as the bugs were worked out of the system. However, audio quality was never fully satisfactory and remained a problem throughout the field test. Most of these findings parallel those reported by the Center for Naval Analyses in its evaluation of the Damneck VTT system (Rupinski & Stoloff, 1990). Both systems successfully delivered training to remote students.

A preliminary cost analysis indicates that conducting training with a T1-based, two-way VTT system is more costly than sending an instructor to a remote site but that VTT can be less costly than sending students to the instructor. The analysis is based on a particular system (two points connected by T1), geographic region (west coast), and other simplifying assumptions. This analysis raises concerns about the cost-effectiveness of VTT as an alternative to traditional methods of training delivery. Rupinski and Stoloff (1990) report significant cost savings in their analysis of the Damneck VTT system but caution against using their findings to project savings of future systems and recommend that further cost-benefit analyses be conducted to obtain additional data on future systems; we concur with this recommendation. CNET's Videoteletraining Implementation and Management Plan envisions extending a multipoint, satellite-based VTT system to the west coast in the future (Chief of Naval Education and Training, 1990). We feel that CNET should conduct cost analyses using a variety of real-world scenarios to determine whether a west coast VTT system modeled on that of the east coast VTT system will realize comparable cost savings. The scenarios should model probable system architectures, classes, student loads, and travel costs, and should consider the competing alternative of instructor rather than student travel to meet training requirements.

The west coast's experimental VTT system was expensive to operate and ultimately led us to question the need for using two-way video during instruction. Two-way systems may permit greater instructor-student interaction, but there is no empirical evidence that they are essential for effective training. Most instructional television systems in public education, industry, and the military use one-way video (Pugh, Parchman, & Simpson, in press). If the Navy's remote-site training requirements could be met with a one-way VTT system, it would be an order of magnitude less expensive than the two-way system currently envisioned by CNET. Further research is warranted to investigate this and other questions relating to the use of VTT for Navy training. Such research should also investigate enhanced multiple-channel VTT and videotape instruction with and without on-line instructor access.

The use of VTT is relatively new and much work needs to be done to realize its full potential. In conducting the west coast demonstration project, we became aware of many areas in which we had to operate on intuition rather than established principles. Among these areas were training instructors to operate effectively in the VTT classroom, modifying live courses for VTT delivery, and determining the most effective instructional methods, strategies, and materials to use in the VTT classroom. We learned much during the field trial but it was not a good environment for conducting research to obtain definitive answers. The VTT laboratory we have established at FTC,

San Diego, will provide a high degree of experimental control and flexibility, a steady flow of students, and a relatively low-cost environment for conducting the necessary research.

RECOMMENDATIONS

1. The CNET should conduct cost analyses using a variety of real-world scenarios to determine cost break-even points for multi-point, satellite-based VTT systems using simplex and fully-duplexed transmission modes.
2. VTT instructor training methods and materials developed by NPRDC should be refined into a VTT instructor training course that includes learning objectives and tests, course outline, instructional strategies, learning activities and resources, and other essential curriculum elements. Upon completion, CNET and Chief of Naval Technical Training (CNTT) should consider this material for inclusion in curriculum development and delivery guidance, such as the forthcoming Naval Education and Training (NAVEDTRA) 130-series publications.
3. Research should be conducted to determine the relative costs and effectiveness in meeting training objectives of live instruction, one-way video, two-way video, multi-channel two-way video, videotape instruction with on-line instructor access, and videotape instruction without instructor access.
4. Research should be conducted to determine the most effective instructional methods, strategies, and instructional materials to use in the VTT classroom. The research should explore the applicability of VTT to a range of different types of courses, and include laboratory as well as lecture-based instruction.

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APPENDIX A

COURSE QUESTIONNAIRE FOR VTC STUDENTS



COURSE QUESTIONNAIRE FOR VTC STUDENTS

INSTRUCTOR/

FACILITATOR: Administer to students on the last day of class and send all questionnaires to Dr. Larry Pugh at NPRDC, Code 15, San Diego, CA 92152-6800.

1. Name _____ 2. SSN _____ - _____ - _____
First Middle Last

3. Today's date ____/____/____

4. Course title

- ☐ a. 3M Admin/Ops
☐ b. Safety Officer
☐ c. Safety Petty Officer
☐ d. Other (specify) _____

SECTION 1: COURSE EVALUATION

For each of the following statements (1 through 21), check the appropriate box corresponding to a scale of 1 (unsatisfactory) through 5 (outstanding). Leave any statements that do not apply to this course blank.

INSTRUCTOR	Unsatisfactory _____ Outstanding				
	0-50% OF TIME	51-60% OF TIME	61-80% OF TIME	81-90% OF TIME	91-100% OF TIME
1. Instructor prepared for class	☐	☐	☐	☐	☐
2. Instructor presented lessons clearly	☐	☐	☐	☐	☐
3. Instructor answered student questions	☐	☐	☐	☐	☐
4. Instructor encouraged class participation	☐	☐	☐	☐	☐
5. Instructor was available for individual assistance outside of class	☐	☐	☐	☐	☐
6. Instructor treated students fairly	☐	☐	☐	☐	☐
<u>AUDIO-VISUAL AIDS</u>					
7. Video screen was large enough to be seen	☐	☐	☐	☐	☐
8. Video screen was close enough to be seen	☐	☐	☐	☐	☐
9. Image on video screen was clear	☐	☐	☐	☐	☐
10. Audio transmission was loud enough to hear instructor's voice	☐	☐	☐	☐	☐
11. Audio transmission was clear enough to hear what instructor said	☐	☐	☐	☐	☐
12. Graphics/Slides/Transparencies on TV were readable	☐	☐	☐	☐	☐
13. Television was in working order	☐	☐	☐	☐	☐
14. Your microphone was in working order	☐	☐	☐	☐	☐

TESTS/HOMEWORK	Unsatisfactory					Outstanding				
	0-50% OF TIME	51-60% OF TIME	61-80% OF TIME	81-90% OF TIME	91-100% OF TIME					
15. Test questions were clearly written	☐	☐	☐	☐	☐					
16. Test questions were directly related to course	☐	☐	☐	☐	☐					
17. Test answers were graded fairly	☐	☐	☐	☐	☐					
18. Homework assignments were understandable	☐	☐	☐	☐	☐					
19. Homework assignments were directly related to course	☐	☐	☐	☐	☐					

OVERALL	Unsatisfactory					Outstanding				
	0-50% OF TIME	51-60% OF TIME	61-80% OF TIME	81-90% OF TIME	91-100% OF TIME					
20. Comparison of this instructor to other Navy instructors that have taught you in the past	☐	☐	☐	☐	☐					
21. Comparison of this course to other Navy courses that you have taken in the past	☐	☐	☐	☐	☐					

SECTION 2: INSTRUCTOR-STUDENT INTERACTION

22. Did you talk to the instructor or ask any questions during the regular hours of this course?

- ☐ a. Yes
☐ b. No

23. How did the video tele-training method of instruction affect your opportunities to talk to the instructor or ask questions, as compared to traditional methods of instruction?

- ☐ a. More opportunities
☐ b. No effect on opportunities
☐ c. Fewer opportunities

24. Were there adequate opportunities for remedial instruction outside of the regular hours of this course?

- ☐ a. Yes
☐ b. No
☐ c. Remedial instruction was not necessary for this course.

25. Did you attend any remedial instruction periods?

- ☐ a. Yes
☐ b. No

ANSWER QUESTIONS 26 AND 27 ONLY IF YOU ANSWERED YES TO QUESTION 25.

26. From whom did you obtain the remedial instruction?

- ☐ a. Instructor via video tele-training
☐ b. Instructor who was physically present in same room
☐ c. Other (specify) _____

27. How many hours of remedial instruction did you receive? _____

SECTION 3: STUDENT COMMENTS

28. Which method of instruction would you have preferred for this course?

- ☐ a. Video tele-training where instructor is on TV
- ☐ b. Traditional methods of instruction where instructor is physically present in the classroom
- ☐ c. Indifferent between video tele-training and traditional methods of instruction

29. How did the participation of students at other site(s) affect your learning during this course?

- ☐ a. Improved learning
- ☐ b. No effect on learning
- ☐ c. Reduced learning

30. What did you like most about this course?

31. What did you like least about this course?

32. Discuss any suggestions that you have for improving how video tele-training is used in this course.

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