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Distance learning involves any method of presenting training that is interactive and in which the trainees are physically separate from the trainers. The advent of interactive multimedia, satellite communications and the Internet have dramatically expanded the number and variety of instructional technology alternatives. Resource constraints and Base Realignment and Closures (BRAC) activities limit conventional educational opportunities. Current DoD simulation research centers on real-time interactive simulation of realistic, complex, "virtual worlds" is collectively known as Distributed Interactive Simulation or DIS.

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The DTIC Review

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FOREWORD

The advent of interactive multimedia, satellite communications, and the Internet has dramatically expanded the number and variety of instructional technology alternatives, including distance learning in all its manifestations in both government and the private sector.

This edition of *The DTIC Review* features an overview of advances in electronic media and communication systems as applied to the various concepts of distance learning, distributed training, networked simulation, distributed interactive simulation, video teletraining (VTT), remote-site training, computer conferencing, and related developments.

The selected documents and bibliography are a representation of the information available on distance learning and distributed training from DTIC's extensive collection on these subjects. The editorial staff hope you find this effort of value and appreciate your comments.



Kurt N. Molholm
Administrator

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INTRODUCTION

Distance learning involves any method of presenting training that is interactive and in which the trainees are physically separate from the trainers. The advent of interactive multimedia, satellite communications, and the Internet has dramatically expanded the number and variety of instructional technology alternatives, including distance learning in all its manifestations in both government and the private sector.

For the Department of Defense (DoD), as resource constraints and Base Realignment And Closure (BRAC) activities limit conventional educational opportunities, the new possibilities must be examined in light of their obvious advantages: replication of high-quality instruction, lower overall costs, increased quality in educational outcomes, and the strategic and tactical advantages derived from the ability to provide these benefits over long distances, and in real time.

Current DoD simulation research centers on real-time, interactive simulation of realistic and complex "virtual worlds," - is an effort known collectively as Distributed Interactive Simulation (DIS).

A sincere thank you is extended to DTIC's Manpower and Training Research Information System (MATRIS) staff in San Diego, CA for compiling and researching this edition of The DTIC Review. This edition features an overview of advances in electronic media and communication systems as applied to the various concepts of distance learning, distributed training, networked simulation, distributed interactive simulation, video teletraining (VTT), remote-site training, computer conferencing, and related developments.

The selected documents and bibliography are a representation of the information available on distance learning and distributed training from DTIC's extensive collection on these subjects. Additional references, including electronic sources, can be found at the end of the volume. In-depth literature searches may be requested by contacting the Reference and Retrieval Services Branch at the Defense Technical Information Center: (703) 767-8274/ DSN 427-8274; FAX (703) 767-9070; E-mail - bibs@dtic.mil.

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Distributed Training Technology Project: Final Report

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April 1996

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San Diego, CA**

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Distributed Training Technology Project: Final Report

C. Douglas Wetzel

**Distributed Training Technology Project:
Final Report**

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13. ABSTRACT (Maximum 200 words) The objective of the Distributed Training Technology project was to extend the use of videoteletraining (VTT) beyond lecture-based courses traditionally given by VTT to courses with interactive or hands-on laboratory environments. Lessons learned and guidelines resulting from the effort were derived for this final project report. The project formally evaluated the feasibility of using VTT to deliver training in four course content areas representing different challenges for VTT: Celestial Navigation, Navy Leadership, Fiber Optic Cable Repair, and a computer laboratory in a Quality Assurance course. A combination of three approaches has the greatest generality for implementing VTT laboratory courses: (1) students can be better prepared prior to performing laboratory work, (2) support at the remote site can be increased by providing a surrogate for the instructor in order to supervise students and conduct laboratory activities, and (3) video technology can be used to increase the visibility of activities between sites. An increased level of effort is required to convert and deliver VTT laboratory courses. Training equipment adapted for portability allows classrooms to be used by other VTT courses. Courses must be selected for student throughput sufficient to provide savings in travel costs.					
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Foreword

This report describes research conducted as part of the Navy Personnel Research and Development Center's Distributed Training Technology (DTT) project. The DTT project is part of our Classroom and Afloat Training research program and falls under the Education and Training project (L1772) of the Navy's Manpower, Personnel, and Training Advanced Development Program Element (0603707N). The work was performed under the sponsorship of the Bureau of Naval Personnel.

The research evaluated training strategies and technologies to extend videoteletraining (VTT) beyond traditional, lecture-based courses. The findings have direct implications for the design of future distance education systems in the Navy and elsewhere.

The recommendations in this report are intended for use by the Chief of Naval Education and Training and the Chief of Naval Personnel in developing policy for the application of VTT in the Navy.

P. M. SPISHOCK
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Commanding Officer

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Technical Director

Summary

Problem and Background

Many Navy personnel requiring training are geographically separated from training resources. Videoteletraining (VTT) enables an instructor to teach multiple classes at different geographic locations. VTT has been an efficient and cost beneficial way to deliver training and is in operational use by the Chief of Naval Education and Training (CNET) within the CNET Electronic Schoolhouse Network (CESN). VTT has been used for lecture-based instruction and additional cost savings could be achieved by delivering other types of content, such as courses with hands-on laboratories or learning environments that are highly interactive.

Objective

The objective of the Distributed Training Technology project was to evaluate and develop training strategies and technologies to extend the use of videoteletraining (VTT) beyond lecture-based instruction to courses with interactive or hands-on laboratory environments.

Approach

The project objective was addressed by conducting work in three areas: (1) a laboratory was developed at the Fleet Training Center San Diego as a prototype classroom containing new VTT technologies; (2) experimental studies were conducted to evaluate the feasibility of using VTT to deliver selected courses with nontraditional types of content; and (3) lessons learned and guidelines resulting from the effort were derived.

Results and Conclusions

Formal evaluations of the feasibility of using VTT to deliver training were conducted in four nontraditional course content areas that represented different challenges for VTT.

1. A Celestial Navigation course was successfully adapted for delivery by VTT. The course contained hands-on laboratories involving difficult computations and plotting. Detailed visuals of nautical tables were adapted and plotting was scored at remote sites with aids that captured the expertise of the instructors. Performance on a practical final examination was 4 percent lower for remote site than local site students.

2. Navy Leadership (NAVLEAD) training was delivered by VTT in two studies that evaluated three courses. There was some reduction in student interaction and participation in VTT classes, which is considered a valuable feature of the training. However, no decrement was found on measures of student performance and knowledge.

3. A Fiber Optic Cable Repair course was experimentally delivered by VTT. The course contained several hands-on laboratories on connector repair and trouble-shooting. It was instructionally feasible to deliver the course by VTT. Remote students performed as well as local students. However, extra course conversion and support efforts were required to deliver the training. A facilitator was needed to supervise all laboratory activities. The small number of

students per class offered marginal travel savings. Enhanced preparation of students prior to laboratories was used to offset the reduced assistance available from the instructor.

4. A Quality Assurance (QA) course with a student computer laboratory was successfully delivered by VTT from San Diego to remote students in Pearl Harbor. Existing VTT classrooms were accommodated by using portable laptop computers and a wireless network that avoided a clutter of cabling. Remote student performance was not impaired.

Lessons learned from the project include suggested VTT delivery approaches and an evaluation of feasibility, effort, and cost factors. A combination of three approaches can be used for delivering laboratory courses by VTT: (1) students can be better prepared for performing laboratory work prior to the laboratory, (2) support at the remote site can be increased by providing a surrogate for the instructor in order to supervise students and assist with laboratory activities, and (3) technology can be used to increase the visibility of activities between sites.

1. Preparation and Aiding: There are several ways to better prepare, assist, or augment students for conducting their own laboratory work with less support from the instructor. These include: (a) enhance lectures and demonstrations given prior to the laboratories, (b) present additional instruction prior to laboratories by videotape or by computer-based instruction, and (c) provide a job performance aid to assist students during the laboratory. These strategies compensate for the physical absence of an instructor who normally circulates among students in traditional laboratories to monitor progress and provide interactive forms of instruction.

2. Facilitator, Site Support Logistics, and Portability: The VTT facilitator plays an important behavioral, technical, and logistical role in laboratory courses. Many laboratories would require a facilitator to be present to assist students and to act as an agent of the instructor. Some laboratories would require a safety monitor. CESN facilitators for laboratory courses may have to become more knowledgeable of subject matter than is currently the case. There would be somewhat greater logistical demands on both local and remote sites to deliver laboratories by VTT, such as for setting up course equipment, storage, and maintaining supplies. Laboratories require flexible physical arrangements and additional space within VTT classrooms. Laboratory training equipment must be adapted to be portable so that it can be taken in and out of classrooms that are also used by other VTT courses.

3. Use of Technology as an Aid: Several themes are illustrated in the use of technology to support laboratory and lecture-based instruction: (a) increase the visibility of activities among sites, such as to provide a remote presence for the instructor; (b) use technologies to assist students during laboratories or to better prepare students for laboratories; and (c) reduce demands on the instructor with the aid of automated technologies, such as those that avoid the need for a camera operator.

Feasibility, Effort, and Costs: It is feasible to use VTT to deliver a range of courses that fall between traditional lecture courses and those laboratory courses that are prohibitive to deliver because of physical, safety, supervision, and cost requirements. Mild forms of laboratory courses could be delivered by VTT with little inconvenience to the CESN (e.g., the Celestial Navigation and Quality Assurance courses). Other courses, representing a moderate level of

difficulty, are also feasible to deliver if greater effort is devoted to convert and support the delivery of the course. These courses require more effort in adapting materials and equipment, require duplicate training equipment and additional technology for remote sites, and require that more attention be devoted to deliver the course with greater assistance from semi-skilled facilitators at remote sites (e.g., the Fiber Optic course). The characteristics of these different levels of difficulty are developed within the report. Cost considerations for laboratory courses include the expense of duplicating equipment at remote sites and student throughput. Laboratory courses with a small number of students would provide marginal savings in avoided travel costs when delivered by VTT.

Recommendations

The following recommendations are for the Chief of Naval Education and Training, and the CNET Electronic Schoolhouse Network.

1. The lessons learned documented in this report should be provided as background material for use in adapting laboratory courses to VTT.
2. The approach to delivering laboratory courses by VTT should include enhanced preparation of students prior to conducting their laboratory work, technology that increases the visibility of activities between sites, and supervision by a VTT facilitator in remote-site laboratories.

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Introduction

Problem

Many Navy personnel who must receive training are geographically separated from training resources. An increasingly efficient approach to meeting this requirement is needed as the Navy downsizes and training resources become constrained. Videoteletraining (VTT) has been found to be an efficient and cost beneficial way to address this issue because it enables a single instructor to teach multiple classes that are at different remote geographic locations. The Chief of Naval Education and Training (CNET) has VTT in operational use in the CNET Electronic Schoolhouse Network (CESN). This VTT system utilizes an interactive two-way video and audio television system that allows distant *remote site* students to participate in the instruction originating from a *local site* where other students are co-located with the instructor.

VTT has been used for the delivery of lecture-based instruction. Even with current VTT technology, there is some reduction in the quality of the audio and video as compared with live instruction (e.g., it reduces the visibility of personnel at different classroom locations and also reduces the ability of instructors and students to interact as they do in a traditional classroom). These constraints make it more difficult to conduct training which is not instructor centered, such as courses with hands-on laboratories or learning environments that are highly interactive. Significant travel or instructor costs could be avoided if such training could be delivered via VTT rather than in traditional classrooms. There has been little experience with delivering this training by VTT because of the challenge presented by laboratory activities when remote students are separated from the instructor. The development of new instructional strategies and technologies to address this problem would extend the use of VTT to courses containing laboratories.

Objective

The objective of the Distributed Training Technology project was to evaluate and develop training strategies and technologies to extend the use of videoteletraining (VTT) beyond lecture-based instruction to courses with interactive or hands-on laboratory environments.

Background

Previous research and development has demonstrated that VTT can be an efficient and cost beneficial method to deliver training to remote Navy personnel (Bailey, Sheppe, Hodak, Kruger, & Smith, 1989; Barry & Runyan, 1995; Rupinski & Stoloff, 1990; Rupinski, 1991; Simpson, Pugh, & Parchman, 1990, 1991a, 1991b, 1992, 1993; Stoloff, 1991; Wetzel, Radtke, & Stern, 1993, 1994). This research on the use of VTT in Navy training has shown that typical lecture-based courses can be delivered by VTT without detrimental effects on achievement. Prior research on instructional television also indicates that student achievement is not affected by this method of delivery and that any initial unfavorable attitudes lessen as a result of experience with the medium (Wetzel, et al., 1993, 1994). The present project extends the research and

development conducted in two previous NPRDC projects on adapting instructional content for delivery by VTT or video media.¹

The major cost benefits of video teletraining systems are in circumstances where travel, per diem, or duplicated instructor costs are avoided by usage that is intense enough to offset the costs of the technology. Courses that are particularly beneficial in reducing travel costs are those with a high student throughput and which are short in duration (a week or less). Cost and efficiency benefits have resulted from use of the VTT system implemented in the CESN. Historical cost data maintained by the CESN from 1989 through the present indicate that the system reaches the break-even point approximately half way through a year (i.e., VTT system costs are approximately half the costs that are estimated to have been avoided for training and travel costs and those for conferences).

The possibility of using VTT for a wider range of courses would extend the cost and efficiency benefits of VTT beyond the lecture-based courses that are typically delivered by VTT. A substantial amount of Navy technical training involves a range of activities that extend beyond lectures. Surveys conducted in the mid 1980s showed that training administrators identified some form of laboratory in as many as three fourths of their courses. Training objectives involving procedural learning were also found to be the most frequent objective beyond those involving basic factual information (Wetzel, Van Kekerix, & Wulfbeck, 1987a, 1987b).

There has been little experience with using VTT to deliver a variety of courses with hands-on laboratories or with highly interactive learning environments. These activities are more challenging when the pattern of communication departs from that in lecture-based instruction where information primarily flows from the instructor to the students. VTT technology constrains the ability of the instructor and remote students to hear and see one another more than it does for local students who are with the instructor. Laboratory courses are more difficult to conduct by VTT because the instructor and students are not physically present together when individual laboratory activities are performed. This restricts the face to face nature of the instruction when there is significant interaction, such as in Navy leadership training or in many other laboratories. Instructors normally perform several functions during laboratory courses as a consequence of their ability to circulate among students. These involve supervising and overseeing the activities of students during laboratories and providing students with assistance and guidance. This interactive form of instruction is present in courses that involve a wide variety of hands-on activities with equipment or in learning computer skills. These problems were addressed by conducting research on new instructional strategies and technologies that would allow these forms of laboratory instruction to be delivered by VTT.

¹These two Exploratory Development projects were funded by the Office of Naval Research Program Element 0602233N (Training Technology Project Numbers RM33T23.02 and RM33T23.03). The Communication Networks in Training project conducted initial experimental work on the feasibility of using VTT in Navy training, compared alternative audio-video strategies, and developed VTT course conversion guidelines (Pugh, Parchman, & Simpson 1991, 1992; Simpson, et. al., 1990, 1991a, 1991b, 1992, 1993; Simpson, 1993). The Videographic Interface Technology project contributed an extensive review of the effectiveness of learning from a variety of video-based media (Wetzel, et. al., 1993, 1994).

Project Approach and Products

The objective of extending the range of courses that could be delivered by VTT was addressed by conducting work in three areas: (1) a VTT laboratory classroom was developed at the Fleet Training Center San Diego as a prototype VTT classroom containing new VTT technologies, (2) selected courses were converted to VTT and evaluation and experimental studies were conducted on the feasibility of delivering these courses by VTT, and (3) the methods developed and lessons learned from the effort were used to develop VTT guidelines documented in this report.

The major products from the project are described below. The remainder of the report summarizes the results of the experimental studies, the technologies explored during the research, and the lessons learned from the project. The courses evaluated were deliberately selected to represent a range of different problems that challenged the VTT medium. These included two courses with hands-on student laboratories, a course with a computer laboratory, and Navy leadership training courses involving highly interactive content.

The products resulting from this project include courses converted to VTT, technical reports documenting the feasibility of delivering selected courses by VTT, videotapes, software, hardware, and the lessons learned from the project documented within the present report. The major products of the project are as follows.

- Evaluations of the feasibility of delivering Navy leadership (NAVLEAD) training by VTT were conducted in three courses. This work was documented in two technical reports (Simpson, Wetzel, & Pugh, 1995; Wetzel, Simpson, & Seymour, 1995).
- A Celestial Navigation course was converted to VTT and an evaluation of the course was documented in a technical report (Wetzel, 1995).
- A Fiber Optic Cable Repair course was experimentally converted to VTT and documented in a technical report (Wetzel, Radtke, Parchman, & Seymour, 1996). Several other products resulted from this work. Three training videotapes on fiber optic cable repair were produced: (1) "The ST Connector," (2) "The Rotary Mechanical Splice Connector," and (3) "The Veam backshell and Hughes Connector." Fiber optic cable systems used in the course were adapted to be portable by installing them on four roll-away equipment carts. A video microscope was developed to allow student connector repair work to be shown over the VTT system. Computer-based instruction on fiber optic system trouble-shooting was developed.
- A Quality Assurance (QA) course was converted to VTT and an evaluation of the converted course was conducted (Wetzel, Pugh, Van Matre, & Parchman, 1996). A system of laptop computers with a wireless local area network was developed so that the course could be conducted within existing CESN classroom facilities.
- A videotape was developed for training new VTT instructors in the CESN. The 21 minute videotape "Videoteletraining Instructor Training" covers three topics: preparing

materials for VTT, coordinating with remote-sites, and instructor behaviors. An additional videotape was produced that contains selected scenes recorded from three of the courses studied: "Distributed Training Technology project: Scenes from courses adapted to videoteletraining."

- An experimental VTT laboratory classroom was developed at the Fleet Training Center (FTC) in San Diego to conduct the research. The VTT laboratory serves as a prototype classroom incorporating new technologies that were explored and which can be considered for use in other VTT classrooms in the CESN. The classroom and its equipment were turned over to the San Diego CESN site at the completion of the project. The various technologies in the laboratory are described later. The products for the Fiber Optic and QA courses were also transferred to those courses.

- This report is the final product of the project and it documents the lessons learned from the research. Other work during the course of the project contributed to these lessons learned. This included observations and analyses of other courses that were considered for potential conversion to VTT. The project also collaborated with the CESN to establish facilities when the initial VTT system was brought on-line in San Diego and provided consulting assistance with some initial course conversions.

Course Evaluations

Formal evaluations were conducted with four types of courses that were delivered by VTT on either a regular basis or for an experimental evaluation of feasibility. These courses represented a spectrum of challenges consistent with the purpose of the project. These nontraditional types of course content involved highly interactive small group processes, hands-on laboratories, and the use of computers in VTT classrooms.

Evaluation Research Design

The course evaluations compared three treatment groups: (1) traditional classrooms, (2) VTT local classrooms with an instructor and students, and (3) VTT remote classrooms where students were connected to the local classroom by a VTT system. The VTT system was a fully interactive two-way audio and two-way video system that transmitted digital video at 384 Kbps. Students used push-to-talk microphones to speak over the system. Remote classrooms were generally monitored by a VTT facilitator who was not a subject-matter expert in the content of the course.

The outcome measures (dependent variables) varied somewhat over the studies. These measures fell in three general categories: (1) student performance measured in terms of academic achievement on written tests, performance on procedural tasks, or observer ratings of student performance; (2) student or instructor questionnaire responses evaluating the training; and (3) an observer tally of student-instructor interaction or help and assistance given to students.

Research Studies

The four research studies discussed below were conducted with a Celestial Navigation course, three Navy Leadership (NAVLEAD) courses, a Fiber Optic Cable Repair course, and a Quality Assurance course. Several other courses that were considered for delivery by VTT because of their challenging content are discussed later.

Celestial Navigation Course

The feasibility of delivering a Celestial Navigation refresher course by video teletraining was evaluated in a study by Wetzel (1995). The course presented challenges for conversion to the VTT format because it contained features that departed from those found in the typical lecture-based course. The course used various visuals with detailed print from nautical tables, contained hands-on laboratories involving difficult computations and plotting, and there was a concern for assisting remote site students in resolving problems with computations.

The adaptation of the course required a concerted planning phase to address potential difficulties, revising visual materials, procuring remote site materials, developing new instructor behaviors appropriate to VTT, and developing support mechanisms at remote sites.

Three treatment groups were compared with a total of 279 students who were in traditional, VTT local, and VTT remote classrooms. The treatment groups were compared on student academic performance, student questionnaire responses, and an observer tally of instructor-student interaction.

Performance. Student academic performance was generally at a high level over three measures of performance. There were no significant differences among the treatment groups on homework during the week. There was a small but statistically significant decrement in final examination scores for remote students, but there was no significant difference between groups in the percentage of students passing the course. Final examination scores were lower at remote sites than at the local site by 4.4 percent for officer students and 5.1 percent for enlisted students. Statistically controlling final examination scores for inequities in student characteristics due to different enrollment patterns at the sites showed an adjusted mean difference of about 4 percent between local and remote sites when officer-enlisted and military seniority status were controlled.

Student Evaluations. Student responses on questionnaire rating items were higher for VTT local and traditional students than for VTT remote students. However, the magnitude of differences between groups was generally small. Ratings for all groups were generally high and in a positive direction, and the observed pattern was typical of that found in previous VTT research. The differences among groups were negligible for topics concerned with class participation, hearing and seeing the instruction, and instructor presentations. Remote students gave slightly lower ratings than local students on topics related to getting assistance or attention, but did not rate the difficulty or pace of the course significantly different. Remote students were more likely to agree that they had less access to and interaction with the instructor, and to identify other students as a source of assistance outside of class. However, remote and local students were equally willing to take another VTT course. VTT students were more accepting of

the VTT method of instruction than were traditional students who had not experienced this method.

Interaction. An observer's tally of interactions during lectures indicated that there were adequate levels of remote site student participation and instructor interaction with remote students. Interactions were most commonly initiated by instructors with a mix of questions that were open to any site to answer, directed to a site, or directed to individual students identified from a roster. This mixture allowed the instructor to assess computational knowledge in students likely to respond when they knew an answer, as well as those individuals that were less likely to participate. There tended to be fewer interactions per hour associated with remote sites because there were fewer students than there were at the local site. However, remote students were not disadvantaged when these interactions were expressed in terms relative to the number of students (per student per hour). In these terms, remote site students received a higher rate of instructor questions associated with their site than did local students. After the first day of class, student initiated questions increased, unanswered instructor questions decreased, and instructor reminders for local site students to use their microphones declined.

Technology Evaluations. This study included two small evaluations of video technologies. One of these examined picture-in-picture (PIP) technology. PIP was found beneficial for showing both the instructor and his visuals (such as "strip form" work sheets) during periods when only the visuals and not the instructor would normally have been shown. The use of PIP was favored more by remote than local site students. VTT remote students gave higher ratings for the quality of the presentation with PIP. The difference between ratings of effectiveness with and without PIP was also larger for remote students. When asked for their preference, remote students overwhelmingly chose the presentation with PIP over the presentation without PIP. Local students were relatively neutral in their preference for PIP. This technique could be used for the outgoing video sent to remote students in other courses where an instructor might be off-screen for lengthy periods.

Another brief questionnaire was given to students that asked them to compare an electronic presentation program lesson with the conventional hand-written method used in other lessons. Students had no preference for one method or the other and gave the methods similar effectiveness and readability ratings. Thus, the choice of these technologies can be based on practical and efficiency factors.

Discussion. The Celestial Navigation refresher course was successfully adapted for delivery by video-teletraining. The course has been offered regularly to remote VTT sites without problem and is accepted by students and instructors. The initial concerns with the feasibility of delivering the course were overcome as a result of several course conversion techniques and the efforts of the instructors to monitor remote site students.

Several aspects of the adaptation of this course and its materials provide an illustrative example of a VTT conversion methodology applicable to other courses. Instructor transparencies typically must be revised to contain fewer lines and words, put in a landscape format with a consistent size, and reproduced on paper to avoid reflections. The approach to the visuals in this course addressed a problem with using video displays to show the many small print tables in nautical publications. Showing an entire table rendered the small print unreadable,

while zooming in on relevant text lost the overall context of relevant column and row headings. Critical portions of the text were enlarged and arrows pointed to the location of these entries in the table so that students could locate the entries in their own publications. Lengthy "strip forms" used for a series of calculations were also enlarged and segmented into several pages. An important principle illustrated in this course was the development of scoring methods that captured the expertise of the instructors and allowed facilitators to act as an extension of the instructor. Facilitators were able to score student plotting on charts by using an acetate overlay marked with the correct course, fixes and labeling required of students. Although this was a relatively mild form of a laboratory course, student questionnaire responses revealed a facilities related issue applicable to laboratory situations. Students at some sites indicated that table space was more confined and this made it more difficult to use the four publications and various small items used in plotting. Such facilities concerns would likely be more severe in laboratory courses with more extensive equipment.

The success in delivering this course by videoteletraining allows its delivery to be expanded to other sites that originate instruction (e.g., an East coast CESN site). Experience with this course indicates that an adjustment in the frequency of VTT delivery can be balanced with enrollment demand at remote sites. The recommendations derived from delivering this training are applicable to other VTT laboratory courses. It was recommended that VTT courses with atypical requirements, such as student laboratories, should be given special attention to maintain a high quality VTT version of the course. Such attention includes monitoring remote-site student comprehension, conveying VTT "lessons learned" as remote site facilitators and instructors rotate in their assignments, and providing sufficient space for the additional instructional materials found in this and other future laboratory courses.

Navy Leadership Courses

The objective of this evaluation was to test the feasibility of using VTT to deliver Navy leadership (NAVLEAD) training. This training represents a departure from the instructor-centered, lecture-based courses typically given by VTT because it involves high levels of instructor-student and student-student interaction. These courses involve a combination of lecture, discussion, and experiential learning activities, such as case studies, simulation exercises, and team work in small groups. One type of activity involves team members working together on assigned group problem-solving tasks that are subsequently reported to the class. The training is conducted by a team of instructors who facilitate interaction and the sharing of experiences as part of the learning process. Traditional classrooms are arranged so that instructors are able to stroll among tables in physical proximity to student groups. Nonverbal cues such as body language and facial expressions may be used to interpret student understanding and attitudes. There is a high demand for this training and the use of VTT would avoid instructor and student travel costs. The primary evaluation issue was whether the highly interactive instructional environment of the live classroom would be compromised by the lack of physical proximity of instructors and students trained by VTT.

The feasibility of using VTT to deliver Navy leadership training was tested in two studies with three courses. One study evaluated a Division Officer Basic Navy Leadership course with 105 students (Simpson, Wetzel, & Pugh, 1995). The other study evaluated Chief Petty Officer

(CPO) and Leading Petty Officer (LPO) courses with 192 students (Wetzel, Simpson, & Seymour, 1995).

The evaluations compared traditional, VTT local, and VTT remote treatment groups. Six evaluation measures were used: student evaluations of VTT, student evaluations on instructional topics, daily observer evaluations on several dimensions of the training, an interaction tally of class participation, observer evaluations of student performance on a simulated classroom activity (LPO and CPO only), and performance on an end-of-course multiple-choice knowledge test (DIVO only).

Student Evaluations. Student questionnaire responses tended to favor traditional instruction slightly more than VTT instruction. Rating item responses were on the positive end of the scale, and differences among the treatment groups were generally small or modest.

Little difference between local and remote sites was observed in either study on the questionnaire concerned with VTT topics (only VTT groups completed these items). Audiovisual factors typical of findings for other types of courses were the only significant rating differences observed in one study. Students did, however, express the opinion that VTT reduced their opportunities to interact with the instructor, and although they were somewhat divided in their preference for VTT, they indicated they would take another VTT class.

The questionnaire covering instructional issues revealed somewhat larger differences as a consequence of the wider range of treatment conditions that included VTT local, VTT remote, and traditional students. These differences were again modest, with the largest group differences appearing on topics that tended to be common to both evaluation studies (DIVO and LPO/CPO). The largest differences between groups in favor of traditional instruction were on topics related to seeing and hearing students, teams, and instructors; or on topics related to interaction and participation. Compared with the responses of DIVO students, larger treatment group differences were observed for the combined data of the LPO and CPO students. This larger difference was primarily due to CPO and not LPO students. CPO students gave lower ratings overall, were generally more critical, and were less accepting of VTT.

Student responses to open-ended questions were most often related to some aspect of the course content and interaction. Response rates were greater for what students liked than for what they disliked about the course. In general, about half of the comments were positive and a third negative. Remote students were more likely to respond on open-ended questions and were more likely to comment about VTT related problems.

Observer Ratings. Daily ratings by subject-matter experts on various dimensions of the training generally yielded the largest group differences observed in both studies. These observers gave higher ratings to traditional instruction than VTT, and the pattern was generally the same over the week so that VTT courses did not reach parity with traditional courses. Observers rated VTT lower on effectiveness, interaction, and control over the class, and rated the difficulty of conducting the instruction as greater. There was a general tendency for interaction and participation to have been rated as increasing over the early part of the week. A recommended technique to foster such interaction is to get students actively using a VTT system early on the first day of a course.

Interaction Tally. The tally of student initiated questions and comments represents a behavioral measure of student interaction and participation that is more objective than the ratings above. The general pattern across all classes in both studies indicated a similar level of interaction for traditional and VTT local classes, while VTT remote classes were on average about two thirds this level. About a third of the individual VTT remote classes fell below the lowest level of local and traditional classes. Thus, some remote sites interacted at a somewhat lower level, and the observed data suggest that some variability should be expected from class to class and instructor to instructor.

Student Performance and Knowledge. Each of the two studies contributed a different measure that assessed an aspect of student performance or knowledge. These aspects were assessed near the end of the course where they would be expected to reflect student learning during the training.

Several dimensions of student performance during a classroom simulation activity were assessed by instructor/observer ratings in the evaluation of the LPO and CPO courses. No statistically significant differences were found among the three treatment groups on any of the ratings for either LPOs or CPOs. There was a trend for the VTT remote students to be rated somewhat lower on a few items. The results suggested that VTT had little effect on student performance. This performance was assessed on a specific task that was more behaviorally focused in nature than the other more general ratings made by observers at the end of each day.

Student knowledge was assessed at the end of the Division Officer course with a multiple-choice quiz that covered course content. Traditional, VTT local and VTT remote students showed identical levels knowledge of course content.

Discussion. The feasibility of using VTT for Navy leadership training was demonstrated in the sense that the classes were conducted successfully, students received training and graduated, and there was no significant outcry about the way their training was being received. However, adapting the instruction to delivery by VTT may have led to some changes in areas that have been held to be important in the Navy leadership community: the intensity of a learning environment involving instructor-student and student-student interaction was lessened, the ability of instructors to circulate among teams and to perceive remote students' nonverbal cues was limited by the view offered through the VTT system, and some experiential learning experiences were more difficult to conduct with VTT.

Based on the subject-matter expert ratings and the data pertaining to participation, some reduction in the interactivity of the NAVLEAD learning environment was suggested for VTT classes as compared with traditional classes. On the other hand, it was not clear that the course had been compromised and several other considerations may play in the decision to offer the training by VTT. First, some of the observed significant differences between VTT and traditional NAVLEAD courses mainly reflect perceptions of reduced quality among ratings that were generally on the positive end of the scale. Among the more objective measures, the interaction count was nonetheless lower by about a third, but two instances reflecting learning were not affected. Second, this research involved the first attempts to deliver NAVLEAD instruction by VTT and the training has not been offered in this way on a regular basis. Regular delivery of these courses by VTT would likely lead to some improvements as more experience

is gained with VTT and instructors develop new techniques to foster interaction. Evolving new instructional strategies and instructor behaviors to encourage greater student participation could also be supplemented with new video technologies to show better views of individuals between sites. Compared to when sites participate together as a whole class, the ability of instructors to monitor the audio and video of activities involving multiple small groups at remote sites appears to be the greatest challenge in this course.

A decision to use VTT for NAVLEAD involves weighing potential cost savings against the modest reduction in interactivity associated with using VTT for the training. There is a strong demand for NAVLEAD training and significant travel or instructor costs could be avoided if such training could be delivered by VTT. If a decision were made to conduct NAVLEAD instruction with VTT, ways to foster higher levels of interaction should be tested and refined.

Fiber Optic Cable Repair Course

The feasibility of using VTT to deliver a Fiber Optic Cable Repair course was evaluated in a study by Wetzel, Radtke, Parchman, and Seymour (1996). This course was selected as a representative of challenging hands-on laboratory courses. The course contained a range of activities that included instructor demonstrations and student laboratories for three types of fiber optic connectors, the use of test equipment, and a hands-on performance test.

Three treatment groups were compared with a total of 50 students in traditional, VTT local, and VTT remote classrooms. The VTT local and remote conditions were simulated in the sense that students were located within the same building in different classrooms. A second instructor served as a VTT facilitator to monitor the VTT remote students for safety reasons during VTT classes. The groups were compared on procedural errors during connector laboratories, a trouble-shooting performance test on faulted fiber optic systems, help received during laboratories, final examination scores, student questionnaire responses, and an observer tally of interaction over the VTT network.

Performance. There were no significant group differences in student performance indicating impairment for remote site students as a consequence of delivering the course by VTT.

Procedural errors during two connector repair laboratories were no higher for remote students compared to either local or traditional students. Errors declined about 20 percent during the second laboratory, suggesting that student performance improved with experience. There were no significant group differences on observer ratings of safety, the quality of student work, or objective light loss readings for the connectors. About 6-7 percent of all students received the lowest rating on wearing eye glasses and controlling fiber fragments. There was a slight trend for more instances of help and assistance for remote students and for them to aid one another more than the other groups. A video microscope used to show connector ends over the VTT system was found beneficial in allowing remote site student work to be inspected by the instructor and for other students to observe examples of acceptable and unacceptable work.

Trouble-shooting test performance on faulted fiber optic systems also revealed no significant differences between the treatment groups. The groups had similar success in finding a fault and

they listed a similar number of possible fault causes and corrective actions. Students required less help and less time to solve the fault on the second of two test systems and this improvement was slightly less pronounced for remote students. Help given to students during the performance test predominately concerned trouble-shooting logic, followed by help on test equipment. The fiber optic systems were installed on roll-away carts, illustrating the adaptation of equipment to be portable so it can be taken in and out of VTT classrooms that are used for other courses.

Remote-site students generally required slightly more time to complete the various laboratory periods than did the other groups. This might reflect logistical delays in establishing communications over the system or the absence of an instructor who is immediately available for assistance or supervision. Scores on a final multiple-choice test did not differ significantly between groups and there is typically little decrement for remote students on such lecture-based material.

Interaction and Student Evaluations. A tally of instructor-student interactions across the network indicated little disadvantage for remote-site students during lectures and demonstrations when students participated as a combined class. During laboratories when students worked individually or in small groups, the network was used primarily by remote students to ask questions of the instructor. Student questionnaire responses revealed few significant differences between the treatment groups. The groups did not differ in their perceptions that some course activities were more difficult to conduct than others. Most VTT students indicated that they would take another VTT course. They also were more accepting of the VTT method of instruction than were traditional students who had not experienced this method.

Discussion. It was instructionally feasible to deliver the Fiber Optic course by VTT based on the results of the experimental test run. Enhanced preparation of remote students prior to performing their laboratory work was identified as a method to offset the reduced assistance available to students who are at a distance from the instructor. Examples of this preparation in this study included the use of three videotapes on connector repair, computer-based instruction on trouble-shooting, and moving topics taught during laboratories into lectures and demonstrations given prior to conducting laboratories. Other technologies were used during laboratories to support instructors and students. These included portable cameras used for instructor demonstrations (e.g., with preset pan/tilt/zoom setting to allow the instructor to demonstrate test equipment without need for a supporting camera person), a microphone-based video switching system to show individual student work stations when students asked questions, the video microscope to show connector ends over the system, and the general use of methods that permitted portability (e.g., portable roll-away fiber optic system carts created to allow the course to be delivered outside the traditional laboratory).

Although the evaluation showed that it was feasible to deliver the course by VTT, the conversion and delivery of the course involved a moderate amount of difficulty. Substantial preparation to accommodate the use of course equipment and the development of compensatory techniques were required to convert the course for VTT delivery. Delivery of this course by VTT would increase demands on VTT site personnel and would involve additional room preparation and support logistics. A VTT facilitator would need to be present during student laboratories as a safety monitor and to assist the students and instructor. Offering the course by

VTT would offer marginal travel cost savings because of the small numbers of students per class, although other laboratory courses with greater throughput could be beneficial.

Quality Assurance Course

The feasibility of using VTT to deliver a course with a student computer laboratory was evaluated in a study by Wetzel, Pugh, Van Matre, and Parchman (1996). A 3 day Quality Assurance (QA) course was selected because it contained a hands-on computer laboratory and the course had sufficient student throughput to warrant the VTT conversion efforts. The course is primarily lecture-based, with heavy emphasis on correct use of reference materials to fill out QA forms. Several laboratory sessions involve filling out various paper-based forms and a 2 hour laboratory requires the use of a computer to create a printed document. Students produce a Control Work Package (CWP) document during the laboratory with a CWP computer program designed for this purpose. Students use the CWP program to enter data that will be printed in blocks on the document and to enter paragraphs for narrative sections of the report.

Approach. The primary elements of the VTT approach to this course involved: (1) a portable computer system using a wireless network, (2) demonstrating QA software over the VTT system via a video scan converter, (3) enhanced preparation of students prior to the computer laboratory, and (4) use of an existing computer classroom at the local site so that new equipment was primarily needed only for a remote site.

Conversion of the course to VTT involved the adaptation of course materials and training instructors in VTT delivery techniques. Instructor presentation materials were converted to a landscape hard copy form and revisions were made to enhance the quality of numerous visuals. High quality still photographs of a mechanical valve were created so that identification marks inscribed on the valve could be seen in demonstrations presented over the VTT system. A demonstration of the computer program, accompanied by a discussion of useful operation tips, was added prior to conducting the student computer laboratory. A phased approach was used to tryout and refine the delivery of the course. Instructors first practiced using the VTT system and then used the computers in a simulated local-remote environment. Several dry-run courses were conducted with simulated remote students who were located in a VTT classroom adjacent to that of the instructor. This permitted instructors to practice using the VTT system and allowed the lectures and demonstrations to be refined. The course then went on-line with actual remote students located in Pearl Harbor, Hawaii. The local (originating) classroom was located in San Diego.

Laptop computers were used at the remote site because they are portable and can be moved in and out of VTT classrooms that must be used for other VTT courses. This avoided having to dedicate the rooms to computer laboratories with larger equipment that requires more space and results in fewer seats. An infrared wireless local area network (LAN) was used with the laptop computers to reduce a clutter of wiring in the room. The wireless LAN allowed students to print their work on a laser printer that was attached to a personal computer server.

A scan converter was used so that computer screens could be transmitted as video over the VTT system. The scan converter allowed the instructor to demonstrate the operation of the computer program to students prior to conducting the laboratory. Although the resolution

provided by the scan converter was less than that of the computer display, it was sufficient to provide general orientation and to show the sequence of operations when accompanied by the instructor's verbal description. The capability also allowed the instructor to answer student questions on operating the program during the laboratory. The instructor would locate the particular point in the program where the student was encountering difficulties and show that screen over the VTT system. Thus, the difficulty of an exclusively verbal exchange was reduced because both participants were viewing the same screen.

With the exception of the computer laboratory, both local and remote students received all instruction in the VTT classrooms. VTT local students left the VTT classroom during the computer laboratory and used an existing computer laboratory in another building at FTC San Diego. Remote students remained in the remote VTT classroom at Pearl Harbor during the computer laboratory. One of two QA instructors accompanied the local students to their laboratory while the other instructor remained in the local classroom to monitor remote students over the VTT system. A VTT facilitator was available at the remote site to assist students. A pair of students shared a laptop computer if there were too many students to allow individual use of a computer.

Evaluation Results. The course evaluation compared VTT local and VTT remote treatment groups with a total of 100 students. Evaluation measures consisted of performance on an objective 50 item final examination, an experimental 10 item quiz on facts about the computer program, a student questionnaire, and an observer tally of student-instructor interaction over the VTT network.

There were no significant differences between local and remote students on the end-of-course final examination on various aspects of the QA process. These scores were also comparable to those for 133 students who had previously received instruction in traditional classrooms. There was no significant difference between the local and remote students on the quiz covering facts about operating the computer program in the laboratory.

Student questionnaire responses generally showed few differences between the local and remote students. Significant differences between the groups were found in three topic areas. First, the visibility of instructional materials and training aids was rated slightly lower by remote than by local students. Second, access to, or attention from, the instructor was rated lower by remote students. Local students were more likely to cite the instructor as a frequent source of assistance, whereas remote students cited assistance from a combination of the instructor, VTT facilitator, and other students. Third, a group of questions indicated slightly greater problems for remote than for local students on aspects of the computer laboratory (i.e., operating the computer program and printing documents). However, the average difficulty ratings of remote students were in a positive direction and slightly above the portion of the scale indicating "few" problems (i.e., rating were on a scale ordered in terms of "no," "few," "some," and "many" problems). Remote and local students indicated a similar acceptance of VTT as a method of instruction on other questionnaire items.

The tally of interactions over the VTT network showed that instructor initiated questions during lectures were many times greater than when students were engaged in performing laboratory activities. Remote students initiated interactions less than local students, but remote

students participated equally when instructor questions identified a site or student that should respond.

A cost analysis was conducted for the anticipated use of the computer equipment used in this research at two remote sites located in Pearl Harbor, HI, and Bangor, WA. Avoided travel costs to San Diego for 10 students from each of these two sites were compared with the costs of delivering the laboratory course by VTT. Avoided student travel costs for four class convenings were estimated to be \$15,504 in excess of the VTT delivery costs (i.e., travel costs minus the sum of VTT classroom contract costs plus amortized computer costs). Additional course convenings where other courses share the same computers would reduce the impact of the costs for outfitting VTT remote sites.

Discussion. The experimental implementation of the QA course computer laboratory was successful. Remote students performed as well as local students on the final examination and on the computer operation quiz. The student evaluation questionnaire showed little difference between the groups. The judgement of the instructional staff and researchers was that it was feasible to deliver the course in this manner. The implementation of this course could be expanded to other sites and the portable computer technique could be used in other courses with similar requirements. However, it should be noted that the QA course involves a mild form of a hands-on laboratory in the sense that the computer laboratory is not long, the task is not difficult, and students could perform the task without extensive instructor assistance. As with the Fiber Optic Cable Repair course, progressive enhancements made to instructor demonstrations illustrated the technique of better preparing students for conducting their laboratory work with less assistance.

Delivering Laboratory Courses by VTT

This section presents considerations applicable to delivering laboratory courses by VTT according to the following topical organization: (1) a review of general conversion methods for VTT courses that emphasizes a systematic approach, (2) discussion of approaches and lessons learned for delivering laboratory courses, and (3) identification of the several characteristics of training that are related to the degree of difficulty in converting or delivering instruction by VTT. The final section of the report presents a series of general guidelines derived from this discussion.

VTT Course Conversion Methodology

Simpson (1993) developed a guide to converting Navy courses to VTT that is generally applicable to both lecture and laboratory instruction. A slightly modified version of this methodology is outlined below because it has value as a systematic approach with several important elements that could be overlooked without previous experience in VTT course conversion. Additional considerations applicable to converting laboratory courses are discussed later. These considerations are elaborations of the analysis and redesign steps given below. The methods for laboratory courses involve significant problem solving efforts, case by case consideration of specific problems, and experimentation to achieve the best approach. A new element reflecting cost considerations that could be associated with laboratory courses has been added to the initial steps given below.

Course Conversion Steps

1. **Form a Working Group.** Members of a working group should represent expertise in several areas: a training/education specialist, a subject-matter expert on the course to be converted, and an audio-visual or media specialist. Additional skills of benefit to the group would be prior experience in videoteletraining and training evaluation. The group should identify conversion tasks, define member roles and responsibilities, and set milestones.

2. **Observe Training and Collect Data.** The working group should have previously observed other VTT courses prior to collecting data on the course being proposed for conversion to VTT. The working group should observe the actual training course and systematically record data on the course activities. Observations of the course should include details on all course activities, such as instructor demonstration requirements, the type of interaction between instructor and students, the materials used by students, the media used by the instructor, testing, and the requirements of student laboratories. Data should be assembled to assess the estimated student throughput and costs of duplicating training equipment at remote sites.

3. **Analyze Training.** Based on the observations of the course, the working group performs an analysis to determine how the requirements of the instruction can be met when delivered by VTT. The constraints on delivering the training by VTT are identified and candidate solutions are developed. Instructor visual presentation materials to be converted are identified and scrutinized for visual detail and small print that cannot be supported by the resolution of video. Materials that will have to be procured or duplicated for the remote site are identified. Test administration, scoring, and reporting procedures are reviewed with respect to how they will be performed at remote sites. Lectures, demonstrations, and laboratories should be analyzed for modifications that are required by specific training activities and for atypical communication or interaction needs. Functional areas used within the classroom are identified that may have to be duplicated in new ways within the VTT classroom. Demonstrations involving large or difficult to see items are identified and alternative procedures or training aids are proposed. The assistance that will have to be provided by remote site facilitators is identified. For laboratory courses, alternative ways must be devised to supervise students and to provide the assistance to students that would normally require the physical presence of an instructor. As described later, a cost analysis should be conducted at this point to determine if there is sufficient student throughput to warrant a conversion of the course to VTT.

4. **Redesign and Convert Training.** The best candidate solutions from the analysis of the course are used to convert and redesign the training for delivery by VTT. Simplicity and fidelity with the original traditional training are design goals in developing the compensations required by the constraints of VTT. Materials required for remote sites are procured and remote site testing and scoring procedures are developed. Training materials are converted to hard copy form in a landscape format for presentations on a video document camera. New simplified graphics are created as appropriate to the lower resolution of the video medium. Training aids are revised or new ones are created. New instructional delivery or demonstration techniques are developed. Demonstrations that contain aspects that are difficult to perform live can be videotaped in advance to provide the best views. All converted or redesigned materials and demonstrations should be tested over the VTT system to assess their visibility to remote observers. The classroom layout is modified to accommodate any extra space requirements for

demonstrations and for student work areas during laboratories. Techniques and technologies for supporting laboratory course activities are discussed later in this report.

5. Train Instructors and Facilitators. Instructors should observe other VTT classes, become familiar with the architecture of the VTT system and classroom equipment, try out converted instructional materials, and practice delivering instruction before observers in a VTT classroom. Suggested topics for instructor training are given in Simpson (1993), in relevant instructions maintained by the CESN, and in a training videotape for new instructors that was developed during this project (the tape covers converting instructional materials, instructor behaviors, and coordinating with remote sites). Coordination with the remote site should be initiated and course procedures should be reviewed with remote site facilitators. A daily list of course events should be created which specifies when materials are to be distributed, when tests are to be given, and the procedures for scoring tests.

6. Implement and Refine Training. An initial pilot course is conducted with actual students. Instructor techniques and converted materials can then be revised based on this experience and critiques from observers. All modifications to the training should be documented at the time that the course goes on-line. The training should be formally evaluated after implementation in terms of student achievement and the observations or comments provided by students, remote site facilitators, subject-matter experts, and training specialists. Experience in actually delivering the course should be used to refine the training by repeating portions of the earlier analysis and redesign steps. A subsequent evaluation after a lengthy period of implementation would also be recommended to assess whether any undesirable drift in training procedures has occurred.

Cost Analysis

Delivering laboratory courses by VTT could involve cost issues that are not found with lecture-based VTT courses. Some laboratory courses may have fewer students than are found in typical lecture-based courses. Some laboratory courses may also require expensive equipment that would have to be duplicated at remote sites. Additionally, the number of students may be constrained by access to a limited amount of training equipment. These circumstances would require an analysis to ensure that offering the course by VTT would provide a cost benefit. Some value judgement may be required if the training is judged to be important because a skill is critical. The primary benefit of VTT is obtained when student travel and per diem costs are avoided because students do not travel and instead receive training near their duty station. A brief outline of methods to assess the benefit of VTT delivery is given below. It is based on first estimating student throughput and development costs, and then comparing the relative level of costs for avoided travel with those for using VTT.

Estimating Student Throughput. The estimated student throughput for a proposed course can be developed by: (a) examining historical data from course rosters to determine the extent to which previous students traveled to the proposed training delivery site, (b) examining data on student throughput at remote sites where a course might be eliminated, (c) estimating demand for students that would not otherwise take the training unless it were made available locally at a

remote site. A brief survey of commands or ships might be conducted to estimate anticipated throughput for students who do not receive training because of the unavailability of travel funds.

The estimated student throughput for each remote VTT site is then used to develop an estimate of the avoided travel costs for a class convening. Avoided travel costs would typically be the product of the estimated student throughput and the sum of the round trip airfare, local travel, and per diem for the length of the class.

Estimating Significant Development Costs. Initial costs required to enable the capability to deliver training at a remote site may need to be considered if the expense is significant. These initial costs could be for training equipment that must be duplicated at the remote site. These initial costs could also be for unusual expenses required to develop new training aids or methods. If these initial costs appear to be significantly above what might be expected for a lecture course, then the costs can be included with the VTT delivery costs. These initial costs can be amortized over the expected life of the training equipment or the life of the VTT training course. For example, if the expected lifetime were 5 years, the yearly costs computed for a course would be increased by an amount equal to one fifth the initial training equipment costs. An example of an analysis incorporating amortized initial costs is given in Wetzel, et al. (1996) for the computers required to deliver the QA course by VTT.

Judging VTT Delivery Benefit. Several alternative approaches can be considered for determining the benefit of offering a course by VTT.

Parity with Average Throughput: If development and equipment costs are negligible, then student throughput is the primary consideration in deciding to offer a course by VTT. Delivering the training by VTT would likely be beneficial if the estimated throughput were at least the average throughput found in the CESN. This average has historically been between 10 and 11 students per classroom, based on an average of about three participating sites. This range has typically been used as a minimum by the CESN for considering whether to deliver courses by VTT. Using this average as a criterion reflects the assumption that the level of throughput for the CESN has been successful in generating a cost avoidance in excess of the costs of maintaining the VTT system.² The benefit of operating this VTT system reflects a combination of courses that vary in throughput, where some high throughput courses compensate for others with lower throughput, as well as ancillary use of the system for conferences.

Student Travel versus VTT Classroom Costs. A successful use of VTT would be suggested if the costs avoided for student travel exceed the costs for using the VTT system. This method reflects the current costs for operating the VTT system and is in effect a miniature version of the cost comparison made for the CESN as a whole. The following analysis might be performed in

²Estimated costs in the historical record of the CESN from 13 March 1989 through 30 September 1995 indicate a total VTT system contract cost of \$5,164,456 and total avoided travel costs of \$9,174,332 (\$7,108,424 training costs and \$2,065,908 conference costs). Thus, the contract costs are about 56 percent of the estimated avoided costs, which leads to the statement that operation of the system breaks even about half way through a year. Excluding the ancillary use of the system for conferences, the contract costs are about 73 percent of the estimated avoided training travel costs. An early cost analysis of the CESN is given in Stoloff (1991).

situations where no instructor exists at remote sites and student travel would be required to obtain the training.

The costs of the VTT delivery method for one class convening would be the current CESN contract costs for the number of VTT classrooms to be used for the duration of the class. The daily cost of the VTT classrooms would be the sum of the yearly contract costs for the local and remote classrooms participating in the training divided by the available training days per year. The per convening cost of a class would be the daily cost of the VTT classrooms times the number of class days for the convening. Any significant initial fixed costs for equipment or development would be added to the per convening cost for each of the remote sites (i.e., amortized fixed costs per year divided by the number of class convenings).

The estimated throughput per class convening is used to develop an estimated travel avoidance. The throughput could reflect prior actual student travel and that resulting from the training opportunity at the remote sites that represents travel that would have been expended were funds available. Round trip airfare, per diem for the duration of the training, and local travel costs for the anticipated number of students at each site would be summed for all of the remote sites.

The estimated cost avoidance for travel and per diem for the remote sites would then be compared to the VTT classroom costs for the class convening.³ A beneficial use of VTT would be suggested to the extent that estimated student throughput generates avoided student travel costs that exceed the cost of using the VTT classrooms. The per year costs would be the product of these per convening costs and the number of convening. To achieve parity with the previously noted historical benefit obtained by the CESN for training (excluding conferencing), the costs of using VTT would have to be about three fourths of the estimated avoided travel costs.

In some circumstances there may be an opportunity to use VTT to centralize the delivery of training and reduce the number of instructors duplicated at more than one site. However, the benefit may depend somewhat on the details of a particular course and the perspective that is

³For example, assuming \$70,000 as the average cost of a CESN classroom and 251 available training days a year, the daily cost of one classroom is \$279. The VTT classroom convening costs for a local and one remote classroom would be \$1,674 for 3 days and \$2,790 for 5 days. If a second remote site is added to these, the total is \$2,511 for 3 days and \$4,185 for 5 days. Avoided per student travel costs for a 3 day class convening with round trip airfare of \$76 (Government rate between San Diego and San Francisco), local travel of \$20, and 4 days of per diem at \$25 per day would be a total of \$196, and for a 5 day convening would be a total of \$246. Assuming 10 students for one remote site, avoided student travel would be \$1,960 for a 3 day class and \$2,460 for a 5 day class. If a second 10-student remote site with the same airfare were added, avoided student travel would be \$3,920 for the 3 day class and \$4,920 for the 5 day class. Comparing the avoided travel costs with the cost for using the VTT classrooms, one remote site generates avoided travel sufficient to exceed the cost of the two VTT rooms for a 3 day course (\$1,960 vs. \$1,674), but not for a 5 day course (\$2,460 vs. \$2,790). However, the addition of a second remote site (1 local and 2 remotes) generates avoided student travel in excess of the VTT classroom costs for class convenings of both 3 days (\$3,920 vs. \$2,511) and 5 days (\$4,920 vs. \$4,185). Thus, an extra VTT remote site provides the advantage of generating additional travel avoidance and minimizes the impact of the local classroom costs where there are no avoided travel costs. Fewer students would reduce the travel avoidance without affecting the VTT classroom costs. Additionally, shorter class convenings have a relative advantage because room costs are proportionately less, while travel avoidances are only slightly reduced by the days of per diem.

taken. From the perspective of a remote site that delivers training, eliminating a duplicated instructor might be a benefit if that resource continued to be available locally and could be used in another way. A local command would benefit by reassigning an instructor when the cost of the VTT system is funded from other than local sources. From the perspective of the entire Navy training enterprise, the costs for a duplicated instructor and the costs for the VTT system are alternative ways to provide the training. At this level, the costs are incurred either way and the two alternatives would be compared (e.g., costs for two instructors versus costs for one instructor plus the costs for the VTT classrooms involved). The least expensive alternative would have to be determined based on the details of the particular course, proportion of instructor time devoted, number of sites, and throughput. In those cases where the VTT system appeared to be beneficial, avoided travel costs would still be required to exceed the costs of the system.

Approaches to Delivering Laboratories by VTT

In traditional laboratories, students are physically present with the instructor and may cluster around the instructor to view a demonstration. During student laboratories the instructor may circulate among students, look over their shoulders to observe progress, and deliver instruction as needed in an adaptive fashion. These interactive tutorials amplify details, clarify concepts, or provide the student with corrective guidance. This form of instruction may appear unplanned when students seek help, are observed to need help, and when conveyed through casual conversations. A related situation exists in laboratories where small group processes are involved. Proximity is also valuable when there is a high degree of interaction among participants and nonverbal cues are an important part of the communication.

This learning environment in traditional laboratories may need to be conveyed in different ways to provide the same information to VTT remote students who are not physically with the instructor. When remote students perform laboratory activities at a distance from the instructor they must use the VTT system to communicate with the instructor, rely on resources at their own site, or rely on prior instruction to work more independently.

Possible Approach Alternatives

Several approaches can be considered for delivering courses that contain laboratories. A subset of these alternatives are more likely to be implemented as solutions. Other possible approaches are more applicable to specific circumstances or may be less acceptable in several respects.

Three approaches have the greatest generality and are more likely to be used to implement VTT laboratory courses. First, students can be better prepared for performing laboratory work prior to the laboratory or given aids to augment performance during the laboratory. Second, support at the remote site can be increased by providing a surrogate for the instructor to supervise students and conduct laboratory activities. Third, technology can be used to increase the visibility of activities between sites to achieve a greater degree of remote presence for the instructor. A combination of these approaches would offer the best solution for most courses.

Several other approaches are possible in specific circumstances. Probably the least acceptable alternative is to eliminate a laboratory from a course, or to segment the course so that lectures and laboratories are in different courses. Another problematic solution is to conduct the laboratory portion of the training on the job instead of in a formal training course. A related practice is where an instructor travels to a site to use existing equipment for training. Another solution is to conduct the course laboratory off-line within the VTT classroom or in another suitable space with the part-time assistance of a local subject-matter expert or a trained VTT facilitator. Finally, in some circumstances the audio and video services of the VTT classroom could be extended to an actual laboratory space for the purposes of conducting an instructor demonstration or a student laboratory.

These alternative approaches require case by case examination of course details to develop the best solution for each course. The best solution may result from a willingness to accept new alternatives and to engage in some experimentation. Resistance to converting courses to VTT is occasionally encountered and it is more likely when addressing the greater challenge of delivering a laboratory course. The following discussion involves a combination of the first set of alternatives (i.e., where better prepared students conduct laboratory work while being monitored over the VTT system by an instructor who is assisted by a remote facilitator who is physically present to supervise laboratories). The discussion documents the lessons learned from the courses studied and is directed at illustrating several techniques that might be generalized for adapting other laboratory courses.

Preparation, Aiding, and Augmenting

There are several ways to better prepare, assist, or augment students for conducting their own laboratory work with less support from the instructor. These include: (1) enhance lectures and demonstrations given prior to the laboratories, (2) present instruction prior to laboratories by videotape or by computer-based instruction, and (3) provide a job performance aid to assist students during the laboratory. Several of these techniques can be used together. A combined approach was illustrated in the Fiber Optic course where videotapes were used to demonstrate cable repair, and computer-based instruction and enhanced preparatory lectures were given prior to trouble-shooting.

Preparatory Instruction. Information conveyed during interactive exchanges in traditional laboratories can be developed into an explicit instructional segment given prior to the laboratory in order to better prepare students for performing more work on their own. The idea that students can do work on their own would seem to highlight the weakness of using the VTT system. Although designed to benefit VTT remote students, this approach is merely an extension of good instructional practice applicable to VTT and non-VTT classes alike.

When an instructor is distant from students during laboratories the normal interactive exchanges and one-on-one adaptive forms of instruction are difficult to accomplish because the instructor cannot circulate among the remote students. Activities that may be difficult to accomplish over the VTT network typically involve interactive back and forth exchanges in front of equipment. For example, successive adjustments to test equipment may be made while laboratory participants share a view of the same screen, point at events on the screen or equipment controls, and engage in interactive exchanges to achieve an understanding of the

procedure. In the Fiber Optic course, it was not uncommon for additional learning to take place in instructor-student exchanges during a performance test involving trouble-shooting and test equipment operation. The inability of the instructor to circulate among remote-site students in the normal fashion focused attention on developing alternative ways to provide this assistance. It became apparent during early class convenings in this course that the help sought on several topics could be lessened by explicitly presenting important aspects of the assistance normally given during the laboratories. Lecture material and demonstrations were enhanced to address problems previously observed during the test equipment and trouble-shooting laboratories. This material was then presented prior to the laboratories to prepare remote-site students for performing work more independently in the absence of an instructor within the room. Following this enhanced preparation for the laboratories, instructors judged that difficulties encountered by students were lessened during later classes.

A similar interactive situation existed in the computer laboratories of the Quality Assurance course. Some information normally conveyed in interactive exchanges while learning to operate a computer program was used as part of an instructor demonstration that was developed to prepare students prior to the laboratory. During the laboratory, student problems were resolved by the instructor while showing his computer screen over the VTT system so that they shared a common view of a concrete example during instructor-student exchanges.

Use of Videotapes. Videotapes can be used as an alternative to a live demonstration, to complement the demonstration, and as a primary form of instruction to prepare students for a laboratory. The ultimate rationale for these uses of videotapes is to ensure that remote students receive the best possible views of the demonstration in the event that detailed views and critical aspects of a live demonstration are not shown reliably. Videotapes can be used to reduce the demands on the instructor and may allow a more elaborate demonstration through various production techniques, such as editing to present the best views of equipment. A short demonstration can be presented by videotape when there is some difficulty in performing the demonstration live because it is difficult to recreate, or when there are constraints due to the size, angle, lighting, or hidden interior parts of objects. When short segments are used for a specific demonstration purpose, a videotape need not involve an expensive production. A low-budget depiction of only parts of a demonstration can be used to show views that normally require extra effort to display. These various uses of prepared materials can standardize the content and quality of the instruction. Videotapes provided for self-study by students also allow material to be reviewed several times and at a time and place that is convenient (cf. review in Wetzel, et. al., 1994).

Computer-based Instruction. As with videotapes, computer-based instruction can be used to prepare students for a laboratory as well as to provide other stand-alone instruction. Computer-based instruction offers a more interactive approach than does videotape. However, the software must support the student and impose minimal requirements for learning a computer skill. This approach was used in the Fiber Optic course by presenting fiber optic trouble-shooting problems prior to hands-on trouble-shooting laboratories. The inability of the instructor to circulate among remote-site students to provide assistance focused attention on the need to better prepare students for trouble-shooting with a simulated experience.

Job Performance Aids. Job performance aids are another way to augment remote site laboratories to compensate for less direct support from a distant instructor. Many existing student guides and job performance/assignment sheets are designed to provide guidance for students as they conduct their laboratory work. However, if students are to perform more independently, then these aids need to be carefully evaluated for self-sufficiency and revised to better support the student. Experience with actual students should be used to develop supplements and enhanced materials that address important missing points, common problems previously encountered by students, and important tips normally conveyed by the instructor during the laboratory. In some cases an aid may have to be developed because none exists. Laboratories on equipment operation may use a set of printed instructions or steps that can be enhanced to capture the expertise normally provided by the instructor during the laboratory. For example, some feedback provided by the instructor may be developed in the form of checklists so that students can verify for themselves that the steps of a task have been completed. A performance aid documenting correct plotting conventions was suggested for the Celestial Navigation course because remote students were at a disadvantage in not having an instructor circulating during laboratories to provide corrective guidance when these techniques were observed to be deficient. A similar support mechanism capturing the expertise of the instructors was developed to allow remote site facilitators to score student plotting on an examination by using an acetate overlay with the correct plotting information.

Facilitator, Site Support Logistics, and Portability

Delivering many laboratory courses by VTT would require somewhat greater efforts on the part of site personnel and would involve additional logistics support for the array of equipment and supplies required. These liabilities are not insurmountable for many courses, but each laboratory course needs to be considered on a case by case basis.

VTT Facilitator. The remote site facilitator plays an important role in supporting VTT courses. Normally, the facilitator is present during portions of a class, is the technical expert on the operation of the VTT system, operates cameras and other equipment, prepares the classroom, distributes class materials, serves as a test proctor, and scores examinations. The facilitator typically has little subject-matter expertise in the courses being delivered. Delivering student laboratories by VTT would increase the demands on the facilitator and would require a somewhat greater role for the facilitator during the delivery of these courses. Several areas of concern that could impact the facilitator are discussed below: supervision, safety, certification, subject-matter expertise, laboratory equipment logistics, and the behavioral role of the facilitator in assisting students and the instructor. Not all of these concerns would necessarily apply to a particular course.

Many laboratory courses would require that the facilitator be present in some or all laboratory sessions. This presence might be for general supervision of student activities and to maintain progress in some courses. In other courses, this presence would be required as a safety monitor because of electrical, chemical, or physical danger. For example, students would have to be monitored to ensure that they wore eye protection, were careful with liquids, and properly controlled tools and power sources. These issues would not prevent courses from being delivered by VTT if the facilitator were present during laboratories to warn students who disregard safety.

The facilitator would play an important behavioral role in many laboratory courses. The facilitator serves as an intermediary by acting as an agent of the instructor and by acting on behalf of students. The facilitator can serve as the eyes and ears of the instructor for on-going activities that are not visible or audible to the instructor. The facilitator supervises students and can inform the instructor of student progress or problems observed within the remote classroom. The facilitator also acts on behalf of the students by redirecting their questions to the instructor or by soliciting instructor assistance for observed problems. In the Fiber Optic course, the physical absence of the instructor and the physical proximity of the facilitator often led students to initially direct their requests for help and assistance to the facilitator, who then redirected them to the instructor. Several of the evaluation studies also suggested a trend in which remote site students were more likely assist one another. Thus, students may tend to rely on resources within their remote site, including other students, prior to using the two-way audio-video VTT system to consult with the instructor.

Somewhat greater logistical assistance would be required of facilitators because of the additional equipment used in some laboratory courses. This could include operating small portable cameras, and providing assistance when student work is shown to the instructor on these cameras or via the document camera. During laboratories, the facilitator might have to prepare, configure, or operate some equipment so students could perform their work. The facilitator might also have to serve as a proctor for performance tests and setup or restore test problems, such as prearranged faults for trouble-shooting. As in other VTT courses, providing remote sites with a detailed list of daily course events would ensure that materials and equipment are ready at the appropriate time. The logistics of conducting some laboratory activities might also result in slightly longer class periods at remote sites, as was observed in the Fiber Optic course.

Several of these support functions suggest that facilitators would be required to be somewhat more knowledgeable of course content than is usually the case. Courses that require certification of students would demand that some solution be devised. For example, the facilitator could serve as an instructor surrogate if the need for extensive subject-matter expertise could be minimized by training the facilitator in a very specific set of criteria documented in a well designed checklist. Alternatively, subject-matter expertise from personnel at remote commands could be used in a limited way for specific laboratory periods. In some cases, a facilitator could take a course as a student to become acquainted with the course procedures. However, it should be noted that recurring issues for the CESN concern how much skill facilitators should have in the content of the various VTT courses and how much time they have available when performing the facilitator role as a collateral duty.

Site Support Issues. There would be somewhat greater logistical demands on both local and remote sites to deliver many laboratory courses by VTT. A facilitator would be required to setup a room with course equipment and then store it away following a class. Additional storage space for course equipment at a site would be required between class convenings. There would also be a somewhat greater demand on the resources of the remote site to maintain a stock of the various consumable supplies used in some laboratory courses.

A flexible classroom layout can accommodate a variety of courses and would enable laboratory courses to be delivered with less difficulty. Greater classroom space is the primary

factor in accommodating demonstrations and laboratory equipment used in this kind of training. There is some variability in the size of current VTT classrooms. Laboratory activities could be better accommodated if future VTT classrooms were selected to provide somewhat greater space for equipment at the front and one side of the room and for student work areas within the room (cf. Simpson, et al., 1992; Simpson, 1993; Wetzel, 1995). Other room considerations for equipment oriented laboratory courses could include providing power to student work stations by using low-profile power cords. The electrical supply to VTT classrooms may also be need to be increased to accommodate additional equipment.

Portability. VTT classrooms must be used by a variety of courses. Setting up a VTT classroom for a laboratory course can be made easier if the required training equipment is portable or can be adapted to be portable. In the Fiber Optic course, fiber optic cable systems were installed on roll-away carts. This method can be used for a variety of training equipment in other courses. The assortment of other small items in this course also lent themselves to being taken in and out of the classroom (e.g., suitcases containing the cable repair kits). Other laboratory courses have been successfully delivered by VTT which involved less support and laboratory equipment demands. A fewer number of small items than used in the Fiber Optic course are routinely taken in and out of VTT classrooms in the Celestial Navigation course without imposing undue burden (cf. Wetzel, 1995) (e.g., four navigation publications and an array of small navigational equipment such as used during plotting). The computer laboratory in the Quality Assurance course was conducted successfully by using portable laptop computers linked to a laser printer via a wireless local area network that avoided a clutter of wiring in the VTT classroom. Simpson et al. (1992) also used portable roll-away training aids for demonstrations in a Damage Control Petty Officer course or used videotapes to replace live demonstrations.

Use of Technology as an Aid⁴

Several technologies were explored during the project for their value in supporting VTT instruction.⁵ Several themes were illustrated in the use of these technologies: (1) increase the visibility of activities among sites, particularly the remote site; (2) use technologies to assist students during laboratories or to better prepare students for laboratories; and (3) reduce demands on the instructor with the aid of automated technologies, such as those that avoid the need for a camera operator. The use of technology to prepare students for laboratories was discussed previously with regard to videotapes and computer-based instruction. Several technologies are suggested in the following discussion that are applicable to delivering laboratory instruction, or which constitute augmentations to VTT classrooms that are applicable to lecture and laboratory courses alike. Many of these would be of value for regular use within the CESN and several illustrate a theme of providing flexibility and portability that should be followed in future equipment acquisitions.

⁴There is no implied endorsement for any of the commercial products mentioned in this report. In most cases there are alternative products that could have been employed and mention of these products simply documents the actual equipment used in the research. Product names and brands mentioned herein are trademarks of their respective holders.

⁵Several suggested technologies for CESN classrooms discussed here are summarized in Appendix A.

VTT classrooms are typically configured to support lecture-based instruction with several standard pieces of equipment. Large monitors are used at the front of the classroom for students to view instruction or to see participants at other sites. Monitors at the rear of the room allow an instructor to see both incoming and outgoing video. The classroom typically supports four outgoing video sources which are controlled by a hand-held remote or from an equipment control station at the rear of a room. A pan/tilt/zoom camera on the front wall of a classroom is used to show a view of students within the room and a similar camera on the rear wall of the classroom shows a view of the instructor at a podium. A videocassette recorder (VCR) allows tapes to be played or recorded. A pedestal-mounted document camera at an instructor podium is the primary device used to show instructional materials, consisting of hard-copy materials, transparencies, or instructor writing. Chalkboards or whiteboards are typically not present in these classrooms. Students are provided with push-to-talk microphones to reduce extraneous noise, such as private conversations, shuffling of papers, or moving books.

Laboratory courses generally require an expanded number of video sources to show a wider variety of activities that demand a flexible and portable arrangement. The Elmo brand document camera found in all CESN VTT classrooms works well for many demonstrations because it allows extreme close-ups of small items. However, there are many instances where objects are too large for the document camera and some form of camera must be taken to the object to be demonstrated. Large items may have to be placed on a table or installed on carts that can be rotated. A camera mounted on a tripod can create an obstruction unless demonstration space is sufficient or the tripod has been made portable with wheels.

Several camera configurations were used in the adaptation of the Fiber Optic course to explore their potential for aiding the instructor or increasing the visibility of activities at the remote site. This equipment configuration provides an illustrative example that could be tailored to suit other laboratory courses. As described below, this configuration included several small portable cameras, a switch to accommodate additional video sources, a special purpose video source, and an automatic switching system to show views of individual students.

Expanding Video Sources and Portable Cameras. Expanding the number of video sources available at the instructor podium was found to have great utility for increasing the flexibility of using a variety of video equipment. Several video sources were accommodated by attaching a manual six-input video switch to the instructor podium so that one of several devices could be selected as the outgoing video from that location (e.g., Panasonic WJ-220 or equivalent switch). Thus, the document camera at this location became one of several video sources. The other video devices switched from the podium were a Video Labs brand "FlexCam," a small tabletop Canon VC-C1 brand video camera, a video-based 35mm slide projector, and a video microscope. Providing such a switch at the podium is recommended for all VTT classrooms because it easily accommodates a variety of other equipment, such as a scan converter used to show computer screens.

Two different small portable cameras were found useful in the Fiber Optic course. One of these was a Video Labs brand "FlexCam" that was used to show the array of small parts lying outside the view of the document camera during instructor demonstrations. This device consists of a small camera that is mounted on a table-top pedestal via a flexible gooseneck rod that allows the camera to be easily positioned in a variety of directions. The camera was connected

to a long cable so that it could be taken to other tables within the room to show student work or test equipment being used at a student workstation. This camera has subsequently been used in other classes for demonstrations showing large items that will not fit under the standard document camera.

Another small portable camera was beneficial because it provided preset pan/tilt/zoom positions that eliminated the need for a supporting camera person during instructor demonstrations. The Canon brand VC-C1 camera uses a hand-held remote that allows six preset pan/tilt/zoom setting to be stored in memory and these can be activated by pressing six buttons associated with each view. This camera was used during instructor demonstrations of electronic test equipment to switch among views of a display screen, the control knobs and buttons, and an overall view of the entire front panel of the equipment. The test equipment was also on display in the remote classroom during these demonstrations so that remote-site students could see details of the actual equipment.

Views of Individual Students. The view of students at the remote site is typically either a wide view of the whole classroom or a more restricted view of only part of the classroom. The wide view is generally not sufficient to see details of students. The narrow view requires some effort in that the camera must be zoomed by an operator and this improved view of fewer students is achieved only after a delay. For typical lecture-based classes the view shown of remote students may be more of a monitoring convenience for the instructor and has little impact (Simpson, et al., 1991b, 1993). However, the benefit of a full two-way video capability is much more important when conducting instruction involving hands-on laboratories or highly interactive small group processes. Technologies for showing better views of participants between sites are currently evolving. As described below, an automated approach to this problem that avoided the need for a camera operator was informally explored in the Fiber Optic course.

A video switching system was developed which allowed each of four student workstations at the remote site to be viewed when a student used a push-to-talk microphone. Four cameras were suspended from the ceiling so that each camera showed a view the width of a students' worktable. An automated video-switcher used the closure of a set of contacts in a push-to-talk microphone to switch the outgoing video to show the individual student workstation where that microphone was located. Although this system was not formally evaluated, it was apparent that it provided a better view of individual students at their workstations and it avoided manually adjusting a pan/tilt/zoom camera. An automated system like the prototype developed here would be of value at remote sites. This configuration also could have been used for a course with small groups to show a closer view of team members around a table. An alternative configuration with fewer cameras could be used to show alternative halves of the classroom so that student faces and expressions would be more visible over the system. These configurations would involve some effort to install and an additional expense for the CESN. Off-the-shelf technology using a single pan/tilt/zoom camera is currently available for this purpose (e.g., the Parker Vision CameraMan or equivalent). However, the movement shown in the views with this configuration could be slightly more distracting than the immediate "cuts" between views in the system used in the Fiber Optic course study (cf. general reviews of production techniques in Wetzels, et al., 1994).

Special Purpose Devices. Special purpose video devices could also be used or developed for specific requirements in some courses. For example, some equipment may already be supplied with video outputs that allow it to be fed into the VTT system, such as some test equipment. Other examples of special devices for difficult situations could include headsets with microphones for noisy environments, a helmet mounted camera for intensive hands-on work in inaccessible spaces, or specially mounted cameras for heavy workbench work.

Instructor guidance was important in the Fiber Optic course when students sought assistance in judging the adequacy of their connector work. This guidance was made possible in VTT by constructing a video microscope that allowed connector ends to be viewed over the VTT system from either the local or remote site. A high resolution video camera with a reversed zoom lens allowed up to 190x magnification to show about three quarters of a 2.5 mm diameter connector tip. The camera was mounted on a small optical table with a photographic X-Y positioner in front of a holder for the connector. The video microscope allowed fiber optic cable ends to be inspected remotely and was clearly a benefit in allowing all students to share a view of good and bad examples of connector work. This public view of the connectors circumvented the difficulty of verbally describing what was being seen in the traditional viewing scope that could be used by only one person at a time. Students gave the video microscope one of the highest ratings received on a questionnaire. Although not appropriate for use with the fiber optic connectors, several other inexpensive camera products are available for use with conventional microscopes and other optical viewers.

Other Technologies. Several other technologies that augment the capabilities of VTT classrooms can be briefly mentioned. One such device described later is a scan converter that allows computer screens to be displayed over the VTT system. This allows standard computer presentation software to be used, an approach that is replacing several conventional media such as transparencies and 35mm slides. A video version of a 35mm slide projector is available at some CESN sites and it is still useful in accommodating older 35mm slide material. A variety of special purpose furniture is also useful in VTT classrooms, particularly when it is mobile to allow the rooms to be used in a flexible manner. One item of furniture found useful at the San Diego site was an instructor podium with a glass viewport in the top surface. This configuration allows a monitor contained within the podium to be easily viewed while graphics are being positioned on a document camera that sits atop the podium.

The equipment configuration used in the Celestial Navigation course may prove useful in circumstances where an instructor is off-screen for lengthy periods or where the instructor must move around beyond the podium area. A early version of the Parker Vision brand CameraMan device was used. This pan/tilt/zoom robot camera tracks a small infrared device worn by the instructor in order to maintain a continuous image of the instructor centered in the view shown by the camera. This view of the instructor was shown in a picture-in-picture panel in the right third of the outgoing video screen and the instructor's visuals and handwritten computations were shown in the remainder of the screen. These two images were combined by using a video mixer. The video mixer has also been used for other applications where it was desired that two camera sources be shown simultaneously (e.g., two participants viewed by different cameras or from different VTT sites). Such a mixer could be used at transmitting VTT sites that regularly originate instruction.

Emerging technologies may enable VTT to be extended beyond the current CESN classrooms. There may be opportunities to export the audio-video facilities of the VTT classroom to other environments if the spaces were nearby. For example, laboratories containing equipment too large to transport to the VTT classroom could be connected to the VTT classroom by a fiber-optic relay device to extend the incoming and outgoing audio-video lines to the laboratory. Another rapidly emerging possibility is the interconnection of VTT classroom sites with shipboard sites. Small computer-based workstations with audio-video facilities are being experimented with on-board ships. These workstations could also be used at small commands that are at remote locations.

Use of Computers in VTT. Computers are increasingly used in many courses which could be delivered by VTT. Issues with delivering this instruction by VTT include the way that computers are used in the training, instructor demonstration techniques, assisting students, and logistics.

Two broad categories of computer use can be distinguished that differ in how easily the activity can be conducted by VTT. Using computers to deliver instruction to students presents less of a difficulty than when the student activity involves learning a computer skill. When computers are used as a mechanism to deliver information or instruction, the software generally supports the student rather than an instructor. Examples are not limited to computer-based instruction. Computers are also used as information delivery or resource mechanisms in the case of interactive electronic technical manuals (IETM) and with other large sources of information distributed on CDROMS.

Training that involves learning a computer skill is more challenging when VTT students are distant from the instructor. The skill required to operate a software program varies with the specific details of the program and the training may require interaction with an instructor to resolve problems. As with other hands-on laboratories, the physical presence of the instructor is a benefit when this interaction involves activities such as pointing at portions of a screen or seeing sequential changes in a program when resolving problems. A perception that there was need for such student-instructor interaction played in a decision to not attempt a VTT conversion for one high throughput course (i.e., Communications Security Material System (CMS)). Some instances of learning a computer skill could be delivered by VTT more readily than others if the software is not very complex or if students have some prior experience. However, some enhanced preparation of students prior to their laboratory would be recommended to reduce the need for help when the instructor is distant.

There are several limitations with using computers in VTT. The resolution afforded by the video transmitted over a VTT system is less than that of computer displays. Additionally, video cameras cannot be readily used to show most computer screens without revealing a crawling band across the screen due to the frequency mismatch of these two devices. The scan rates for some laptop computer screens do not cause this problem, but they can cause reflections from lighting within the room and be difficult to position in front of a camera. One readily available solution for using computers in conjunction with VTT is a video scan converter (i.e., to convert computer VGA video to NTSC video). The resolution of the computer display is reduced when converted to NTSC video, but this device has still been found useful for several purposes in VTT classes. In addition to software demonstrations, virtually any of the many computer

presentation programs that are available can be used. A scan converter is recommended for any CESN classroom where instructors present an electronic slide show or where visitors for teleconferences bring such materials on laptop computers.

Instructor demonstrations of application programs that students are to learn may have displays that cannot be altered to increase the visibility of details (e.g., diagrams or the size of text). A scan converter may also be used in these instances, but the demonstration techniques used by the instructor may have to be adapted to compensate for the loss of detail shown over the VTT system. In this circumstance, the displays may be for orientation purposes. An accompanying verbal description would be required to identify details and to point out the important aspects of changes to the screens being displayed. This orientation technique was used by instructors in the Quality Assurance course while demonstrating the sequence of operations for a program used to generate a report. Material with low legibility was described verbally and the instructor described steps to be shown prior to executing commands so that student attention could be focused on the change when it occurred. During laboratories when students had questions on a segment of the program, the instructor located that segment on his computer and showed it over the VTT network so that both sites shared a common view while discussing that part of the program.⁶ A similar orientation technique was used in the Celestial Navigation course for small print tables in nautical publications. Critical portions of the text were placed within "bubbles" containing enlarged text and arrows pointed to where that entry was located on the page so that students could locate entries in their own publications.

Using computers in VTT classrooms presents several logistical problems. A VTT classroom must be used for a variety of courses and the installation of computers hampers the ability to share the classroom. Desktop space could be preserved for other classes by installing computer desks with a glass desk top that allows the user to view a monitor mounted within the desk. However, the size of these desks reduces the number of student seats per room compared with the desks now used for lecture classes. Additional wiring for this equipment would also be required. An alternative solution to this problem was tested in the Quality Assurance course computer laboratory. Laptop computers were used because they were portable and could be taken in and out of the classrooms. A wireless local area network (LAN) for printing documents was used to avoid the installation of wiring within the classroom.

Portable computers are recommended for other computer classes to avoid modifications to existing CESN classrooms. A more elaborate computer laboratory could be developed for VTT classrooms if there were sufficient demand to warrant the expense and logistical difficulties associated with a permanent installation. A wireless LAN would not be required if a single LAN wiring path were installed. This wiring could remain in place and the benefit of being able to remove the portable computers when other courses used the classroom would still be realized. More ambitious computer laboratory configurations could be developed if the demand for this capability were to grow in the future. For example, a data network could be installed in parallel with the VTT system to allow local and remote site computers to be internetworked (e.g., data could be shared between sites, student work could be inspected remotely, or remotely operated

⁶A scan converter could also be used to show the screens of remote students back to the instructor, but connecting student computers to the device may create logistical problems that could outweigh the benefits when student-instructor interactions are relatively brief.

programs could be displayed in a higher resolution than that supported by the video of the VTT system).

Course Characteristics and VTT Delivery Difficulty

Four profiles of course characteristics will be described which represent degrees of difficulty in delivering training by VTT. Lecture-based instruction currently delivered by VTT is at one extreme, and at the other are laboratory situations that are prohibitive to consider for VTT delivery. Between these two extremes are two laboratory situations where training could be delivered by VTT, but which differ in the amount of effort required to convert and deliver the instruction. These have been termed "mild" and "moderate" difficulty laboratory situations. These profiles differ in the extent to which they would impact the present operation of the CESN. It is possible that the individual characteristics found in a specific course may span more than one of the profiles. The characteristics listed below may be useful in evaluating the feasibility of delivering courses by VTT.

Typical Lecture-based Courses

The following course characteristics are typical of those found in lecture-based courses currently being delivered by VTT.

- The training is primarily instructor-centered and involves lecture-based material.
- Video is used primarily for showing the instructor and the instructor's training materials. Audio is the primary two-way medium.
- Visibility of remote-site students is more for general monitoring than it is for observing details, such as seeing student expressions, inspecting student work, or for supervising activities, safety, or certification.
- Instructor materials are paper, slides, or transparencies that can be presented by a document camera, 35mm video slide projector, or computer-based presentation program. Adapting these materials for VTT primarily involves revisions to accommodate these media to the lower resolution of video.
- Materials brought into the classroom are small, portable, and are not extensive; such as paper handouts, books, and manuals.
- Demonstrations are minimal or not demanding. Laboratories are typically for in-class exercises and homework that are performed by students with minimal need for physical presence of instructor to provide assistance.
- Interaction and assistance to students is primarily verbal. Document camera may occasionally be used to inspect student work.

- Subject-matter expertise at remote sites is minimal.
- Supervision of students is minimal and can be handled over the network or by the facilitator. Facilitator presence in classroom may be occasional.
- Testing can be supervised and scored by the facilitator. Scoring of tests is straight forward and requires little expertise on the part of the facilitator.
- Cost saving are related to having selected courses with a sufficient numbers of students, course convenings, class size, and a course of 5 days or less that allows more courses to be given.
- Costs for remote-site materials are for duplicates of local site paper-based materials and reflect a simple extension of the number of students.

Prohibitive Laboratory Situations

Attempting to use VTT for many laboratory situations would be prohibitive because they would require excessive conversion or delivery efforts, undue expense, or would be impractical because of adverse conditions.

- Subject-matter expertise is required at remote site beyond that which can be addressed by technological aids, a facilitator, or a semi-skilled facilitator.
- Supervision and safety are critical and require physical presence of instructor. Safety is of concern because of electrical, chemical, or physical danger. A specified instructor-student ratio requires multiple instructors.
- Certification is important or critical. The physical presence of a subject-matter expert is required and the certification function cannot be performed by a remote site.
- Visibility of students is critical and requires the physical presence of an instructor. Students cannot be adequately prepared for independent work prior to performing a laboratory and the physical presence of an instructor is required for active monitoring during the laboratory.
- Full scale equipment or an extensive system mock-up is required for the training. It is fixed at a location and cannot be moved, made portable, decomposed into smaller units, or simulated in some manner. Equipment is too cumbersome and expensive to duplicate at a remote site.
- Computers used in the training are too large, heavily entrenched, or expensive to be relocated to VTT a classroom. The computers are used to learn a complex skill requiring intensive interaction between instructor and student.

- The laboratory situation involves physical constraints. The use of cameras and audio equipment would obstruct the ability to move around and perform tasks or would disrupt the training activity itself. The environment involves excessive noise, poor lighting, a limited ability to see the interior of equipment, and a need to be unhindered by VTT technology.
- Cost considerations are prohibitive. Equipment or supplies are expensive and prohibitive to duplicate at remote site. Number of students may be small or constrained by access to laboratory equipment.

Mild Difficulty Laboratory Situations

Some laboratory courses are feasible to deliver by VTT with little inconvenience to the operation of the CESN. Converting and delivering these courses by VTT would involve a mild degree of difficulty relative to the lecture-based courses currently being delivered by VTT. Existing facilities would generally be sufficient to support these courses.

- Requirement for subject-matter expertise at remote site is minimal and facilitators can be trained in specific procedures used during laboratories. Subject-matter expertise can be addressed with job performance aids for students and aids that capture expertise required for facilitator to score tests or conduct laboratories.
- Compensating instructional techniques or technologies already exist or require some improvement to support relatively independent performance of laboratory work by students working on their own (e.g., job performance aids, preparatory instruction).
- Student laboratories can be given with minimal supervision of students by instructor or facilitator. Safety monitoring and student certification are not an issue in the course. Visibility of students is not critical.
- Physical presence of instructor is not critical to assisting students because students can perform laboratory work relatively independently. Students can get assistance verbally over the network, through occasional use of existing document camera to show student work, and students may assist one another.
- Interaction can be maintained by behavioral techniques used by the instructor, such as encouraging student questions and use of the system, and using a variety of preplanned questions directed at the remote site or to individual students identified from a roster. A group view is sufficient to observe students between sites.
- Some small group activities may be accommodated by appointing remote-site discussion-group leaders or by occasional monitoring by a facilitator. The teams can use the VTT system to report the results of group activities or discussions at the end of the activity for critique purposes. The team activities need not be observed or heard extensively during the activity and can be monitored occasionally with existing pan/tilt/zoom classroom camera.

- Demonstrations can be performed under a document camera or in front of the instructor camera. Details of the demonstration show well or may not be required. Students can be provided with copies of detailed graphics so that graphics used in demonstrations are primarily for orientation purposes. Demonstrations or laboratories that do have taxing requirements are short and not a major portion of course.

- Logistics are not a prominent concern because training equipment is portable and training materials are not extensive. It is possible to provide duplicate equipment and instructional materials at the remote site without undue expense. Demonstration items can be provided to allow remote students to see or manipulate actual objects.

- Computers used in laboratories are for instructional delivery, for acquiring or inspecting information, and the software supports the student. If computer software skills are learned, they are minor or not complex. Demonstrations of computer screens can be shown with a scan converter to provide general orienting and sequence information without exacting detail and can be supplemented by verbal descriptions.

- Cost considerations are not substantial because sufficient student throughput is anticipated. Laboratory materials or equipment are not costly and their availability does not constrain the number of students served.

Moderate Difficulty Laboratory Situations

Some laboratories are feasible to deliver by VTT if greater effort is devoted to support the delivery of the course. There would be an impact on the current operation of the CESN in terms of the demand placed on its resources. These laboratories are feasible if more effort is devoted to course conversion, adapting equipment and materials, additional technology is provided, sufficient facilities are provided, and more attention is devoted to deliver the course with greater assistance from a remote site. The simplicity of delivering the course may be sacrificed as a consequence of using technology.

- Some subject-matter expertise is required at the remote site. It can be addressed with a semi-skilled facilitator, part-time assistance of local experts, or by developing supplementary aids. The level of skill for the facilitator is less than that of an instructor and is specific to tasks in the laboratory. Testing involving expert judgement or student certification would require developing new methods or aids to capture this expertise for the remote staff, or concerted use of the VTT system to show student work or performance to the instructor.

- New development of compensating instructional techniques or technologies is required to provide more extensive support to students performing laboratory work. Preparation of students prior to the laboratory can be developed in the form of videotapes, computer-based instruction, enhanced lectures, and tips on problems to be encountered. New technology can be introduced to assist in judging student work by showing it over the system, such as small

portable cameras, cameras showing workstations, or a special purpose device (e.g., video microscope).

- Physical presence of the facilitator is required as a surrogate for the instructor because visibility of student activities is important. The facilitator is required to be present during a major portion of the course to manage the laboratory and serves as a safety monitor.

- Assistance and interaction during the laboratory requires a concerted effort to use the VTT system to meet training objectives. Much visual and verbal information may have to be shared between sites. Instructor behavior involves active monitoring of remote site students, directed inquiries about progress, coordination with the facilitator, and staying on camera to be available for requests for assistance. The facilitator actively monitors students, redirects needs for assistance to instructor, and assists with equipment configuration or operation. Compensating technologies and instructional techniques have been fully exploited to maximize independent work and reduce assistance required during the laboratory.

- Instructor demonstrations require development of new presentation methods, developing new or revised training aids and mock-ups, and require the assistance of technology. Limitations on the ability to deliver a live demonstration or to see the details or interior of equipment can be addressed by developing videotapes. Additional cameras may be required to show a demonstration. These should be used to assist the instructor without disrupting the demonstration, such as with portable cameras and a pan/tilt/zoom camera with preset settings for equipment demonstrations.

- Highly interactive small group processes that are thought to require monitoring during the activities would require developing new instructional strategies or monitoring technologies. VTT can easily be used when all sites participate together as a whole class at the end of group tasks. However, monitoring the audio and video during the activities of several small groups at remote sites would require additional technology and efforts by instructors to monitor multiple groups.

- Logistics are a concern because equipment must be taken in and out of a classroom, numerous items must be setup in room, equipment requires additional storage space, or duplicating equipment at remote site is an issue. Delivery of course is still possible because equipment can be adapted to make it portable. Room electrical requirements can be addressed and it is possible to provide sufficient space by rearranging or enlarging classroom to accommodate laboratory equipment, table space for student work areas, and for storage.

- Training involving the use of computers for learning a software skill would represent more of a challenge than when they are used as an instructional delivery mechanism. Learning to operate some software could demand an increased level of interaction with an instructor. Portable computers could be used to address logistical problems. Better preparation of students prior to a laboratory could address common questions, problems, and tips on program operation. However, the impact of fully addressing complex software situations to make them feasible by

VTT could involve the use of substantially more technology to allow distant participants to share views when resolving problems, the installation an additional data network between sites, or the selective part-time use of local expertise at a remote site.

- Costs must be scrutinized with more challenging laboratory activities because equipment is expensive to duplicate at remote sites, access to equipment may constrain the number of students, or the training typically involves few students. Sufficient student throughput may justify equipment costs or lower throughput may be justified when critical skills are in demand.

Examples of Course Difficulty

Several examples of courses can be cited to illustrate the mild and moderate difficulty laboratory situations described above. These situations differ in the degree to which there would be an impact on the current operation and configuration of the CESN. These examples are from the courses that were formally evaluated and several other courses which were considered for possible conversion to VTT during the research project.

The Celestial Navigation and Quality Assurance courses are examples of courses representing a mild level of difficulty. The Celestial Navigation course required many small items to be taken into the classroom and these were accommodated because they were portable. Graphics used for orientation purposes were redesigned and a picture-in-picture display allowed the instructor to remain on-screen during lengthy periods of on-screen computations. Instructor assistance could be handled verbally and scoring expertise was captured in an aid used by remote-site facilitators. The Quality Assurance course also allowed VTT classrooms to be shared by other courses because portable computer systems were used. The laboratory was also short, involved a computer skill that was not too complex, and students were able to perform the laboratory without excessive assistance. Problematic portions of the software were addressed in a demonstration used to better prepare students prior to the laboratory. The resolution provided by a scan converter was adequate for showing computer screens of the general sequence of the program and for orientation purposes when students sought assistance.

Navy Leadership training courses might be considered either mild or moderate difficulty courses depending upon how much remote presence for instructors would be acceptable in the VTT situation. Team activities that could be reported over the network at the end of the group activity represent a mild level of difficulty. However, monitoring individual teams during the group activity would involve a moderate level of difficulty because new methods and technology would need to be developed beyond that which currently exists. Additional cameras and a switching system at a remote site would allow individual groups to be monitored with a consequent increase in the load on an instructor to monitor both classes. In either case, the highly interactive nature of this training would require experience delivering the course by VTT in order to evolve new instructional strategies and instructor behaviors to encourage greater interaction and participation. Delivering the training by VTT might also be feasible were it possible to use a remote site facilitator for some specific instructor functions during selected activities in order to monitor the progress or content of the group conversations.

The Fiber Optic Cable Repair course represents an example of moderate difficulty because it was feasible to deliver the course by VTT, but only with greater difficulty and substantial preparation. Numerous pieces of equipment had to be brought in and out of the classroom and portable carts had to be created to allow the fiber optic systems to be used in the VTT classroom. Various preparatory techniques were introduced into the course in the form of videotapes, computer-based instruction, and enhanced lectures given prior to the hands-on laboratories. Additional cameras were introduced to allow equipment demonstrations and the remote inspection of student connectors via a video microscope. Delivery of the course and the investment in conversion efforts would yield marginal cost returns with the small number of students typically enrolled per class.

Other courses considered for possible delivery by VTT during the research project illustrate examples of situations with a level of conversion and delivery difficulty that was either moderate or bordered on being prohibitive. These courses were of interest because they were both challenging and appeared to offer sufficient student throughput. The majority of courses reviewed for potential VTT delivery at FTC San Diego were more lengthy than what is typically offered by VTT (up to five days) or were prohibitive laboratory situations.

An example of a physical constraint limiting the use of computers was a system used for administration of maintenance and material management (i.e., the SNAP II computer system). The system used at the time the course was examined involved a large rack mounted configuration with a set of hard-wired terminals that was entrenched within an existing laboratory so that it could not be moved. Portable laptop computers could have been used in lieu of stand-alone microcomputers in another relatively high throughput Communications Security Material System (CMS) course considered for VTT. However, a perception by course personnel that student-instructor interaction was needed played in a decision to not accept an experimental VTT delivery of the training when a computer laboratory was added to the course. Subject-matter expertise was involved in guiding students and for scoring a performance test with document tracking software that allowed alternative paths to achieve similar outcomes. The course would probably involve a moderate level of difficulty to develop expertise and assistance compensations appropriate to the software skill.

Laboratory equipment adaptations and supervision were issues in two other courses that were examined. A magazine sprinkler course involved the use of large mock-ups of a system of pipes and valves during laboratories. A partial mock-up at a remote site might have allowed a limited laboratory experience on one portion of the system since different students operated on different portions of the system during the laboratory. However, creating the new training aid would have involved some effort and it would have required coordinated operation by the remote facilitator. A similar situation was involved in considering a basic course in boilerwater/feedwater test and treatment certification. Cumbersome portable sinks could have been constructed that involved several logistical problems and storage. Additionally, support at the remote site was required to certify students and for safety monitoring while hazardous chemicals were used.

A few operator and maintenance courses are short and they might be feasible to deliver by VTT with some development work. However, these courses commonly involve electronic devices that are expensive and difficult to duplicate at a remote site (e.g., full size global

positioning system devices such as the AN/WRN satellite navigation equipment). An approach similar to that used in the Fiber Optic course could be used if such equipment could be duplicated at remote sites. Each piece of equipment would present a slightly different problem as to whether cameras could be used to show views between sites and what compensatory aids could be developed to assist students.

Finally, there are other situations where unconventional approaches could be attempted. As noted earlier, laboratory courses normally considered too difficult to deliver by VTT could be converted to a course with mild requirements if laboratory activities could be conducted off-line by remote-site personnel, could be conducted on-board ship, or eliminated from the course. Some sites may also provide an opportunity to extend the audio-video facilities of the VTT classroom to a nearby conventional laboratory. The use of teleconferencing on-board ships is also an emerging possibility. Although only very short or highly serialized formal training courses would appear feasible because of the shipboard regimen, several forms of ship-to-shore consultation have drawn interest. These promising uses of videoteleconferencing involve medical consultation and training related consultation on equipment maintenance. Some of this consultation can be accomplished via workstations with video conferencing capabilities. However, some equipment maintenance could involve working in hostile environments that would require additional equipment that constrains the ability to work normally, such as mobile lighting, mobile cameras, and headsets to overcome background noise.

Conclusions

The following guidelines summarize the important aspects of the foregoing discussion on offering laboratory courses by VTT.

- It is instructionally feasible to deliver some laboratory courses by VTT. Mild forms of laboratory activities can be delivered without undue burden on the existing operation and facilities of the CESN. It is also possible to use VTT for moderately difficult to deliver laboratory courses that are more demanding and which would impact the operation of the CESN. These more challenging situations are feasible if more effort is devoted to adapting the course, additional technology is provided, greater assistance is provided by the remote site, and more attention is devoted to instructional delivery techniques.

- The learning environment in traditional laboratories may need to be conveyed in different ways in order to provide the same learning experience to remote students who are not physically with the instructor. A combination of three approaches would offer the best solution for most laboratory courses delivered by VTT. First, students can be better prepared for performing laboratory work prior to the laboratory. Second, support at the remote site can be increased by providing a surrogate for the instructor to supervise students and conduct laboratory activities. Third, technology can be used to increase the visibility of activities between sites to achieve a greater degree of remote presence for the instructor.

- There are several ways to better prepare or assist students for conducting laboratory work when they are at a distance from the instructor and must perform more independently.

Topics taught during laboratories can be moved into enhanced lectures and demonstrations given prior to conducting laboratories. Students can also be better prepared through prior computer-based instruction and videotapes, and can be assisted during the laboratory with job performance aids capturing the expertise of the instructor.

- The VTT facilitator plays an important behavioral, technical, and logistical role in laboratory courses. The VTT facilitator would need to be present during many student laboratories to assist students and instructors. This assistance would be minimal in mild forms of laboratory courses, but in more demanding courses facilitator supervision would be critical, such as to act as a safety monitor. The facilitator would have to be more knowledgeable of the subject matter in many laboratory courses than is typically the case in the CESN. An increased use of facilitators can be accommodated with less effort to the extent that courses can be selected where these requirements are minimal or required for short periods on specific tasks.

- The training equipment used in laboratory courses must be adapted so that it is portable and can be taken in and out of classrooms used for other VTT courses.

- Laboratory courses conducted by VTT require somewhat larger rooms to accommodate demonstrations and other training equipment. Room power requirements and facilities should be examined to accommodate equipment used in laboratory courses.

- Logistical demands on VTT sites would be increased with some laboratory courses. The VTT sites would incur somewhat greater demands on their resources in terms of the logistics for preparing classrooms during each class convening, maintaining supplies, and storing equipment between classes.

- Technology can be used to aid instructors and students in laboratory courses by exploiting several themes: (1) increase the visibility of activities among sites, particularly of the remote site, (2) use technologies to assist students during laboratories or to better prepare students for laboratories, and (3) reduce demands on the instructor with the aid of automated technologies, such as those that avoid the need for a camera operator. Laboratory courses involve a wider range of activities that must be shown with a flexible arrangement of more video sources. An expanded number of video sources that could be switched at the instructor podium was found to be useful in accommodating portable cameras and other special purpose video devices. Instructor demonstrations that are difficult to conduct live should be videotaped.

- The configuration of a classroom should provide for optimal student viewing of the instruction and participants at distant sites. For typical lecture-based classes the wide view of students in a remote classroom may be more of a monitoring convenience for the instructor and has little impact. However, the benefit of a full two-way capability for video and audio would appear to be much more important when conducting instruction involving hands-on laboratories and highly interactive small group processes. Additional camera views of remote students and their work are beneficial in these situations.

- There could be some sacrifice in the simplicity of delivering courses as a consequence of laboratory activities and the use of additional technology. To the extent that new VTT technologies can be used to mimic a live classroom, instructors and students can behave in ways they are already familiar with from traditional classrooms (Simpson, 1993).
- An initial cost analysis should be performed to assess whether converting a laboratory course to VTT would be beneficial. Travel savings would be marginal for laboratory course that typically have a small number of students per class, such as when access to laboratory equipment limits the number of students. Other laboratory courses with greater throughput could be beneficial when delivered by VTT.
- Initial costs for enabling remote site laboratory capabilities can be a liability when course training equipment is expensive and development efforts are extensive.
- A systematic approach was outlined for converting lecture or laboratory courses to VTT that should be executed by a team of individuals representing subject-matter, videoteletraining, and instructional expertise (cf. Simpson, 1993). The techniques and lessons learned illustrated in this research can be generalized for application to other laboratory courses. A case by case analysis and some experimentation are needed to achieve the best approach for the specific requirements of each course.
- VTT courses with atypical requirements such as student laboratories should be given special attention to maintain a high quality VTT version of the course. Such attention includes monitoring remote-site student performance, conveying VTT lessons learned as remote site facilitators and instructors rotate in their assignments, and providing sufficient resources. These courses should be periodically monitored by individuals knowledgeable of course content, instructional, and VTT issues.
- New courses to be created for delivery in the traditional manner should be scrutinized for potential delivery by VTT. Those suitable to VTT delivery should be developed from the outset with materials and procedures applicable to the VTT format.

Recommendations

The following recommendations are for the Chief of Naval Education and Training, and the CNET Electronic Schoolhouse Network.

1. The lessons learned documented in this report should be provided as background material for use in adapting laboratory courses to VTT.
2. The approach to delivering laboratory courses by VTT should include enhanced preparation of students prior to conducting their laboratory work, technology that increases the visibility of activities between sites, and supervision by a VTT facilitator in remote-site laboratories.

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Appendix A
Equipment for Use in the CESN

Equipment for Use in the CESN¹

The following equipment could be considered as a supplement to the standard equipment found in CESN classrooms.

- A manual video switch box at all instructor podiums to accommodate a wider range of video sources (e.g., for 35mm video slide projector, portable cameras, scan converter, etc.).
- Instructor podiums that allow a video monitor to be housed inside and which can be viewed through a glass viewport mounted in the top surface of the podium.
- A robot tracking camera to follow instructor movements via a device worn by the instructor. This device could be used in one room at a major site that transmits instruction on a regular basis.
- Picture-in-Picture capability for transmitting sites where an instructor may be off-screen for long periods while showing graphics (this configuration was used in the Celestial Navigation course).
- A video mixer to allow two video sources to be shown on same video output. For use in heavily used classroom at a site that transmits instruction regularly. The video mixer also requires preview monitors and two video switches.
- A video switching system would be useful at remote sites where student laboratories will be conducted. The outgoing video would be switched to show particular locations where a student push-to-talk microphone has been pressed. A pan/tilt/Zoom camera configuration supporting preset positions is an alternative (e.g., Parker Vision CameraMan or equivalent). The purpose of this system is to allow individual student workstations to be shown (e.g., hands-on laboratories), or to show small groups of students (e.g., courses involving small group processes, such as Navy leadership courses).
- An audio mixer would be beneficial for sites that transmit instruction or which have numerous microphones such as in the video switching system. An audio mixer allows more audio sources to be accommodated and provides greater control over audio levels.
- A variety of portable carts provide a more flexible arrangement within a classroom and allow demonstration equipment to be moved in and out of a classroom.

¹There is no implied endorsement for any of the commercial products mentioned in this report. In most cases there are alternative products that could have been employed and mention of these products simply documents the actual equipment used in the research. Product names and brands mentioned herein are trademarks of their respective holders.

- Small portable cameras can be used to show demonstration items that are too large for the typical document camera, items which are outside the view of the document camera, or for taking cameras to the equipment to be shown. The Video Labs brand FlexCam or an equivalent with extended power and video cables fills this function. The Canon VC-C1 camera or equivalent was found useful in demonstrations because it provides presets that reduce the need for a supporting camera person (these were used in the Fiber Optic Cable Repair course).
- Camcorder for developing videotaped instructor demonstrations.
- VGA-NTSC scan converter to allow VGA computer screens to be converted to NTSC video for transmission over the VTT system. This device is required for laboratory demonstrations of computer programs. The device also allows commonly available computer-based presentation programs to be used for instruction and accommodates conferences and briefings using this method of delivery. The device would be recommended for all sites.

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Application of Distance Learning Technology to Strategic Education

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**U.S. Army War College
Carlisle Barracks, PA**

**STRATEGY
RESEARCH
PROJECT**

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**APPLICATION OF DISTANCE LEARNING
TECHNOLOGY TO STRATEGIC EDUCATION**

BY

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United States Army

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U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

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APPLICATION OF DISTANCE LEARNING TECHNOLOGY TO STRATEGIC EDUCATION

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ABSTRACT

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Rapid advances in computer and communication technology present opportunities for the Army War College to enhance and expand strategic knowledge throughout the force. This paper examines the concept and theory of distance learning, briefly traces the history of its development and describes technology currently available. It discusses issues of quality and institutional planning and management and suggests some potential applications at the Army War College. It argues that, through the application of distance learning technology, the Army War College core missions of instruction, research, and outreach can be enhanced to meet the challenges of increased need for strategic knowledge at all levels, limited or declining resources, and the changing needs of students.

Introduction

The past decade has been one of extraordinarily rapid world wide change. Two areas in which change has been particularly rapid and pervasive are world politics and technology. The former has required a complete reassessment of both the national security and the military strategy of the United States. The latter has produced and is producing means to pursue these strategies in ways previously unimagined.

In the area of technology some of the most significant changes have been in computerization and communications. A synergistic effect has developed between these two technologies allowing one to leverage the advancements of the other, producing a phenomenally fast rate of change and improvement that affects nearly every aspect of human endeavor. In the realm of national defense, they have led to what some have referred to as a “revolution” in military affairs. In the realm of education, they have shaken the very foundations of the ideas about how, when, where, and for whom education can be provided.

These technological advances also have profound implications for what military leaders must know and must be able to do. For example, instantaneous global communication has blurred the lines between the strategic, operational, and tactical levels of war and other operations such as peace keeping and peace enforcement. Strategy, which is the ends, ways, and means of accomplishing national policy, is no longer exclusively the “art of the general,” as it was for the ancient Greeks. The strategic, operational, and tactical levels of war have collapsed into virtually a single entity. Actions of soldiers at the most direct tactical level can have strategic impacts that they must understand.¹ Likewise, the rapid pace of world events

makes it increasingly difficult for senior leaders to keep fully apprised of matters of strategic importance.

For these reasons, the need for creation and dissemination of strategic knowledge throughout the force has assumed even greater importance. It is the mission of the U. S. Army War College to meet this critical need. Fortunately, harnessing the technologies that generate the impetus for this change can help meet the challenge.

The purpose of the U.S. Army War College is to prepare future strategic leaders for the Army and, more generally, for the entire defense establishment. Its mission is:

"To prepare selected military, civilian and international leaders to assume strategic responsibilities in military and national security organizations; to educate students about the employment of the U.S. Army as part of a unified, joint, or multinational force in support of the national military strategy; to research operational and strategic issues; and to conduct outreach programs that benefit USAWC, the U.S. Army, and the nation."²

The vision statement of the college is to be:

"The nation's preeminent center for strategic leadership and landpower... a learning institution... preparing today's leaders for tomorrow's challenges... pursuing mastery of the strategic art through education, research and outreach."³

In a manner similar to other institutions of higher education, the Army War College faces considerable challenges in fulfilling its mission and achieving its vision. First and foremost is the issue of resources; the budget of the Department of Defense will fall nearly 48% from 1988 to 1998. A decline of this magnitude certainly limits the level of available resources; additionally, this decline effects the nature and needs of the Army and the student population. Secondly, the budget reduction has forced a decline in staffing without a concomitant decline in missions; increased pressure upon the officer corps is the net effect. The top officers who are the best candidates for selection to attend the Army War College are

the very ones who are in most demand by commanders in the field. A third challenge relates to the corresponding studies program through which two-thirds of the college's student population is enrolled. Competition is stiff for enrollment in this high-quality program with selection limited to only those officers with the greatest potential for senior leadership positions. Yet, more than 30% of the students who are selected and enroll do not graduate.⁴ This high rate of attrition is wasteful of resources and human potential.

The leadership of the U.S. Army War College recognizes the need for change to address these and other concerns and help shape the future of the institution in a vision statement and plan for change labeled the "Fourth Army War College." The "Fourth Army War College" seeks to aggressively incorporate the latest technology in all aspects of its operation including the delivery of instruction and distance learning through electronic means.⁵ The recently established modernizing department of corresponding studies and distance learning task force will pursue this end.

The thesis of this paper is that through the application of distance learning technology, all three core missions of the institution - *instruction, research* and *outreach* - can be enhanced to meet the new demands of force-wide strategic learning, limited resources, and changes in student population and retention. It will define distance learning concepts, consider the range of capabilities and how they might apply to various program components, and examine managerial and organizational issues.

Definition and Concept

To understand the concept of distance learning or distance education, it is necessary to understand the meaning of the term. Unfortunately, in this rapidly evolving field there is not a universally accepted definition, rather, the definition employed by different authors reflects their particular perception of the role of distance education in their setting. Nonetheless, there are certain characteristics that are recognizable in the most commonly used definitions. As will be demonstrated, these characteristics pertain to the relationships among the teacher, the learner, and the information.

There are at minimum, four components of any teaching-learning situation. They are: a teacher, a learner, a communication system or mode, and something to be taught and learned. In traditional settings, all of these components are present in the same time and place in the "classroom box." The concept of distance learning redefines and reorganizes the "classroom box" to accommodate separation of any or all the components by time and distance.⁶

Simply put, distance education occurs when students and teachers are separated by distance and, perhaps, time. Technology, which can range from the simple exchange of printed material through mail (correspondence education), to the establishment of interactivity through electronic means, bridges the gap in time and space. The net result is the same regardless of how teacher and student maintain their relationship at a distance: the transporting of information, not people; students stay put and school comes to them.⁷

A Historical Perspective

The basic concept of distance education is not new. Its apparent beginning in the United States occurred in 1728 when an advertisement appeared in the Boston Globe advertising short hand lessons through the mail.⁸ Home, correspondence, external or independent study and open learning are names by which the field has been known over the years. As the field evolved it tended to reflect the technology available at the time. In the earliest years it relied exclusively on printed material. It developed and began to use broadcast technologies in the late 1930's and 1940's. In the late 1960's, a new era in distance education began with the establishment of the Open University in the United Kingdom. This fully accredited, totally-distance oriented institution focused upon high quality and the adult learner. In so doing it earned new credibility, acceptance, and respectability for the field.⁹

In more recent times, the explosion of electronic communications technology has resulted in great new possibilities and a resurgence of interest in the field. While the basic concepts remain unchanged, emphasis is now upon interaction between teachers and learners. Cable television, fiber optics, microwave transmission, slow scan television, satellites, and microcomputer networking are changing the scope of distance education. "These technologies permit live interaction and immediate feedback between teacher and student(s), create opportunities for educational institutions to coordinate schedules and share resources, and provide expanded curricular offerings and educational opportunities for students."¹⁰

During the 1990's, there has been a dramatic expansion of distance learning programs in the higher education community.¹¹ This trend, expected to continue into the future, is

being driven by three factors. The first factor is the characteristics of the student population. Increasingly, adults are seeking opportunities to further their education but lack the time to participate in traditional programs. Second, the continuing evolution of computing and communication technologies make the delivery of high quality programs at a distance increasingly possible. Finally, it is believed that, over the long run, delivery of programs in this manner will prove to be less costly and just as effective as conventional modes of delivery, particularly when an increased number of students can be served and collaboration with other institutions can be established to share resources.

To understand the new growth and popularity of distance education it is important to understand the concepts of bandwidth and interactivity. Bandwidth is the size or "carrying capacity" of the communication channel between the sender and the receiver of a communication. Greater bandwidth permits greater interactivity; the wider the bandwidth of a communications medium, the more immediate and rich can be the learning experience. Greater bandwidth permits greater interactivity. Greater interactivity enables the communication of more feedback to motivate and individualize learning.¹²

Historically, the lack of available bandwidth has hampered instruction over a distance as compared to face-to-face learning situations. For example, correspondence courses that limit communication to the physical transportation of written messages inherently limit immediacy, richness, motivation and individualization.¹³ The ongoing trend toward the merging of computer and communications technology is having tremendous impact upon distance learning by increasing bandwidth and thereby the possibility of greater interactivity at much lesser cost.

This rapid technological change is leading to further refinement of the definition of distance education. Some more recent definitions add the concept of interactivity to the simple idea of a teacher and learner being connected by a communications medium. Networking and recombining dispersed and decentralized learners forms new learning communities.¹⁴ Teacher, learner and resources are located on any point or node in this network. No longer needed for teacher or learner, the classroom as a physical entity ceases to exist and the concept of "classroom box" becomes obsolete.

The Quality Issue

As has been observed, the concept and practice of distance learning have existed for many years and have benefited thousands of students. The recent rapid advances have reduced the cost and increased the availability technology resulting in an explosion in the quality and quantity of distance learning programs. As a result, an increasing number of institutions of higher education, including some of the most prestigious in the nation and the world, have implemented or are implementing distance learning programs.

Higher education is traditionally a quality conscious industry. Self regulation through voluntary regional and program specific accrediting agencies and State Postsecondary Review Entities (SPRE) mandated by the Federal government ensures oversight and quality control. These entities conduct cyclical and ongoing reviews of the operation of institutions and educational outcomes to ensure quality. The reputation of institutions as well as the eligibility of its students for governmental financial aid often depends upon the outcome of these reviews. Before initiating new approaches to instruction such as distance education in

this highly scrutinized environment, reputable institutions must first be convinced of both the quality and effectiveness of the program. The increasing willingness of prestigious institutions and the higher education community in general to implement distance learning programs is evidence of their belief in the effectiveness and quality of the approach.

Institutional confidence in the quality of distance education is well founded. Many educators have asked if distant students learn as much as students receiving face to face instruction. Research conducted by Moore and Thompson¹⁵ (1990) and Verdun and Clark¹⁶ (1991) indicates that "teaching and studying at a distance can be as effective as traditional instruction, when the method and technologies used are appropriate to the instructional tasks, there is student - to - student interaction and where there is timely teacher - to - student feedback."¹⁷

Technologies currently available and those which are emerging, can directly enhance interaction and feedback while enriching instruction by engaging more fully the spectrum of how people learn. These findings, coupled with the prospect of even more significant technological developments in the future, have profound implications for the conduct of distance education. Delivering some kinds of education at a distance as effectively as in a traditional classroom will decrease the justification for gathering students and teachers in the traditional setting and the enormous cost associated with that approach.

Technology Which Supports Distance Learning

While any consideration of distance learning must focus upon educational effectiveness and instructional outcomes desired, any understanding of the range of technical capabilities available is essential. These technologies fall into four basic categories - Print, voice, video, and data.¹⁸

Print remains the most fundamental media for distance learning. Due to the convenience and universality of print, it is likely to remain important. However, even this element is being affected by technology. In some cases, printed text is being converted to a computer readable format and packaged on computer disk or CD - ROM. While this may improve convenience, it does not change the fundamental nature of the media. That is, it remains a passive form of instruction and does little to contribute to the essential elements of interaction and feedback.

Audio technology was among the earliest forms of technology applied to distance learning. These were passive learning devices such as tapes and radio. Telephone and audio conferencing employ audio technology in more interactive ways. Audio telephone conferencing is widely available. Typically, it uses the public telephone system to link learners at two or more locations through an audio bridge. A subset of this technology is audiographic conferencing that combines voice communication with image or data transmission through devices such as electronic blackboards, still video, and personal computers. Audio conferencing has the advantage of being readily available and relatively inexpensive. It does permit some interaction and feedback and can be effective when

combined with other media. Limitations on the type of content communicable in a purely auditory manner and its impersonal nature are primary disadvantages of this media.¹⁹

Video is a popular media for distance education. Instructional video tools include still images such as slides, films, video tapes, and real time video that may be combined with audio conferencing. Video may be either passive or interactive; the passive approach normally involves production and distribution of video by cassettes, or by broadcast, cable, or satellite. The interactive approach can incorporate one way or two-way video and two-way audio. Use of video, particularly interactive video, has proved to be an effective means for handling complex or abstract concepts, introducing and summarizing and reviewing concepts, and improving student motivation. An important limitation on the use of video, particularly interactive video, is its cost. At present, fully interactive systems typically require a satellite and both uplink and downlink capabilities to tie together a limited number of sites. The capabilities to both send and receive must be available at all the sites.²⁰

The U. S. Air Force Command and Staff College developed an interesting and promising approach to dealing with the high cost of interactive video. The college has created what it refers to as "teleseminars" with a one-way, real time video broadcasting system supplemented with interactive audio. In this format, students gather at any of the 69 Army Satellite Education Network sites or 262 Air National Guard Warrior Network sites to participate in interactive, real time seminar sessions. Instruction emanates from a single uplink site with distribution by way of a leased commercial satellite channel to each of the more than 300 sites. The sites are equipped with facilities for interactive audio.²¹ This system permits effective interaction between students and faculty and provides timely

feedback to students. Its primary limitation is that of access; students must be simultaneously present at a limited number of sites. Future developments in the area of direct broadcasting (DBS) may overcome this impediment and permit student to participate directly from their homes.

The technology that is having great effect on the field is that of personal computers and global computer networks. Applications of this technology include computer assisted instruction (CAI) and computer mediated instruction (CME). Computer assisted instruction uses the computer as a stand-alone, self-contained teaching machine. Students work independently through software and material developed for their use. While this approach does not enhance interaction or personal feedback, it can make the learning experience richer by multimedia presentation of material including video, sound, color and animation. Multimedia authoring software is used to develop courseware and package it on CD-ROM for distribution and use by distance learners.²² This format has the advantage of improving interactivity and the quality of presentation at relatively low cost. It also empowers students to work independently at the time and place of their choosing given the availability of an appropriately configured personal computer system. However, design or redesign of courses and the development of courseware for this medium requires substantial effort.

The growth of public access computer networks, particularly the Internet, has facilitated the growth of computer mediated communication (CMC) for education. The rapid growth and global reach of the "net" present seemingly unbounded opportunities for the development of distance learning. CMI using the Internet or other computer networks incorporates electronic mail to: deliver communications, assignments or software; establish

bulletin boards to facilitate interaction among students and faculty; and provide access to library catalogs, data bases, and more than 1.3 million computers connected world-wide. CMC provides students opportunities for interaction with other students, enables collaborative group work for distance students, facilitates interaction with instructors, decreases turn around time for instructor feedback, allows student access to on-line resources, and permits students to upload and download assignments and take on-line quizzes and tests.²³

The assembly of these capabilities permits the establishment of "virtual" classrooms or seminars where interaction can be either simultaneous (synchronous) or at different times (asynchronous). The medium permits interaction between students and faculty and permits the sharing of data, programs, text, video, sound and graphics depending upon hardware capabilities. Network service providers such as America On Line, or a "home page" produced directly by the institution along with software for interaction known as groupware provides infrastructure for the system.

Some Potential Applications at the Army War College

Invention is the process of developing new tools and technologies. Innovation is the process of finding ways to apply new tools and technologies for the benefit of people and the organization.²⁴ Often innovation is the more difficult and time consuming task. The technologies described in the previous section are powerful tools for expanding and enhancing the educational process. This section will briefly examine three core functions of the Army War College - instruction, research and outreach or public service - to identify

some potential areas where distance learning technologies can bring innovation to the program. There are two over arching principles to follow when assessing what distance learning technologies will work best in a given situation. The first is to focus primarily on the needs of the learner and the organization - not on the technology used. The second is not to assume that any one type of technology provides all the answers and to consider the full range of technology.

The purpose of education is to effect change in the learner. In considering the application of technology to instruction, as in course and curriculum design, the focus must be on instructional outcomes, not on the technology of delivery. "The key to effective distance education is focusing on the needs of the learners, the requirement of the content and the constraints faced by the teacher, before selecting a delivery system"²⁵ Without exception, effective distance education programs begin with careful planning and a focused understanding of course requirements and the needs of the student. A detailed understanding of these elements should form the basis for choosing appropriate technology.²⁶ It is important that the exploration of technologies not take precedence over analysis of the purpose and use of the potential system. "In short, managers must ask themselves what is to be done, why it is being done and who will benefit."²⁷ Integrating the efforts and perspectives of students, faculty, support staff and administrators is the best way to accomplish this. Meeting the instructional needs of students is the cornerstone and test by which success or failure must be judged. However, the success of any distance learning effort begins with the faculty. Faculty must develop and understanding of the characteristics

and needs of distant students, adopt new teaching styles and function effectively as facilitators as well as content providers.²⁸

After clarity of purpose is achieved, appropriateness and effectiveness are the criteria for evaluating available media.²⁹ Typically, such a systematic approach will lead to a mix of instructional media, meeting the needs of the learner in a manner that is instructionally effective and economically prudent.³⁰ The organizational structure of the Army War College derives from and corresponds to the institution's key functions of instruction, research, and outreach. The instructional element consists of three subject matter departments and a functional department, the Department of Corresponding Studies. The Strategic Studies Institute, the Military History Institute, the Center for Strategic Studies and the Army Physical Fitness Research Institute are the primary executors of the research and outreach components of the mission. A substantial academic support organization and academic library provide support to the above.³¹

In the realm of instruction at the U. S. Army War College, the most obvious application for distance learning technology is the Corresponding Studies Program. This totally print-based program consists of ten courses designed for completion in two years. The program includes two week long resident seminar programs at the War College campus in each of the summers. Written submissions associated with each of the ten courses and the resident phase seminars are the fundamental learning vehicles of the college. The program is of high quality. While the college does not have degree granting authority, the American Council on Education (ACE) recommends that universities consider granting up to 21 graduate credits for completion of the program.³²

A key fact about this program is the wide geographic dispersion of enrolled students. For example, presently enrolled students reside in 47 states and many countries. The program is rigorous and only about 65% of those who enroll complete the program.

Currently totally print based, the program suffers from the limitations associated with that medium including passivity, limited interaction, slow feedback, lack of richness of presentation, and motivation. Distance learning technology provides several ways to address these shortcomings.

The first and perhaps most obvious action would be to supplement the printed material with non interactive audio and video media. For example, an important component of the resident program is a series of lectures by distinguished speakers and subject matter experts, including faculty, on topics under study. A question and answer period and seminar discussions follow these large group lectures. As most of these subjects closely relate to the corresponding studies course work, these lectures could be captured in an audio / video format for inclusion in the corresponding studies program materials. Ideally, these lectures could be broadcast to allow student interaction by telephone. Although desirable, this approach may be impracticable, given the wide dispersion of students and the attendant scheduling difficulties. Alternatively, these programs could be distribute to students using video cassette tapes.

Another possible application is to convert existing courses and printed material to digital and electronic form for distribution to students. This would have the effect of reducing the volume of printed material distributed through the mail. Instructional effectiveness can also be improved if the conversion is accompanied by some course

redesign. That is, courses can be redesigned into multimedia packages including sound, video, and text that can be "played" on student personal computers at home or at offices. An example of this type of course development is being successfully applied by the Air Command and Staff College multimedia course project.³³ In addition, voluminous material used primarily for student research as opposed to verbatim study can be provided in a "searchable" format.

The technology for accomplishing this is readily available at relatively low cost. However, it is important to recognize that the course design required to apply it effectively is essential and could be costly. Improvement in presentation is vital if the change to electronic media is to be effective in improving learning. Otherwise, the result will be the same - passive, non interactive instruction - placed in a different form without qualitative improvement.

Computer mediated communication and instruction is the technology that perhaps has the most immediate applicability to the corresponding studies program. This technology typically incorporates computer conferencing, electronic mail and electronic bulletin boards. Students and instructors use personal computers and modems to connect to a central computer that is running a conferencing software package. This method can transcend both time and distance as sessions can be held either concurrently or at different times. Innovative use of this technology enables establishment of "virtual" classrooms or seminar rooms. Besides increasing the efficiency of course routines such as giving and receiving assignments, the technology enables a broad range of interaction and permits rapid feedback. For example, the virtual classroom can be structured to facilitate course related and social

interaction with peers, enable student collaborative projects, facilitate interaction with the faculty instructor, decrease turn around time for instructor feedback, allow students to access on line resources and upload and download assignments.³⁴ Research indicates that this form of distance learning works best for courses involving discussion, brainstorming, problem solving and "...reflective contributions which might be based on special preparation or research."³⁵ These are precisely the higher order skills that the Army War College seeks to develop.

The use of CMC and the virtual classroom has proved effective. An example is a pilot project involving the U. S. Army Reserve Forces School of the Engineer Officer Advanced Course. A study of this program conducted by the U. S. Army Research Institute for the Behavioral and Social Sciences found an increase in completion rates over traditional correspondence course participants, better performance on retention scores and costs below correspondence and resident course programs.³⁶

The administration of the Army War college is well aware of these potential benefits. In 1995, a task force was appointed to study modernization of the corresponding studies program through distance learning technology. Initial changes should occur for the class entering in 1997.

CMC does have its limitations. Students must have the appropriate hardware, software and network connection to participate. Also, the much touted desk top multi-point interactive video conferencing that would substantially enhance this approach is not yet readily and economically available. Predictions are that developments in this area will be rapid and dramatic. At least one expert has stated that "...it's going to be embarrassing how

much better people learn.." with interactive video as compared with less sophisticated techniques.³⁷

While the corresponding studies program is perhaps the most obvious area for the application of distance learning technology it is not at all the only opportunity. Indeed, many institutions are finding that the primary benefit of this technology is not the "exporting" of instruction. Rather, the most beneficial results are achieved through applications that facilitate inter institutional collaboration. This collaboration can permit the expansion of programs or course offerings, increase the richness of current programs, and permit increased enrollment at reasonable cost. Accordingly, distance learning technology may have at least as much benefit for the resident program as it does for the corresponding studies program.

The Army War College resident program enrolls approximately 360 selected active and reserve component officers, government civilian employees and international fellows in a ten month course of instruction at Carlisle Barracks. The organization of the curriculum is three academic terms during which students take three core courses and eight advanced courses. Other requirements include a regional strategic appraisal, a strategic crisis exercise, a significant research paper and a week long national security seminar. The primary mode of instruction is faculty led small group seminars of eighteen students supplemented with large group lectures by distinguished guest speakers. Each course requires substantial reading, writing and oral presentation. Equipment for each seminar room includes an extensive array of instructional technology including networked computers, video projector, video cassette player, opaque (Elmo) projector, and broadcast (cable) and closed circuit television. A touch screen display at the instructor's station controls this system of integrated devices. In spite of

many capabilities, the primary use of this system is the display and projection of bullet slides outlining the topics of discussion.

There is little doubt that the small group seminar setting maximizes opportunities for student interaction and the potential for effective instructor feedback. The unlimited bandwidth that exists in this face-to-face setting virtually assures this will be the case. Having met these most fundamental requirements, technological resources can improve the richness and economy of instruction through interinstitutional collaboration.

An important aspect of the mission of the U.S. Army War college is to prepare senior officers to serve in a defense establishment characterized by "jointness," that is, involvement of all the services and a wide array of other government entities in the planning and execution of operations. It is important that officers understand the culture, capabilities and procedures of elements different from their own. The Army War College curriculum incorporates education in joint affairs through lectures, readings and a practical exercise. In addition, the organization of each seminar group includes one or more students from each of the services, the reserve components, and a civilian employee. The expectation is that these individuals bring with them the perspective of their organization. While this is helpful, individual experience and knowledge limits the effectiveness of this approach. Much more effective interaction and learning in this area could occur through the application of distance learning technology to achieve inter institutional collaboration.

Each of the military services operates a senior service or war college. In many ways the missions of these institutions are similar and include education in joint matters and award of the Military Education Level 1 (MEL1) designation to graduates. Each of the institutions

is valuable in that each reflects the unique organizational culture of its sponsoring service, and develops a depth of knowledge and thinking in its particular areas of expertise.

Notwithstanding this uniqueness, the commonality of certain aspects of their missions provide opportunities for collaboration through the application of distance learning technology. This is a particularly rich opportunity for the use of interactive video conferencing and computer mediated communication. For example, through video teleconferencing each institution could share the lectures of its most notable subject matter experts and make them available to lead discussions. These discussions could simultaneously include seminar groups from each of the colleges. Indeed, permanently aligned seminar groups could interact on a regular basis thereby developing a "virtual" joint environment for learning. Further, the use of computer mediated communication enables collaboration on group projects and presentations. The basic academic organization of the small seminar group coupled with technology, most of which is already available in the Army War college seminar rooms, make this approach realistic and achievable.

The concept of collaboration need not be restricted to sister senior service colleges. The same principles can be applied to other institutions or agencies. For example, interactive lectures and discussions could be organized with distinguished faculty from prestigious universities, corporate executives, state department officials or commanders in the field.

Collaboration in the form described above greatly expands the virtual walls of the classroom. It may also present opportunities for substantial cost saving by sharing specialized faculty among institutions. It is also conceivable that entire courses or sections of courses could be cost effectively contracted with distant institutions.

The application of distance learning technology can also enhance the functions of research and public service. The purpose of research programs in higher education is to create, organize or apply knowledge.³⁸ The purpose of outreach (or public service) programs is to make available to the public the various unique resources and capabilities of the institution for the specific purpose of responding to a community need or solving a community problem.³⁹ In the case of the Army War College, these two are tightly linked. For example, research in the areas of strategy or foreign affairs can have effect only if made available to those working in the field. Traditionally, institutions have met this need through publications and journals. The application of distance learning technology can make this process much more efficient, timely and effective.

Perhaps the most obvious application in this area of research and outreach is to establish an on-line library of the various work products generated by the Army War College faculty and students to allow outside users instantaneous access by way of the Internet. The entire text of these documents could be made available in a format that allows interactive searching and cross referencing through hypertext links. In addition, provision could be made to allow for communication with the authors.

Another possible application is the establishment of an on-line global lecture hall as part of a much needed continuing education program. New research data or subject matter of immediate interest could be introduced and discussed through computer conferencing. Users world-wide could obtain the most recent information on a particular topic, and comment, discuss, question and chat with academic experts on the topic.

Planning, Organization and Management

Earlier sections of this paper focused upon technology and some possible applications at the Army War College. While these aspects are important, there is evidence that planning, organization and management issues are of equal importance in ensuring successful implementation of distance learning systems.

One of the most critical success factors is the conduct of detailed planning before pursuing a particular technology. While planning is essential to making any significant change, it is particular necessary when considering the adoption of new instructional and communication technology such as that which supports distance learning. Typically, communication devices have their impact upon institutions in four sequential stages.⁴⁰ During stage one, adoption of the new technology is to carry out existing functions more effectively. An example is the current plan to convert the Army War College Corresponding Studies program. During stage two the institution changes internally - work rules, organizational structure - to take better advantage of the new efficiencies. In stage three, the institution develops new functions and activities offered by the additional capabilities of technology. An example here would be the development of a global lecture hall for continuing education or collaboration with other senior service colleges and universities. During stage four, the original form of the institution may become obsolete, be displaced, or be radically transformed as new goals dominate the institution's activities. A representative example might be a future War College "without walls" where the resident program as known today ceases to exist, replaced by an institution based upon distance learning.

An important role of institutional strategic planning is to help determine and control how far and how quickly the institution will move along this continuum. A strategic planning process involving the entire institution and its primary constituencies can best accomplish this. Instructional outcomes, not the technology of delivery, should be the focus of the planning effort. Without exception, effective distance education programs begin with careful planning and a focused understanding of course requirements and student needs.⁴¹ Viewing the institution as a total system is often the most efficient means of accomplishing this. A distance education system should be thought of as a network of knowledge sources, processors, managers, communications media and learners. Hardware alone will not lead to good distance education. "The future of distance education depends on new forms of organization that are based on the application of principles of systems management."⁴²

Application of a total system approach may lead to the consideration of dramatic changes in organizational structure that recognize the potential for distance learning technology for all programs and services. Traditionally, the responsibility for distance learning resided in distinct organizational units.⁴³ Typically, these units are periphery of the parent organizations' activities, and such marginality has tended to limit the perspective of those involved in telecommunication based education. As technology is increasingly viewed as adding value to education and improving quality, these entities tend to move toward the center of the organization. As a result, organization tension is building in many organizations among traditional media, communication, computer, instructional training and continuing education functions. "The introduction of telecommunication based education appears to be a programmatic catalyst that is forcing education to raise questions about an apparently

disjointed relationship between functions that now need to be integrated.”⁴⁴ One response to this tension is to assemble an instructional design unit which includes media and audio production, electrical engineering, graphics, computer and software engineering, telecommunications and instructional design.”⁴⁵ The development of an instructional design unit brings a team approach to bear, induces a creative environment and provides a mechanism for greater quality control and coordination while avoiding diverting subject-matter specialists from instruction to design work.⁴⁶

The integration of distance learning technology and concepts throughout the institution can also raise questions about basic organizational design for the conduct of instruction. The traditional approach normally segregates faculty and students engaged in distance learning from resident students through the establishment of a separate organizational unit such as a distance learning department. A departure from this traditional approach is the Australian integrated mode. Under this structure, faculty and courses are allocated a mix of both resident and distant students. Designing programs and courses to serve both populations is then possible. The teaching of all the student is the instructor's responsibility. The distance learning department then serves primarily an administrative support function.⁴⁷ This approach has the advantage of making a wider selection of courses available to distant students and the potential for improving course quality by applying resources to prepare a single course for both modes.

As can be seen from the above, vigorously incorporating distance learning technology can have profound impact on the organization. Individuals within the organization also feel these impacts. Accordingly, effective development of this approach is a managerial and

leadership problem as well as a programmatic and technical one. A key determinant of success or failure is the attitude of faculty, administrators and support staff involved in the effort. Research indicates that while many faculty members and administrators begin with reservations about distance education, increased experience leads to acceptance.⁴⁸

The primary concerns of faculty are for: the level of control that they will have over the instructional process, the effect of the new format on their use of teaching strategies, and concern about the support necessary to move toward more technologically based instruction. In many cases, instructors can continue to use or adapt most of the instructional strategies common to the traditional classroom to the distance learning context. Indeed, some instructors report that teaching at a distance has improved their traditional teaching by making them more sensitive to student needs, forcing them to become more organized and shaping their ability to plan and design courses.⁴⁹

Faculty, staff and students alike share a lack of knowledge of and anxiety about distance learning technology. Effective training programs can overcome these concerns. The design of these programs should increase both knowledge and familiarity as well as assist faculty in improving instructional skills. The conduct of such programs tends to increase acceptance.⁵⁰ It is important not to overlook the importance of training of students. Hands-on training with the technology of delivery is critical for both teacher and student. Many distance learning programs emphasize the importance of face-to-face training meetings for students to facilitate interpersonal interaction and speed acquisition of computer skills. After initial training, continuing and responsive support is necessary.⁵¹

Conclusion

The thesis of this paper has been that through the application of distance learning technology, all three of the core missions of the Army War College - instruction, research and outreach - can be enhanced to meet the challenges of increasing demand for force wide strategic knowledge, limited resources and changes in the needs of the student population.

It has been demonstrated that the concepts and practices of distance learning have developed and improved dramatically since its early beginnings in the 1900's, and today it represent a credible and high quality alternative to resident instruction. During each stage of its evolution, distance learning has employed the technology available at the time. Most recently, the development of information and telecommunication technologies has begun to erode the barriers of time and distance that previously prevented the essential elements of interaction and feedback from occurring as effectively for distance learners as those in traditional classrooms. These barriers will erode even further with greater distribution of wider bandwidths throughout the nation's communication system. Employing this technology will increasingly enable the deliver of effective teaching and learning world - wide and can be employed to respond to the changing needs of the Army for more effective ways to assure broader understanding of strategic issues at all levels.

It has also been shown that the array of technologies that can be brought to bear to support distance learning is large, varied and growing. In this environment rich in opportunities, institutions can best meet their educational objectives by first defining what those objectives are and then picking, choosing and combining technologies that best suit the needs of the students and available budgets. There is no "one best answer." This is true for

enhancing the learning of both corresponding studies students and resident students. For distant students, it can enhance learning through interaction, feedback and improved richness of content. This can serve to motivate these students and improve quality, satisfaction and persistence or retention. For traditional resident students, it can enhance learning by broadening perspectives beyond the confines of the seminar room and bringing to the seminar room the resources of other services, institutions, agencies and individuals. Both groups will benefit through collaborative arrangements with other entities and institutions, including other senior service colleges, while the institutions realize the financial benefits of such arrangements. The implementation of distance learning technology within an institution requires careful planning, consideration of organizational structure and astute leadership. The effective introduction of this technology requires viewing the educational enterprise as a total system, often forcing the reconsideration of basic organizational design. Effective management of change requires equipping employees and students alike with the knowledge, skills, and support they need to function in the new environment requires astute leadership.

The Army War College is favorably positioned to successfully implement distance learning technology throughout the organization and across virtually all programs and functions. Strong, top-level support to the process of applying technology is constantly evident. An institution wide strategic planning effort is underway and a strategic action plan developed. Much of the technological skill, knowledge, and hardware is already available and the remainder is readily obtainable.

Numerous similar efforts are underway throughout the Department of Defense and the Department of Army which could serve as an example and offer opportunities for additional efficiencies and cost savings. These include the Force XXI Leader Development Task Force, the total Army Distance Learning Task Force in the Office of the Assistant Secretary of Defense for Reserve Affairs, the Army Wide On Line Training library project and current efforts to develop an Army wide distance learning plan. Finally, much of the groundwork is already being accomplished in the first steps to modernize the corresponding studies program and to establish on line access to selected materials of the Strategic Studies Institute.

All of these factors can contribute to the success of the effort but do not guarantee that it will have the desired results. Ultimately, the steps taken to ensure that technology meets real educational objectives and needs of students, and its constant evaluation to assure its validity, are the keys success. All programs of the institution should be included in this systematic re-evaluation. It should not be assumed that the responsibility resides in only one office, nor that the technology can only be effective in certain types of programs. The effort must be approached with a totally open mind set that recognizes the importance of the educational objectives and institutional vision; the focus must not be on technology. The words of Dr. Michael G. Moore, Executive Director of the American Center for the Study of Distance Education at the Pennsylvania State University applies as much to the Army War College as they do to the nation as a whole:

"The challenge of American distance education is not to produce more technology...the communications industry will take care of that; it is not even to develop techniques for teaching through technology and to train educators in these techniques...though we would be foolish to allow the communications industry to take care of

that. The Challenge is to change our view of distance education, to learn to think big, to change the culture of our institutions regarding the role of the teacher, to learn to give up some fields and to specialize in others, to learn to cooperate with other institutions. In short, our challenge is to learn to make education look more like NASA or United Airlines by turning the development and provision of education into a total system."⁵²

¹ Richard A. Chilcoat, "The 'Fourth' Army War College: Preparing Strategic Leaders for the Next Century." Parameters XXV, 4 (Winter 95 - 96): 15.

² U.S. Army War College, Curriculum Pamphlet 1996 (Carlisle Barracks, PA: U.S. Army War College, 1995), 2.

³ Ibid. i.

⁴ COL. John J. O'Connell, Jr., USAWC Strategic Planner, Interview by author, 9 November 1995.

⁵ Chilcoat. 16.

⁶ Desmond Keegan, Foundations of Distance Education (London and New York: Routledge, 1990), 59.

⁷ Jason Ohler, "Why Distance Education." The Annals of the American Academy of Political and Social Science 514 (March 1991): 24.

⁸ The American Center for the Study of Distance Education, "Broad Sheets in Distance Education, Nov. 1995" 29. TMs [Photocopy].

⁹ Ibid.

¹⁰ Ibid.

¹¹ Robert L. Jacobson, "Extending the Reach of 'Virtual' Classrooms," The Chronicle of Higher Education, 6 July 1994, A19.

¹² Charles J. Dede, "Emerging Technologies: Impacts on Distance Learning," The Annals of the American Academy of Political and Social Science 514 (March 1991): 146.

¹³ Ibid.

¹⁴ Ohler, 25.

¹⁵ M. G. Moore and M. M. Thompson, The Effects of Distance Learning (University Park, PA.: The Pennsylvania State University, American Center for the Study of Distance Education, 1990),

¹⁶ J. R. Verduin and T. A. Clark, Distance Education: The Foundations of Effective Practice (San Francisco: Jossey - Bass Publishers, 1991),

¹⁷ University of Idaho, College of Engineering, Engineering Outreach, Distance Education at a Glance (Moscow, ID.: University of Idaho, 1994), 1.

¹⁸ Ibid., 1.

¹⁹ Ibid., 6.

²⁰ Ibid., 5.

²¹ Woodrow J. Wilson and Kenneth S. S. Montgomery, "Combining Multiple Mediums and Multimedia, the ACSC Approach to Distance Learning" TD [photocopy], p. 4, Air Command and Staff College, Maxwell AFB, Alabama, 1995.

²² Ibid., 2.

²³ Rosalie Wells, Computer-Mediated Communication for Distance Education (University Park, PA: American Center for the Study of Distance Education, The Pennsylvania State University, 1992).

²⁴ Peter M. Sange, The Fifth Discipline (New York: Currency Doubleday, 1990) 5 -6

²⁵ The American Center for the Study of Distance Education, 1.

²⁶ Distance Education at a Glance. 2.

²⁷ Duning, 24.

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- ³⁰ The American Center for the Study of Distance Education, 1.
- ³¹ U. S. Army War College, Curriculum Pamphlet, Academic Year 1995, (Carlisle Barracks, PA: U.S. Army War College, 1994), 3.
- ³² U. S. Army War College, Curriculum Pamphlet, Corresponding Studies Course, Class of 1997, (Carlisle Barracks, PA: U. S. Army War College, 1994), 3.
- ³³ Woodrow J. Wilson and Kenneth Montgomery, "Combining Multiple Medium and Multimedia, the ACSC Approach to Distance Learning" TD [photocopy], (Air Command and Staff College, Maxwell AFB, AL, 1995) 2.
- ³⁴ Wells, 2.
- ³⁵ Ibid. 2.
- ³⁶ H. A. Hahn and others, "Distributed Training for the Reserve Component, Research Report 1581. U. S. Army Research Institute for the Social Sciences, Jan 1991.
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- ³⁹ Ibid., 27.
- ⁴⁰ Dede, 157.
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- ⁴² Michael G. Moore "Is Teaching Like Flying?, A Total Systems View of Distance Education," The American Journal of Distance Education vol. 7, no.1 (1993): 1 - 10.
- ⁴³ Duning, 33.
- ⁴⁴ Ibid., 172.
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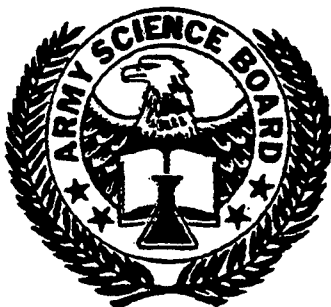
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Army Science Board Ad Hoc Study: Use of Technologies in Education and Training

AD-A303 504

December 1995

**Army Science Board
Washington, DC**



DEPARTMENT OF THE ARMY
ASSISTANT SECRETARY OF THE ARMY
(RESEARCH, DEVELOPMENT AND ACQUISITION),
WASHINGTON, D.C. 20315-6103

ARMY SCIENCE BOARD

AD HOC STUDY

FINAL REPORT

“Use of Technologies in Education and Training”

December 1995

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CONFLICT OF INTEREST STATEMENT

Conflicts of interest did not become apparent as a result of the Panel's recommendations.

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13. ABSTRACT (Maximum 200 words) This Study examines the Army's use of technology in education, here defined as the material presented by the Training and Doctrine Command (TRADOC) at the Officer Basic and Advanced Courses, the Combined Arms and Services Staff School (CAS³), and the Command and General Staff Officer Course (CGSOC). Currently there is a near-revolution in the means of delivering education. Video, CD-ROM's, and other devices, along with new learning techniques such as simulations and gaming, experiential learning, group learning, and structured pathing are enhancing the student's learning experience. Perhaps one of the most significant educational advances for the Army will be the use of distance learning, especially as resource constraints and Base Realignment and Closure (BRAC) activities limit conventional educational opportunities. The Study recommends that the Army: 1) continue to develop and acquire modern classroom technology, but emphasize a move toward distance learning; 2) commit to the use of the electronic classroom and distance learning; 3) develop appropriate outcome evaluation methods, and review the full range of education delivery systems with respect to the Army's own education needs; 4) explore existing civilian resources as alternatives to the Teletraining Network (TNET) currently in use; 5) develop the full capability of the synthesis and synergy possible with digitization, simulation, the Distributed Interactive Simulation (DIS) network, and electronic archiving; 6) develop joint research efforts with a variety of civilian institutions, and with the US Department of Education and state Departments of Education; 7) make the organizational changes necessary to implement distance learning, and institute the necessary training to effectively use and present it; 8) eliminate much of the educational role at the Branch Schools once distance learning is fully implemented; 9) consider creating the equivalent of a Board of Regents to bolster the Army's desire to move toward a "university" system; 10) move toward the notion of "shamrock" education (three types of educators) as quickly as possible; 11) continue to develop the electronic bulletin boards as a means of informal education; 12) develop a complete inventory of skills, knowledge, and abilities for each officer in order to rapidly identify experts for (continued on reverse side of page)				
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teaching or operational situations; and 13) in concert with the ASB, prepare an Army Education Roadmap and request the National Academy of Sciences Board of Army Science and Technology (BAST) to critique the effort.

Adoption of this Study's recommendations will place the Army in a role as an education leader in the United States.

ARMY SCIENCE BOARD

AD HOC STUDY

FINAL REPORT

“USE OF TECHNOLOGIES IN
EDUCATION AND TRAINING”

DECEMBER 1995

ACKNOWLEDGEMENTS

This Army Science Board (ASB) Study on the Army's use of educational technology took place over the course of several months. During this time, the Study Group spoke with a large number of Army and other Department of Defense (DoD) personnel. In addition, the Panel met with a comparable number of civilian educators. Panel members continue to marvel at the dedication of Army educators, most of whom are working with very limited resources, which hampers innovation and experimentation. The Study Group was also taken with the willingness of civilian educators to share their expertise. Those with whom the Panel met have a true interest in the Army and a wish to see it prosper.

A number of people outside the ASB have contributed to this Study. The Information Technology Laboratory (ITL) at the U.S. Army Engineer Waterways Experiment Station (WES) provided a helpful study on technology assessment. The Legal Office of WES outlined the difficulties of procuring computers. LTC (USAR) Terry Bresnick wrote a thoughtful paper on electronic media conferencing, and Dr. John Palmer of Mercer University offered insights and observations that served to focus the Panel's thoughts. Dr. Aaron Byerley, formerly a professor at the United States Air Force Academy (USAFA), contributed an analysis of the Academy's modern classroom. MAJ George F. Stone, III, a doctoral student at Central Florida University, contributed a "white paper" on recent advances in the enhancement of learning with technology. COL Fletcher Lamkin, Chair of the Department of Civil and Mechanical Engineering at the United States Military Academy, brought a "teacher's" perspective to the Study. He was also a valuable link with an ongoing ASB Study on the technical education requirements for military officers. The Panel extends its appreciation to all of these people.

A Study of this magnitude requires an enormous amount of staff effort to set up visits, coordinate travel, gather material, and perform a myriad of other tasks. The Study Group was particularly fortunate to have as a staff assistant Dr. Rebecca Campbell of the Futures Office at Fort Leavenworth; indeed, she is at the heart of this Study. The Panel also benefited from the efforts of MAJ Anne Patenaude as an assistant in the Washington, D.C. area. MAJ Patenaude represents the finest in today's Officer Corps, and reminds everyone that hard work can be accompanied by great joy and good humor.

The Study Sponsors were somewhat legion; however, General Gordon Sullivan, then Chief of Staff, Army (CSA), and General Frederick Franks, then Commander, Training and Doctrine Command (TRADOC) were the key initiators of the work. MG Carl Ernst, the Deputy Chief of Staff for Training at TRADOC, was the Cognizant Deputy; he made the Study participants feel that their work was important. BG Randall Rigby from Fort Leavenworth was another senior officer who helped the Panel appreciate the Army's effort and dedication to improve its education system.

Finally, the Panel would like to recognize a unique individual who was key to shaping this Study. Dr. Walter LaBerge was the Chair of the ASB during the course of the Study and took a keen personal interest in the outcome. He has been a friend and supporter of the Army for many

years, and the Army is fortunate to have had a man of his acumen, talent, enthusiasm, and interest to push and protect Army interests. This Study has benefited from his guidance, and the Study participants have benefited from his friendship and wisdom.

Dr. Allen F. Grum
Study Chair

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EXECUTIVE SUMMARY

General Gordon Sullivan, then Chief of Staff of the Army (CSA), and General Frederick Franks, then Commanding General of the Training and Doctrine Command (TRADOC), requested that the Army Science Board (ASB) conduct a Study to recommend Army uses of technology in education and training. The ASB, with the concurrence of TRADOC, narrowed the scope of the Study to examine only education. The Panel arbitrarily defined "education" as the material TRADOC presents at the Officer Basic and Advanced Courses, the Combined Arms and Services Staff School (CAS³), and the Command and General Staff Officer Course (CGSOC).

The Panel visited a large number of the Branch Schools, TRADOC Headquarters, and Fort Leavenworth. The Study Group also visited several Air Force activities, the Naval War College, and several civilian institutions recognized as leaders in educational technology. In addition, the Panel conducted a reasonably wide literature search.

TRADOC has extensive programs which are developing educational technology within the Army School System; yet there is significantly more activity in the civilian education sector. Therefore, this Study should be considered as only a sampling of the many uses of educational technology. As with any sample, the data may not accurately reflect all possibilities. However, the Panel's sense is that within the education community as a whole, there is a near-revolution in the means of delivering education. Within the classroom, electronic and mechanical devices such as video disks, CD-ROM's, projection cameras, and response pads present instructors with options which were unheard of even as late as the 1980's. Distance learning gives the Army the ability to take the schoolhouse to the student at any place, at any time.

There is an equivalent revolution on the receiving end of learning. Paradigms such as group learning, pioneered by the Army Research Institute (ARI), structured pathing, the use of simulations and gaming, and experiential learning all have the capability to provide an enhanced learning experience. That is, the student may learn the same material more quickly, learn more material in a set time, retain material longer, or develop a more positive attitude toward the material.

These are not two disjointed revolutions. Educators must skillfully blend the two together to achieve the promise that each offers.

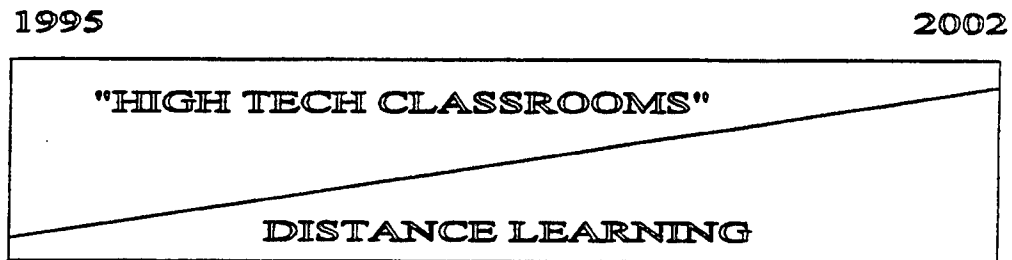
The ASB believes that resource constraints and Base Realignment and Closure (BRAC) activities will force the Army to largely depend on distance learning. Presently, the Army uses distance learning to a limited extent, which, in general, has been well received. In addition, the widespread use of electronic bulletin boards presents the opportunity for informal "education" and information exchange among cohort groups.

Particular Army strong points that will be useful in future education are the move toward digitization, the Distributive Interactive Simulation (DIS) network, and the expertise in simulation. Merging of these three will give the Army a unique capability to capture, archive, and re-create operations throughout the world for analysis and review.

The ASB was asked to identify obstacles to the use of educational technology. It appears there will be few, if any, technical obstacles in the future. Indeed, the technology will come without any overt Army action. The obstacles that do exist within the Army are cultural and organizational. The Army will need to ensure that all officers are computer literate, and will need to make certain organizational changes in order to optimize the use of distance learning.

The Study recommendations are:

1. Continue to develop and acquire modern classroom technology, but emphasize a move toward distance learning. A notional time table for this effort is shown below:



This illustration conveys the sense that the Army now utilizes some distance learning, with a preponderance of modern classrooms. By 2002, the Panel recommends that the Army move to a small proportion of modern classrooms, with a much greater use of distance learning. It further recommends the use of distance learning for the Basic and Advanced Courses and CGSOC. Distance learning will supplement the education which will be provided at the unit level for the officer's Basic and Advanced Courses. CGSOC "clusters" will use distance learning as a primary mode. All of the education will emphasize group learning.

2. Make the commitment to move to the electronic classroom and distance learning. This includes committing to:
 - a. Continuity of leadership.
 - b. Training the professional staff at the various Schools so that they are comfortable with the new technologies, and can effectively incorporate educational technology in rethinking the objectives of education.

- c. The identification and recognition of a cadre of teaching professionals who will champion the approach throughout the School System.
3. Coupled with the technology's introduction must be the realization that the Army will have to develop appropriate outcome evaluation methods. In addition, the Army must seriously review the full range of education delivery systems and evaluate these systems in light of its educational needs.
 4. While the Army could use the Teletraining Network (TNET) as the basis of distance learning, the Panel recommends that existing civilian resources be explored as alternatives. Local cable companies have provided cable at many installations which could possibly be used for land-based transmissions. Sharing the facilities of organizations such as the National Technical University (NTU) may be possible for satellite transmission.
 5. Develop the full capability of the synthesis and synergy possible with digitization, simulation, DIS, and electronic archiving.
 6. Develop joint research and study efforts with a variety of civilian institutions, such as NTU and the Institute for Academic Technology (IAT), and with the United States Department of Education as well as state Departments of Education. Take the lead as the education champion for joint programs with appropriate organizations within the other Services and the Department of Defense (DoD). Much of the hardware research and development, such as increase in bandwidth, will come without the need for Army funds. However, the propagation of the new learning paradigms, particularly within the entire Army (Reserve Officer Training Corps [ROTC] programs, for example), needs Army funding support.
 7. Make the organizational changes necessary to implement distance learning, and institute the necessary training to effectively use and present it. The Panel's preference is to establish Fort Leavenworth and Fort Lee as "managers" of education. In other words, their responsibilities would include such activities as developing qualification tests, identifying distance learning instructors, arranging satellite time, etc. This would parallel the national education philosophy of decentralized education with national standards.
 8. Eliminate much of the educational role at the Branch Schools once distance learning is fully implemented. In the interim, conduct careful tests to determine the appropriate level of Branch School participation in either the managing or presentation of Branch-specific education.
 9. Although Panel members do not unanimously support this recommendation, there is some sentiment that the Army should create a Board of Regents or similarly named group to bolster the Army's desire to move toward a "university" system. In addition, the Army should consider creating a provost position at appropriate institutions within the university. If the recommendation to establish Fort

Leavenworth and Fort Lee as the managers of education were to be adopted, it would be logical to have a provost at each of these locations. The Army would walk the fine line between ossification and instability by following a procedure such as that used with the Dean of the Academic Board at West Point. An officer or civilian would be appointed provost for a five-year period, subject to review and either termination or renewal at the end of the period.

10. Move toward the notion of "shamrock" education (i.e., three types of educators) as quickly as possible. Identify core topics which *absolutely* require active-duty instructors, topics suitable for contractors, and topics suitable for irregular workers. The Army can well civilianize a great portion of its education program. In particular, many retirees have far richer experience in combat, logistics, intelligence, and other Army activities than will exist within the active field-grade cadre of the near future. This suggests the core topics may be quite limited.
11. Continue to develop the electronic bulletin boards as a means of informal education. Require all officers to be computer-literate as certified by appropriate testing; to either own or be provided a computer; and to be connected to the Internet. Explore the emerging World Wide Web as an alternative, in order to be more than a bulletin board but less than the two-way audio, two-way video available through TNET.
12. Develop a complete inventory of skills, knowledge, and abilities for each officer in order to rapidly identify experts for teaching or operational situations.
13. In concert with the ASB, prepare an Army Future Education Roadmap and request the National Academy of Sciences Board of Army Science and Technology (BAST) to critique the effort upon completion.

The ASB strongly feels that adoption of this Study's recommendations will place the Army in a role as an education leader in the United States. This is a rightful position for the Army. Acceptance of a lesser role should not be acceptable.

I. INTRODUCTION

A. BACKGROUND

General Frederick Franks, then Commanding General, Training and Doctrine Command (TRADOC), and General Gordon Sullivan, then Chief of Staff of the Army (CSA), initiated this Study. The Study is a natural outgrowth of General Sullivan's Force XXI philosophy that, "We will achieve this quantum improvement in effectiveness through the power of information, through knowledge based warfare." (See Appendix 1 in the Supplement for the complete Force XXI statement.) The Study also reflects the CSA's concern that the Army needs to "...create pools of skilled leaders that we can draw on to accomplish these missions without unacceptably degrading other units," and his conviction that:

Today's world and the world of the near future will continue to be this kind of complex and difficult world. Our nation will call on us to serve in many ways. Our purpose, to fight and win our nations wars, our vision of selfless service, and our uncompromising quest for quality make us the world leader.... America's Army. (See Appendix 2 in the Supplement for the trip report of GEN Sullivan to Europe and Africa on 9-15 August 1994.)

The Army has enjoyed an enviable system of officer education. Neither General Sullivan's nor General Franks' interest in pursuing this Study is directed at present inherent weaknesses in this system. Their interest is in identifying possible future needs. The initiators of this Study recognize that rapid change in an information age is a discontinuity, not an evolution. Experts estimate the half-life of information is now only 18 months, and by the year 2000 the amount of available information will have doubled 19 times. Army officers and the Army's education system are neither isolated from nor immune to this phenomena. This reality, together with the reduction of the Army's force to 495,000 soldiers--the lowest end-strength since before World War II--and Base Realignment and Closure (BRAC) efforts all call for an examination of the Army's use of technology within its education system.

An expected lesser amount of resources in both dollars and manpower in no way lessens the need for continuing professional education. In fact, continuing education is now more important than ever. In today's world of rapidly evolving technologies and processes, military professionals, like professionals in every sector, must constantly hone and upgrade their knowledge and skills. To maintain professional competence, remain flexible, and be part of an effective team in any situation, an individual has the burden of learning new processes and technologies, thinking critically, and reacting appropriately in every context.

New educational modalities exist that may support this need for life-long continuing education. However, the modalities must be used with caution to ensure they create a learning process that is linked to the goals of education.

Army simulation models such as Janus offer prototypes for understanding the linking of technology with learning. Janus allows the rapid determination of battle outcomes, the ability to replay a battle, and a comparison of many courses of action. In turn, this learning process presents an opportunity for group learning, the utilization of individual pathways to knowledge, creative thinking, and experiential learning. It would appear to be an effective use of educational technology.

The Panel has been unable to identify uniform and statistically significant evaluations of many of the Army's initial uses of educational technology. Educational technology is not a panacea for either teachers or students. Faculties must clearly articulate appropriate goals, and knowing when, where, and how to apply new educational tools is an art in itself. Appropriate and effective application of these tools requires the educator to think about how the tool itself may affect the learning process and, in light of its impact, reshape the course, the curriculum, and the teaching process. Too often, educators simply apply technology to existing courses without realizing that the interaction of technology and curriculum results in new courses, not rehashed old ones.

In short, there are ongoing revolutions in the means by which education is both "sent" and "received." The Army must embrace both revolutions to achieve effective results.

B. TERMS OF REFERENCE

The CSA's and TRADOC's interest resulted in an original Terms of Reference (TOR) (see Appendix A). The Army Science Board (ASB) Study Panel examined the TOR after meeting with TRADOC officials, and suggested that the Study focus on the use of technology in Army education. This focus was approved by the Study Sponsor, GEN Franks (see Appendix B). The Panel defined "education" as:

Education: The courses TRADOC offers to officers at the Basic and Advanced Courses, Combined Arms and Services Staff School (CAS³), and Command and General Staff Officer Course (CGSOC).

The Study Panel emphasized this focus on education in a subsequent letter to Mr. Hollis, following a meeting with General Sullivan (see Appendix C).

After the Study was well underway, the CSA indicated that he was particularly interested in a Study of "leader development," with a lesser focus on the use of educational technology to assist in leader development. As indicated in Appendix B, TRADOC had a strong interest in the use of technology for training. Therefore, the ASB elected to terminate the present Study at a point which may not appear to fulfill all of the requirements of the original TOR. However, the Study has merit in its own right, and will also serve as a valuable data base to support any follow-on studies which focus on leader development and the use of technology for training.

From the beginning, this Panel recognized that the means of delivery and the objectives of education are inextricably intertwined--as one Panel member stated, "The Army wants to use

educational technology; to what end?" This fact became more evident as the Study progressed; however, limited resources prevented a careful examination of the objectives of education. New technology may well bring a need for new objectives and a discarding of old ones. Future studies should recognize this possibility.

C. A BASIC DEFINITION

The Study's TOR asked the ASB to identify technologies and techniques to enhance education. There are numerous rubrics used in the education community to describe these technologies, such as "computer-based instruction," "academic technology," "instructional technology," "educational technology," "multi-media presentations," and perhaps several others. The Panel chose the term "educational technology," to connote as wide a meaning as possible.

Educational Technology (also called learning technologies): All electronically and mechanically assisted education, distance learning, simulations, gaming, new instructional methods and devices (software and hardware), and collaborative learning.

In short, the Panel includes anything that brings technological tools from science, engineering, psychology, or pedagogy to bear in delivering education to Army officers.

D. STUDY LAYOUT

This Study reviews the use of educational technology within the Army, Air Force, Navy, and other Department of Defense (DoD) activities in Section II. It looks at the use of educational technology in the civilian sector in Section III. Material on new learning paradigms that are brought about by the use of technology is presented in Section IV. The Study Group's efforts to foresee the hardware and software of the future are presented in Section V. Organizational constructs are discussed in Section VI. A number of obstacles to the use of educational technology are identified in Section VII. The Panel presents its findings in Section VIII, and its recommendations in Section IX. An extensive amount of background material buttresses the main Report; it is available in a Report Supplement from the ASB Secretariat. In addition, a large collection of files is available for use in future studies.

II. DoD EDUCATIONAL TECHNOLOGY EFFORTS

A. ARMY

1. INTRODUCTION

Leader development and education are the means by which the Army will achieve Force XXI. The key to taking Army education into the 21st Century is to have the capability to provide unrestricted access to knowledge, data, expertise, simulations, real-time operational missions, and other educational resources at any time and from any location around the world. As a result, the Army officer becomes a student-leader-teacher for all of his/her career.

The ASB Study Panel examined the Army's utilization of educational technology by receiving briefings from the organizations listed below. The Panel acknowledges in advance the possibility of omissions and misunderstandings in this process, and of forming conclusions that are filtered through its members' own biases. The Panel hopes that the Army does not react defensively to this Study; if it does, the Panel has failed in its attempt to paint the "big picture." For indeed, there are many bright spots in both the Army and civilian education communities. Rather than spend time posturing about the past, the Panel hopes that the Army will resolve to turn its energies to the exciting, but enormous, task of preparing for the future.

The activities visited include:

TRADOC Headquarters
Fort Eustis
Fort Leavenworth
Fort Sill
Fort Huachuca
Fort Leonard Wood
Fort Gordon
Fort Knox
Fort Benning
United States Military Academy

2. THE TRADOC VISION

TRADOC intends to establish a "World Class" university system of schools and training centers which will graduate leaders capable of winning the Nation's wars--the Land Warfare University. This university will incorporate the latest in educational technology and learning strategies, so that the required research and educational opportunities are available regardless of the time of day or the location of either the student-leader or the source of the necessary information.

TRADOC has begun to implement the vision by linking Active Components, Reserve Components, and Army National Guard units into congruent training. A pilot effort is currently underway with Region C in the southeastern United States. In addition, Classroom XXI and the Classroom Without Walls support the vision, as educational technology will improve the quality of classroom education, as well as provide education beyond the classroom. Taking the classroom to the student rather than bringing the student to the classroom will result in a university that never closes.

TRADOC has established a Research and Development Plan to support this vision, and has completed several experiments which looked at the utility of educational media, such as video teletraining and teleconferencing. In addition, the Army has maintained distance learning facilities for several years. In 1993, TRADOC merged two existing satellite networks--the Satellite Education Network and the Teletraining Network--to form the Army's Teletraining Network (TNET), a network devoted solely to education and training. Since that time, TRADOC has expanded the network by establishing links with several states, the Department of Housing and Urban Development, the Navy's training net, and the United States Air Force Reserves.

The Army has been the leader in developing simulations and an integration capability through Distributed Interactive Simulation (DIS), which allows two or more geographically dispersed units to train together. The move to digitization will also enhance TRADOC's ability to deliver education to the officer.

3. FORT EUSTIS

The Transportation School at Fort Eustis is one site that has developed a prototype classroom of the future. This classroom is a traditional "desk-in-rows" layout with an extensive "hard-wired" computer system. The desk-in-lines concept was apparently dictated by the Architect-Engineer, in spite of the recognition that: (1) it is not the optimal layout for using educational technology; and (2) it is not flexible enough for the small-group instruction that TRADOC emphasizes.

Fort Eustis maintains an electronic bulletin board system that provides access to a CD-ROM multimedia system for officers external to Fort Eustis. The Transportation School offers six courses through this medium. The Panel was led to believe that the School maintains an additional electronic bulletin board, similar to those found on the Internet, to exchange information with Facility Transportation Officers. The Panel believes that this bulletin board is on an Army network that is separate from what is generically described as the "Internet."

The Panel was impressed that Fort Eustis had conducted one of the most careful Army assessments of distance learning outcomes that this Study Group encountered. The basic conclusion: students at remote sites did as well as those in the classroom.

4. FORT LEAVENWORTH

Fort Leavenworth is an example of resource-limited educational technology. At the present time, each student section (16 students) has access to only one 286 computer and printer in the classroom. Some students use other computer assets at the National Simulation Center and the TRADOC Analysis Center.

Some evidence of technology upgrading is apparent, as: (1) computers with Pentium capability are slated for the classrooms; (2) a TNET node will become active in the spring of 1995; and (3) the courses will use existing simulations such as Janus more heavily.

The Panel did see two promising uses of technology at Fort Leavenworth. One is a massive project to electronically archive what amounts to the entire research and library holdings of the School. The second is the production of a CD-ROM version of Field Manual (FM) 100-5. The CD-ROM will eventually include the usual menu of enhancements, such as use of color, voice-over, hyper-text, and illustrations. This multimedia presentation will hopefully increase the educational value of what has been a traditional, printed-page FM. Both of these efforts deserve Army support, and will be useful in offering education to officers in the future.

There is a personnel problem at Fort Leavenworth which affects the introduction of educational technology into the curriculum. The position of Deputy Commanding General, in essence the Chief Academic Officer of the School, has turned over four times in five years. Often, the introduction of educational technology into a program is the result of the efforts of a strong leader. Lack of leadership continuity may make it difficult to develop the willingness to change traditional routines and bring effective educational technology into a program.

5. FORT SILL

Fort Sill is one of the Army's leaders in distance education. The School uses a wide range of technology, which includes instruction-interactive video, computer-assisted instruction, video teletraining, and cohort groups. An Army evaluation indicates that the students in the remote sites do at least as well as those physically located at Fort Sill.

6. FORT LEONARD WOOD

Sixty-five percent of the officers who attend Fort Leonard Wood have a science or engineering degree. The Engineer School recently completed an agreement with the University of Missouri at Rolla (UMR) to award a Master's Degree in Engineering Management to officers who attend the Officer Advanced Course and who complete 16 weeks of additional full-time study with UMR. A separate ASB Panel will comment on the desirability of this arrangement. The Panel realizes that propinquity and tradition may have played a large role in the selection of UMR and the conscious decision to elect classroom-based education. However, the Panel is uncertain whether the Engineer School

was sufficiently cognizant of distance learning opportunities in other civilian educational institutions, or whether these were given sufficient consideration.

7. FORT GORDON

It might be expected that the Signal School is at the frontier in the use of educational technology. At one time this may have been true. Resource constraints have actually caused the School to retreat from the use of technology in previous years. The Army should carefully heed the lessons learned at Fort Gordon, some examples of which follow.

The School began a program to develop Interactive Video Disks (IVDs) in 1985. Unfortunately, each IVD took 18 months to complete, and the program was cancelled in 1991. The IVD developers had no formal training, and were required to learn on the job. Reductions-in-force (RIFs) and transfers resulted in turnover of the IVD experts. Developers were assigned to higher-priority jobs. Finally, software problems such as incompatibility, inflexibility, and difficulty of use caused School officials to question the merit of the IVDs.

The School also initiated a computer-based training (CBT) program in 1989, which was designed to be used within Fort Gordon. A shortage of funds and personnel caused the School to dissolve the program in 1992. In the interim, the School perceived that CBT required high-quality electronic equipment, personnel with experience designing CBT instruction, and extensive training for everyone involved in the presentation of CBT.

Fort Gordon used the satellite instruction available from the Army Logistics Management College (ALMC) through the Satellite Education Network (SEN). One course alone saved approximately \$27,000 in per diem and travel costs. However, the School had difficulty finding and training the facilitators needed for the course. Some equipment failed, and classroom location assignments were "catch-as-catch-can." The School had some difficulty arranging the presentation of the desired classes with ALMC. On the positive side, student responses to the courses were favorable.

One of the highlights of the Panel's visits was the use of the TNET by the 513th Military Intelligence Brigade at Fort Gordon, for language courses presented by the Defense Language Institute (DLI) at Monterey, California. Maintaining a language proficiency is critical for the personnel of the 513th, yet many of the required languages are not available through local schools or translators. Consequently, the 513th and DLI have developed an eminently successful distance learning operation. It is a prototype for further distance learning opportunities.

The Panel found that, despite some bright spots such as the example of the 513th, the trip to Fort Gordon revealed many of the difficulties the Army will face as it attempts to incorporate educational technology into its School System. Lack of resources, management problems, command turnovers, changing priorities, a seemingly large number of prescriptions and proscriptions from higher headquarters, the need to follow set

procedures, and some lack of imagination in attacking problems do not augur well for the introduction and implementation of a successful educational technology program. A strong lesson learned is that local *untrained* instructors, no matter how well intentioned, will not be able to develop effective educational material.

8. FORT KNOX

Fort Knox has a reputation within the higher echelons of the Army as being a leader in the use of educational technology. There is a great deal of activity there, but the Panel's impression is that the School's main thrust is to attempt to upgrade equipment within the classroom. One visitor characterized the School's attitude as "... intending to preserve the schoolhouse." While Fort Knox was monitoring some distance learning efforts, there did not seem to be much real interest in the topic. It must be admitted that the Panel's visit to Fort Knox occurred late in the Study, which may have affected its members' opinions regarding the installation's efforts to provide effective technology within the classroom.

9. FORT BENNING

Fort Benning was a surprise of a different sort. The Infantry School could be expected to be the most conservative, hide-bound School in the Army's education system. The Panel was pleased to learn that the School has active plans for distance learning, using fiber optics rather than satellite. The Infantry School has a training net already established with the Iowa National Guard; the 116th Armored Cavalry Regiment (ACR) at Boise, Idaho; and the 48th Mechanized Brigade, a unit scattered throughout Georgia. There is an active program to export several of the courses, and an openness which the Panel members found particularly impressive.

10. UNITED STATES MILITARY ACADEMY

In 1993, the Military Academy established an Advanced Technology Classroom Laboratory, which resulted from a gift from the West Point Class of 1954, augmented with appropriated funds. The classroom has an impressive array of hardware, but the Academy emphasizes that it is indeed a *laboratory*. The initial uses of the classroom have achieved mixed results. The Academy is now putting together the necessary complement of subject-matter experts, technology experts, and educational psychologists in order to fully understand how learning may be improved through the careful use of technology. The Army should emulate this approach across the board. Simply placing an instructor in a classroom filled with a large menu of electronic devices will improve neither teaching nor learning. In addition, the Academy classroom illustrates that educational technology is expensive, not only in dollars for the purchase of equipment, facilities, and software, but also in time needed by the faculty for lesson preparation. Finally, it must be remembered that funds must be provided for the upgrading of equipment, which at this time unfortunately becomes obsolete quickly. Appendix 3 in the Supplement is an analysis of the Advanced Technology Classroom Laboratory at West Point.

B. AIR FORCE

The Panel examined three Air Force uses of educational technology: (1) the Air Command and Staff College; (2) the use of an Army TNET node by Headquarters, US Air Force Reserves at Robins Air Force Base, Georgia; and (3) the United States Air Force Academy's (USAFA) "Classroom of the Future."

1. AIR COMMAND AND STAFF COLLEGE

The Panel found the use of technology by the Air Command and Staff College to be a singular highlight of DoD activities encountered in this Study. The College loaned an IBM-compatible notebook computer to each member of the 1993-1994 class. The machines had a full complement of software for common tasks such as word processing, data base manipulation, spread sheets, multimedia overhead preparation, and simulations. In essence, the computer was the backbone of the entire academic year. The computer and associated software were a unifying and integrating means which allowed group interaction, capture of lectures and presentations, and a common platform for analysis and presentations. The Air Force built on the year by providing a CD-ROM that was a summary of the year's experience to each student. (This CD-ROM is available at the Futures Office at Fort Leavenworth.)

As with many of the activities the Panel visited, there has been little formal or careful evaluation of the learning enhancement engendered by this technology. However, Panel members' observations, after talking with students and faculty members and viewing the CD-ROM, suggest this was a very successful venture. (The only negative Panel members heard was an expression that at least some of the officers would not have a computer, or at least a compatible computer, at their next station.) Appendix 4 in the Supplement contains additional details.

2. THE WARNER ROBINS AIR BASE ARMY TNET NODE

Panel members visited the Air Force Reserve Headquarters on 22 September 1994, as it uses the Army's TNET to present education, training and teleconferencing throughout the United States. (As an aside, the Study Group found it puzzling that the Air Force should have several Army TNET nodes, while logical Army installations such as Fort Leavenworth and West Point do not enjoy these resources.) The Panel spent two hours in a conference with a talented young Air Force Sergeant: although physically he was in the next room, some ten feet away from Panel members, the conferees used the Army TNET capability to talk via satellite. The TNET is two-way audio/video. Appendix 5 in the Supplement contains additional details.

Perhaps more than any other single experience, this demonstration was compelling evidence that distance learning, using modern technology, was not only possible but resulted in very little, if any, lessening of learning compared with a traditional classroom setting.

The Panel was also impressed with the Army's management of the TNET program. Oklahoma State University (OSU), under contract to the Army, furnishes each TNET node with state-of-the-art equipment, maintains the equipment on-site, and manages the network. The Army concentrates on presenting the instruction. The Study Group lauds this as a worthy role model for future endeavors.

3. THE USAFA's "CLASSROOM OF THE FUTURE"

The Air Force Academy, in contrast to the Military Academy, developed an electronic classroom through a turn-key contract with IBM Federal Systems. The Academy used the classroom for the first time in Academic Year 1992-1993. The facility includes computer screens, digitized video, videotapes, laser discs, a document camera, and CD-ROM capability.

The Academy has used this classroom for a wide variety of classes. Examples include:

- English literature and writing classes used *Daedalus* software throughout the semester for networked peer editing, collaborative work, and discussion sessions which were monitored or actively joined by instructors from the instructor station.
- Economics classes used network software that simulated various economic scenarios, to test the effects of these simulations on learning.
- Freshman- and sophomore-level calculus classes used the commercial software package, *Mathematica*.

Lessons learned by the Air Force regarding educational technology are similar to many Army experiences. Students do like the electronic classroom, but instructors' preparation time is increased. The physical layout is not optimal, and features of the classroom (such as lighting) need careful attention. The evaluations during the first year were at a "fairly superficial level." More careful evaluations are being planned, to include visiting faculty members and graduate students. Appendix 6 in the Supplement contains additional details.

C. NAVY

The Panel's sole contact with the Navy was a visit to the Naval War College (NWC).

Whereas Army and Air Force officers are typically assigned to bases conveniently located near educational institutions, Navy officers spend the preponderance of their careers at sea. Navy schools must educate their officers without the aid of local institutions, in an environment where there is little or no accessibility to professors, libraries, or classroom facilities. It would therefore seem that the Navy would be a leader in using high technology for educational purposes, due to economies of space (e.g., one CD-ROM versus a stack of books) and the accessibility gained by electronic data transmission. However, a visit to NWC revealed that this is not the case. The War College tends to lag behind comparable Army and Air Force institutions, and is only beginning to explore alternatives to traditional education that can be achieved through the incorporation of high technology.

Several years ago, NWC tried to use interactive satellite learning programs, which linked learning centers to one or more teachers in other locations, but the experiment failed miserably. Poor transmissions, long delays in response times, grainy video, and the high cost of telecommunications equipment contributed to the experiment's failure. Now that technology has improved, the War College is again looking into satellite learning as a possible alternative. But to date, distance learning via satellite transmission is not being utilized.

NWC does not have a strong interest in electronic methods. The focus is on education (education is used here in the classic definition of the word, rather than the definition used by the Panel in this Report), not training, and War College faculty members are of the opinion that while technology may be suitable for technical training and tactics courses, it is not suited for education. The education of senior officers is directed at developing high-level cognitive skills, not imparting information. In light of declining budgets and limited resources, NWC is not in a position to make a major investment in high technology for education. Some technological improvements are being incorporated, such as installing a local area computer network. However, the faculty and decision makers at NWC do not appear to be advocating greater use of technology in education. Although the Navy seems less interested in using learning technologies to deliver education than the Army or Air Force, it has provided a rationale for its actions, based on educational purpose and need. The Panel did not hear such an articulation from the Army regarding classroom versus distance learning or high-tech versus traditional classrooms.

Although some courses at NWC are incorporating courseware and decision support systems, use is infrequent. The focus is on seminar-based learning, and attempts to bring technology into this system will encounter a great deal of institutional drag. The commitment is to high-quality professors and their educational mission, and the faculty is not seen as supportive of high technology in the classroom. Technology at NWC is really used to support administrative functions rather than educational missions.

Even in the war gaming course, the computer is not seen as a major contributor to learning. The computer-assisted model is viewed as useful only in logistics planning. Faculty members employ the traditional student-teacher model. The real worth of computer simulations is

apparent at the tactical level, but at the operational level and above they are seen as providing a gross simplification of reality, or a limited set of options. The focus of learning at NWC is on the process of thinking at the strategic level; to date, available computer programs are not viewed as supportive of that educational need.

As technology improves and costs diminish, the Navy may adopt electronic media for assistance in distance learning. However, there is certainly no thrust at NWC for high technology boosts to its education program, as these tools are not viewed as supportive of the level of education or the sophistication of thought that occurs at the strategic or operational level.

D. OTHER DoD ACTIVITIES

The Panel only examined one DoD activity that was not Service-specific. This was the DoD Polygraphic Institute (DoDPI), a unique activity that offers training and education in polygraphic sciences, to include a Master of Science in Forensic Psychophysiology (catalog available in the Futures Office, Fort Leavenworth); the Panel received a report on this activity (see Appendix 7 in the Supplement). DoDPI uses an unusual amount of videotaping, both of classes and practice interrogations; both students and faculty have commented on its utility. While DoDPI has access to an electronic media conferencing center, it is rarely used. There were no other significant uses of educational technology at DoDPI.

III. CIVILIAN EDUCATIONAL TECHNOLOGY EFFORTS

A. INTRODUCTION

In the previous section, the Panel noted the large number of Army activities involved in the use of technology in education and training. The civilian sector is, if anything, even more crowded with schools that are using "technology" in education and training. Much of this use is a matter of definition, as some schools may consider a piece of equipment no further advanced than an overhead projector as a use of technology. Obviously, other schools are farther along the learning curve, using a great variety of technologies within the classroom and in distance learning. Appendix 8 in the Supplement is an extract of an EDUCOM¹ report on 101 success stories on the use of information technologies in higher education. These range from Cornell's Beef Cow Herd Simulation Program, to Delaware's Latin Skills development programs, to the Beowulf Workstation at West Virginia University. There is also a wide range of the sizes and types of academic institutions that reported success with educational technology.

B. MODERN CLASSROOM ACTIVITIES

One of the civilian institutions best known as a leader in the field is the Institute for Academic Technology (IAT), which is a joint effort between the University of North Carolina at Chapel Hill and IBM. Many Army personnel with whom the Panel met had at least a passing knowledge of IAT, and some had significant interactions with this institution.

The hardware at IAT includes a wide spectrum of VCR's, large screen TV's, computers, video cameras, document cameras, etc. IAT emphasizes the electronic network within the classroom, as the institution firmly believes that an effective electronic network is key to all modern classrooms. Another emphasis is on controllers; i.e., the hardware that allows the instructor to switch from, for example, a computer display to a document camera display. IAT feels that an instructor must have a quick and easy means of moving from one hardware device to another in order to be effective in the classroom. Adequate controllers presently cost in the neighborhood of \$8000. IAT also emphasizes the systems approach. For example, a distance learning studio requires special lighting and heating, ventilation, and air conditioning to be effective. This approach may be contrasted with the classroom at Fort Eustis, which was laid out in a less-than-optimal manner by the Facility Engineer, who, in putting together a high-technology classroom, was apparently doing "business as usual."

C. ASSESSMENT

Assessment of "learning improvement" through educational technology has varied from poor (even non-existent) to very good. One of the Panel's contacts characterized many existing

¹EDUCOM is a consortium based in Princeton, New Jersey.

assessments as "happy" surveys (i.e., surveys that asked students and instructors whether they liked the high-technology classroom and instruction). However, there is some body of evidence that indicates that computer-aided instruction, distance learning, and computer-controlled video disk instruction is at least as effective as traditional instruction, and, in some instances, even better. For instance, in "Meta-Analytic Studies of Findings on Computer-Based Instruction," in Technology Assessment in Education and Training, edited by Baker and O'Neil, 1994, Kulik reports the following:

1. Students learn more in classes in which they receive computer-based instruction.
2. Students learn in less time with computer-based instruction.
3. Students like their classes more when they receive computer help in them.
4. The average effect of computer-based instruction in 34 studies of attitude toward subject matter was near zero. In other words, although computer-based instruction was a significant factor in enhancing outcomes in the cognitive domain, the effect of computer-based instruction on outcomes in the affective domain was small.

D. DISTANCE LEARNING

The leader in offering graduate-level engineering degrees through distance learning is the National Technical University (NTU) at Fort Collins, Colorado. This is a truly remarkable organization that has melded quality teaching and technology to offer graduate education to students who otherwise would be unable to matriculate at a traditional academic institution. The course content and professor are exactly the same as in the classroom, as the actual class is captured on video feed. Currently the presentations are one-way video, two-way audio. Students have access to the faculty either in real-time during the presentation, through the use of two-way audio, or after the class in what would amount to a professor's "office hours."

The Army should study NTU closely, as it is an organization that will likely be the model for the Army's School System of the future. The staff at Fort Collins is small--fewer than 50 people--with an annual budget of \$15,000,000. Yet during the 1992-1993 academic year, this organization offered 22,702 hours of academic credit instruction and 2,980 hours of non-credit Advanced Technology and Management Programs. In addition, NTU presented more than 300 short courses during the year. Over 100,000 technical professionals and managers participated in NTU programs. All this with a staff of only 50 personnel! Appendix 9 in the Supplement contains additional details.

NTU manages education. Experts from all over the world provide the education.

Air Force use of NTU is sizeable; Army and Navy use is far less. The Panel was unable to discover the cause of this disparity, although the Military Academy suggested that cost was one issue. It was noted earlier that the Engineer School recently completed an agreement with UMR to award a Master's Degree in Engineering Management to officers who attend the Advanced Course and who complete 16 weeks of additional full-time study with UMR. This is a conventional, in-the-classroom program. The Panel's evidence indicates that the Engineer School probably did not seriously consider NTU or other distance learning opportunities as viable candidates.

E. HIGH-TECHNOLOGY TEACHING

The Army must realize that high-technology teaching differs from traditional teaching. Faculty training is *sine qua non*. New Mexico State University is recognized as one of the leaders in preparing professors for technology-aided classrooms. A representative course, costing \$3,800 for two days of instruction, emphasizes preparing faculty members for television teaching. A second widely recognized institution for high-technology teaching is Boise State University, which offers a Master of Science in Instructional and Performance Technology. This master's degree prepares students for careers in instructional design, job performance improvement, human resources training, and training management. These are skills that will be increasingly important to the Army as educational technology becomes more prevalent. Army personnel in either human resource management or training would be logical students for this program. Boise State puts "its money where its mouth is," as it is possible to complete the program through distance education. Finally, OSU has a long and rich history of offering distance learning for the Postal Service, as well as providing and managing the Army's TNET.

The Panel noted in the previous section that educational technology is labor intensive, as personnel at Fort Gordon have learned. The initial up-front effort in preparing a lesson for a high-technology classroom is significantly greater than preparing a traditional lecture. One faculty member suggested that it may take as many as 80 hours to prepare for a one-hour lecture. A number of factors contribute to this increased preparation time: (1) there is a rich menu of hardware; (2) it must be determined whether the instruction is suitable for computer, document camera, or old-fashioned overhead; (3) it must be decided if gaming or simulations should be used; and (4) if structured pathing is appropriate, then decisions regarding which paths should be used and how many are needed must be made. These decisions go far beyond the organization of a conventional lecture. Once an instructor has prepared a lesson, he/she may use it in subsequent presentations. Unfortunately, this removes some of the freshness and flexibility that exists with conventional instruction. In addition, the Army has a high turnover of faculty within the School System. A "canned" presentation from one faculty member may be unsuitable for his/her replacement.

One of the great benefits for an instructor is the learning he/she gains during preparation for a class. The research, analysis and synthesis, and final amalgamation of numerous sources to form a coherent whole, pitched at a level of student understanding and achieving both sharing of knowledge and creation of excitement is what education is truly about. It is unclear what will happen to this process with the advent of educational technology. If the technology itself--that is,

the use of technology--becomes a time-sink that lessens an instructor's ability to prepare for a class, then education may suffer. Similarly, education might also suffer if an instructor simply pulls a "canned" presentation off the shelf because he/she does not have the time to use the technology. The Army has rightly directed that two classes graduate from Leavenworth each year. One is the large number of students at CGSOC. The second is the group of instructors who have completed their assignment at Leavenworth and are returning to other Army assignments. Misuse of educational technology should not be allowed to degrade the education of either of these groups.

F. RESEARCH

As might be expected, the National Science Foundation (NSF) has a strong interest in educational technology, and has funded research efforts to support its use. The NSF grants have supported course and laboratory upgrades, integration of basic material with applications and practice elements, computer integration, and multimedia integration.

NTU has unofficially offered to join the Army in a number of research efforts (see Appendix E). In particular, NTU would like to jointly research the potential benefits of PC-based multimedia groupware. The Panel believes that this mutual effort would greatly leverage the Army's research effort, which the Study Group believes is underfunded.

The Panel strongly supports the NTU proposal.

G. MEDICAL EDUCATION

As a "profession," the Army is not unique in demanding continuing education as a requisite for remaining in and progressing through the field. Law and medicine, among others, come to mind.

Medical education offers an interesting comparison with Army education. (A full discussion of this is found in Appendix F.) To begin with, there are almost 500,000 M.D.'s in the United States, a population roughly equivalent to the contemplated size of the Army. There is a widely scattered workforce that cannot be easily moved for centralized training. A variety of specialized tasks have special educational needs. The medical profession is increasingly technology-driven, with an accelerating pace of change. Finally, education is directly tied to performance.

The medical profession has used a variety of multimedia educational technologies in basic medical school programs. Perhaps the most revolutionary is an attempt to use virtual reality to "practice" operations. The Panel received a briefing from Eisenhower Hospital on the use of satellite video to "share" medical expertise; for example, a doctor in Haiti can consult with a renowned expert at Eisenhower.

In general, physicians cannot take time away from their practice for traditional centralized schooling. In fact, no such school exists. This contrasts with the Army's system, where a typical officer may spend over four of his first twenty years in Army or civilian education. However, physicians continue to update their education through a variety of formal and semi-formal programs presented, typically, by local hospitals. In addition, physicians qualify for certification by passing board examinations. Many times a group of doctors will "fall in" around a recognized preceptor in the area to collegially prepare for the board examination.

There are a number of lessons and models in medical education that deserve careful study by Army educators as they plan the education system of the future.

H. CONTINUING LEGAL EDUCATION (CLE)

It might be expected that law would be another profession to have a strong continuing education program that could yield some lessons for future Army endeavors, but apparently this is not the case. CLE is controlled on a state-by-state basis. Forty states require CLE, but much of the presentation is in the traditional classroom mode, augmented with videotapes.

The American Bar Association (ABA) does have an ABA-Net Bulletin Board, but its function is not to deliver continuing education; rather, it serves as a medium for information exchange among participating lawyers. Some states have experimented with delivering CLE through live interactive computer systems. Nebraska, for example, uses the state's Higher Education Network for this purpose. The sharing of existing electronic networks for diverse purposes may in itself serve as a small lesson for the Army.

I. ELECTRONIC MEDIA CONFERENCES

Electronic media conferences may be characterized as "mini-education." Companies using remote conferences face many of the same obstacles that the Army will encounter. At the present time, electronic media conferences may challenge the organizational culture, and place power in the hands of media experts rather than subject-matter experts. The latter may not be able to operate all of the "gadgets" without the assistance of media experts, and at times media experts end up dominating the interchange process simply because of their technological expertise. Electronic conferences are primarily group processes, whereas many companies are accustomed to individual processes; i.e., one individual making decisions. Group incentives and rewards, and the inherent difficulty of working collaboratively, are forces which work against electronic media conferences. (These problems are not unique to such conferences, but they may be multiplied due to the geographic remoteness of the participants, in contrast to the conventional group discussion.) However, companies are increasingly utilizing such methods, as travel costs and the difficulty of gathering top executives in one place become prohibitive. Developments in software, and the fact that PC's now have video reception and broadcast capability, suggest that the use of electronic media conferences will increase. This is yet another area the Army must examine for its future education system.

IV. LEARNING PARADIGMS

A. INTRODUCTION

In the forest of computers, video disks, virtual reality, and the like, it becomes easy to forget that the fundamental purpose of this hardware and software (and of this Study) is to enhance learning. Learning technologies are not an end to themselves, but a means to better education and better learning.

General Sullivan reminded the ASB Study Panel that "I want an Army of learning organizations" (8 September meeting with the former CSA). The question then becomes, What is learning? Related questions, of course, are: (1) How do people learn? and (2) How can the Army provide the environment and resources to learn in the future?

General Sullivan's desire for a knowledge-based Army is paralleled in the civilian sector. Herbert Hague (Beyond Universities: A New Republic of the Intellect) notes, "The knowledge society requires people who can reach good decisions, cope with new environments, spot new rules--human and physical--as the world changes. The objective of education, therefore, should now be to inculcate what Toffler calls 'cope-ability' in a world where change is more rapid than ever."

A civilian corporation states:

The individuals...more than anything else must be full time learners. Simple skill development is not enough for the continuous and radical changes...any such skill can be rendered obsolete or irrelevant. Rather, participants must learn how to learn. They must be equipped with the conceptual skills required to deal with perpetual change. And they must be armed with the technology needed to put this ability to work.

One way Lenscrafters helps this learning process along is by making the acceptance of mistakes one of the company's core values. "It's OK to fail in our corporate culture as long as you try ideas and have something not work, as long as you learn from it and the company learns from it...Accepting mistakes is important. It removes fear. It encourages innovation."

If the company, Lenscrafters, were not identified in the quote, it might well be surmised that this is a statement made by General Sullivan.

B. WHAT IS LEARNING? WHAT DOES IT MEAN TO SAY, "I HAVE LEARNED SOMETHING?"

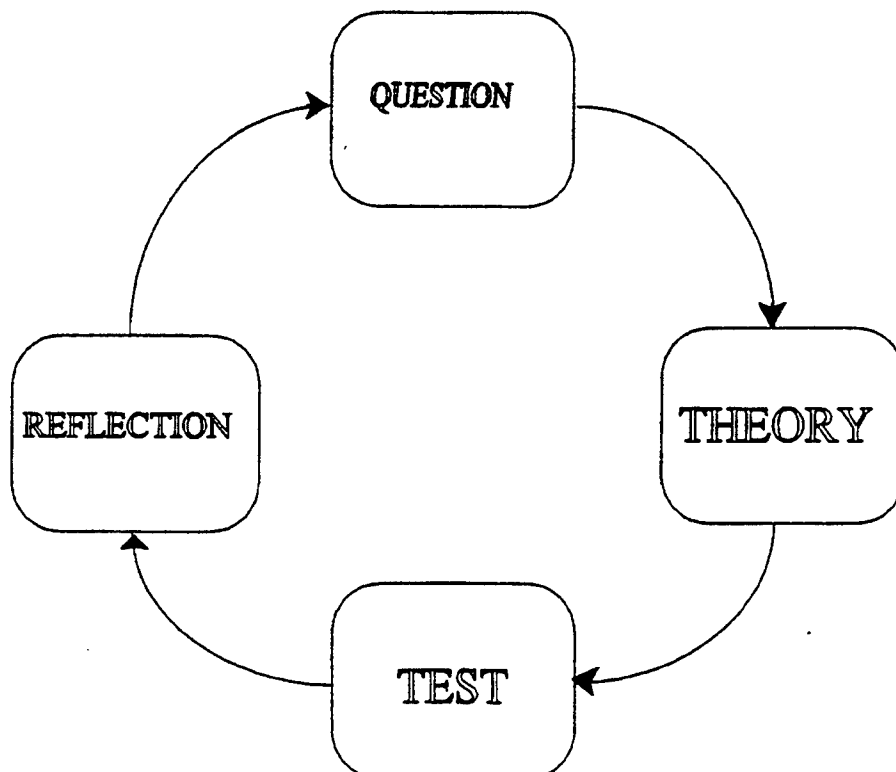
The figure below models the Panel's understanding of the human learning process. The essence of learning in this model is:

- A set of questions reflect a problem to be solved, a dilemma to be resolved, or a challenge to be met.
- These questions in turn lead to a theory, and an investigation of possible ideas to solve the problem/resolve the dilemma/meet the challenge.
- These ideas are then subjected to testing: What works? What does not work?
- Reflection follows this testing. An explanation of what went right and what went wrong is provided. This is the equivalent of the Army's after-action review.

The following quotation presents a good definition of learning:

Learning is not finding out what other people already know, but is solving our own problems for our own purposes, by questioning, thinking and testing until the solution is a new part of our lives.
(Source unknown).

A MODEL OF LEARNING



One outcome of learning may be likened to creative problem solving. Why is a senior officer better able to solve a tactical problem than a young second lieutenant? The answer in most cases is experience. The officer has seen the same, or similar, situation many times over in the course of his/her career.

How can the Army provide this knowledge, this experience? There are many ways:

- Provide real experience.
- Provide a "virtual" experience. Examples are the Conduct of Fire Trainer (COFT), aircraft flight simulators, and DIS.
- Provide access to what authors call "know bodies," an apt name for experts.
- Provide access to data.

The access to "know bodies" is, of course, not new to the Army. However, modern communications allow unprecedented interactions. A communications network will result in increased and wider-spread use of expertise as:

"...expert knowledge among technicians is less a matter of what each individual knows than of their joint ability to produce the right information when and where it's needed. Anecdote, example, analogy, and encounter are the essence of collaborative expertise...In other words, expertise is a social affair." (Schrage, The Shared Mind.)

One of the exciting features of the Internet is the large number of bulletin boards that enable communication among literally hundreds of specialized interests. The Panel only saw one example of such an electronic bulletin board--at Fort Eustis. This would seem to be a natural avenue for the Army to pursue. The Panel was pleased to learn during the writing portion of this Study that the Army has increased its efforts to provide some electronic bulletin boards for "information highway" interchanges.

The future will, without doubt, see all Army officers using a computer-like device connected to a network such as the Internet. The Panel would suggest that even today the Army should require all officers to have a computer linked to the Internet, much as an officer is expected to have a telephone. Possession of a computer implies the ability to use the computer. This computer literacy could be established by qualification tests at entry to the Basic or Advanced Course, or by instruction in the courses.

The Panel recommends that the Army require an officer to have a computer upon entry into the Service; to be computer literate; to possess certain software packages; and to be linked to the Internet.

At a minimum, the Army should provide an officer with a computer and a common suite of software upon his/her entry to Fort Leavenworth. The officer would retain the computer and software for his/her future assignments.

Three alternatives apparently exist for funding these computers. First, the computer could be similar to TA20 equipment and, hence, belong to the government but be under consignment to the officer. Second, the Army could simply require each officer to own a computer, much as he/she is expected to have uniforms or other items of Army use. Third, the Army could charge tuition to attend Fort Leavenworth, with the computer being bought with all or part of the tuition.

C. GROUP LEARNING

Modern communications also allow a greater degree of cooperative learning. The Army has used group discussions in Service schools for some time; however, true group learning is a somewhat different proposition. In "Learning Through Cooperation," an article by Vincent Ercolano which appeared in the November 1994 issue of ASEE Prism, cooperative learning is defined as "instruction that involves students working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual and group accountability* (each member is accountable for the final outcome)." (Note: Emphasis appears in the original article.) Group, or cooperative, learning differs from a discussion group in that each member of the group is responsible for the group's learning. For example, a commitment to true group learning implies that CGSOC would recognize an outstanding group rather than an individual. Research has documented the efficacy of group learning. The Army should emphasize group and cooperative learning in future education.

The Army has a long-standing program with the Army Research Institute (ARI) to foster new methods of training and education. Many of these methods have proven to be very successful. The Panel suggests that the Army carefully examine the greater use of proven techniques for educating and training groups (such as Reserve Officer Training Corps [ROTC] classes).

D. AN ARMY-UNIQUE CAPABILITY

The Panel believes that the Army's interest in digitization, simulation, and DIS can lead to a unique educational opportunity. The scenario goes as follows: Sometime in the future, somewhere in the world, an Army unit is involved in a tactical operation. Digitization allows the

Army to capture in great fidelity all the elements of the operation. Once the operation is reduced to digital data, the data can be processed through a "simulation creator" to produce a real-time simulation of the operation. In the near future, this simulation can be virtual reality. It can be archived for future use and study, or presented immediately to "know bodies" for advice or critique.

This is indeed a unique capability, as few other educational institutions have the capability to produce sophisticated simulations of DIS. Few have the extensive worldwide communications network, and few are attempting to digitize what amounts to experiential learning.

The Army's simulation capability, technology thrust in battlefield digitization, and use of digital compression techniques will allow true-fidelity capture of all operations and activities for:

- Instant interaction, critique, or advice;**
- Archiving for future educational use.**

The Panel would note that simulations such as COFT appear to be eminently successful, in that tank gunnery scores improved after gunners spent time in COFT. However, it may not be true that all virtual experiences translate into improved real achievements.

E. THE SPECTRUM OF OFFICER EDUCATION

Hague answers the question, "What are universities for?" by stating that they:

- Generate curiosity;
- Encourage lateral innovative thinking;
- Arouse excitement;
- Develop students with "the future in their bones." (From C.P. Snow)

A fundamental question, then, is, "Why do officers attend the Army 'University'?" In addition to the general reasons stated above, the Army University also provides hands-on training, a standardization of approaches, and the creation of a social experience and network.

An officer needs hands-on experience early in his/her career. This experience includes the use of basic weapons, maps, communications equipment, etc. Presently, the Army School System provides much of this experience; however, much, if not all, of this responsibility could be shifted to an officer's unit. Later in his/her career, an officer has a fuller appreciation of what knowledge is required in his/her current position, and in the position to which he/she aspires. This realization argues that an officer could secure some of this education remotely and individually, if the data bases and "know bodies" existed and if access to them were provided. However, there is an

increasing need for social networks as an officer moves through his/her career. Most officers find the personal contacts established at CGSOC and the Army War College to be extremely useful in later command and staff positions; this argues for a group experience. Any use of technology must preserve this important element of an officer's educational experience.

Army faculty are somewhat different than civilian faculty. As a rule, Army faculty do not spend long periods of time as instructors. In addition, Army faculty may only be marginally more proficient in the subject matter than the student. True expertise is widely dispersed throughout the Army, not merely concentrated at Army Schools. An officer, as part of his/her education, may have a question about logistics in the desert, for example. The ability to interact with an expert on this topic residing at Fort Hood through two-way audio/video would be an effective learning mode. (In fact, even the CSA suggested that he should be available for such consultation!) An inventory of experts and development of an electronic network would allow access to these "know bodies."

The Army should have an inventory of people and associated areas of expertise so that officers will know where to go to access the "know bodies" he/she needs for his/her education.

V. THE FUTURE VIEW

A. INTRODUCTION

For now we see through a glass darkly, but then face to face:
now I know in part; but then shall I know....

— Corinthians I, Chapter 13, Verse 12

General Sullivan asked that this Study look at the year 2012, seventeen years into the future. Seventeen years ago it was 1978; what would a prognosticator have forecasted for the year 1995? Many of today's wonders then resided on laboratory benches, but would some brave soul have bet on the reality of an Internet, with some twenty million users scattered around the world? The ubiquitous PC, with more power than a 1978 mainframe? The widespread use of CD-ROM technology? Hypertext? Extended use of color and animation? Software packages that "do" calculus? The Sprint voice-activated Fone-card™? Desktop publishing? Portable phones? A DIS that allows simultaneous training at geographically dispersed locations? This would have required a prescient observer, far better than the Study participants. The Panel looks to the future with some hesitation, and recognizes that many of its conclusions and recommendations may merely be stepping stones to an environment that is far beyond its members' imaginations. Study participants, like many others, may exhibit linear thinking when exponential thinking is in fact required. Therefore, the Panel should be excused if it widely misses the mark in this forecast.

The Panel is apparently not alone in this inability. AT&T has produced a videotape, entitled "Connections," which is its vision of the future (available from the Faculty Development Office at Fort Leavenworth). This videotape is well done. However, nearly all of the technology described on the tape exists today, at least in an embryonic state.

Appendix 10 in the Supplement contains a paper prepared by the Information Technology Laboratory (ITL) of the U.S. Army Waterways Experiment Station (WES) in Vicksburg, Mississippi. This laboratory is probably unique to the Army, and the paper describes the organization's view of the future.

The ITL paper is biased toward distance learning (the Panel shares this bias), and suggests that the following technologies and capabilities will exist to support Army distance learning:

- Two-way video;
- Full duplex audio;
- Interactive, multi-point, concurrent whiteboarding;
- Digital video-on-demand servers;
- Wireless, cellular connectivity;

- Long-haul networked personal computers and workstations, with network connections costing the equivalent of a local phone call.

B. HARDWARE/SOFTWARE

The Panel hesitates to call the computer the "machine" of the future. J. Lewis Perleman (School's Out: Hyperlearning the New Technology, and the End of Education) has described a "...telescom communication infrastructure that makes all knowledge accessible to anyone, anywhere, any time. The telescom takes the most powerful knowledge, intelligence, and learning capacity in an environment that would otherwise be only local, and makes it global. For both human and non-human learning the telescom makes the 'best and brightest' located anywhere available everywhere."

A common consensus is mobility and portability. Whatever the device may be and however it may communicate with other people or data bases, it will follow its owner. Bandwidth will no longer be a factor. The ITL paper reports that a single video frame, which contains 96 million bits of information, would require 25 minutes of transmittal time using today's 64Kbps voice links. However, a gigabit network, which is expected in the next five years, would transmit the same frame in a tenth of a second. In addition, present and future predicted algorithms can reduce the bandwidth requirement by a factor of 20 or more. Therefore, either the incoming information will be compressed, or the "pipe" bringing in the data will be large enough to handle any imaginable amounts of data. This "telescom," to borrow Perleman's term, will be an all-purpose machine. No longer will the instructor require a television, computer, VCR, etc. The telescom will respond to voice commands, and will give audio translations from one language to another. Many suggest the world will be paper-free.

Software will no longer exist in today's sense of the word. Something akin to neural networks will be used to exploit the electronic interworkings of the telescom. There may well be direct or indirect connections from the human brain to the telescom. Electronic archiving will allow the access to information that Perleman described. A "personal agent," that is, a program that mimics an individual's behavior pattern, will be the norm for each telescom. These personal agents will make decisions in the absence of their "owners."

Virtual reality will be a certain reality.

The Panel repeats its strong feeling that:

The Army's simulation capability, technology thrust in battlefield digitization, and use of digital compression techniques will allow true-fidelity capture of all operations and activities for:

- Instant interaction, critique, or advice;**
- Archiving for future educational use.**

Cognitive science, molecular psychology, embedded training, and neural networks will all play a role. In addition, pharmaceutical enhancement of creativity, memory, and learning can be envisioned. A better set of psychological tests could also be an interim measure to predict qualities of leadership and decision making.

Finally, there will be any number of pedagogical advances. Educators will more effectively use methods such as group learning, structured pathing, simulations, and individually "tailored" programs to enhance students' learning.

VI. ORGANIZATIONAL CONSTRUCTS

A. INTRODUCTION

There has been extensive discussion in the last few years regarding "re-engineering," "downsizing," "flattening the organization," "value-added activities," and other similar terms. Whichever term is used, the net effect, generally, is a smaller, more focused organization. TRADOC will have to hew to these concepts. The contemplated 495,000-man Army will not support a TRADOC University with a faculty and student body the size it is today. Educational technology has the capability to help the Army achieve a slimmer, more effective education sector.

The Panel wishes to emphasize that the following discussion on organizations only treats the educational role of TRADOC and the TRADOC School System. The Study Group did not look at School activities such as combat development, and claims no competence in such matters.

The Panel believes that the constructs suggested herein will serve as a bridge from the present conventional education organization to the distance learning system of the future, and that they will be satisfactory for the presentation of distance learning.

B. THE SHAMROCK ORGANIZATION

One organizational concept that appears to have considerable merit is the shamrock organization, so-called because the three "groups" of individuals which make up the organization are analogous to the trifoliate shape of the shamrock. The primary group in this organization is a small set of individuals with core competencies; for the Army, this group would be the war fighters. There is also a group of regularly used "contractors"; the implication here is that this group is primarily dedicated to one organization. Analogous Army groups might include reserve units that furnish combat support or combat service support. It might also include contractors, such as RAND, who are "regularly" used by the Army for study support. The third leaf of the organization is an irregular group of part-time workers; the implication here is that these employees work for any number of organizations. There is perhaps no Army equivalent to this group right now, although the Active Guard and Reserve (AGR) positions may come the closest. The necessity for part-time workers also suggests that the Army needs a better inventory of skills in order to quickly identify workers required for a particular assignment.

The TRADOC Schools could very well be a shamrock organization. Army cadre would teach a small subset of unique Army topics. Contractors such as local colleges would teach some part of the curriculum on a regular basis. For example, colleges could teach the English and speech courses that are part of some Programs of Instruction (POIs). Local health club instructors may be well-trained in exercise physiology, and could present the physical training classes. The Panel is convinced that the entire curriculum of the Army Computer Science School at Fort Gordon could be presented by a local college or university, or by distance learning from the finest colleges in the United States. Finally, the shamrock organization suggests that "one-time" lecturers would fill in the holes. For example, outside experts may be asked to present a

lecture, and several Army school POIs contain history or heritage lectures which might be presented by local retirees.

C. FLATTENING THE ORGANIZATION AND USE OF DISTANCE LEARNING

Elimination of layers of management would be possible under at least three scenarios.

The first scenario would be the elimination of TRADOC. This would result in the School Commandants reporting directly to Headquarters, Department of the Army (HQDA). This would seem to involve HQDA in operational rather than policy matters, and would perhaps be inimicable to the officer education system.

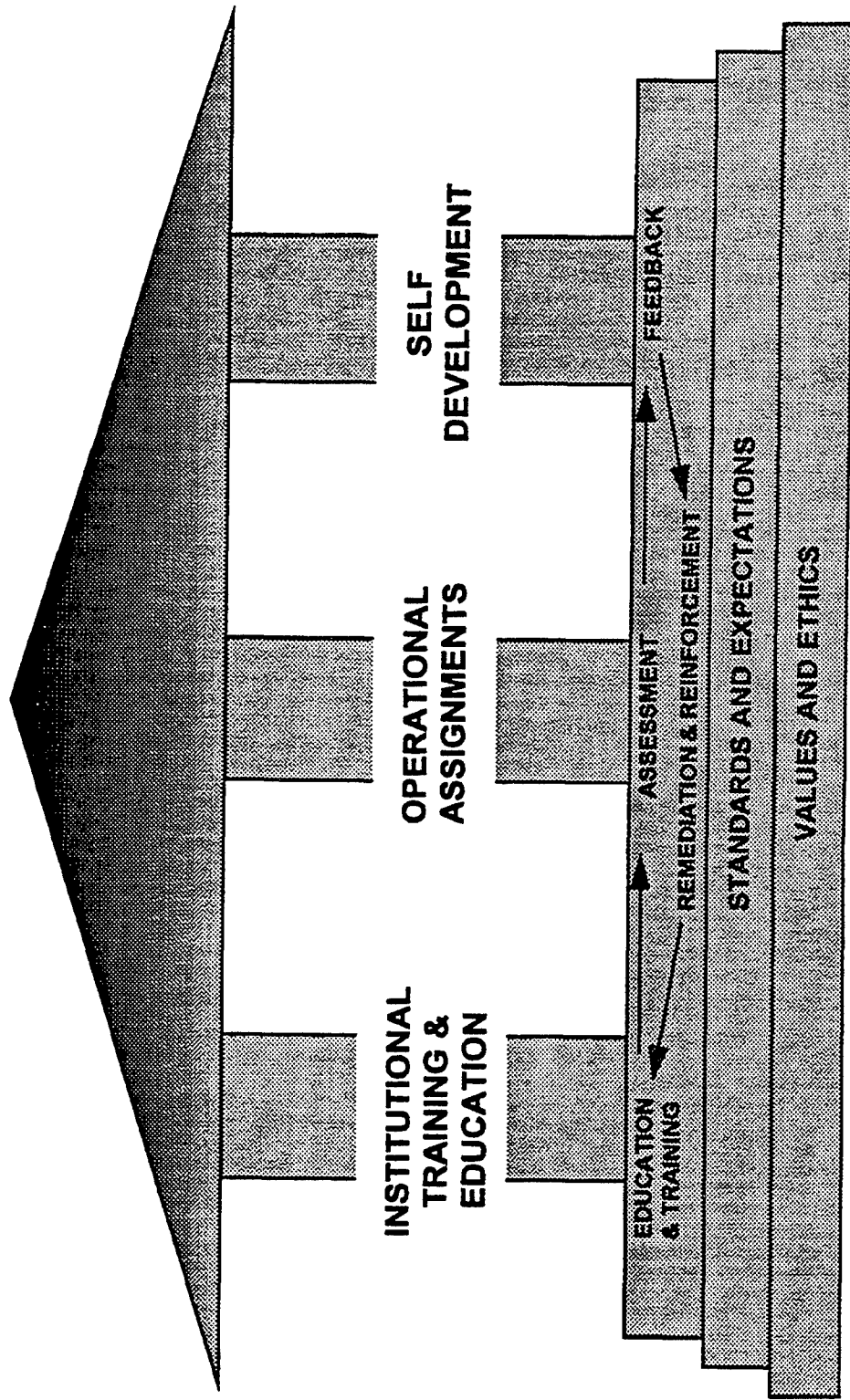
The second possibility would be the elimination of Fort Leavenworth and Fort Lee. This is feasible; the Branch Schools would report directly to TRADOC. Many have argued that the integrating centers were never effective, and that the integration of officer education could pass to TRADOC. However, a description of an organization that seems preferable to the first two scenarios follows.

This last option would involve the elimination of the Branch Schools and Fort Leavenworth as geographic entities where officers gather to gain knowledge. This seems revolutionary, but the Panel is convinced that the Army will have to utilize distance learning. The Panel suggests a plan much like NTU's. Fort Leavenworth and Fort Lee would be managers of education. An officer's education would become the responsibility of his/her unit commander and his/herself. The Army has characterized officer education and leadership development through a three-pillar model, as shown in the figure on the following page. Each pillar in this figure holds equal responsibility for the officer's education. Under the Panel's plan, the three pillars do not disappear; however, the operational assignment and self-development pillars become significantly more important. The relative width of the pillars in the second figure conveys this concept.

The Panel describes this new education scheme as a "managed apprenticeship." For combat arms officers, Fort Leavenworth would develop certain "board tests," much like the medical boards. It would also be responsible for certain system-wide lectures on specific topics, as well as for identifying "know bodies" and other sources of information. However, the unit commander and the individual officer would be largely responsible for the officer's education.

It must be asserted that this scheme may be satisfactory for the Officer Basic and Advanced Courses, but it removes the opportunity for social networking that is important at CGSOC. Again, the Panel feels that the Army must embrace distance learning, and that the present method of gathering 1000-plus officers per year at a central location will no longer be possible. Obviously, officers at CGSOC do not network with all 1000 of their classmates. Most experts have suggested that 50 is a good number for effective collaboration and networking. This suggests that the Army could create 20(±) "clusters" of officers who would be using group techniques and collaborative learning for completing CGSOC. Fort Hood, for example, could be a cluster of officers participating in CGSOC. Many of these officers would have Fort Hood as a

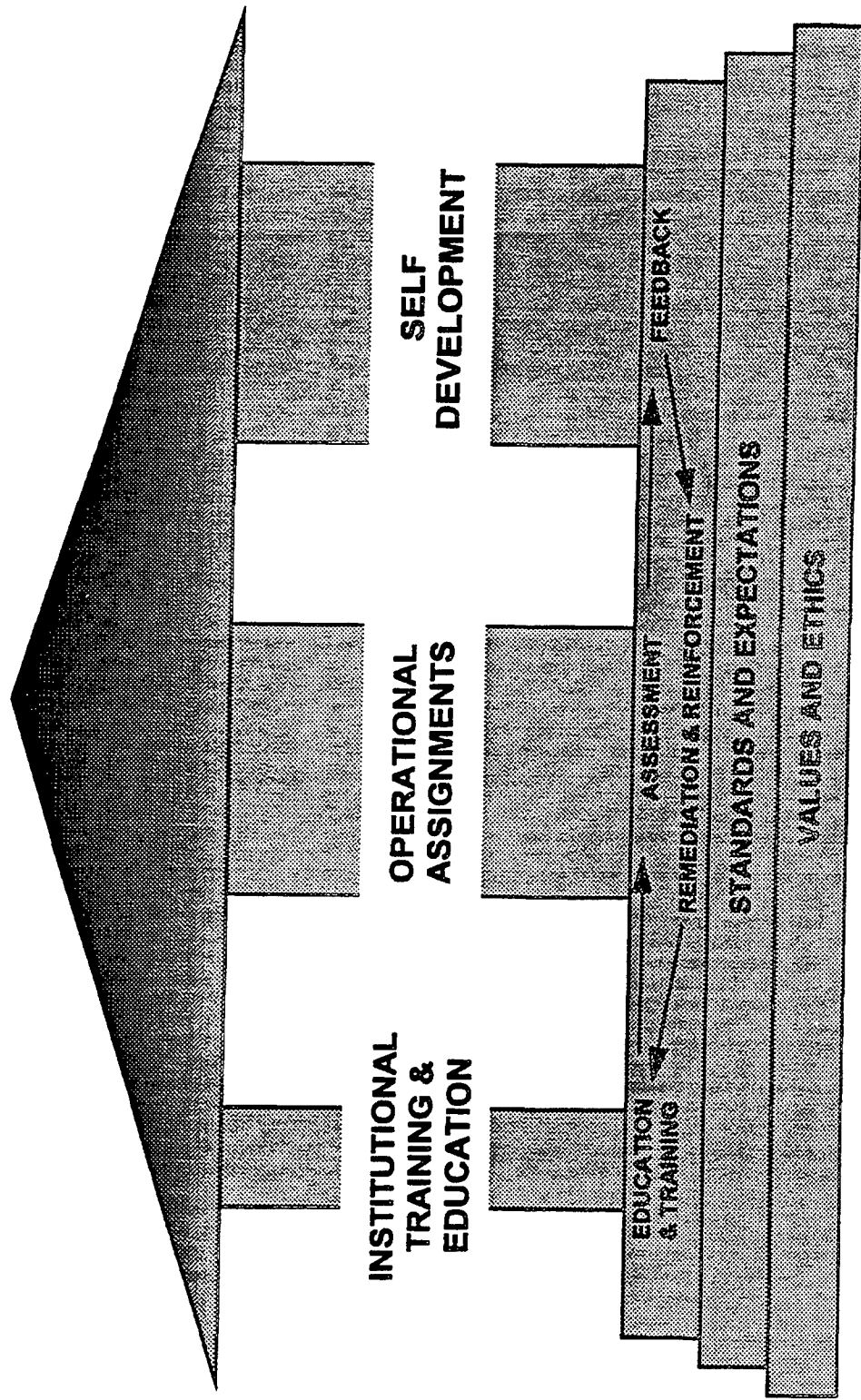
ARMY LEADER DEVELOPMENT MODEL



THREE PILLARS...INTERCONNECTED...PROGRESSIVE AND SEQUENTIAL

FIGURE 1

ALTERED LEADER DEVELOPMENT MODEL



THREE PILLARS...INTERCONNECTED...PROGRESSIVE AND SEQUENTIAL

FIGURE 2

home station. Others might be from Fort Sam Houston or other installations close to Fort Hood. Appendix H contains examples of possible clusters.

The Army could bring all of the clusters together at one location for a short period of time if desired. However, the ability to exchange views and information through two-way audio and video suggests that geographical "togetherness" is not a necessity for effective networking.

The Army School System was designed some time ago, with the desirable and necessary goal of assembling officers in a single geographic location to offer a common and unified approach to Army doctrine, tactics, and problem solving. Educational technology enables the Army to bring the School to the student, rather than the student to the School. This approach requires that the Schools become "managers" rather than "providers" of education. This would parallel NTU's system, where a large number of courses are presented by faculty who are widely scattered geographically rather than being on-campus. An alteration of General Sullivan's pillars indicates that the responsibility for education would shift to the unit and the individual, with the Schools playing a much smaller role. This approach would be consistent with new management philosophies and would effectively utilize technology.

"Know bodies" and preceptors would deliver lectures as needed to either local audiences or to a more global audience over the Army's TNET. Distance learning also has the advantage of saving an enormous amount of annual temporary duty (TDY) expenses. In addition, distance learning provides the opportunity for asynchronous presentation. This would replace the present correspondence course, and would basically enable all officers, if they so choose, to attend CGSOC.

VII. OBSTACLES

A. INTRODUCTION

The TOR asked that the ASB Panel identify barriers to the introduction and use of educational technology within the Army School System.

B. LEGAL

Appendix I contains an analysis of the Brooks Act. This act, which may have been appropriate at a time when the government was buying large mainframes, does not seem to belong in today's PC world. The act places a large number of *a priori* criteria on computer procurements, forecloses the opportunity to lease computers, and, in general, will ensure that the Army never receives state-of-the-art computers. (A related problem is the long length of the procurement cycle. Any procurement action that stretches over two years, as is apparently the case at some installations, will result in the purchase of outdated hardware.) Admittedly, there are a number of ways around this act. One method is to use the blanket purchase agreement that the Services and the General Services Administration (GSA) have negotiated. Also, the Army, by one means or another, has managed to write a contract with OSU to provide and manage the TNET. However, working through DoD, the Army should prevail upon Congress to rescind or modify the Brooks Act. Buying a PC these days should be the equivalent of buying a chair or a table for the office.

C. FINANCIAL RESOURCES

The price of hardware and software which are used in educational technology is rapidly spiraling downward. Nonetheless, the initial cost can still be appreciable. The Panel earlier noted that the Advanced Technology Classroom at West Point costs over \$500,000. There was no budget to sustain orderly replacement of equipment that may have a technical half-life of two to three years. At Fort Gordon in particular, Panel members felt that educational technology efforts had receded over the years due to TRADOC's reduction in personnel and funds. This cutback particularly hit training developers, who should be the leaders in educational technology. Educational technology is not cheap. Once involved, the Army must budget to stay involved.

A particular expense deserves special mention here. The creation, maintenance, upgrading, assessment and testing of courseware is a cost that will likely be much greater than educators now recognize.

D. THE GOOD OLD DAYS AND THE NOT-INVENTED-HERE SYNDROME

Some in the Army have not fully recognized that the halcyon days of resources are over, and the day is now here when budgets will be dramatically lower. Imagination, creativity, and

sharing of assets will be necessary. The Panel found instances of failure to recognize that assets were in place to solve certain problems--assets that would need to be shared. The Army has several networks in place; TNET and the Simulation Network (SIMNET) are two examples. The Panel found no technical reason for having multiple networks, only a desire by commands to own and control their own facilities. While the Panel applauds the Army's TNET, it duplicates existing civilian capabilities. The "not-invented-here" syndrome is understandable and hard to overcome. However, the Panel's feeling is that some Army personnel are looking for fiefdoms, not fixes; for sinecures, not solutions; and for ownership, not "shareship."

E. CULTURE

Appendix 11 in the Supplement outlines the difficulty of introducing technology into the classroom at Fort Leavenworth. All Army instructors carry an inordinately heavy teaching load. Some have been teaching the same subject in the same manner for a long time. Some are not computer literate; some do not want to be computer literate. All of these factors work against the introduction of educational technology. In other words, there may be an institutional bias against new methods and structural reform.

F. FACULTY TRAINING

One method of overcoming this bias is to adequately train the faculty of the Army Schools. Fort Gordon and West Point demonstrated that the use of educational technology takes a significant amount of faculty indoctrination and training. It cannot be assumed that a conventional classroom teacher will automatically be a good educational technology teacher. In addition, it is clear that the initial preparation time for a high-technology lesson far exceeds that needed to develop a conventional lecture.

Multimedia education adds new dimensions to the education process. A professional is needed who understands the aspects of this media. A teacher is needed who understands the subject content. The educational technology that will soon be available is not merely a "computer replacing a typewriter." It is indeed a complete change in the process of thinking and handling information. This change will take time, money, energy, and a full commitment by the Army to "stay the course."

The Panel also suggests that, at least for the time being, an educational psychologist is needed to provide meaningful assessments of education experiments at the Schools. Panel members saw only the beginning of such assessments in Army activities.

G. INSULARITY

The Panel noted a number of strong interchanges between Army educators and the civilian world. However, there were some peculiar exceptions. One briefer reported that the activity did not need to look to the outside world as, "We do it better than anyone else." The "Satellite

Scholar" (P.O. Box 3508, Missoula, MT, 59806) is the "TV Weekly" of satellite education. Yet the Panel was unable to find a single Army subscriber. This would suggest some lack of familiarity with the full spectrum of education available from the civilian sector.

H. QUESTIONABLE CLAIMS

The issue of the assessment of educational technology was previously discussed. Many educators are not prone to commit a large amount of funds, faculty time, and other resources to technology fixes that may or may not be better than present methods.

I. COMMAND INSTABILITY

Few college presidents remain at an institution for as few as two years. Yet this is the norm for many School Commandants. It was previously noted that the position of Deputy Commanding General at Fort Leavenworth has turned over four times in five years. **It is difficult for any technology thrust or organizational change to persist in such a situation.** Some permanent personnel at Army Schools have an interest in preserving the status quo, not rocking the boat or pushing for change. The Army therefore has a recognized dilemma. There are only so many "bright lights"; however, if education is indeed important (and the Panel suggests it will become even more so in the years to come), then the Army simply must put its "best and brightest" in the TRADOC University, and leave these officers there for an extended tour.

J. OPERATIONAL BIAS

Army units traditionally have a penchant for "mission" activities, which translates into operational activities. In the past, education efforts such as encouraging non-commissioned officers (NCOs) to complete the Graduation Equivalency Diploma (GED) requirements during duty hours have been significantly weakened by the attitude that an NCO was a "shirker" if he/she was at the Education Center rather than with the unit. A significant shift of responsibility for officer education from TRADOC Schools to units will thus require a significant change in the Army's culture. A commander's efficiency report should include a sizeable evaluation of his/her success in fostering officer education on the part of his/her subordinates.

VIII. SIGNIFICANT FINDINGS

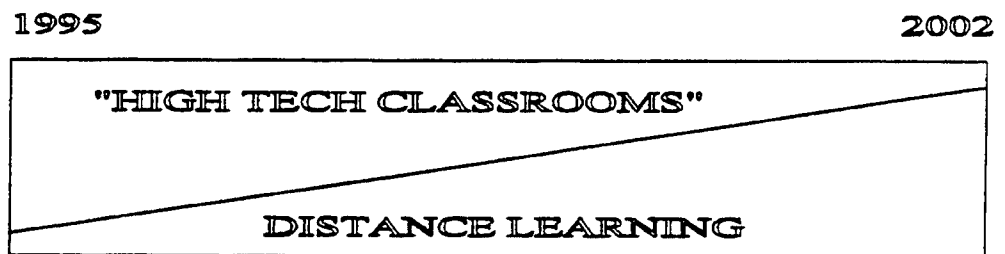
1. Educational technology will be an enabling force that will allow the Army to make changes in its present education system--changes that appear certain in the face of BRAC and a smaller Army.
2. The Army's major use of distance learning is fore-ordained. Advancements in two-way audio/video transmission and digital compression, along with cheaper satellite time, will allow for effective education, group participation, and at least some of the networking that is prevalent in the officers' courses today.
3. In addition to the rapid development of the hardware and software of educational technology (the delivery end), there is an equally rapid development in learning paradigms (the receiving end). Many of these methods, such as cooperative learning, were originally fostered and supported by ARI, but the Army could use the techniques more effectively in its School System. Additionally, the Army School System is being extended to new audiences, such as the ROTC program, that could benefit from educational technology.
4. The Army is engaged in an enormous flurry of activity in educational technology. Such experimentation may be good, but the Panel is uneasy regarding the lack of focus or direction. In addition, some installations have actually regressed in their attention to and use of technology due to TRADOC resource cuts.
5. The Army's efforts, despite their enormity, are dwarfed by the totality of civilian educators' interest in and use of technology. The Army should be a major player on the national scene in educational technology, and joint research efforts with civilian educators are both desirable and possible. The Panel was uncertain whether there is enough Army awareness of the total extent of civilian efforts. Panel members also note that some Army programs seemingly failed to adequately consider cooperation with or use of civilian resources. Such sharing of resources will be necessary in the context of budget limitations.
6. The Panel found little evidence of inter-Service programs or ventures. There is considerable interest within DoD as a whole in utilizing educational technology, and the thrusts for joint and cooperative programs among Services should include efforts to use educational technology effectively, and to preclude duplication of equipment, research and development efforts, and training.
7. The Army is not taking full advantage of existing educational technology. For instance, the Panel was surprised at the Army's inadequate use of electronic bulletin boards. These bulletin boards could support a variety of cohort groups. For example, Infantry Brigade Commanders could use one board, adjutants another, etc. The Army could move quickly to establish these collaborative educational means; late in the Study the Panel was led to believe that some efforts are underway to use this technology.

8. A move toward distance learning and a "leaner, meaner" Army School System requires a concomitant organizational change. A flatter organization would require the elimination of either TRADOC, Fort Leavenworth and Fort Lee, or the Branch Schools—or some combination of the three. A related organizational change would be a transformation to a shamrock organization. This type of organization includes a small set of full-time employees devoted to the core activities of the organization, a group of regular contractors, and a number of "irregular"—i.e., "as needed"—contractors. The TRADOC Schools could use a shamrock organization as a bridge between the classroom of today and the distance learning mode of the future.
9. The Army has an unprecedented opportunity to achieve effective education by integrating digitization, simulations, DIS, and electronic archiving.
10. Any scheme of dispersed teaching and calling on "know bodies" for lectures, critiques, doctrine development and other tasks requires an accurate and full inventory of each officer's skills, knowledge, and abilities.
11. Throughout this Report, the Panel has commented on the lack of evaluation of the Army's use of educational technology. The Army must develop appropriate outcome evaluation methods that can provide relevant comparative data concerning the quantity and quality of the learning occurring through differing pedagogic techniques. The evaluation has to be conducted over time, in order to measure the long-term effects of educational technology. How long is the material retained? How is it useful throughout the course of an officer's career? Is book and classroom learning more effective for long-term retention? Is interactive computer-based learning a better way to have students participate in the learning process? Or is pure experiential learning most effective? These are difficult questions, but their complexity should not hinder attempts to answer them.
12. Similarly, the Army must review the full range of alternative delivery systems for education, and evaluate these systems in light of the Army's educational needs at a particular level, for a particular course, and at a particular time. The Panel did not see much evidence of such an assessment. Instead, Panel members came away feeling that technology is driving some change where it is used, rather than educational needs driving technological alternatives. More often than not, officials continue to rely on older methods based on habit and past experience, rather than considering and consciously choosing from among various alternatives. The choice of the UMR Engineering Management Program by Fort Leonard Wood is one example of this.
13. The Army must conduct a more careful evaluation of the role of social networking and the relationships that develop in the traditional classroom. What impact will a shift to distance learning technologies have on the bonding which now occurs among the officers? How serious would the loss of this social community be? How can the best of educational technology be utilized while maintaining the necessary social and human interaction? These are critical questions which are not currently being addressed.

IX. RECOMMENDATIONS

The Study recommendations are:

1. Continue to develop and acquire modern classroom technology, but emphasize a move toward distance learning. A notional time table for this effort is shown below:



- This illustration conveys the sense that the Army now utilizes some distance learning, with a preponderance of modern classrooms. By 2002, the Panel recommends that the Army move to a small proportion of modern classrooms, with a much greater use of distance learning. It further recommends the use of distance learning for the Basic and Advanced Courses and CGSOC. Distance learning will supplement the education which will be provided at the unit level for the officer's Basic and Advanced Courses. CGSOC "clusters" will use distance learning as a primary mode. All of the education will emphasize group learning.
2. Make the commitment to move to the electronic classroom and distance learning. This includes committing to:
 - a. Continuity of leadership.
 - b. Training the professional staff at the various Schools so that they are comfortable with the new technologies, and can effectively incorporate educational technology in rethinking the objectives of education.
 - c. The identification and recognition of a cadre of teaching professionals who will champion the approach throughout the School System.

3. Coupled with the technology's introduction must be the realization that the Army will have to develop appropriate outcome evaluation methods. In addition, the Army must seriously review the full range of education delivery systems and evaluate these systems in light of its educational needs.
4. While the Army could use the TNET as the basis of distance learning, the Panel recommends that existing civilian resources be explored as alternatives. Local cable companies have provided cable at many installations which could possibly be used for land-based transmissions. Sharing the facilities of organizations such as NTU may be possible for satellite transmission.
5. Develop the full capability of the synthesis and synergy possible with digitization, simulation, DIS, and electronic archiving.
6. Develop joint research and study efforts with a variety of civilian institutions, such as NTU and IAT, and with the United States Department of Education as well as state Departments of Education. Take the lead as the education champion for joint programs with appropriate organizations within the other Services and DoD. Much of the hardware research and development, such as increase in bandwidth, will come without the need for Army funds. However, the propagation of the new learning paradigms, particularly within the entire Army (ROTC programs, for example), needs Army funding support.
7. Make the organizational changes necessary to implement distance learning, and institute the necessary training to effectively use and present it. The Panel's preference is to establish Fort Leavenworth and Fort Lee as "managers" of education. In other words, their responsibilities would include such activities as developing qualification tests, identifying distance learning instructors, arranging satellite time, etc. This would parallel the national education philosophy of decentralized education with national standards.
8. Eliminate much of the educational role at the Branch Schools once distance learning is fully implemented. In the interim, conduct careful tests to determine the appropriate level of Branch School participation in either the managing or presentation of Branch-specific education.
9. Although Panel members do not unanimously support this recommendation, there is some sentiment that the Army should create a Board of Regents or similarly named group to bolster the Army's desire to move toward a "university" system. In addition, the Army should consider creating a provost position at appropriate institutions within the university. If the recommendation to establish Fort Leavenworth and Fort Lee as the managers of education were to be adopted, it would be logical to have a provost at each of these locations. The Army would walk the fine line between ossification and instability by following a procedure such as that used with the Dean of the Academic Board at West Point. An officer

or civilian would be appointed provost for a five-year period, subject to review and either termination or renewal at the end of the period.

10. Move toward the notion of "shamrock" education as quickly as possible. Identify core topics which *absolutely* require active-duty instructors, topics suitable for contractors, and topics suitable for irregular workers. The Army can well civilianize a great portion of its education program. In particular, many retirees have far richer experience in combat, logistics, intelligence, and other Army activities than will exist within the active field-grade cadre of the near future. This suggests the core topics may be quite limited.
11. Continue to develop the electronic bulletin boards as a means of informal education. Require all officers to be computer literate as certified by appropriate testing, to either own or be provided a computer, and to be connected to the Internet. Explore the emerging World Wide Web as an alternative, in order to be more than a bulletin board but less than the two-way audio, two-way video available through TNET.
12. Develop a complete inventory of skills, knowledge, and abilities for each officer in order to rapidly identify experts for teaching or operational situations.
13. In concert with the ASB, prepare an Army Future Education Roadmap and request the National Academy of Sciences Board of Army Science and Technology (BAST) to critique the effort upon completion.

The ASB strongly feels that adoption of this Study's recommendations will place the Army in a role as an education leader in the United States. This is a rightful position for the Army. Acceptance of a lesser role should not be acceptable.

APPENDIX A

ORIGINAL TERMS OF REFERENCE



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
RESEARCH DEVELOPMENT AND ACQUISITION
103 ARMY PENTAGON
WASHINGTON DC 20310-0103

21 JUN 1994



Dr. Walter B. LaBerge
Chair, Army Science Board
2001 Robin Hood Trail
Austin, Texas 78704

Dear Dr. LaBerge:

I request you initiate an Army Science Board (ASB) Ad Hoc Study on "Use of Technologies in Education and Training." The study should address, at a minimum, the Terms of Reference (TOR) below. The ASB members appointed should consider the TOR as a guideline and may include in their discussions and reports related issues deemed important. The study group should coordinate modifications to the TOR with the ASB office.

I. BACKGROUND.

The Army is in a time of expanding roles and missions, decreasing training and education opportunities, sharp limits on procurement, and ever expanding information technologies.

The Army schools have served the country well for many years. Soldiers have received the necessary skills to function as riflemen, tank gunners, wheel vehicle mechanics, cooks, and the numerous other MOS's that are necessary for modern warfare. Young officers attending Basic and Advanced Branch schools have emerged as competent company grade platoon leaders, commanders and staff officers. Fort Leavenworth and Carlisle Barracks have produced senior officers capable of planning and executing complex battle campaigns such as JUST CAUSE and DESERT SHIELD/DESERT STORM. The Army's education and training system continues to be the center piece to prepare our Army for the 21st Century.

In the past, traditional "schoolhouses" embraced early educational and training techniques. Few visual aids existed in the classroom beyond an overhead projector. The delivery medium was a lecture following a carefully scripted lesson plan. Hands-on training for soldier skills such as wheeled vehicle mechanics complemented lectures while officers would perhaps participate in group discussions or map or field exercises (such as terrain walks). The Army's text books were field manuals and technical manuals. While these manuals were informative, one may charitably characterize them as drab, dry, and uninspiring. Each student proceeded at a common pace. Evaluations required the students to basically play back the lecture material to be considered as "passing." In short, the Army followed the instructional mode prevalent in the United States.



However, Army education and training have evolved and continue to be dynamic. The Command and General Staff College's (CGSC) schools, for example, have significantly enhanced their educational methodologies. Education is more important than training. Schools stress how-to-think vice what-to-think and the application of knowledge. Simulations, critical thinking exercises, problem solving/decision making scenarios, subjective essay-type examinations, self-directed study, and active vice passive learning in small group instruction are essential elements of the Training and Doctrine Command (TRADOC) education system. Specific to training, the National Training Centers provide training opportunities in a virtual, synthetic environment - preparing units for success in operations such as DESERT STORM.

Much more will change in the next 20 years. Information technology in its broadest sense will allow almost unlimited freedom and flexibility in providing education and training to soldiers. We are beginning to break through the traditional leader development paradigm that worked so well during the Cold War era. At the heart of this breakthrough is the notion of the leader-student... constantly learning in a learning organization. Rapid changes require leaders to have instant access to the worlds of theory and practice - connectivity of the leader-student to learning institutions, units in the field, and other leaders on demand. Leaders will not stop being students when they leave the schoolhouse. This leveraging of Information Age technology will provide powerful tools for leaders to learn and to train units and soldiers throughout the Army. The Army is carefully analyzing its present education and training strategy to take the fullest advantage of future technology and looks to seize the opportunities to make quantum leaps in its education and training processes.

Allied with this technology explosion is a concern for the requisite technical skills for the Army of the 21st Century. As you know the ASB is presently preparing a study, "The Science and Engineering Requirements for Military Officers and Civilian Personnel in the High Tech Army of Today and Tomorrow." Obviously, this study is closely related to the study I am now asking you to undertake.

Many exciting prospects loom on the horizon. The basic notion of a student coming to the schoolhouse may be replaced by the schoolhouse coming to the student. Learning strategies such as structured pathing, exploratory learning, and extended use of gaming and simulation are no longer theoretical constructs but are in hand. Electronic access to data bases and bulletin boards can be a strong unifying force within the Army. Compact Disc - Read Only Memory (CD-ROM) technology promises to replace the written word of text books with graphics, film clips, and animations.

A key issue one must remember is the success of the present Army school system. In particular, the socialization that occurs at each level of schooling must not be lost in the face of technology. In addition, Army education and training is indeed a system, a university in the

true sense of the word. Any future change must be holistic and preserve a system, not simply tinker with or sub-optimize the pieces of the system.

II. TERMS OF REFERENCE.

The study should, as a minimum:

- a. Review technologies used for professional education in the Army, other Services, public and private institutions, academia, and companies.
- b. Identify technologies and techniques to enhance education. Recommend uses of these techniques for the Army education system.
- c. Delineate the changes in learning strategies that are associated with the use of technology in education.
- d. Recommend how the Army can locate and access potentially useful adjunctive technology based materials already in use by industry, academia, and other Services.
- e. Identify the barriers and issues of concern which accompany educational technology implementation, and recommend how the Army can overcome them.
- f. Recommend the uses of technology for distance learning.
- g. In particular, carefully address for the distance learning mode the preservation of socialization, camaraderie, and networking that now are prevalent in conventional course attendance.
- h. Insure that appropriate recommendations from the ongoing ASB study, "The Science and Engineering Requirements for Military Officers and Civilian Personnel in the High Tech Army of Today and Tomorrow" are communicated to the Sponsor.

III. STUDY SUPPORT.

Commanding General, US Army TRADOC will sponsor the study. MG Carl Ernst, Deputy Chief of Staff for Training, TRADOC, will be the Cognizant Deputy. Dr. Rebecca A. Campbell, Chief of Faculty Development, Command and General Staff College, will be the Staff Assistant. Major Anne Patenaude, Special Assistant, Office of the Under Secretary of the Army, Operations Research, will be the alternate Staff Assistant.

IV. SCHEDULE.

The Study Panel should begin its work immediately. As a first step, the Study Chair should submit a study plan to the Sponsor and to the Executive Secretary, ASB. The Panel should furnish an interim report to the Cognizant Deputy by 1 September 1994 and a final report to the Sponsor by 31 December 1994.

V. SPECIAL PROVISIONS.

The study is not expected to enter into any "particular" matters within the meaning of Section 208, Title 18, of the United States Code.

Sincerely,

A handwritten signature in black ink, appearing to read 'G. F. Decker', is positioned above the printed name.

Gilbert F. Decker
Assistant Secretary of the Army
(Research, Development and Acquisition)

APPENDIX B

GENERAL FRANKS' REPLY TO SUGGESTED CHANGES TO THE ORIGINAL TERMS OF REFERENCE



DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
OFFICE OF THE COMMANDING GENERAL
FORT MONROE, VIRGINIA 23651-6000

REPLY TO
ATTENTION OF

July 25, 1994

Allen F. Grum, Ph.D., P.E.
Army Science Board Study Chair
1400 Coleman Avenue
Macon, Georgia 31207-0001

Dear Dr. Grum:

In response to your June 22, 1994, letter, believe your focus on professional education is on target. Officer Basic and Advanced Courses, CAS3, and Command and General Staff Officer Course provide a good study basis on which to recommend technology strategies.

Regret you will not have time to study Noncommissioned Officer Educational System courses; however, your recommendations for technologies should apply to them as well as to West Point and Carlisle Barracks. Suggest a video teleconference with Sergeants Major Academy which is in the process of making a significant investment in technology.

As pointed out during your Fort Monroe visit, majority of TRADOC training resources support basic and advanced individual, aviation, and general skills training. Technology investment must be centered on largest return for the dollar. Would appreciate a recommendation in your final report on need for a Phase II or follow-on study.

Your recommendations may well guide Army training into the future. Cannot overemphasize importance of your work.

TRADOC--Where Tomorrow's Victories Begin!

Sincerely,

Frederick M. Franks, Jr.
General, U.S. Army
Commanding

Copies Furnished:

Mr. Walter W. Hollis, Deputy Under Secretary of the Army
(Operations Research), 102 Army Pentagon, Room 2E660,
Washington, D.C. 20310-0102
Dr. Walter B. LaBerge, Chair, Army Science Board, 41 Toulon,
Laguna Niguel, California 92677

APPENDIX C

ASB PANEL'S LETTER TO MR. WALT HOLLIS

MERCER UNIVERSITY

SCHOOL OF ENGINEERING

Office of the Dean

August 29, 1994

Mr. Walter W. Hollis
Deputy Undersecretary of the Army
Operations Research
SAUSOR
Room 2E660
102 Army Pentagon
Washington, DC 20310-0102

Dear Mr. Hollis:

Walt
We appreciated the opportunity to meet with General Sullivan on 17 August 94. We were impressed with General Sullivan's vision and his obvious interest in our study.

I have inclosed a diagram that attempts to capture some of General Sullivan's remarks. The diagram is faulty as the activities leading to leader behavior are obviously not disjoint. However, we suspect that a Venn diagram with seven activities would be confusing. One of the intents of this exploded pie chart is to suggest that while we will at least consider all of the activities of the pie chart (and the interaction of technology with these activities), our primary focus will be on using technology to enhance education.

In closing, we thank you for your help and support in the study. We see our product as having a potential for significant changes in Army training and education. We feel this responsibility deeply.

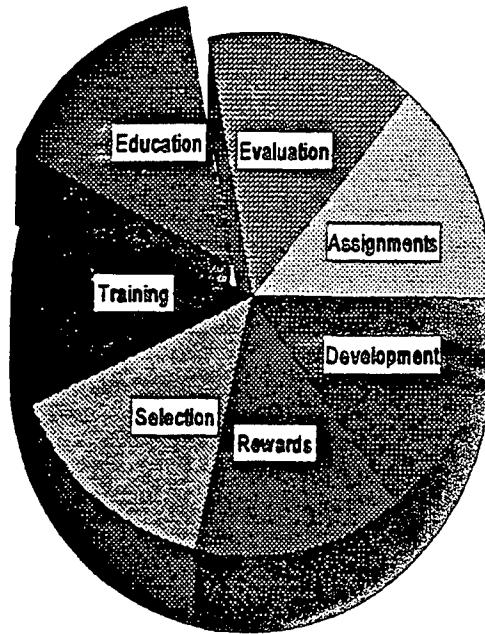
Yours truly,

al
Allen F. Grum, Chair
Army Science Board Study
on Using Technology in Education
and Training

Incl.

AFG/vf

DESIRABLE LEADER BEHAVIOR



TECHNOLOGY

APPENDIX D

PARTICIPANTS LIST

PARTICIPANTS LIST

ARMY SCIENCE BOARD AD HOC STUDY "USE OF TECHNOLOGIES IN EDUCATION AND TRAINING"

CHAIR

Dr. Allen F. Grum
Chairman, Mechanical and Industrial Engineering Department
Mercer University

ASB MEMBERS

Dr. Crystal C. Campbell
President, Managing Director
Padanaram Associates, Inc.

Dr. A. Bruce Montgomery
Vice President of Medical and
Regulatory Affairs
Patho Genesis

Dr. Joyce Lee Shields
General Manager, Washington
Metropolitan Area
HAY Management Consultants

Dr. Marlin U. Thomas
Professor and Head, School of
Industrial Engineering
Purdue University

Dr. Janet T. Vasak
Vice President and Senior
Technical Manager
Science Applications International
Corporation

Dr. Peter J. Weinberger
Director, Software and Systems
Research Center
AT&T Bell Laboratories

SPONSOR

GEN Frederick M. Franks, Jr.
Commanding General
U.S. Army Training and Doctrine
Command

COGNIZANT DEPUTY

MG Carl F. Ernst
Deputy Chief of Staff for Training
U.S. Army Training and Doctrine
Command

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MAJ Anne Patenaude
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(Operations Research)

GOVERNMENT ADVISORS

COL Fletcher Lamkin
Vice Dean of the Academic Board
Office of the Dean
U.S. Military Academy

LTC Bruce D. Jette
Headquarters, Department of the Army

APPENDIX E

THE NATIONAL TECHNICAL UNIVERSITY PROPOSAL FOR JOINT NTU-ARMY RESEARCH



National Technological University
700 Centre Avenue
Fort Collins, CO 80526-1842
303-484-0668 (FAX)
303-495-6400

A HIGHER
Order of
Education™

August 18, 1994

Dr. Allen F. Grum
Interim Dean
Mercer University
School of Engineering
1400 Coleman Ave.
Macon, GA 31207-0001

Dear Dr. Grum:

Just a note to follow up on our telephone conversation of today. We believe that now is the time to research the potential benefits of PC based multi-media groupware. Combining the "soon-to-be-widely-available" hardware and software with ready access to Internet will provide a supporting network that we believe could greatly enhance a broadband distance learning system such as the one operated by NTU. Among the tasks that we have identified for testing are the following:

- collaborative learning
- team building
- socialization
- mentoring
- academic advising
- video e-mail
- asynchronous videoconferencing
- simulations

Please let me know if a more detailed research statement would be helpful.

Sincerely,

Lionel V. Baldwin
President

LVB:lg

Arizona State University
Boston University
Colorado State University
Columbia University
Cornell University
The George Washington University
Georgia Institute of Technology
GMI Engineering & Management Inst.
Illinois Institute of Technology
Iowa State University
Kansas State University
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APPENDIX F

MEDICAL EDUCATION

October 7, 1994

ARMY SCIENCE BOARD

I. Introduction:

The medical industrial complex now represents over 12% of GDP in the United States. Nearly 500,000 M.D.'s are actively in practice with 60,000 medical students and a similar number of physicians in post-graduate training courses. More importantly, because of the R&D spent on medical research, medical care is in consistent flux as improvements are made. The mechanisms of how these groups receive education are instructive to the army education process as both share many of the same problems:

1. a work force that can not easily be removed from job site for retraining;
2. large geographic distribution;
3. variety of specialized tasks each requiring special educational needs;
4. education is directly tied to performance.

These are some of the major differences:

No central educational system or goals for post-graduate training, the largest group of physicians.

Novel technology is used in multiple applications to enhance medical education. There are three distinct phases of medical education. Each phase has used various novel applications. The three phases: basic medical school curriculum; in-hospital training; and post-graduate continuing medical education, are distinct in their goals and have used different solutions to unique problems.

II. Basic medical school curriculum:

The first phase of medical education is the first two years of medical school. The primary purpose of this education is to teach basic information in such subjects as anatomy, physiology, microbiology, pathology, biochemistry, and psychology. The usual format is not very different from an undergraduate education with lectures and laboratories. Novel technology has been used in three areas: computer aided learning, virtual reality for anatomy teaching; and televised lectures to decentralize medical schools. Computer aided learning is often used to illustrate and reinforce physiologic principles, allowing the rapid completion of physiology experiments that in past times required the use of animals. The advent of color high-resolution monitors with representative pictures has also decreased the use of microscopes to study pathology and microbiology specimens

The second major novel technology is virtual reality in anatomy training. The teaching of anatomy by cadaver dissections has been a "rite of passage" for generations of medical students. Dissection is time consuming, technically difficult, often botched and requires a supply of cadavers that have been preserved in known carcinogenic preservatives. The advent of virtual reality cadavers allows rapid repetitive virtual dissection, eliminates hours of tedious work and presents idealized information at no risk to the health of the medical student.

The third major use of technology is to decentralize medical education. In order to combat the trend for physicians to become specialists, a movement to change the venue of the basic training of medical students from the ivory towers to rural communities has started. The concept is that early exposure to rural and/or nonspecialty practices will encourage students to take that career path. The largest example in the United States is the WAMI program (an acronym for the four sponsoring states involved: WA, AK, MT, ID), which is approximately one-third of the students starting medical school at the University of Washington, who will spend their freshman year at sites in Alaska, Montana, Idaho or rural Washington. The

program, now 25 years old, has been very successful in creating rural based primary-care physicians. The technology required is video-taped lectures or live satellite broadcasting of lectures unavailable by professors on site.

Considering there are over 30,000 first- and second-year medical students, the improvements of technology in their training over the past two decades are limited. The reasons for this are not obvious. Perhaps the lack of research monies to explore novel technologies (the primary mission of most medical schools is to do research not teach), may explain this missed opportunity.

III. Hospital based training:

The second phase of medical education is hospital or clinic based and consists of direct patient experience in a facility with various degrees of supervision. The role technology plays in the hospital is high due to the high technology nature of in-patient medical care. In terms of teaching, the most significant impact of technology is the development of multiple user-friendly computer data bases to facilitate diagnosis, treatment options and drug usage. The medical literature is very large and complex but covers almost every possible clinical situation.

Therefore, well organized data bases improve the care of patients. The use of data bases has reduced the influence of major text books that presented dogma. An average physician now has raw data at hand. Computer data bases are nonjudgmental as they just report the author's results and potentially biased conclusions. To recreate dogma, consensus statements on various treatment options have now become vogue. The lesson for the army is clear.

The other use of technology is virtual reality in training of use instruments, such as endoscopes, in surgery. This allows residents to develop eye, hand coordination prior to their first case. This technology has no downside. Virtual reality is starting to be used to train physicians in complex patient management. However, the army is taking the lead in the area. At a recent

medical virtual reality symposium, two of three examples were army funded academic effects including a combat casualty virtual reality model.

IV. Continuing medical education:

Health care, at least to now, is not organized on a national scale in the United States. Each physician, hospital, and university have self-determined continuing medical educational goals. Although, continuing medical education is required for relicensure, the nature and course content are, with a few exceptions, completely at the discretion of the individual physician.

Education is expensive. Prior to discussing continuing medical education, a brief review of economics help explain the current system. The pharmaceutical industry has heavily subsidized medical education as a mechanism to both increase awareness of various conditions and to promote specific pharmaceutical products. The total expenditure may exceed \$5,000 per physician or 2.5 billion dollars. Although most of this money is spent without central goals, it allows major experiments in this area. Health care reforms, influenced by managed care, may start the process of centralized goals, with the paradoxical effect of insufficient funding for continuing medical education. If physician choice on pharmaceutical products is limited, the pharmaceutical companies may decrease their expenditures in this area.

The inability to remove physicians from work areas for retraining have led to redistribute teachers both electronically and physically. Commonly, guest lecturers by visiting professors and experts are provided via hospitals to physicians. Sale representatives will wait for hours to demonstrate to physicians fine points of new surgical equipment or deliver the latest in medical papers. This approach has obviously worked to encourage the use of novel expensive technology but has drawbacks. First the cost of transporting experts around the country is expensive, they are usually well reimbursed by a pharmaceutical company. They also tend to speak on what is new and exciting rather than the most cost effective solutions to problems at hand.

The electronic technologies include teleconferencing and on-line access to medical information data bases. Remote video is used when the economics of scale don't support a lecture. Rural areas are often served by such systems. Electronic data bases are commonly used by most physicians; this tool, as described previously, is introduced during their in-hospital training.

V. Major differences between medical and army education:

Most medical education is based on facts whether they are based on science or observational experience. Judgment is taught relative to patient management. To my knowledge no medical school or post-graduate course teaches people management or leadership skills. Basic human resource concepts, such as performance reviews, are never practiced by physicians on nurses as the latter are employed by a hospital not the physician. Physicians are seldom graded on performance and peer review organizations have been successfully attacked by targeted physicians on anti-trust "restraint-of-trade" grounds. Physicians also work in a logistic worry-free environment. There are seldom, if ever, limitations of medications, hospital beds, or high-tech equipment. In fact, most physicians do not know their cost or have any knowledge of their supply.

Army education, on the other hand, is organized, formal and eventually leads successful students to command more complex situations. Army doctrine training is uniform. Army commanders are responsible for all facets of their command, including logistics, personnel (two areas in which physicians are not trained).

VI. Conclusions:

Medical education offers two major technology application lessons for the army. The first is that information data bases are a powerful, easy to use tool to teach in an ongoing fashion. The downside is if the data is not somehow put in context, doctrines may be compromised.

The second lesson is that electronically distributed education is possible. Although this may decrease the "rite of passage" at a school house, it provides an opportunity for soldiers at distant bases to participate in advanced courses. In view of future downsizing and limited personnel, this may be a cost-effective solution to some courses.

APPENDIX G

CGSOC “CLUSTERS”

Leavenworth "Clusters"

This is the results of a quick and obviously inaccurate look at the station of origin of the Class of 1994 at Fort Leavenworth. I have divided the group into some geographic areas that are pretty arbitrary on my part. As an example, students from Fort Benning, Fort Stewart, Fort Gillem, and Fort McPherson are all classified as the "Georgia" cluster.

Baltimore-12

Northern Virginia/D.C.-104

Germany-95

Central Texas-30

Hawaii/Korea-27

Central Colorado-17

Georgia-42

Fort Bragg-44

Fort Huachuca-13

Fort Irwin-18

Fort Knox-13

Fort Leavenworth-65

Coastal Virginia-29

Fort Lewis-11

Alabama-26

Fort Polk-17

West Point-61

**There are many "onesies and twosies" scattered all over the world
not clustered.**

APPENDIX H

AN ANALYSIS OF THE BROOKS ACT



DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
3809 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6188

REPLY TO
ATTENTION OF

August 23, 1994

Information Technology Laboratory

Allen F. Grum, PhD, PE
Chairman, Industrial & Systems Engineering
Mercer School of Engineering
1400 Coleman Avenue
Macon, Georgia 31207

Dear Dr. Grum,

Thank you for the opportunity to assist in your study, and the confidence reflected in your request. The acquisition of automation/communication technology is closely managed at all levels and, it appears that, as it becomes more pervasive in industry and society, the bureaucracy makes it even more difficult. Enclosure 1 provides an overview of the current level of technology management in the federal government. Since technology management issues involve the IM Office, Contracting, Office of Counsel and Audit, representatives from these offices worked together to prepare the answers.

There is a bias against leasing automation and communications technology (AR 25-1, paragraph 2-8) with some specific exceptions. The spirit of the regulation seems to put the time limit at two years, which may be as long as you need. It also allows leasing if the equipment is "approaching technological obsolescence". In today's technology, micro computers are definitely obsolete two years after they are manufactured. The other issue is, however, that leasing must be the lowest life cycle cost alternative. Today's marketplace reality is that leasing for a relatively long period of time would have a substantially greater life cycle cost than purchase since there is no market or salvage value for micros after 10-12 months.

A service contract that furnishes hardware and maintenance over a defined period, without transferring title to the user, is a lease. This type of contract would be subject to the same restrictions and regulations imposed on the lease of any FIP hardware and software. It appears that the most viable and probably the most economical approach to obtaining the required equipment, would be to enter into a supply contract by issuing a delivery order under one of DOD's Indefinite Delivery/Indefinite Quantity contracts.

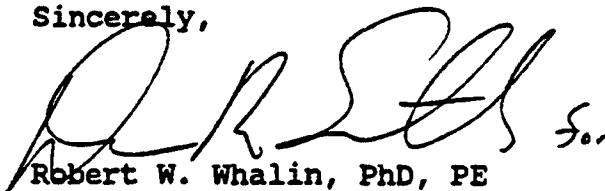
These contracts cover the level of technology that you require. Maintenance can usually be obtained as a separate line item under the same delivery order, or you could take the same approach to

maintenance that we do and not buy it. We have found that stand-by PC maintenance is expensive compared to the actual need. In addition, some of the warranties are now written for extended periods.

Government computers cannot be sold or given to individual students. However, under the Federal Property Administrative Services Act, as amended, 40 USC 471 et seq., and its implementing regulations, such property may be transferred from one agency and/or command to another. A procedure could possibly be set up to transfer the particular computer assigned to the student to his command upon completion of the course.

We will be pleased to provide any additional information that will assist you in your analysis. Our point of contact at the Waterways Experiment Station is Mr. H. Murray Huffman at telephone number 601-634-3661.

Sincerely,



Robert W. Whalin, PhD, PE
Director

Enclosure

Technology Management in the Federal Government An Overview

In 1965 the Congress gave the GSA sole oversight authority over the acquisition of Information Technology for the Executive Branch of the Federal government in PL 89-306. Two significant things which subsequently happened were: (1) The GSA Regulation known as the Federal Information Resource Management Regulation (FIRMR) which describes the planning, approval, contracting and management of Federal Information Processing (FIP) resources, and (2) the delegation of FIP resource management responsibility through a technology stovepipe vs. command channels. The person in each agency to whom these responsibilities are delegated is known as the Agency's Designated Senior Official (DSO) for Information Resource Management.

The FIRMR instructions are extensive and specific. To give you an idea of the high emphasis on FIP acquisition, it is explicitly stated in the FIRMR that, when there is a conflict between the FAR or DFAR and the FIRMR, the FIRMR takes precedence. The definition of FIP resources as shown in part 201-4.001 of the FIRMR is provided as an attachment to this paper.

The FIRMR goes on to exempt equipment used for intelligence/national security activities (Warner amendment), television, sonar, radar, and radio. Just to make sure there is not even the slightest loophole, however, it makes the point that cellular telephones (technically radio transceivers) are NOT exempt and are covered by the FIRMR. Since almost all technology is covered in the above definitions, it would be reasonable to assume that this would apply only to "significant" dollar value acquisitions. This assumption would, however, be wrong from both the specific language of the FIRMR as well as recent case studies.

The DSO and the people lower in the technology stovepipe who get further delegation have the responsibility to assure that the procedures described in the FIRMR are followed in their respective organizations. These people then give a Delegation of Procurement Authority (DPA) to the Contracting Officer who, in turn, acquires the required FIP. Contracting for FIP without a valid DPA places the Organization's FIP procurement authority as well as the organization's Contracting Warrant and the specific contract(s) in jeopardy.

In addition to these management controls, the GSA, with enthusiastic support from Congress, set up a kind of Technology Supreme Court known as the Board of Contract Appeals (GSBCA) to adjudicate procedural disputes between government agencies and the vendor community. This is a very powerful, very conservative board which will not hesitate to make decisions having devastating impacts on government agencies. As an example, a firm in the greater DC area, C.A.C.I., was given a government

contract for work which delivered a FIP resource. After the work had begun, another vendor protested that the FIRMR procedures had not been properly followed. After a significant period of time (during which C.A.C.I. continued to work), the protest escalated to the GSBCA which ruled that in the absence of a valid Delegation of Procurement Authority (the result of properly followed FIRMR procedures), there is no contract. There were no contractual rights or obligations on the contractor or government side. As you can imagine, this created substantial problems all around.

The purpose of providing this information is to help establish the perspective that, for whatever reason, the Congress has, through public laws and procedures, made it clear that technology is a non-routine government resource and must be managed very closely. There are many of us at the operating level who see this as more restrictive than necessary. In fact, an original component of the National Performance Review was to reform the process of acquiring FIP resources. There was a lot of noise and activity, but when the dust settled, nothing much had changed. It appeared that the Congress told the administration to go sit in the corner on this issue and made it stick. The power behind this has traditionally been the Chairman of the House Committee on Government Operations; previously Jack Brooks, currently Congressman John Conyers. While substantial changes in this area would be welcome, knowledgeable federal officials are not optimistic they will happen.

In defense of the policies and procedures put in place to manage the use of technology in the government, a major underlying objective is to force agency recognition of the technology issues beyond acquisition. Technology, especially with the active support of vendor propaganda, can easily seduce the unwary into thinking, "Just buy a product and all of your problems will be solved". It is easy to forget things like strategic and tactical technology planning, adherence to industry standards, separating "needs" from "wants", looking at total life cycle costs vs. initial acquisition costs, dealing with support issues, assuring immediate and long-term interoperability, etc. The principles coming out of the FIRMR are intended to force the agencies to address all of these issues. Unfortunately, since across the federal government, there is uneven and, at times, even arbitrary application of the FIRMR, more energy may be spent trying to circumvent the rules than addressing these important issues.

While the FIRMR has some room for interpretation, there may not be many remedies to mitigate a conservative approach. Because of the high profile of FIP acquisition, it is probable that the conservative approach will always be supported by higher levels in the organization in question. This is especially true since, in general, the command channels have no direct authority for FIP acquisition.

FIP Resources as Defined in Part 201-4.001 of the FIRMR

"Automatic Data Processing Equipment as defined in PL 99-500 and set out in paragraphs (a) and (b);

(a) Any equipment or interconnected system or subsystems of equipment that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception, of data or information -

-
(1) by a Federal Agency, or
(2) under a contract with the Federal Agency which --
(i) requires the use of such equipment, or
(ii) requires the performance of a service or the furnishing of a product which is performed or produced making significant use of such equipment.

(b) Such term include --
(1) Computers;
(2) Ancillary equipment;
(3) Software, firmware, and similar procedures;
(4) Services, including support services; and
(5) Related resources as defined by regulations issued by the Administrator for General Services.

(c) The term, FIP resources, includes FIP equipment, software, services, support services, maintenance, related supplies, and systems. These terms are limited by paragraphs (a) and (b) of the definition of FIP resources and are defined as follows:

(d) FIP equipment means any equipment or interconnected system or subsystems of equipment used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information.

(e) FIP maintenance means those examination, testing, repair, or part replacement functions performed on FIP equipment or software.

(f) FIP related supplies means any consumable item designed specifically for use with FIP equipment, software, services, or support services.

(g) FIP services means any service, other than FIP support services, performed or furnished by using FIP equipment or software.

(h) FIP software means any software, including firmware, specifically designed to make use of and extend the capabilities of FIP equipment.

(i) FIP support services means any commercial non-personal services, including FIP maintenance, used in support of FIP equipment, software, or services.

(j) FIP system means any organized combination of FIP equipment, software, services, support services, or related supplies."

APPENDIX I

GLOSSARY

GLOSSARY

ABA	American Bar Association
ACR	Armored Cavalry Regiment
ACT	Adaptive Control of Thought
AGR	Active Guard and Reserve
ALMC	Army Logistics Management College
ARI	Army Research Institute
ASB	Army Science Board
BAST	Board of Army Science and Technology (National Academy of Sciences)
BRAC	Base Realignment and Closure
CAS ³	Combined Arms and Services Staff School
CBT	Computer-Based Training
CGSOC	Command and General Staff Officer Course
CLE	Continuing Legal Education
COFT	Conduct of Fire Trainer
CSA	Chief of Staff, Army
DIS	Distributive Interactive Simulation
DLI	Defense Language Institute
DoD	Department of Defense
DoDPI	DoD Polygraphic Institute
FM	Field Manual
GED	Graduation Equivalency Diploma
GSA	General Services Administration
HQDA	Headquarters, Department of the Army
IAT	Institute for Academic Technology
ITL	Information Technology Laboratory
IVD	Interactive Video Disk
NCO	Non-Commissioned Officer
NSF	National Science Foundation
NTU	National Technical University
NWC	Naval War College
OSU	Oklahoma State University
POI	Program of Instruction

ROTC	Reserve Officer Training Corps
RIF	Reduction-in-Force
SEN	Satellite Education Network
SIMNET	Simulation Network
TDY	Temporary Duty
TNET	Teletraining Network
TOR	Terms of Reference
TRADOC	Training and Doctrine Command
UMR	University of Missouri at Rolla
USAFA	United States Air Force Academy
WES	Waterways Experiment Station (U.S. Army Engineer)

APPENDIX J

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DOCUMENT 4

Distance Learning: Part of the National Performance Review Initiative on Education

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September 1995

**Institute for Defense Analyses
Alexandria, VA**

IDA DOCUMENT D-1745

DISTANCE LEARNING: PART OF THE
NATIONAL PERFORMANCE REVIEW INITIATIVE ON EDUCATION

Laurna J. Hansen, *Project Leader*
Dale Schoenberger

September 1995

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IDA DOCUMENT D-1745

DISTANCE LEARNING: PART OF THE
NATIONAL PERFORMANCE REVIEW INITIATIVE ON EDUCATION

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INSTITUTE FOR DEFENSE ANALYSES
IDA Central Research Program

PREFACE

This paper has been prepared as part of a Central Research Project on the National Information Infrastructure (NII). The objective of the paper was to enhance IDA's understanding of the activities, organizations, and issues related to the implementation of Distance Learning as part of the NII. With an increased understanding of this issue in particular, and the NII in general, IDA will be in a position to support a sponsor on tasking related to the NII.

Information presented in this paper was derived from reports issued by the Information Infrastructure Task Force (IITF), which are listed in Appendix B, minutes of various IITF committee meetings, Armed Forces Communications and Electronics Association sponsored symposiums, and personal meetings with various government representatives.

The authors thank Mr. Edward Kerlin and Mr. Willard (Chris) Christenson for their careful and thorough review of this document.

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I. INTRODUCTION

A. BACKGROUND

In his technology progress report for economic growth, delivered on February 22, 1993, President Clinton said, "Facilitating the development of a National Information Infrastructure (NII) is a top Administration priority, a necessity for economic growth in the 21st century." Essential ingredients to this initiative are the technologies to create, manipulate, manage, and use information, which is one of the nation's more critical economic resources. The development and employment of these emerging information technologies will form the core of the National Information Infrastructure.

In September 1993 the White House formed the Information Infrastructure Task Force (IITF) to articulate and implement the Clinton administration's vision for the National Information Infrastructure. In May 1994, the Task Force released a report entitled *Putting the Information Infrastructure to Work*. This report is a collection of papers describing how the evolution of the NII can impact seven key areas of interest as defined by the IITF's Committee on Applications & Technology. These seven initial areas were chosen because of their significant, and in some cases immediate, impact on the public through the application of advanced information and communications technologies. One of these seven areas of interest is quality education and lifelong learning for all Americans.

The NII will be the vehicle for improving education and for providing lifelong learning, as well as employee training, throughout America. Through the NII, students of all ages will use multimedia electronic libraries and museums containing text, images, video, music, simulations, and instructional software. The NII will give teachers, students, employers, and instructors access to a great variety of instructional resources and to each other.

Successful implementation of the NII to serve the nation's education and lifelong learning needs will require significant contributions by the private sector, state and local governments, the federal government, and the non-profit sector. The possible contributions and roles of these three sectors are briefly discussed below.

- The private sector's role in providing telecommunications services and applications for education and lifelong learning has been expanding rapidly in recent years, and should continue to do so. The private sector will build the telecommunications infrastructure and must make substantial investments in applications development for education and lifelong learning.
- State and local governments provide over 90 percent of the nation's investment in elementary and secondary education and provide a large percentage of the investment in higher education. Accordingly, they must continue this level of spending for expanding information technology capability throughout the nation's elementary and secondary education infrastructure. In addition, states are in the position to remove regulatory and tariff barriers to NII access in the local communities.
- The federal government has three principal responsibilities. It facilitates the private sector investment in infrastructure and applications for education and lifelong learning by creating incentives; removing regulatory barriers; establishing standards; supporting research, evaluation, and prototype development; developing visionary benchmark applications; and providing assistance to the education and training communities. It communicates a vision for the education, training, and lifelong learning uses of the NII. And, most importantly, the federal government must promote access for all citizens to the resources of the NII.

A key enabling service that will support the education initiative will be digital libraries—also one of the seven initial areas of interest that the administration is considering for development through the application of advanced information technology. Digital libraries will provide the ability to create information resources that allow access to electronic documents. Access to publications in digital format via the NII supports the goal of the Clinton administration of providing education on a lifelong basis.

The initiative to improve education and provide citizens with the capability of lifelong learning commits the government to promote the use of advanced information technology as a tool to develop a quality educational process. Part of the education initiative involves establishing an infrastructure that supports distance learning, which is the focus of this paper.

B. DISTANCE LEARNING

Distance learning is a general term used to cover the broad range of teaching and learning events in which the student is separated from the instructor, or other students, by distance and/or time.¹ It includes such scenarios as computers in the classroom or workplace, local area networks on a college campus, remote training, and access to educational opportunities from the home.

Through the implementation of the NII, distance learning can take the very simple form of home computer access to an on-line educational service, or the highly complex form of interactive multimedia and videoconferencing. Interactive, high performance uses of technology, such as networked teams collaborating to solve real-world problems, retrieving information from electronic libraries, and performing scientific experiments in simulated environments, are indeed the ambitious goals of distance learning that can be achieved through the development and implementation of the NII.

By employing advanced information and telecommunications technologies, organizations can provide new and enriched training scenarios. The applicability of these new technologies for distance learning will most likely depend on where the learner is located—at home, in workplace training, or at a training center. In general, the home office has the fewest assets, especially advanced information technology assets, while a centralized training center can provide very powerful multimedia and telecommunications equipment. The work place training environment is equipped somewhere in between.

When organizations are developing remote training programs, they must consider where the training will be located and the type of telecommunications and computer assets that will be available. Also, the training developers need to keep in mind that some technological or telecommunications configurations provide more effective solutions to a certain training problem than others.

From the Department of Defense perspective, distance learning or remote training refers to any type of training that occurs through a distributive environment. For instance, providing training from a central hub location to military members at various permanent duty stations at the same time constitutes remote training.

¹ Throughout this paper the terms *distance learning*, *distance education*, and *remote training* are used interchangeably.

A prime example of remote training is the dual simulation training program for selected units of the US Army National Guard. This program is supported by a distributed software training system that was developed by the Institute for Defense Analyses using the Janus computer model. Janus is a combat simulation with a long history of applications in the field of training and analysis.

II. GOALS AND OBJECTIVES OF DISTANCE LEARNING

A. THE NATIONAL PERFORMANCE REVIEW

The National Performance Review (NPR) was created in March 1993 when President Clinton requested that Vice President Gore lead an intensive, 6-month study of the federal government. In September 1993 the NPR released its report. One element that the NPR focused on was the utilization of advanced information technology to improve such areas as health care, government services, and education.

The NPR envisions that the NII can take students, workers, teachers, and private citizens beyond the limits of traditional learning environments, offering them greater access to a variety of instructional materials from a wealth of sources. The NII will provide access to a great variety of instructional resources and will allow students access to their peers throughout the country. It will give educators and managers new tools for improving the operations and productivity of their institutions. Workplaces will become lifelong learning environments, supporting larger numbers of high skill, high wage jobs.

One key advantage of integrating information technology in schools may be the opportunity for innovation. With schools and universities increasingly connected through the NII, teachers will be able to use computers in new and creative ways. *When [computers are] properly integrated into the classroom, students become active learners instead of passive sitters, test takers, and clock watchers. They are inspired to excel and to become involved with the learning process, not only for today, but for life.*¹

Of course, these benefits depend upon several factors, including the instructional methods used, the quality of the applications, the availability of professional development for educators, the accessibility of instructional materials, and the presence of a technical support staff. Several state-sponsored prototype programs, in after-action reports, have cited the importance of having good technical support available to the schools. These

¹ *Putting the Information Infrastructure to Work*, report released by the IITF Committee on Applications & Technology, May 1994.

same reports have highlighted the importance of institutionalizing this training process, through implementation and practice, in order to fully achieve the benefits of advanced information technology.

B. DEPARTMENT OF DEFENSE

The Department of Defense is focusing on new ways to train and maintain readiness in the face of reduced defense budgets. Two areas of concentration are the use of distributed modeling and simulation (M&S), and the use of distributed networking to provide the traditional schoolhouse training. Both techniques increasingly rely on advanced information technology and broadband networks to provide training to military members at their permanent duty stations instead of at a centralized training center.

When implementing a distributed training environment the DoD should keep in mind that participants working at their permanent duty stations may be easily distracted from training exercises by their daily work routine. Also, it is obvious that some unit training objectives can be accomplished only through troop deployment exercises. In the end, the customers' (or users') needs and requirements will influence the feasibility of using a distributed training process. However, as deployment costs rise and information technology improves, the military is expected to increase its use of distributed training techniques.

The Department of Defense is developing and implementing a network to support distributed interactive simulation (DIS). This technology, which allows dispersed learners to engage in collaborative problem-solving activities in real time, is now ready for use by schools and workplaces outside of the defense sector.

The Department of Defense is involved in providing lifelong education and training to hundreds of thousands of military personnel. It also supports Research and Development (R&D) for education and training and is expected to transfer knowledge and software to schools and non-Defense workplaces under its Dual-Use and Technology Reinvestment programs. The Department of Defense Dependent School System is expected to serve as a testbed for new applications.

The Department of Defense is also conducting pilot programs and advanced technology demonstrations in the area of providing distance learning, or remote training, to the military forces. These initiatives are being explored from the perspective of reducing training costs by providing training on a decentralized basis instead of a centralized basis. The standard training programs of the past have assembled military

personnel in a central school location for training, or instruction, on a particular curriculum. This training format, besides being very costly, caused military participants to be away from their permanent duty stations for an extended period of time.

The DoD is also actively involved in developing information technology standards. To achieve standardization the Department of Defense has a strategy that entails championing DoD's requirements in commercial standards, utilizing to the maximum extent possible standards-based commercial off-the-shelf (COTS) products, and developing guidance for the military services that is based on commercial standards.

III. ORGANIZATIONAL ACTIVITIES

The creation of an advanced information infrastructure that can support an educational environment on a national basis, as proposed by the National Performance Review (NPR), requires solutions to many technical, legal, security, financial, and regulatory barriers. Also, widespread adoption and use of a variety of technical standards for communications, information processing, and security are necessary. To overcome these barriers and to develop and implement standards, numerous organizations have instigated education-related activities. Some of the organizations working on educational issues are described below.

A. DEPARTMENT OF EDUCATION

The Department of Education (DoED) advocates for the needs of all learners in the development of the NII. The Department is the principal source of federal support for distance learning, via the Star Schools Program.¹ The Department also supports applications and programming development, pilot projects, teacher networks, research, and planning grants to states and districts.

The Star Schools Program provides support for distance learning through the funding of telecommunications partnerships. These partnerships include local school districts, state departments of education, public broadcasting entities, and other organizations. Programs produced and offered by grantees include formally structured courses, instructional modules, and video "field trips," and are available in schools in one or more states. Course offerings include hands-on science and mathematics, workplace skills, and six foreign languages. Grantees also offer teacher training programs, parenting seminars, and other services to as many as 500 schools at a time. A variety of telecommunications technologies are being employed to establish one-way and two-way communication. These technologies include satellite communications, cable, fiber optics, microcomputers, digital compression, interactive videodiscs, facsimile machines, and the ordinary telephone.

¹ The Star Schools Program provides quality, cost-effective instruction through distance education. It is funded by grants from the U.S. Department of Education.

The Department of Education has a Gopher² server which points to or contains educational research information, such as the AskERIC service and information from sources such as CNN, Academy One, and the Educational Testing Service. AskERIC is a service that enables teachers and other educators to ask questions via electronic mail and have their questions answered by researchers of the Educational Resources Information Center (ERIC) clearinghouses. ERIC is a nationwide network of clearinghouses that produce education databases, prepare over 200 publications each year, and respond annually to approximately 100,000 information requests. ERIC resources are available throughout the world on-line (via the Internet and on many commercial services such as Dialog, America Online, CompuServe, and GTE), as well as in print, CD-ROM and microfiche.

B. DEPARTMENT OF ENERGY

The Department of Energy (DoE) is developing advanced information technologies, such as high performance computing, high speed networking, and high capacity data storage and data bases. The Department is developing computing and communication applications that support new learning techniques and take advantage of the regional presence and capabilities of the Department's laboratories. Emphasis is placed on reaching a broad range of students, including women and underrepresented minorities. Another key technology initiative is the development of digital libraries that will provide users at the various DoE laboratories speedy and economical access to Energy information over an advanced information network.

The National Education Supercomputer (NES) program provides access to a Cray X-MP/18 computer donated to the DoE by Cray Research, Inc. It is located at the National Energy Research Supercomputer Center (NERSC), Lawrence Livermore National Laboratory. The NES is available for on-line use, through dial-up modems, by elementary and high school students and at selected community colleges.

² Gopher service is an information access tool that is used over the Internet. It allows a local computer to access different host computers being maintained by other agencies or organizations and to search data bases for information.

C. DEPARTMENT OF COMMERCE

The Department of Commerce provides support and direct funding for telecommunications infrastructure planning and development, and plans to support improvements in workplace training using the NII. The Department's National Institute of Standards and Technology (NIST) supports standards development, which is critical to providing ubiquitous access to the NII.

D. NATIONAL SCIENCE FOUNDATION

In fiscal year 1995 the National Science Foundation (NSF) will support pilot projects to demonstrate applications of intelligent systems in teacher training and lifelong education. The NSF also will develop cross-directorate demonstration projects that explore major efforts to reform interdisciplinary curricula based on technology-enabled science methodology, and will initiate joint agency demonstration projects to provide models for education reform or lifelong learning.

The main NSF activities in support of the education initiative include programs in the Education & Human Resources (EHR) Directorate and the Computer and Information Science and Engineering Directorate (CISE). For EHR, the primary emphases are understanding the costs and benefits of integrating computer networking into the educational infrastructure and developing testbeds and models of network access in support of science and mathematics education at various levels. EHR programs also support research in advanced information and computer technologies for innovation in education. CISE programs focus more on undergraduate and graduate education and research. However, there is increasing emphasis on supporting new research in the development of applications for the general public, as well as for computing sciences, that can be accessed through the NII.

The National Science Foundation also funds the collaborative visualization (CoVis) project. CoVis is a scientific visualization application that uses collaborative hardware and software tools, including desktop videoconferencing. It allows high school students and teachers to study environmental and atmospheric science with their peers and scientists from around the nation. CoVis aims to bring additional knowledge to students as they work on projects related to science, mathematics and technology.

E. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration (NASA) continues to build on its High Performance Computing and Communications (HPCC) program, its aeronautics and space science research and engineering missions, and its existing education outreach infrastructure to support mathematics, science, and engineering education. This program consists of pilot projects at seven NASA Centers involving many of the local schools and school districts.

F. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

The Department of Housing and Urban Development (HUD) is providing distance learning, policy announcements, and briefings to its staff and to client agencies through satellite downlinks to 55 field offices, as part of the HUD Television Network (HTN). The HTN was implemented in response to a recommendation from the Secretary's Task Force on Departmental Training that technology be used to deliver training and information to HUD staff and client agencies on a nationwide basis. In conjunction with this broadcast capability, HUD has installed a student response keypad system which supports interactive distance learning

This technology gives HUD the ability, on a nationwide basis, to deliver HUD developed training; broadcast information about HUD's programs to a wide audience; and capture satellite broadcasts sponsored by professional organizations, universities and other government entities. With these capabilities HUD can train more staff at lower cost, and more efficiently deliver information about its programs to citizens and HUD's programmatic partners at the local level.

G. DEFENSE INFORMATION SYSTEMS AGENCY

The Defense Information Systems Agency (DISA) is the DoD agency responsible for developing the architecture and strategy for implementing the wideband networks of the Defense Information Infrastructure (DII).³ These high data rate networks, operating at data rates of 45 Mbps and higher, will provide the bandwidth required to support the various education and training forums that occur throughout the military services on a routine basis.

³ The Defense Information Infrastructure is a subset of the National Information Infrastructure.

Besides providing the high bandwidth capacity telecommunications networks, such as the Defense Information Systems Network (DISN), DISA is also actively engaged in developing telecommunications standards. The development and promulgation of standards is critical to ensure interoperability between the numerous operating systems and operating platforms that exist throughout the DoD.

H. ADVANCED RESEARCH PROJECTS AGENCY

The Education and Training Initiative of the Advanced Research Projects Agency (ARPA) is designed to dovetail key DoD needs for training and education with the critical research and technology development required by other national education initiatives. Under this program, selected clusters of community assets, including local military bases, universities, libraries, school districts, and businesses, will be networked with shared assets, such as digital curriculum libraries and educational tools. Several types of tools will be developed so that teachers can take advantage of multimedia, virtual labs, and simulation to obtain critically needed training in technology-related skills. The goal of these pilot programs is to establish an information infrastructure in support of education that will persist beyond the life of these programs.

ARPA is also developing and demonstrating distributed simulations and training programs. The objective of this program, as defined by ARPA, is to double or triple unit training effectiveness compared with that of 1991 through the application of advanced technologies. The simulators and training programs are being developed in concert with the networking and distance delivery attributes of the National Information Infrastructure.

I. INFORMATION INFRASTRUCTURE TASK FORCE

The Information Infrastructure Task Force (IITF) consists of high-level representatives of the federal agencies that play a major role in the development and application of information and telecommunications technologies. It is presently chaired by the the Secretary of Commerce. The primary mission of the IITF is to articulate and implement the Clinton administration's vision for the National Information Infrastructure.

The IITF holds frequent public forums to discuss the issues and areas of interest associated with the NII. These meetings are held to allow the public, private, and government sectors to better understand the issues and barriers pertaining to the

development and implementation of the NII. They also provide a structure for determining how to resolve issues and how to break down barriers. During several of these meetings public school administrators have presented overviews of pilot programs being conducted in their school districts that incorporate advanced information technology to support the educational process.

J. TENNESSEE VALLEY AUTHORITY

The Tennessee Valley Authority (TVA) Education and Skills Development Department, along with the Tennessee State Department of Education, established a five-county computerized learning network to enhance basic skills and adult literacy education. Each network consists of "learning labs" established in schools, businesses, and human service agencies, linked by phone lines to a host computer. The program utilizes a computer-based educational assessment and instructional system that diagnoses, prescribes and presents instruction on a comprehensive primary curriculum. This curriculum will support the educational process for all students, but is aimed primarily at the educational development of at-risk students, illiterate adults, and persons lacking basic skills.

K. PUBLIC SECTOR

The public sector has numerous pilot programs, grant sponsored programs, and demonstration projects underway in the field of education. Almost every state has sponsored activity in this area. In some instances these activities date back to the late 1960s, but most activities originated within the past five years. Funding for these educational initiatives come from a variety of sponsors, such as the U.S. Department of Education, state departments of education, state legislatures, federal grants, state universities, and private corporations.

Although numerous educational initiatives are underway throughout the U.S. school systems, few of these initiatives are actually capitalizing on the use of advanced information technology. Most of these projects rely on the use of telephones, facsimile machines, one-way communications, and outdated and unsupported automation tools. Several factors contribute to this dilemma: a lack of consistent funding, a need for more telecommunications specialists and telecommunications consultants for the schools involved, a lack of facilitator training, and a lack of comprehensive information on the selection of technology components for these projects. A few of the state initiatives are described below.

The Iowa Communications Network (ICN) currently includes over 2,600 miles of fiber-optic cable that links together 15 regional centers, 3 regent universities, and Iowa Public Television. The ICN currently provides 63 college courses via distance learning. Also workshops and seminars for educators and town meetings are conducted over the ICN. It is the goal of the State Administration to ultimately link up every college and high school via the ICN.

In Alaska, the State Department of Education has developed a network of computers and audio equipment that permits computer screen images and sound to be transmitted over standard long-distance telephone circuits. The network permits instructors to interact with many students located at various remote sites, and enables students to interact with each other in a multipoint-to-multipoint configuration. The network supports interactive communication among all connected sites. Courses are taught from a central hub in Kotzebue or from campuses at Fairbanks, Anchorage, or Juneau.

In Ohio, a number of local and statewide organizations are working to increase access to networks for educational use. These include the State of Ohio Network for Integrated Communications, which provides connectivity for all state agencies; the Ohio Educational Computer Network, charged with developing K-12 educational links; Cleveland FreeNet, a regional network; and the Ohio Academic Resources Network, which links colleges and universities.

The County of Anne Arundel, Maryland, in collaboration with three cable companies in the county, has established studios in 12 high schools for the delivery of two-way video and two-way audio broadcasts. A projection screen in the classroom provides a large image for the receiving class, and facsimile machines permit the transmission of information between locations. Each location has a classroom dedicated to interactive cable television, allowing the master teachers to teach from their schools. This system allows teachers to instruct from their homes and enables students who are at home to watch their classes on cable television.

The Global Schoolhouse (GSH), a project being developed and implemented through the California Regional Education Network (CalREN), is a nationally recognized K-12 pilot project that uses information technology to join classrooms and teachers around the state and around the country. Teachers work with technology experts to

develop specialized curricula using the powerful learning tools available through computer software and networking technology. Students collaborate to investigate global scientific issues using the tools and curricular materials. This project will enable significant information access to urban and rural disadvantaged and minority students of all ages

The Public Broadcasting Service (PBS) offers a distance learning program, "Going the Distance," which has signed up 49 colleges to participate in a nationwide effort to coordinate adult telecourse offerings. The colleges will list their courses in a PBS catalogue and assign faculty to be responsible for answering students' questions and grading assignments.

IV. BARRIERS TO IMPLEMENTING DISTANCE LEARNING

A. SECURITY

The absence of security management and user authentication are two of the most challenging issues related to distributed networks and to applications running on these networks. Security management ensures that no one can tamper with, or intercept information transmitted through, the network. User authentication verifies the identities of parties on both sides of an electronic transaction. Customers, or users, on distributed networks are reluctant to exchange sensitive information.

The NII will need to accommodate adequate security systems to protect privacy, the confidentiality of sensitive information, and intellectual property rights. The network must also accommodate varying levels of access to resources in education and training settings.

B. CORPORATE CULTURE

While many institutions and businesses have been forced to make advances to regain or maintain their competitiveness, schools' instructional methods have not changed appreciably over the years. School officials still are not convinced that traditional teaching techniques will be enhanced through advanced information technology tools, and they are therefore reluctant to make the enormous investments necessary to obtain them.

Fear of change, reluctance to collaborate, and unwillingness to use new applications and systems regularly also hinder improvements of the educational process. To realize the full benefits of new applications and the NII, users must be willing to change their work habits and life styles, and organizations must be willing to change their traditional ways of doing business.

C. TECHNICAL SUPPORT

Frequent technical problems encountered when using computer technology are a source of irritation, frustration, and discouragement for users. For teachers and students who have limited skills, these inconveniences may mean the difference between no

change and quick adoption. Lack of responsive technical support is a real detriment to employing information technology in any forum. A help desk set up for network users will serve to minimize this issue.

D. COST

Incorporating telecommunications networks and new applications into schools requires a large initial capital investment. Schools must be completely rewired to provide classrooms with modem lines, a basic requirement for using the NII. In addition, they have to purchase and install new computer hardware, multimedia devices, and software systems. For most schools, this type of investment is impossible within their current budgets.

School administrators are particularly concerned about the day-to-day expense of using on-line information services. The current telephone line charges for using these services can be prohibitive for schools. Additionally, since overall cost is based on use, and since use varies per person, it is difficult to know in advance how much to budget and whether funding will be sustained.

In the workplace the application of information technology to training is more extensive and technologically advanced than in educational environments, yet it lags well behind what is needed and available. Small firms, those with 100 employees or less, provide about 35 percent of total U.S. employment. These firms lack the expertise to provide in-house training. They also lack the volume of people needing training at one time to justify the cost of contracting-out for training. Larger firms are more likely to provide training than smaller ones, but the training they provide is mostly limited to highly skilled technicians and managers. The lower the level of skills possessed, the less likely the worker is to receive training from any source.¹

E. PERFORMANCE ASSESSMENT

When organizations conduct economic performance assessments to determine the viability of investing in NII applications, they often fail to understand or even consider the potential long-term advantages. The costs of designing and implementing a new information management system are usually fixed and easy to determine at the outset. The benefits, however, often accrue based on how much an organization uses the

¹ *Breaking the Barriers to the National Information Infrastructure*, a conference report by the Council on Competitiveness, December 1994.

application, and how much it integrates those applications with new ways of doing work. Difficulty in measuring the benefits against the costs of new applications makes the initial investment harder to justify.

Organizations conducting an economic analysis of NII applications should consider more than monetary savings. Improved information management, service to the customer, and employee efficiency are other spillover benefits, though difficult to measure. Excessive concern with immediate cost savings or short-term marginal efficiency gains may cripple an organization's potential for long-term benefits, causing it to decide not to implement information technology applications.

F. EQUITABLE AND UBIQUITOUS ACCESS

Computer technology is unevenly distributed in our schools today when measured by computer density, the ratio of computers to students. Those schools in the top quintile have nine times as many computers as those schools in the bottom quintile. Video technologies such as distance learning equipment, VCRs, and cable TV are more evenly distributed. Schools in rural and poor areas actually have higher densities of these types of equipment. For instance, every school in West Virginia, regardless of its location, has a satellite receive-only dish that provides ready access to televised courses.

A disparity in technology investments also exists between large businesses and small firms which can make only limited investments in training, with or without NII support. In particular, entry level training to facilitate school-to-work transitions remains at the bottom of priority lists. Some of the entry level training needs are being met by electronic home learning. Nonetheless, the situated apprenticeship and basic skills training that could be provided through the NII remain to be developed.

G. AVAILABILITY OF APPLICATIONS

All the capabilities of computer-based instruction and multimedia instruction can be distributed through the NII to schools, workplaces, kiosks, homes, libraries, museums, community centers, and other locations. Yet the infrastructure and applications to support this level of accessibility for education, remote training, and lifelong learning uses have yet to be developed. Until market driven applications are available, education will not realize the full potential of the NII.

H. DIFFICULTY OF USE

Difficulty of use and lack of interoperability frustrate users as they adopt new applications. Application developers must work with users up front to design applications that are specific to users' needs, easy to adopt, and usable with minimal training. Implementation must be as simple as possible so that the changes and new skills required to use the application are perceived to be trivial.

We cite the case of the Val Verde School District in Southern California as an example of what may result when ease of use and interoperability are not taken into consideration when implementing an application.² A school reform plan included placing high performance, multitasking, Unix-based computers on every teacher's desk and additional computers in classrooms for student use. Val Verde discarded its existing system and replaced it with new computers. Unfortunately, the new system was unfamiliar to the teachers and students and was not considered user friendly. As a result of this premature scrapping, teachers and students struggled with steep learning curves, and the school system experienced higher than expected training expenses.

I. REGULATIONS AND STATUTES

Two promising NII applications are customizing educational materials and conducting university classes in one part of the country while students watch and respond via two-way video in another. Both are running into legal and regulatory hurdles.

Uncertainty surrounding the use of intellectual property is a common dilemma caused by unclear guidance on how copyright law applies to the use of electronically transmitted materials. There are also differing state education requirements and uncertainty over who has authority. Generally the authority to regulate education belongs to the states, but in distance learning programs can be delivered electronically across state lines. As things now stand, 50 state jurisdictions, each with its own standards and requirements, can seek to regulate distance learning programs.

It is not clear whether state laws should apply to distance learning, or whether transmitting education across state lines constitutes interstate commerce, potentially making it subject to federal jurisdiction instead of state jurisdiction. Outmoded intellectual property laws and differing state education requirements must be altered for the NII to move forward in the area of distance learning.

² *Breaking the Barriers to the NII, op. cit.*

V. SUMMARY

All the capabilities of computer-based instruction and multimedia instruction can be distributed to schools, workplaces, homes, libraries, museums, and community centers through NII facilities. Yet the infrastructure and applications to support this level of accessibility for education, training, and lifelong learning uses have yet to be fully developed and implemented. Numerous organizations and agencies are expending considerable effort to develop proper strategies, to develop solutions to barriers impeding progress, and to establish collaborative efforts that will expedite development of the NII.

The barriers, in particular, hamper and limit the development of critical information infrastructure applications by the private sector, the prime builder of the NII. All parties involved—government, private, and public—must work together to overcome the barriers that are impeding the full development and implementation of the National Information Infrastructure.

The government needs to develop policies on security, intellectual property rights, and privacy, and the private sector needs to develop applications that support these policies. In addition the private sector needs to develop distance learning tools and open systems that provide interoperable and secure applications.

At the same time the Department of Defense should develop strategies and perform systems assessments to determine the best solution for implementing distance learning activities throughout the Department. Obviously, the issue is not whether the Department of Defense should adopt distance learning, since it has already implemented portions of the distance learning applications. The issue is how the DoD and the DISA will develop and implement a distance learning architecture.

The Institute for Defense Analyses, as an independent third party, can assist the federal government and the Department of Defense in realizing the full potential of advanced information technology to support distance learning. IDA has the expertise to perform economic benefits analyses of alternative solutions for implementing distance learning applications and assessments of required regulatory and statutory changes to support the full implementation of distance learning.

A critical step in the successful implementation of the distance learning initiative is to identify existing or potential barriers that hinder ubiquitous capability. Once the barriers are identified, organizations need to be assigned primary responsibility for overseeing the resolution of relevant issues and implementation of solutions.

With the multitude of organizations involved with the National Information Infrastructure and with the distance learning initiative, the steps outlined above will not be a simple process to accomplish. IDA, as an independent third party, could assist these organizations in identifying barriers to implementing distance learning applications and in developing solutions to removing those barriers based on analytical studies.

APPENDIX A

CHRONOLOGY OF KEY EVENTS

Appendix A

CHRONOLOGY OF KEY EVENTS

February 22, 1993	The Clinton administration issues a report entitled <i>Technology for America's Economic Growth</i> , which states that the development of a National Information Infrastructure is a top administration priority.
March 3, 1993	President Clinton announces a 6-month review of the federal government to be led by Vice President Gore. This becomes known as the National Performance Review.
September 1993	The White House through the Office of Science and Technology Policy establishes the National Information Infrastructure Task Force (IITF). The IITF is to articulate and implement the Administration's vision for the NII.
September 1993	The National Information Infrastructure Testbed (NIIT), an industry led consortium, is formed. The mission of the NIIT is to create new jobs, new business opportunities, and spur the growth of a new information infrastructure industry, by accelerating the development of high performance computing and communications technology.
September 7, 1993	The Report of the National Performance Review, <i>From Red Tape to Results: Creating a Government that Works Better & Costs Less</i> , is released.
September 15, 1993	President Clinton issues Executive Order 12864 to establish within the Commerce Department the United States Advisory Council on the National Information Infrastructure. The Council shall advise the Secretary on matters related to the development of the NII.
September 15, 1993	The IITF report, <i>The National Information Infrastructure: Agenda for Action</i> , is released.
January 1994	The IITF report, <i>What it Takes to Make it Happen: Key Issues for Applications of the National Information Infrastructure</i> , is released.
May 1994	The IITF report <i>Putting the Information Infrastructure to Work</i> is released.
December 1994	A Council On Competitiveness conference report, <i>Breaking the Barriers to the National Information Infrastructure</i> , is released.
March 1995	NIAC report, <i>Common Ground: Fundamental Principles for the National Information Infrastructure</i> , is released.

APPENDIX B
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Appendix B

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APPENDIX C

LIST OF ACRONYMS

Appendix C

LIST OF ACRONYMS

ARPA	Advanced Research Projects Agency
ATD	Advanced Technology Demonstration
CalREN	California Regional Education Network
CD-ROM	Compact Disc Read Only Memory
CISE	Computer and Information Science and Engineering Directorate of DoED
COTS	Commercial off-the-shelf
CoVis	Collaborative Visualization, a program sponsored by NSF
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information Systems Network
DIS	Distributive Interactive Simulation
DoC	Department of Commerce
DoD	Department of Defense
DoE	Department of Energy
DoED	Department of Education
EHR	Education and Human Resources Directorate of the DoED
ERIC	Educational Resources Information Center
GSH	Global Schoolhouse, a program under CalREN
HPCC	High Performance Computing and Communications
ICN	Iowa Communications Network
IITF	Information Infrastructure Task Force
Mbps	Mega Bits Per Second

NASA	National Aeronautical and Space Administration
NES	National Education Supercomputer
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NPR	National Performance Review
NSF	National Science Foundation
PBS	Public Broadcasting Service
R&D	Research and Development
TVA	Tennessee Valley Authority
UC	University of California

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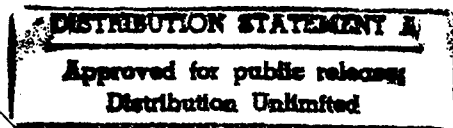
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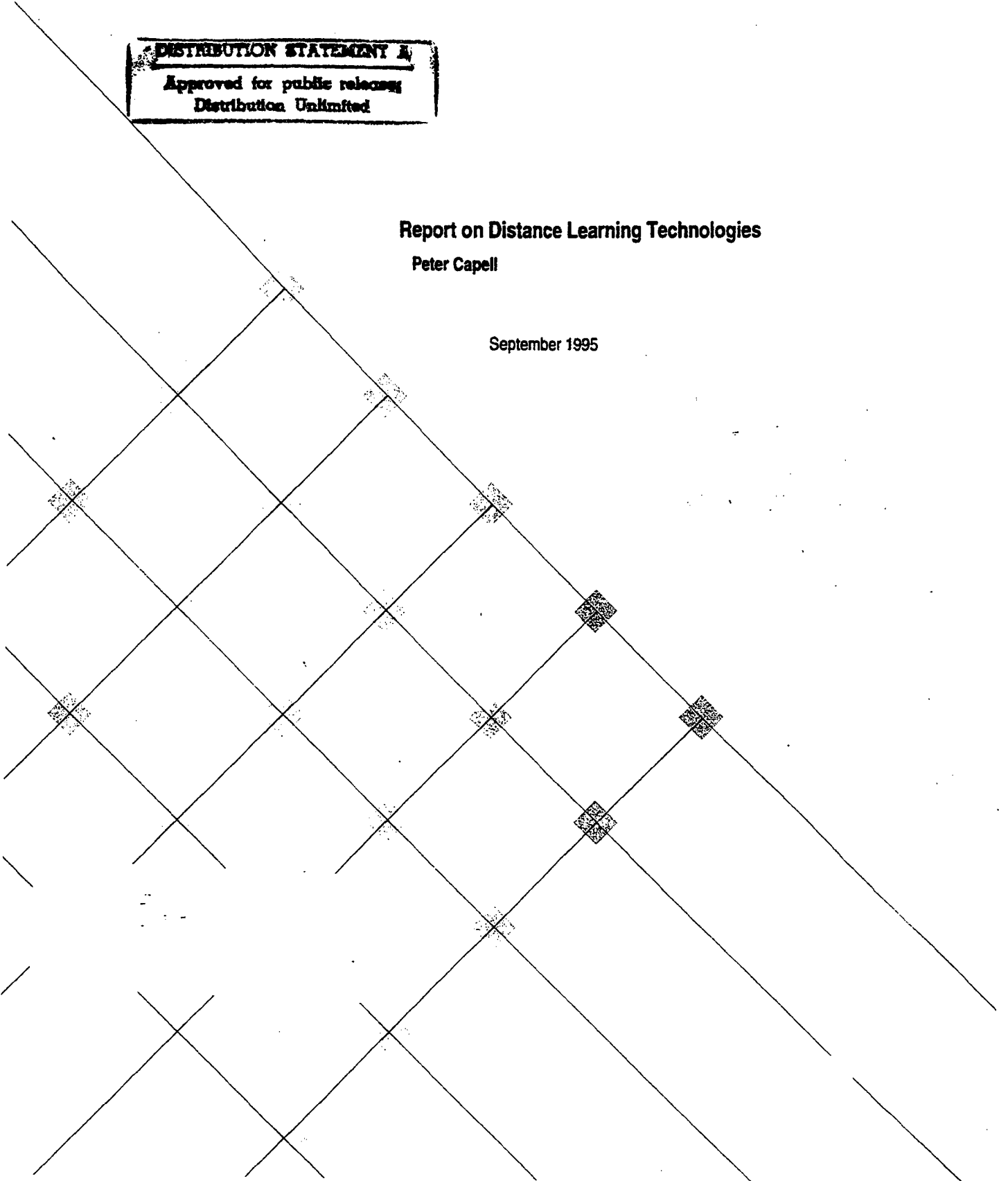
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Report on Distance Learning Technologies



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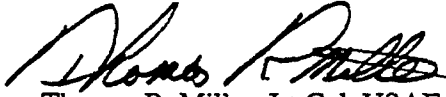
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FOR THE COMMANDER



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Report on Distance Learning Technologies

Abstract: This report provides a wide view of the costs, risks, and benefits associated with instructional technology alternatives. The number and variety of possible paths to learning through this technology have increased markedly in recent years with the advent of interactive multimedia, satellite communications, and the Internet. More than ever before, learning technologies have created new educational possibilities for people and organizations. In this era of increasing financial stringency, we are obligated to examine these new possibilities in light of their obvious advantages: replication of high-quality instruction, lower overall costs, increased quality in educational outcomes, and the ability to provide these benefits over long distances. This report will show that with today's computer-based instructional technology, the question is no longer *whether* to use the technology, but rather *how* to use it.

1 Overview

This report provides a technology-independent rationale for an overall distance-learning strategy, including a compilation of the author's and reviewers' views on distance-learning approaches.

Following an introduction, overview, statement of the objectives of the report, and a presentation of the assumptions guiding the report, Section 1.3, Current Status, describes the current educational and technological decision space that this document addresses. Section 2, A High-Level Look at Core Educational Issues, is a discussion of features that affect learning. My intention in writing this chapter is to provide the reader with a description of certain educational premises used in making determinations about the relative effectiveness of learning systems. Section 3, Computer-Based Multimedia and Related Solutions, summarizes the characteristics of the set of educational technologies described in this report. A large part of this section deals with multimedia and related solutions, because multimedia represents extremes on two fronts: tremendous positive potential for distance learning and high development cost. Additionally, multimedia and related solutions include a superset of the issues for all of the computer-based learning systems that could possibly be deployed. Section 4, A Technology-Specific Analysis, is a detailed review of these technologies relative to their associated management complexity, cost, and learning-effectiveness values. Section 5, Summary, Recommendations, and Conclusions, suggests possible deployment scenarios. Because the list could be voluminous, only a few examples are given as realistic candidates. Appendix A provides one example of the needs of a course development process.

1.1 Objective of the Report

The purpose of this report is to provide sufficient background knowledge of delivery systems to enable sound decisions to be made about the deployment of courses focusing on three lev-

els of student proficiency. I present the systems in this report in consideration of their ease of implementation, cost, educational benefit, and ease-of-fit to today's practices.

1.2 Assumptions

Alongside cost and risk, I will feature educational concerns prominently among the issues that determine the type of delivery solution recommended. Assumptions about the organizations to which this report is addressed are

- A certain amount of instructional infrastructure is already in place.
 - Satellite hardware and system support is readily available for wide-scale transmission of one-way and potentially two-way educational offerings.
 - The existing computer hardware base is composed largely of Intel® microprocessor-based machines, capable of delivering text-based instruction [computer-based training (CBT)].
- The organization is willing to explore the possibility of expanding the existing infrastructure to include technologies capable of interactive multimedia¹ and other advanced computer-based instructional solutions.

1.3 Current Status

Given today's austere budgets and the likelihood of future budget reductions, organizations need to plan for this trend for the foreseeable future. At, say, \$1400 for travel and per diem for each student, the cost of training can become prohibitively expensive. Travel and per diem alone often account for more than half of the cost of a course. For many organizations, reducing these travel and per diem figures has become imperative.

¹. *Multimedia* is defined here as digital audio, video, images, music, text, or animation that is integrated on a computer system.

2 A High-Level Look at Core Educational Issues

There are many possible strategies for distance learning delivery that could support or potentially replace the current state of educational practice. The main issues are educational benefits and costs. The costs of implementing any instructional system, whether computer based or human, are high. There will always be a cost for developing a system, maintaining it, transitioning it to others who will teach it, distributing it, and so on. In this part of the report, I discuss costs and educational benefits in sufficient detail to enable a sound choice to be made among possible system implementations.

2.1 General Learning Factors

The best educational practices must be folded into any distance-learning strategy. While there are many other learning factors, the scope of this report will be limited to an essential few.

2.1.1 Interactivity

Interactivity is a set of measurable instructional qualities such as "time on task," "immediacy of feedback," "learner engagement," and so on. Laurel [Laurel 86] provides the following definition:

Interactive frequency, range, and significance correspond to how often user input is enabled, the range of choices available to users at a given moment in the interaction, and the impact of the user's choices and actions on the whole experience.

In the world of educational technology, interactivity has become a byword for high quality in learning materials. Even though this term is still gaining clearer definition and is sometimes carelessly applied, it is useful in describing a general characteristic important to any effective instructional system—that the learner must be continuously and actively engaged.

2.1.2 Learner Adaptability

Another area of prime instructional concern is the adaptability of the learning system to the individual student. In human terms, this adaptability comes in the form of a tutor. Human tutoring is considered by educational researchers to be among the most effective forms of instruction [Anderson 85]. One reason for this is the tutor's ability to home in on students' misconceptions and provide problems and explanations appropriate to individual needs in real time.

Computer systems that emulate the methods of human tutors are called *intelligent tutoring systems*. These systems are capable of providing all of the interactive features of multimedia in addition to precise commentary on the student's performance and the selection of remediations that are appropriate to an individual student's needs.

2.1.3 Situated Learning

It is well known that learning is enhanced when it takes place in a context that is much like that in which the student will be expected to perform after instruction.² While this may seem obvious to most of us, the idea of situated learning has not traditionally been used in most classroom instruction. The most readily available example of a situated learning experience is a simulation. Flight simulators, for example, are designed to provide the trainee with as close an approximation of actual flight as possible. In theory, with enough refinements, it would be possible to create an instructional system that would permit the immediate assignment of pilots to aircraft upon completion of instruction. While actual flight training always includes time in a real aircraft, it is technologically feasible to avoid this step entirely.

In terms of regular classroom circumstances, however, situated approaches call for ways of mimicking the circumstance in which the students will be expected to use their knowledge. This mimicking can involve role plays or any other teaching device that will reconstruct an experience similar to "real life." Moot court, simulation, and role play are all common teaching methods for situating the learning experience.

2.1.4 Retention

Retention of information is the ability to recall it on demand after instruction. Anything learned decays in the time between the training and application. Recently, technology has opened another door to the possibility of providing these features in the form of on-the-job electronic performance support. Electronic performance support systems (EPSS)³ provide in-context instruction as a job is being performed (see Section 3.5.1). The more practice a student has in a realistic setting, the more likely the knowledge is to "stick." An optimal instructional system would provide highly interactive, realistic (situated) training, preferably in a time frame very close to its actual use in a job or on a project. Further, the optimal training system would be readily accessible, so that any forgotten information or skill training could be revisited on demand.

2.2 The Importance of Bloom's Levels

Bloom's taxonomy [Bloom 56] provides a means of targeting course expectations to potential audiences (GS levels). In this section, I address Bloom's levels in the context of the technologies described in this report.

There are two primary assertions that provide useful guidance in applying Bloom in the technological context:

-
- ² Beginning with the work of David Ausubel in the mid-1970s, educational researchers began to examine the concept of *grounded theory*, the notion that it is important to consider the instructional context as a factor in learning.
 - ³ For a complete military case history on EPSS, see DTIC Document No. AD-A201 401, *Implementing Embedded Training (ET)* [DTIC 88].

1. Computer-based multimedia can be employed for any of the six Bloom's levels of learning.
2. By properly specifying the objectives for a course using Mager's model [Mager 62] for performance objectives and Bloom's levels, reasonably accurate projections about the scope, scheduling, and cost for a multimedia project can be determined.

The second assertion above is essential from a project-management standpoint, because the complexity of the performance objectives will have implications for the technical development of the system. For every interaction specified in the curriculum, there will be a corresponding set of system requirements implied. The first hints at the overall complexity and scope of a computer-based multimedia system will be seen through its objectives, and, depending on Bloom's levels, will imply more or less complexity. For example, after creating a series of training objectives for Bloom's level 4 through 6, based on their descriptions, system designers can ascertain some of the complexity of interactions suggested: how much programming will be needed, what kinds of photos and renderings may be required, whether video will be needed, and so on. This level analysis is still "gut feel;" however, combined with critical path analysis techniques, this kind of estimate is much more meaningful than guesswork alone.

2.3 Consistency of Training

Consistency of training means that once the developer has managed to create a successful training system, there is no degradation from one class to another in terms of instructional quality. The reason for a tight specification of the instructional system is to ensure consistency and high quality in a curriculum used by many instructors. When the objectives are spelled out, the quality of instruction can be measured in terms of the objectives. Even with tight specification, there is often much inconsistency between any two human instructors. One of the positive features of a well-designed, interactive, computer-based training system is consistency of training throughout the life of the subject matter.

2.4 Costs: Time and Money

With technology-based solutions, costs always depend on the complexity of the solution. For example, while a satellite-based course need not require any more time in design and materials than a regular on-site course, it will incur cost for the uplink and added complexity for mailing of materials and remote monitoring of test results. Although these processes can be made efficient, costs related to satellite course delivery will be relatively permanent. With multimedia, there are large costs for planning and development. Lead times are often long (greater than eight months to delivery), and supervision of the development effort is a required and time-consuming activity. With traditional human-based instruction, development and delivery costs are high, especially with necessary travel included.

3 Computer-Based Multimedia and Related Solutions

The following paragraphs describe available technologies that are candidates as distance-learning solutions. I will present a high-level view of instructional technologies as background for a more detailed comparison of each technology against specific criteria related to development and learning factors.

The word *multimedia* has come to include many possible educational delivery strategies. In this document, multimedia is the integration of digital video, audio, text, graphics, or sound (in any combination) in a computer system. Virtually all computer-based training and educational delivery solutions could have multimedia elements associated with them. In the most elementary computer-based training (CBT) systems, the level of interactivity between the user and computer typically consists of a set of fixed responses. A reasonable system response is "Sorry, try again," at which point the student is routed back through a presentation of the initial course materials in the hope that learning will happen on a second or third explanation of the same concept. Even in the worst case, with only text and the limitation of fixed responses, this basic model of instruction has proven to be effective. With the addition of interactive videodisc and graphics, systems of this kind advanced in their variety and diversity, and the term multimedia began to gain prominence.

The following list includes broad categories of the computer-based delivery systems currently available in which some level of multimedia is likely to be a part:

- Hypermedia and Internet-based instruction
- Just-in-time lecture
- Intelligent tutoring
- Commercial off-the-shelf (COTS) training

Multimedia has stepped beyond simple text-based responses such as "sorry, try again," not by changing the complexity of the underlying computer program, but by adding color and variety to the user's environment. Thanks to significant and timely technological improvements, we now have a wide assortment of media techniques that can be applied to make the learning environment more interesting and dynamic. In truth, there is nothing inherently new about the modes of delivery in the multimedia-based learning technologies. In one form or another, classroom teachers have been using multimedia since the 1950s. Film, overhead projectors, chalkboards and tape recorders are all forms of multimedia that teachers have used to provide a richer classroom experience for their students. All of these media strategies now have their corollaries in the current multimedia gold rush.

What *is* new with computer-based multimedia is the integration and automation of these features in a tightly focused way, assuring repeatability of instruction. Approximately 10 years ago, there were many start-up efforts by researchers in the area of videodisc-based multimedia, beginning with such projects as MIT's Aspen Project, a system that provided an interactive video tour of Aspen Colorado. And there were the new Discovision™ systems with "level two"

interactivity, and the "Puzzle of the Tacoma Narrows Bridge Collapse," which provided learners with a new and interesting window into the physics of standing waves.

One important attribute that has changed since that time is the digitizing of media (particularly video) so that we no longer need to use the large-platter videodisc to capture analog video. The change to all-digital media now permits the use of full-motion video, animation, and audio on networks. It is possible to have independent usage of a training program by as many as 40 users on a single local-area network (LAN) with complete multimedia functionality. This means that entire courses can be made available anywhere on the earth with appropriate computer hardware, including the ability to monitor student progress remotely on a remote mainframe through Internet or other long-distance network.

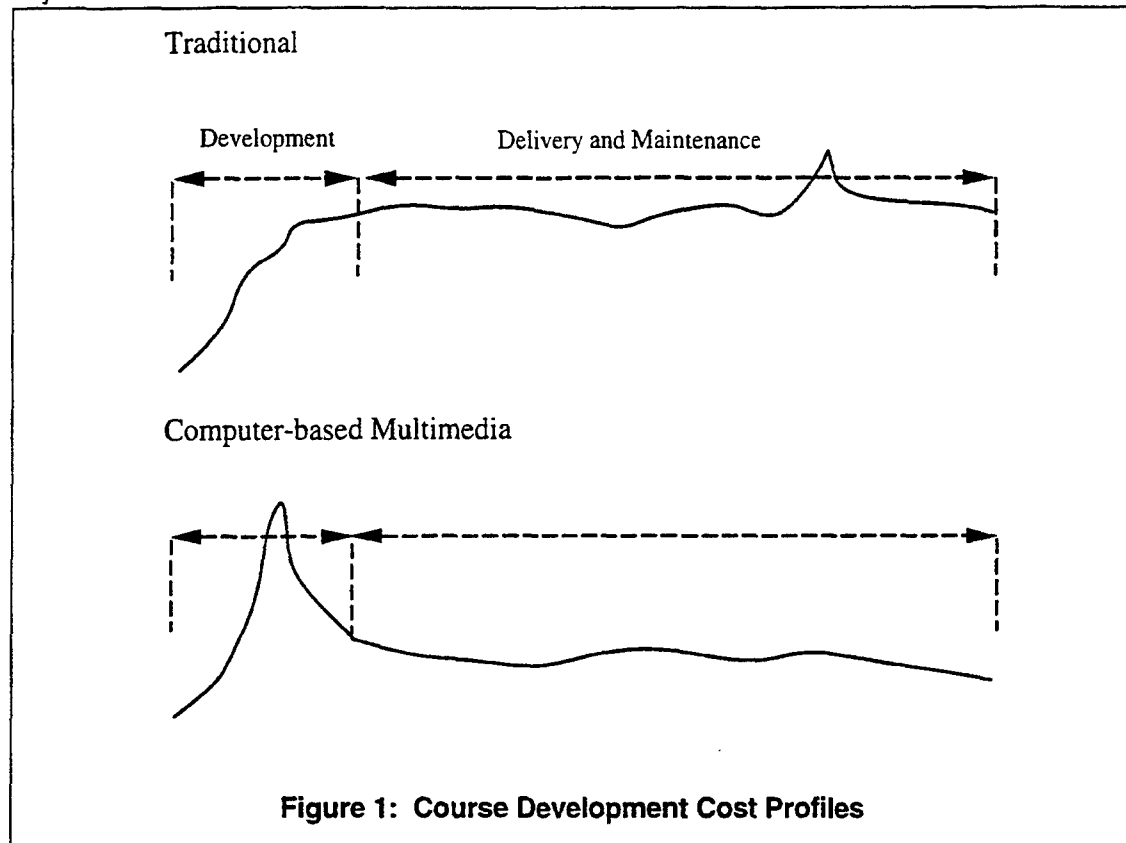
Additionally, the tools to produce highly interactive systems have improved continuously, resulting in more and better system and learner interactivity in the training programs that are being developed. Today, there is really no question of the instructional efficacy of interactive technologies. Regardless of subject matter, sophistication of audience, or complexity of training mission, the means now exist to create a computer-based educational solution fully competitive with any traditional classroom, and in some instances competitive with the ultimate instructional system, the human tutor.

The following paragraph is an abstract taken from the Institute for Defense Analyses (IDA) [Fletcher 90]:

In response to Congressional direction, a quantitative, analytical review was completed of interactive videodisc instruction applied in Defense training and in the related settings of industrial training and higher education. Over all instructional settings and applications, interactive videodisc instruction was found to improve achievement by about 0.50 standard deviations over less interactive, more conventional approaches to instruction. This improvement is roughly equivalent to increasing the achievement of students at the 50th percentile to that of students currently at the 69th percentile. An improvement of 0.38 standard deviation was observed across 24 studies in military training (roughly an increase from 50th to 65th percentile achievement). An improvement of 0.69 was observed across 14 studies in higher education (roughly an increase from 50th to 75th percentile achievement). Interactive videodisc instruction was more effective the more the interactive features of the medium were used. It was equally effective for knowledge and performance outcomes. It was less costly than more conventional instruction. Overall, interactive videodisc instruction demonstrated sufficient utility in terms of effectiveness, cost, and acceptance to recommend that it now be routinely considered and used in Defense training and education.

In general, while traditional instruction has a lower cost to get started, the cost for repeated deliveries and preparation for those deliveries will be relatively constant. By contrast, the cost profile for developing a computer-based solution will have a large spike in the initial effort that

continually lowers as the development cost is amortized over the lifetime of the product [ATP 85].



Taken together—the high level of learner interactivity, the richness of the latest multimedia features, and the improvements to networks and CPUs—computer-based training solutions have come into their own. It is now possible to provide students with an engaging, skill-based learning experience using some combination of multimedia features in virtually any domain imaginable.

3.1 Development Issues in Multimedia

There are at least three well-known models in the interactive multimedia development process:

1. turnkey in-house development
2. turnkey vendor development
3. shared in-house and vendor development

Option number 3 is the most common, and it too is divided by degrees that range from partial to total participation on the part of the purchasing organization. In any of these cases, the same competencies apply. Sharing of responsibilities between organizations increases risk, from communications, differences of management style, physical distances, and a host of other factors. In almost any case, the decision to build an interactive multimedia system will be

an organizationally shared responsibility. It is therefore in the interest of the managing organization to understand the hardware and personnel issues associated with the development process. The contracting organization that is sizing up potential development vendors must understand the vendors' capabilities in both the equipment and the people they intend to employ.

3.2 Working with Vendors

Because developing multimedia is inherently complex, the contracting organization must understand development costs, lead times, and the minimum competencies that the vendor should be able to demonstrate. Sections 3.2.1 and 3.2.2 provide a set of issues that the contracting organization should look for in selecting a vendor. If one or more of the hardware components seem suspect, if certain team roles are missing, or if price quotations are out of line with what is shown in this report, the vendor is probably ill suited to manage an interactive multimedia project of significant size. Naturally, a proven track record is persuasive, but experience alone cannot be used as a guarantee of success.

3.2.1 The Hardware

The hardware for creating and delivering multimedia applications must be chosen with a forward-thinking perspective so that the solution is extensible and maintainable. Even with careful thinking, market changes in multimedia systems are occurring so rapidly that even the most informed developers are frequently caught by surprise. If there is a risk to pursuing large-scale course delivery through computer-based instructional strategies, it is this dynamism of the marketplace. The best advice in pursuing any advanced computer-based training system is to seek out the expertise of an experienced consultant and vendor/developer to help determine the appropriate configuration for the organization's needs. The vendor must have a very strong grasp of available delivery platforms with an eye to coming trends.

3.2.1.1 Delivery

The use of multimedia narrows the field to two primary candidates for delivery: Macintosh® and Intel-based personal computers (PCs). Currently a computer capable of delivering multimedia programming can cost as little as \$2,000 for a 486-based PC, or approximately \$4,000 for a full A/V Macintosh (16 mb RAM, 500 mb hard drive, CD-ROM). The prices listed would undoubtedly be lower for bulk purchases. Obviously the field is much wider for systems using only text-based training or text with limited audio.

3.2.1.2 Development

The two most prominent authoring packages on the market are Macromedia Director® (street price approximately \$900) and Authorware® (approximately \$7,000). With any development platform, the possibility of creating runtime "players" exists for cross-platform delivery. The safer bet is to develop the software on a platform consistent with the target delivery system.

A complete professional development machine for multimedia Intel-based PC costs about \$3,000. This would typically include at least 16 mb of RAM, a 486-66 DX/2 processor, a 1,024

X 768 monitor, and at least 1 gigabyte of storage memory either on a hard drive or magneto-optical drive. An equivalent Macintosh-based system costs approximately \$6000, including PowerPC processor, a high-quality full-color monitor, and a gigabyte of memory. Of course the printing resources in either case add anywhere from \$1,500 to \$5,000, depending on the printing requirements of the project. Combined with a flatbed and other image-scanning devices, the total for either an Intel- or Mac-based multimedia development system will near \$10,000 per system. In general, Intel-based equipment costs less than Mac-based equipment. There is, of course, ongoing disagreement among developers about the superiority of one development environment over the other.

In the normal case, there is at least one machine dedicated to a project of small-to-medium size (small = less than \$50,000, medium = \$50,000-\$300,000). Projects of medium size will often require one central development machine and anywhere from two to four satellite machines for others on the supporting team: writers, image-preparation personnel, and so on. Therefore, the cost of hardware for any medium-sized development project will most likely not be less than \$50,000 to establish a very basic development infrastructure. Add software costs to this, and the initial costs for a basic development configuration approaches \$70,000.

3.2.2 People Issues

Any multimedia effort is a team venture. The developer should have at least the following functional roles: project manager, content expert, writer, computer artist, graphical user-interface (GUI) designer, programmer, and instructional designer. The contracting organization should view weakness in any of these areas as suspect. Typically, multimedia vendors are small, or are small subsets of larger software development firms. Established methods for qualifying vendors such as software capability evaluations will be difficult to match to most of these specialty companies, which are known in the multimedia publishing industry as "boutiques" because of their small size and resemblance to storefront retail operations.

3.2.2.1 Development Roles

Project manager: Strong project management skills are an absolute requirement for multimedia development of any kind. The project manager must be adept at determining the scope of the project before scheduling and must be competent at developing the schedule estimate based on the scope. The project manager must also be able to set customer expectations appropriately.

Content expert: The content expert is obviously essential to the creation of any instructional material. When interactive multimedia technology is involved, it is best if the content expert has experience with and understands the technology. Having a content expert who understands the technology on the team is an added bonus that allows communications to go more quickly and smoothly. The content expert will often turn up insightful methods to use the various media elements to best advantage. The content expert can often quickly discern where the media is interfering with the message being conveyed.

Writer: The writer often serves a role that is central to development of the project, often stepping over the bounds that one might associate with writing, at first glance. The writer often becomes involved in requirements elicitation, project organization, organization of materials, analysis of content, and other roles.

Computer artist: A computer artist processes or creates all of the imagery required to illustrate ideas, backgrounds, and text for the system. If the organization developing the computer-based multimedia system is competent in their personnel selection process, the artist will also have strong ability in computer-interface design. Finding these skills in one individual can be considered very lucky.

GUI designer: This individual must have a keen intuitive sense of design as well as formal training on how to understand and administer field trials for potential system users. The GUI designer is familiar with how people work with computers and how to use the computer screen effectively.

Programmer: Ideally, a programmer on a multimedia development team are capable of crossing boundaries with art and design. More typical; however, is the case in which these functions are separate, requiring team discipline and consistency in maintaining communications between members. There is often the need for someone with low-level programming skills to create specialized functionality to operate under higher-level COTs programs (such as Authorware or Macromedia Director) and multimedia elements such as digital video or large volumes of text.

Instructional designer: Instructional design is a consultive and quality-control function. It is an invaluable function to the educational design of any multimedia system. The instructional designer can establish and evaluate mid-project user tests and provide useful feedback as a result of those evaluations. An instructional designer should have strong facilitator skills and the ability to elicit requirements for the system. Often the instructional designer is a project manager as well, serving a central position in specifying the system, maintaining communications between project team members and the system customer.

3.2.3 Development Costing Guidelines for Computer-based Multimedia

Based on estimates from Anderson Consulting, Inc., one half-day of instruction will cost \$277,500. Anderson's breakdown of these expenses is

Design and development	(300 days x \$500/day)	\$150,000
Administration and management	(60 days x \$600/day)	\$36,000
Video subcontract		\$80,000
Direct reimbursables (travel, etc.)		\$11,500

Estimates of the ratio of development time to user contact hours (also called *seat time*) are shown as follows:

Low	400:1
Medium	800:1
High	1200:1

Contrasted against a small multimedia-development firm, Visual Symphony, Inc.,⁴ these figures are consistent. Anderson reports their typical hourly development cost at \$75 per hour. Visual Symphony provides a range from \$60 to \$100, explained by the variation in the complexity of creating user interactions. Visual Symphony adds the further cost of front-end analysis (scoping) at a flat rate of \$10,000.

3.3 System Maintenance

Because of the rapidly evolving state of multimedia today, the market should be approached with caution. While the prices of delivery platforms are becoming less expensive and the software to run on those platforms is becoming more available, the problems of relevance still remain. That is, off-the-shelf multimedia programs are unlikely to be relevant to a specific training need unless an instructor can adapt the commercial software package to fit the need. Development of multimedia still requires specialized development. Allen Communications, a prominent multimedia developer, has produced training for Air Force fighter maintenance and a system to teach fundamentals of running a business. Anheuser-Busch has a training program entitled "Sales Source 2000" that teaches "beer-selling basics." Electronic Data Systems, Inc. has a program that teaches inventory policy, procedures, charging, and troubleshooting. Boeing has a multimedia program teaching maintenance of the new 777 airplane. All of these are dynamic programs with many interesting features. Each of these systems is also "tailor made." So far, multimedia development is a job-shop process and requires a hand-in-hand relationship between the developer and the developing organization. Furthermore, it is not common for organizations to have in-house capabilities to develop multimedia. There are exceptions to this, however, such as Anderson Consulting.

When development is so specialized, maintenance is obviously an area of concern. At least three appropriate questions to ask before development are

1. Who bears responsibility to maintain and repair the system once it is deployed?
2. Will the contracting organization commit to learning to maintain the system, or will the developer be responsible?
3. How volatile is the subject matter?

⁴. A small multimedia development company in based in Pittsburgh, Pa.

Each of these questions must be carefully considered.

3.4 System Life Cycle: Long Term vs. Short Term

Clearly multimedia is an appropriate choice for a course with a long-term need. In the best case, a careful front-end analysis will reveal the longevity of the need. The contracting organization should establish a satisfactory relationship with a trusted multimedia developer. Such a partnership should enable courses to be created with maximum reuse of existing materials and code modules developed in initial projects.

In any case, the contracting organization should structure its agreement with the developer to retain rights to any software created during the project. Such an arrangement is typically documented in a standard agreement that permits the developer to reuse code on future projects for other clients but allows the contracting organization to have full access to any part of system code at all times.

3.5 Related Solutions in the Multimedia Family

The following descriptions involve one or more media elements that can be categorized as multimedia. Any one of these systems can present digital sound, images, text, video, or music, either in a piecemeal fashion or as an integrated instructional system.

3.5.1 Electronic Performance Support

EPSS are a kind of computer-based multimedia that are integrated directly into the context of work being performed. A recent application is a spreadsheet created by Lotus®. If, while using Lotus 1-2-3®, the user has a question on how to create a macro, a training module can be invoked. Because it offers so many possibilities to optimize on learning and performance outcomes, electronic performance support is gaining a solid following among technologically astute educators. Again, the same "platform" learning factors are in play: interactivity, situated experience, and learner adaptivity.

The issues surrounding EPSS are not intrinsically different from multimedia generally. Although these systems offer a great educational payoff, there are not many of them in existence, and creating them requires the proper front-end analysis to justify an organizational commitment to their development. Otherwise, there are exceptional examples for specific target domains such as the Lotus example above.

3.5.2 Hypermedia Information Services

Hypermedia is computer jargon describing the interlinkage of text and symbols to provide system users with the ability to move from one link to the next. This linking of information is intended to provide informational points of departure through large bodies of information.

The WorldWide Web (WWW) is now a prime example of hypermedia, whose use is expanding daily. With Internet hosts increasing at a rate of approximately 7 percent per month, network

usage is rapidly becoming commonplace and will undoubtedly be as common as the telephone in the very near future. Corresponding to this growth is the number of available information sources on the network. Currently there are WWW sites for information on the National Aeronautics and Space Administration (NASA), American Telephone and Telegraph (AT&T), Apple Computer, Software Engineering Institute, major U.S. magazines, the U.S. Patent Office, and many others. Creating curricula to use these resources is a new idea. It is possible to download entire multimedia presentations from the network. To date there is not a great deal known about teaching courses using the Internet interactively.

Currently, courses taught using the Internet are new and varied. One course developed at Gallaudet University has linked deaf students with another class at Rochester Institute of Technology; however, interactive use of the Internet for instruction is experimental. Its use as a resource with network news services, email, and specially created newsgroups is more than ten years old however, and in conjunction with rapidly developing WWW sources, the Internet stands to be an ever-richer resource for any instructor who has ready network access.

3.5.3 Just-in-Time Lecture (JIT)

JIT lecture is a very straightforward use of various multimedia technologies to store and retrieve lectures for access. The Carnegie Mellon University (CMU) Multimedia Lab is developing a standard process by which lecturers can easily record their own lectures in digital video to be organized by a topical outline for random access to lecture topics by students. The system is integrated into the CMU campuswide network, and students are able to submit questions to the instructor (or teaching assistant) through email. If a question is submitted by several students, the instructor will add more material to the lecture; otherwise the question is answered individually. Currently the system permits instructors to provide visual and audible email responses. The objective of the JIT development effort at this time is to reduce the current lecture production time from 40 hours to 20 within the next year.

3.5.4 Intelligent Tutoring

Intelligent Tutoring Systems (ITSs) are computer-based instructional systems that diagnose the responses of a user in order to make incisive remediations as a human tutor would. Although all indications are that multimedia would do nothing but improve such systems, ITSs can be used with or without multimedia. In contrast to standard computer-based training, ITSs do not follow a fixed set of responses to student errors. Their "intelligence" is in figuring out the "cognitive malady" of the student in the context of instruction. ITSs attempt to deduce why the student is making a specific error, for example a math tutoring system, would try to determine why a student was failing to add two numbers correctly. It would use analysis rules to make instructional decisions related to the domain. For example, the student might not performing a "carry" properly, or perhaps is not understanding "place value." In other words, the system reasons as a human tutor would about the causes of a student's problems and attempts to match this "diagnosis" to insightful tips and remedial commentary.

Building intelligence into a computer-based instructional system requires a skilled programmer who is familiar with expert-system and artificial-intelligence-based programming. Development costs have decreased as new tools have been developed, and the continual improvement of delivery systems is creating new possibilities for developing this type of system more easily.

3.5.5 Text-Based Computer-Based Training (CBT)

Most online tutorials (for example those using Intel-based PCs) are text based. While this kind of training is far less demanding in development than multimedia, its effectiveness as a training vehicle is limited by its lack of the richer features of full multimedia capability. Lack of full-motion video and images, the value of which has been described by Christel [Christel 94], places definite limitations on the educational environment. While the effectiveness of interactive video systems has been proven, I know of no major studies pertaining to the effectiveness of text-based, online tutorials. To the extent that they are interactive, they will undoubtedly have instructional value; however this would in most cases be highly procedural training.

3.6 The Multimedia Family of Solutions and Travel Reduction

Because of its potential distribution to any properly configured desktop computer system, interactive multimedia can virtually eliminate travel to classrooms. Multimedia can be delivered with or without a connection to a network. When delivery to a network is not feasible, a complete multimedia training program can be delivered on CD-ROM.

Figure 2 shows a currently available network configuration that permits full audio-visual functionality, including full-motion video on a 40-user LAN. This is not hypothetical. Starlight Networks® produces this hardware, and there is a slightly less powerful and reliable version produced for Novell®. In this configuration, students can work at their individual workstations independently in a cluster configuration or at widely separated sites.

Real-World Example

When a network is used, results of training can be downloaded to a mainframe using a modem. This type of configuration is currently being used by CSX Transportation for conductor training. Their system permits conductors to take portions of the required 8-hour program as they travel over a span of 26 cities. The CSX system includes full-motion video, animations, audio, and interactive examples and testing to teach the use of a new computer technology for work-order report that is to be installed in all CSX train cabs.

The network configuration used for the CSX application is not particularly complex. The following reflects current prices for one 40-user multimedia workstation configuration:

- \$2,500 per workstation
- \$8000 per 64 mb RAM server
- \$4000 per 6 gigabyte hard drive
- \$25,000 network driver software
- \$8000 per switched hub

When the system requires five or fewer users per LAN (as with CSX), the switched hub is not needed.

Multimedia Server Configuration

Features

- Full-motion video
- Independent usage
- Full multimedia capability
- As many as 40 users per server
- Remote student progress monitoring
- Ease of updating for changes to courses

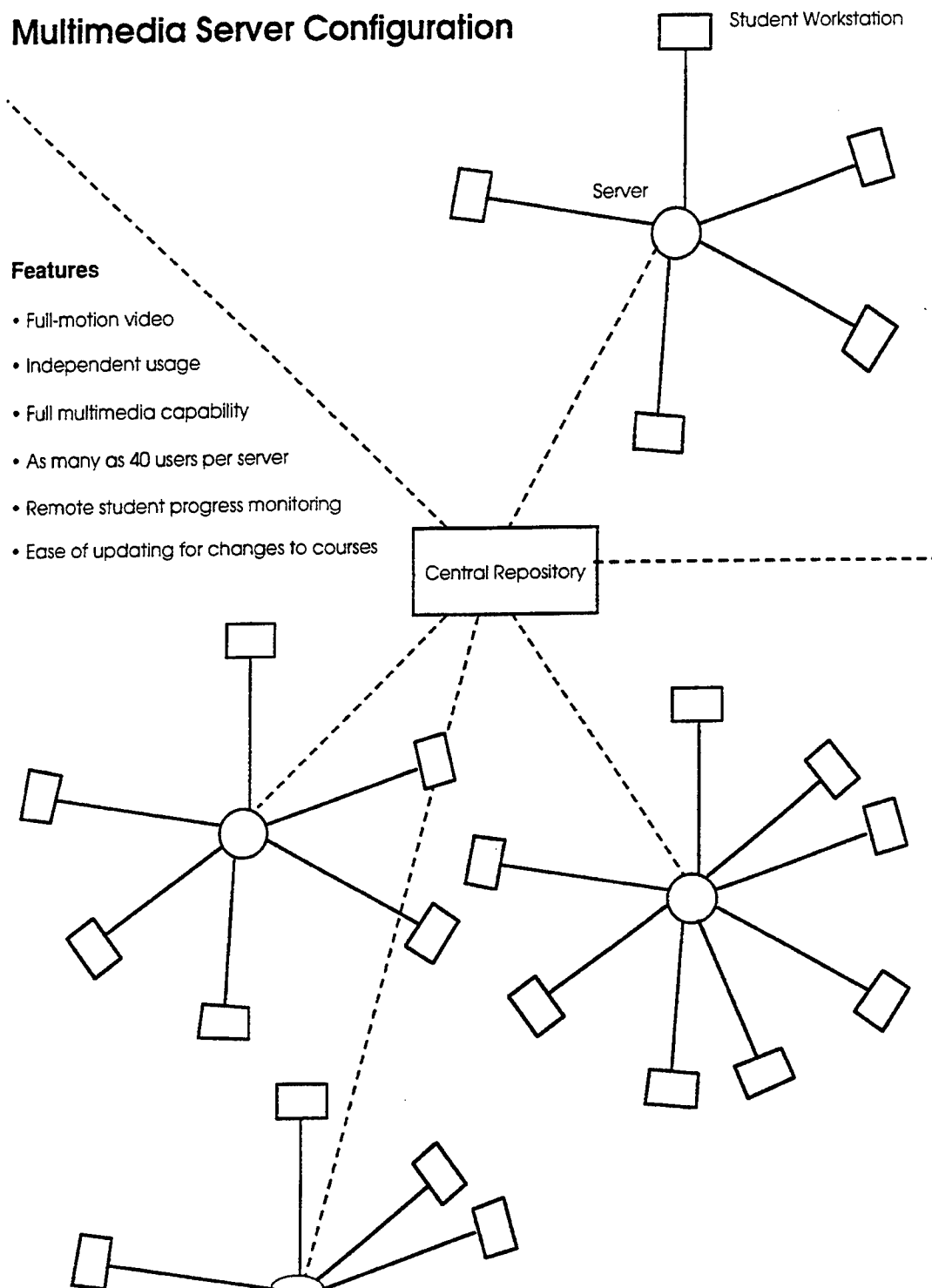


Figure 2: Multimedia Network Configuration

As a distance-learning solution, the CSX example demonstrates that training that utilizes state-of-the-art interactive multimedia can be delivered to sites that are separated by hundreds of miles, while at the same time providing centralized performance monitoring. Virtually any interactive multimedia that can be used in a stand-alone system can now also provide the benefits of the network as well.

3.7 Other Potential Distance-Learning Solutions

Outside the realm of the interactive computer-based systems, there are still the "tried-and-true" methods of course delivery. Videotape, satellite, and travelling lecturers have well-known positive features as well as certain clear limitations. For better or worse, these methods represent a "stepping back" from the revolutionary change implied in the current wave of advances in the computer-based systems. I consider these methods in the following paragraphs.

3.7.1 Videotape

Videotape has been available as an instructional technology for many years and provides us with many useful lessons in understanding the educational value of video in the new computer-based technologies. For instance, interactivity is essential. An inherent weakness of videotape is its slow rewind and fast-forward capability. While video can show us many things, it is only as good as the methods used to present the content. This holds true for the fanciest of technological solutions, from multimedia to intelligent tutoring to satellite instruction—success depends on the quality of the production. While this may seem an obvious point, it is remarkable how often this precept is ignored. The "talking head" video is one of the most common in educational fare and provides us with a landmark of "things to be avoided" as we venture down the technological highway.

3.7.2 Satellite

Satellite is a well-understood educational technology. Although it is not often taken advantage of, the potential for interactivity is great for satellite courses. For example, the satellite program managed through the Air Force Institute of Technology (AFIT) offers brief instruction on the development of course materials for satellite broadcast. Although the visual feed is one way, AFIT provides conference audio through phone lines. This enables the instructor to communicate with students and enables students to hear answers and explanations given to one another. At a cost of \$200 per hour, not including a \$50 technician's fee and course development costs, satellite is now facing stiff competition from computer-based distance-learning solutions in terms of the educational value added.

It is possible to have full, two-way communications through satellite at a correspondingly higher price than one-way video. Obviously, the interactive capabilities are improved with both two-way audio and two-way video; however, unless the audio and video are operating at a high display rate, communications can seem confusing and garbled. Real-time satellite communication is only as good as the preparation of the materials designed for the course and the pre-

sentation skills of the instructor. With no technical problems, two-way satellite provides the possibility of a "virtual classroom."

3.7.3 Lecturers On Site

Rather than taking the student to the course, we can also send the course to the student. As in one-way satellite delivery, the lecturer's use of interactivity can vary widely. As a facilitator, a classroom instructor can provide the highest levels of student engagement as are possible beyond one-to-one tutoring. The risk, however, is that the lecturer will use little or no interactivity. Many instructors are simply not comfortable with high levels of interaction with students. Classroom lectures are only as good as the planning and design that goes into them, and even with excellent designs, a lackluster instructor can ruin the experience. In general, any measurable educational outcome can be achieved using computer-based technology. Further, computer-based technologies guarantee a stable style and manner of instruction over time and for any number of classrooms. Additionally, articles in major interactive multimedia journals are providing examples of this technology used as a classroom support.⁵

⁵. A recent example appears in *Multimedia Today* 3, 1 (Jan.-March 1995): 57-60.

4 A Technology-Specific Analysis

Figure 3 matches each of 10 educational delivery methods with factors related to instructional effectiveness, development complexity, and associated costs. This figure is an educated guess of the relationships known and represents a combination of research, experience, and rules of thumb in the absence of hard science. Many of these technologies are new and developing rapidly. Most of the data supporting this figure comes from cases and field reports cited throughout this report. The purpose of the figure is to provide decision makers with a grounded overview of technologies and relevant implementation factors as of today. Because these are fast-emerging technologies, the data will likely be quickly dated; nevertheless, the data can provide valuable insight for today's decision space.

The following descriptions correspond to the factors listed across the top of Figure 3.

4.1 Potential Level of Interactivity

This category defines *interactivity* as the potential amount of time the learner is engaged in a task, actively pursuing an instructional goal. As stated earlier, educational researchers refer to interactivity in various ways, such as "time on task." Informally, we can think of various positive learning experiences in which students were alert and contributing to the educational process. The question this analysis seeks to answer is "To what extent is the technology capable of maintaining an interactive experience with the student?"

Of the systems listed, seven are fully capable of engaging students in a rich instructional dialogue. Videotape is obviously a one-way communication; while students may be engaged by a well-produced tape, for the purposes of this report I would not consider videotape interactive in the same sense as a dynamic classroom or multimedia experience could be.

4.2 Project Management in Development

There are differences in the amount of time required to manage the development of any new product. Instructional technologies are no exception, and today the differences are so wildly divergent that it is very easy to be caught unprepared. I intend this category primarily as a general warning about the amount of time needed to properly develop computer-based instructional systems. With or without the use of technologies, course development is time consuming and often difficult. Technologies of any kind add to this difficulty and complexity. In particular, interactive multimedia requires intensive planning and management activity, preferably with the help of software tools.

4.3 Availability of Delivery Platforms

This category defines the available means by which the instruction is delivered to the student. Specifically, this category largely refers to hardware availability: computers, satellites, VCRs, overhead projectors, satellite downlinks, and so on. Remembering that Figure 3 is a compar-

ison chart, we can say that lecturers are more readily available to deliver instruction than computer-based multimedia instructional systems, for example (even though this may not be the case in the near future). It is also important to note that the military has a large satellite infrastructure available for nationwide course delivery, which is more readily available for course delivery than computer-based instructional-delivery platforms.

4.4 Maintenance Estimate

Maintenance is defined as the required modifications made to existing course materials. The circles in this category provide a comparison of the amount of this activity required for the types of technologies listed. They do not answer the question of how many modifications will be required for any given course; rather, they are meant to make it possible to compare how much modification effort will be required once the course exists as a product. For example, even though individuals often share their lecture and course materials, these often undergo significant changes from one instructor to the next depending on instructors' preferences in emphasis and so forth. In general, computer-based technologies are less modifiable than human-dependent instructional systems (including satellite). This implies that

- Because of the relative difficulty in modifying computer-based instruction, course developers should carefully prepare materials for long-term use.
- While lecturers have the advantage of wide flexibility in modifying instructional materials, modification adds the risk that key instructional issues will be inconsistently addressed over the lifetime of a course.

In light of these considerations, for better or worse, there will in general be less maintenance of multimedia-based instructional systems and more maintenance for other human and computer-based instructional systems. Of course, content volatility is a consideration with respect to any course development effort; however, courses are typically a mix of volatile elements and static principles. Clearly, where substantial amounts of the content are changeable on a monthly basis, any computer-based technology will become a questionable option.

4.5 Delivery Cost

The cost of delivering a course includes personnel required in the classroom at the time of delivery, the cost of any printing or creation of materials required for the delivery, and any other overhead specific to the classroom. In Figure 3, all computer-based delivery methods are rated as relatively low. The on-site lecturer is higher because of required materials preparation and the lecturer's time. Satellite delivery is ranked highest because of the cost per hour for use of the facilities in addition to those costs associated with the lecturer and materials. Videotape is ranked lowest because it can be shipped to any site with access to a VCR and observed without cost other than the time taken to view the tape.

4.6 Overall Development Cost

This category refers to expenses related to the design, development, and production of education and training relative to delivery methods. Currently, there is a much development associated with any computer-based instructional education strategy. It is therefore an important consideration in planning for this kind of technology. Among the computer-based delivery methods, any that use multimedia will be at the highest end of development cost because of the many detailed activities involved. Comparing two computer-based methods, text-based CBT and multimedia, both will be complicated to produce; however, because text-based CBT involves only the use of ascii text, it will be far less difficult to create than multimedia. Using multimedia implies the creation or selection of photographs, voice, music, or video. For each element, there are processing steps involved and decisions, such as the scanning of photos, shooting of video and so on.

4.7 Potential Reduction of Travel

Each of the delivery methods listed has some potential to reduce the travel time. Regardless of the method of course delivery selected, we can assume that course developers hope to maintain high-quality instructional outcomes. In light of this assumption, the shading of the circles in this category answer the question "Which technology is best able to retain the highest level of instructional outcome even when the students cannot travel to the lecture itself?" Irrespective of distances, computers will deliver the same level of instructional quality that was programmed into them in the first place. The same can be said for satellite systems: depending on the instructional effectiveness of the instructor using a satellite, distance will not change the outcome.⁶

4.8 Potential for Materials Reuse

Reuse of materials is of obvious importance in product development. I found no evidence to suggest that one delivery method provides greater materials reusability than another. Computer-based instructional systems allow for the reuse of certain code routines used for student evaluation. Computer-based multimedia can provide the opportunity for reusing image libraries, evaluation routines, video, audio, and sound, *depending* on the nature of the course and how generic the need. More human-dependent instructional methods, such as satellite, provide for the possibility of reusing lecture materials and even interaction methods *depending* on the inclination of the instructors to do so.

4.9 Overall Estimate of Instructional Effectiveness

Based on the instructional factors provided earlier in the report, my intention for this category is to provide a general view of the capability of the delivery methods to be instructionally effective. My assumption here is that the more the instructional medium is capable of providing

⁶ In the absence of scientific data to refute the idea, this seems like a reasonable assumption.

sustained involvement and attention to specified learning tasks, the more effective it is. For example, videotape, even when used with a specialized interactive videotape machine, cannot provide for the same degree of student involvement because of the relatively long seek times associated with it.⁷ The student has to endure lengthy waits while the machine rewinds the tape. While two-way satellite would seem to be able to provide near-classroom-style fidelity, in fact it does not, because of variations in transmission speeds. These variations are often disruptive and distracting to dialogue. Intelligent tutors, EPSS, multimedia, and human-based on-site instruction all have the potential for rich and attention-demanding interaction with the learner.

4.10 Potential Learner Adaptability

The human tutor is an accepted baseline measure of instructional effectiveness against which instructional technology has often been compared [Anderson 85]. Tutors are able to analyze the difficulties of their students and make adaptations to their teaching strategies as circumstances arise. The rankings listed show that four of the computer-based technologies are the most highly adaptable to the individual learner. Because an instructor's ability to adapt to the individual is constrained by the number of students enrolled, on-site lecturers have less adaptability. Of course this also applies to satellite technology because of its relative dependence on the instructor and class size in addition to the separation of instructor from the class. Text-based CBT has the potential for adaptability, but adding this capability would push this technology into the intelligent tutoring category. (To reiterate, *text-based CBT* is defined for the purposes of this report as a label to describe text-based computer tutorials with branching capability, having no capacity to adapt to specific learners.) Just-in-time lecture provides random access to segments of lectures, offering some learner adaptability; however, these adaptations depend on the learner's ability to seek out the information. By contrast, videotape simply does not adapt.

7. Despite certain specific instances where individuals have created usable random-access videotape systems, this technology can rightly be thought of as obsolete.

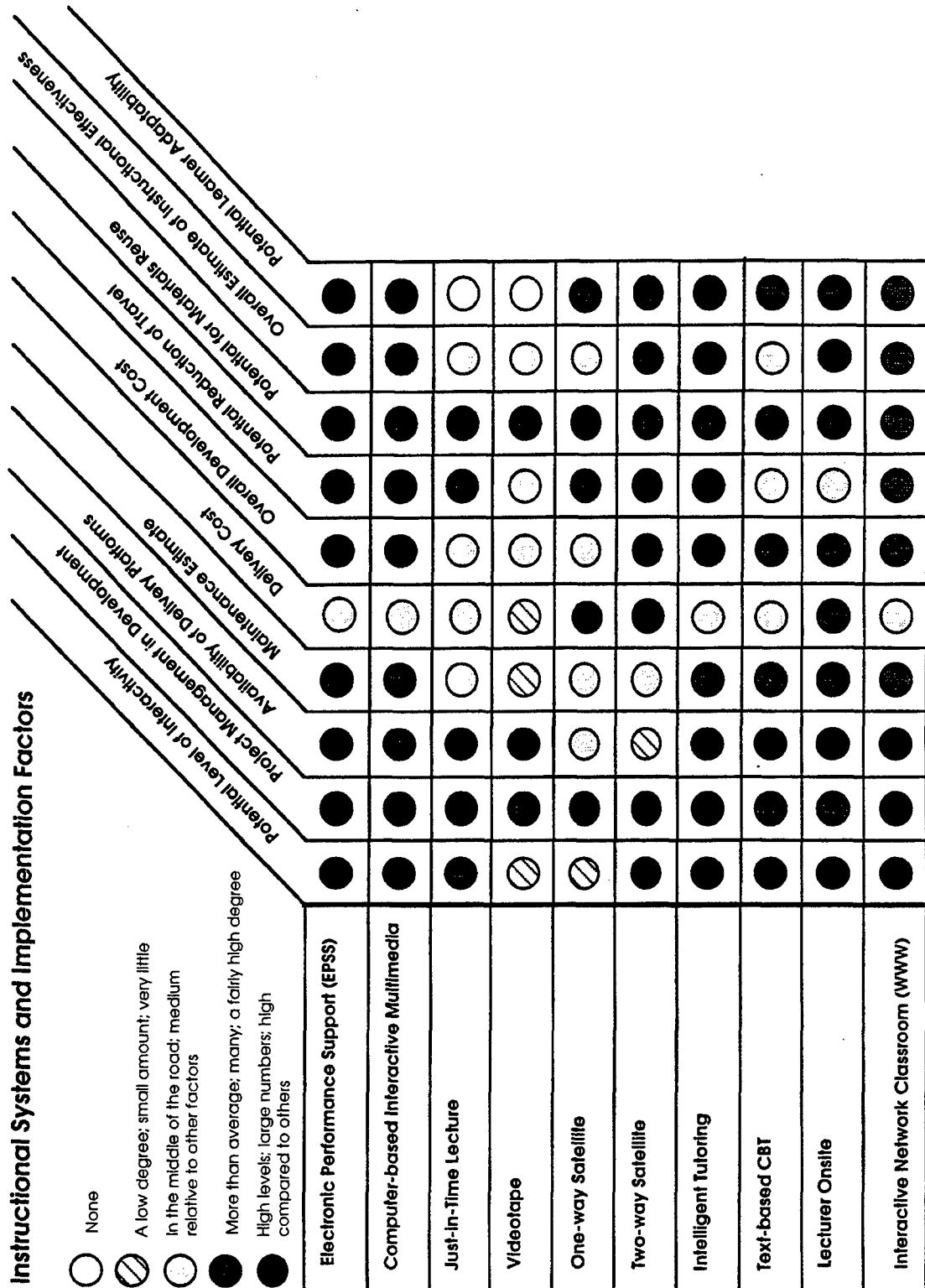


Figure 3: Estimated Instructional and Development Factors

5 Summary, Recommendations, and Conclusions

Based on the discussion of core educational issues and the available technologies, our task becomes one of "mix and match," based on how much money there is to spend against the learning outcomes that are to be achieved.

5.1 Summary

There are two primary considerations in selecting an instructional technology solution: learning factors and delivery logistics. The technology selection objective, therefore, is to optimize on the best and most appropriate learning factors while minimizing the negative effects of the logistics involved in delivering instruction.

Prominent among the learning factors are

- interactivity
- learner adaptability
- situated learning
- retention
- volatility of instructional content
- consistency of training quality
- overall development cost
- existing hardware and software infrastructure
- ease of maintenance
- potential for course participant travel reduction
- potential for course content reuse

To provide interactive multimedia functionality, the computer infrastructure must be adequate. Depending on the types of multimedia services that an organization wishes to provide, the possible delivery mechanisms can range from \$1,700 to \$6,000 apiece. It is possible to provide an infrastructure capable of supporting all of the top-of-the-line multimedia features, such as full-motion (hardware-assisted) video, in a LAN configuration, or to provide only a limited set of these features, where a LAN may or may not be a part of the system configuration. A hypothetical 10-user LAN supporting full-motion hardware-assisted video (30 frames per second) as well as any other available multimedia feature will cost approximately \$65,000. This price would include 10 workstations, a 6-gigabyte server and set-up charges.

Using Intel-based systems, full-multimedia capability can be made available including an in-board CD-ROM drive and modem on any desktop for under \$2000. A machine having these capabilities permits access to existing WWW offerings, the Internet, and the use of CD-ROMs. This is not to paint an overly rosy picture. Obtaining access to the Internet and assuring reasonable system performance (speed) in downloading images and other types of large-data

items will require the purchase of the appropriate high-bandwidth connections,⁸ adequate local host storage,⁹ server software, and any other ancillary support devices such as Ethernet cards for user machines.

The network technologies required to deliver WWW and corresponding multimedia functionality to the classroom are well understood and will require a separate analysis considering the numbers of students that would participate in pilot courses. The major technical considerations in this regard will revolve around the number of users and their influence on network performance. Solutions must be scalable to larger numbers of students, with an eye to hardware improvements and upgrades.

5.2 High-Level Recommendations

5.2.1 Build an Educational Infrastructure

The purpose of this infrastructure is to support WWW access and provide for potential multimedia course distribution. Given the rapidly growing availability and shrinking cost of computer-based multimedia hardware and software, the time is ripe to establish a technological infrastructure that will open the door to the full range of multimedia offerings and anything on the WWW—all at one time. Among the rapidly growing number of subscribers to the WWW, there is no argument as to the horizons that this technology is opening, especially from an educational standpoint. Further, there is already a well-established precedent among American universities, where the value of the networks is inarguable.

5.2.2 Assess Information Repositories to Be Made Available Through the WWW

There also must be a forward-thinking assessment of the target workstation suitable for use both online and as a stand-alone system with full multimedia capability. It is now possible to purchase a complete multimedia workstation with large storage capacity and inboard modem for \$1,700 in the consumer marketplace. This cost implies that with an understanding of the geographical distribution of the student population, that both LAN-based and stand-alone system configurations are feasible.

5.2.3 Pick a First Target for Computer-Based Multimedia

Establish a candidate project for implementation as a multimedia course. Remembering that a rule of thumb is that complexity costs more, determine a relatively long life-cycle, low-complexity course for implementation.

⁸. Ethernet, token ring, or equivalent

⁹. greater than 2 gigabytes at a minimum

5.3 Lower Level Suggestions

The following represent four possible approaches, as well as a framework for thinking about strategies of implementation. These are not exhaustive, but each represents a plausible set of choices, assuming that the basic system infrastructure is in place. As stated in Section 1.2, assumptions about the organizations to which these suggestions apply are the following:

- A certain amount of instructional infrastructure is already in place.
 - Satellite hardware and system support is readily available for wide-scale transmission of one-way and potentially two-way educational offerings.
 - The existing computer hardware base is composed largely of Intel® microprocessor-based machines, capable of delivering text-based instruction [computer-based training (CBT)].
- The organization is willing to explore the possibility of expanding the existing infrastructure to include technologies capable of interactive multimedia¹⁰ and other advanced computer-based instructional solutions.

5.3.1 Strategy 1: Network-Distributed Computer-Based Training

This strategy consists of downloading low-level interactive training courses to LANs for use at student terminals.

Objective

Engage in a slow migration to computer-based course delivery. This plan would optimize existing capacity while building for greater infrastructure capacity in a "slow-growth" scenario.

Features

Many sites across the U. S. currently have 386-level, Windows-compatible computers available for course distribution. These machines are capable of communication with the Internet or LAN.

Advantages

Given the current state of practice, this option could be put in place quickly. It would enable an organization to run test cases to determine the efficacy of the approach on a limited basis.

While the development cost for any interactive, computer-based instructional solution always has the drawback of initial development cost, text-based CBT is the least expensive of the existing computer-based instructional approaches in this regard. And it holds the edge of interactivity as an instructional approach.

Limitations

Text-based CBT is among the least interesting of current possibilities in existing instructional technologies. Although studies on the effectiveness of CBT indicate that it is capable of meet-

¹⁰. *Multimedia* is defined here as digital audio, video, images, music, text, or animation that is integrated on a computer system.

ing basic training requirements, it is more limited than full-function multimedia on educational grounds.

Costs

Training developed for CBT will have to be developed according to the specific needs of the organization. This development implies creating the software in conjunction with a developer and the management of all the activities thereof.

5.3.2 Strategy 2: Combined Semi-Interactive Instruction

The combined semi-interactive strategy is designed primarily to reduce travel costs without a loss of instructional effectiveness.

Objective

Map current practice into a combined satellite- and computer-based instructional solution.

Features

This approach would utilize any existing satellite infrastructure in combination with network-distributed exercises and tests. For any organizationwide distributed system for delivering courses, an advanced record-keeping system will have to be created.

Advantages

This approach is optimized to take advantage of existing resources. The only new programming required would be related to the network-distributed aspects of the approach, which would provide students with simple text-based exercises and tests in which results would be stored in a central file server.

Limitations

Although interactive video communications by satellite and computer network are improving, neither is easy to use. Frame-display rates for two-way satellite often make meetings with only a few individuals somewhat confusing. This becomes even more problematic in scaling to full course implementations. Existing courses will require modifications for use in this new scenario as well. Costs are high for delivery.

Cost

Costs associated with this approach include the uplink time, course test and exercise development and design, programming for those materials, and lecturer preparation time.

5.3.3 Strategy 3: Computer-Based Multimedia

Currently all features of any multimedia system can be used on LANs linked to a central server or as stand-alone systems. Full-motion video, sound, animation, music, and a high level of interactivity are all available at relatively low cost.

Objective

Create an infrastructure to support future network-based WWW access and multimedia-based course development.

Features

This delivery configuration will suit any scale of multimedia delivery. All the attributes of multimedia can be delivered to student workstations on LANs or on stand-alone units. To support the capabilities of the WWW, it is necessary for the target workstations to have full multimedia capability.

Advantages

Multimedia provides effective instruction. By virtue of the range of possible presentation styles and devices, multimedia provides a learning environment with possibilities previously unknown in the history of education. With proper development, interactivity is built into course delivery, and the richness and variety of the learning environment is enhanced by photographic-quality images, full-motion video, sound, and music.

Limitations

Initial multimedia course development is expensive, requires management and supervision, and requires relatively long lead times to create a successful system. Further, poor multimedia is always a potentially costly risk. Developing multimedia programs from scratch is a complex process that requires careful expert supervision.

Cost

As stated above, multimedia has many initial costs associated with it. These costs are primarily incurred as functions of course and project planning, creation of graphics, animations, and screen design. Video used in multimedia is no more or less expensive than in any other video production. Programming time is somewhat more extensive than with a CBT program, although the nature of the work is not substantially different. If development capability is not created within the organization, there will be costs incurred to supervise a developing subcontractor. Building the capability in house is difficult, with a steep learning curve.

5.3.4 Strategy 4: Real-Time Internet-Based Instruction

The Internet is perhaps the fastest growing educational technology in existence. According to statistics gathered at Software Engineering Institute (SEI), the Internet is growing at a rate of 7 to 10 percent per month. Corresponding to this growth rate are the tools for navigating and communicating by the network. Carnegie Mellon University is currently producing a computer-based tool for collaborative distance work. Individuals may see one another by video as well as being able to write and critique documents in real time. While this technology requires that each workstation have its own video card, it is only a matter of time before this type of system is commonplace for office work, and there is no factor in particular that would prevent its use for classroom interaction.

Objective

Provide an easy-to-use Internet front end for interactive teacher-student dialogue.

Features

Collaborative work systems are not new; however, collaborative writing tools that include video are only now becoming available for multichannel communications on the Internet. With multi-party communications, an instructor and class can participate in dialogue from multiple distant locations. Various programs currently exist to support this kind of interaction, and the technology to facilitate this type of network-based dialogue is rapidly improving.

Advantages

Relative to other computer-based distance-learning options, this option can be made available with less effort. No new materials would have to be developed to conduct a class. In this sense, the Internet is rapidly becoming like two-way satellite communications. Materials developed specifically for this medium require some modification to optimize on the dialoguing aspect, but no special-purpose materials such as graphics, animations, or screen designs would have to be created.

Limitations

There will be hardware required to make full-duplex video and audio communications possible. If the implementation platform is Intel based, video frame rates may be fewer than 15 frames per second. Video display on computer terminals will in all likelihood be less than full screen for at least one year. Currently the size of these displays is either 320 x 240 (quarter screen) or 160 x 120 (one eighth). Naturally the size of the video display window is a limitation relative to any workstation's monitor size.

Cost

The cost for this solution will stem primarily from hardware purchases and network installation. Each unit would require a video card plus enough memory and CPU to provide students with equivalent interactive capability.

5.4 Conclusions

The rapid rise of the Internet and computer-based multimedia have opened the door to educational delivery possibilities that have never been seen before. Students of all ages can now have access to video archives of lunar travel, photos of the Shoemaker-Levy Comet as it crashed into Jupiter, international communications, and archives describing foreign peoples in full color, with music and voice. These technologies are no longer restricted to elite research organizations. Soon it is likely that they will be in homes all across the United States. The nature of training and education will be changed forever as a result. Organizations are no longer asking questions that begin with "If we get on the Internet..." but rather they assert, "When we get on the Internet..." Because of the intense demand of this user population, the very nature of learning will change. The demand will be on improved interfaces and more interesting and dynamic computer-based experiences.

This report has only touched upon satellite instruction. No matter which final distance-learning strategy is selected, it appears that satellite instruction is always a possibility, given the ready resource that it is. The cost for satellite delivery appears to remain relatively constant and is expensive. In my estimation, satellite- and computer-based delivery solutions will be competitive in the short term; however, the cost of satellite delivery will remain high while the cost of network-based solutions allow for reduction through amortization of their initial development cost.

The military has in many instances led the development of leading-edge educational technology, and should continue to do so. To pursue a comprehensive strategy to employ these technologies effectively, however, sufficient resources must be committed to provide not only adequate materials, but human energy as well. The change to network-based multimedia is inevitable. The questions that remain pertain only to the logistics of the implementation.

Appendix A Course Example

This appendix describes a protocol to assist in selecting from among instructional delivery strategies.

A.1 The Questions to Ask

With any project development where training *may* be an issue, question number 1 is "Do I have an instructional problem to solve?" The question can have subtle implications—to answer it, one must make a delineation between instruction and the providing of information. In terms of this report, *instruction* is defined as a set of activities designed to impart verifiable changes in student's cognitive or procedural abilities toward specific learning objectives. By contrast, *providing information* is a communication designed as a one-way transmission of ideas. In other words, providing information requires no verification of its effectiveness in accomplishing the goal, whereas in this context, instruction does.

Once the decision is made regarding instruction vs. providing information, it becomes appropriate to ask whether technology might provide some benefit to the course delivery. Because current technologies are proven to be of benefit in many instructional contexts, it is not premature to begin examining this question before content development, because many times there is a purely logistical component to the technology question. For example, if students are widely dispersed geographically and instructor resources are low, some form of distance-learning technology should be considered.

The next set of questions to be addressed revolves around content development. Instructional systems design (ISD), as defined by various authors,¹¹ assumes a fully integrated approach to curriculum development that includes the following steps at a high level:

1. Identify instructional goals.
2. Conduct instructional analysis.
3. Identify (student) entry behaviors.
4. Write performance objectives.
5. Develop criterion-referenced test items.
6. Develop instructional strategy.
7. Develop and select instructional materials.
8. Design and conduct formative evaluation.
9. Design and conduct summative evaluation.

¹¹. Prominent among these are Walter Dick and Lou Carey of Florida State University [Dick 85].

While the precise implementation of these steps may change from one instructional designer to another, ISD is based on a set of learning principles that have become commonplace among instructional-design professionals.

While it is beyond the scope of this report to provide an exhaustive discourse on each part of the ISD model, there are assumptions of the model that have a direct bearing on the instructional selection process. For example, ISD always assumes that a set of learning objectives must be established. At first, this often amounts to identifying "key ideas," or what otherwise might be called the *conceptual core* of the curriculum. Broadly speaking, the question in this phase of development is "What set of understandings do I want my students to have once they have finished with the curriculum?" Often a curriculum committee or other team brainstorms these ideas. At first they may be identified as simple two- or three -word labels, such as *partial differential equations*, *linear algebra*, *key signature*, *color mixing*, etc. In other words, in this part of the curriculum development a high-level set of ideas within a domain is articulated.

Once the set of ideas is elaborated satisfactorily, relationships between the ideas should be determined. This phase assumes that, in general, students learn best when ideas are presented in a simple form at first, with more complexity introduced as this knowledge is integrated with new information and varied contexts. As such, the ISD model advocates organizing a map of the concepts to show these relationships explicitly. For example, in Figure 4 on page 41, the high-level concepts are organized from simpler to more complex. Instructors might argue about which ideas are more difficult and which ones belong first in the curriculum, but the value of the visual representation is not in question. Further, the "concept map" can be augmented to show how the ideas are related to one another in the horizontal direction as well. In Figure 4, the relationship of variable assignment in structures needs to be accounted for.

Next, for each of the concepts outlined, behavioral objectives must be defined. An assumption of the ISD model is that both physical and cognitive actions can be assessed only by using behavioral indicators.¹² Therefore, the curriculum developer must identify the exact nature of the student's desired performance for any level of knowledge.

¹² Hence Bloom's Taxonomy [Bloom 56] is entitled, "Taxonomy of Educational Objectives: Book 1, Cognitive Domain."

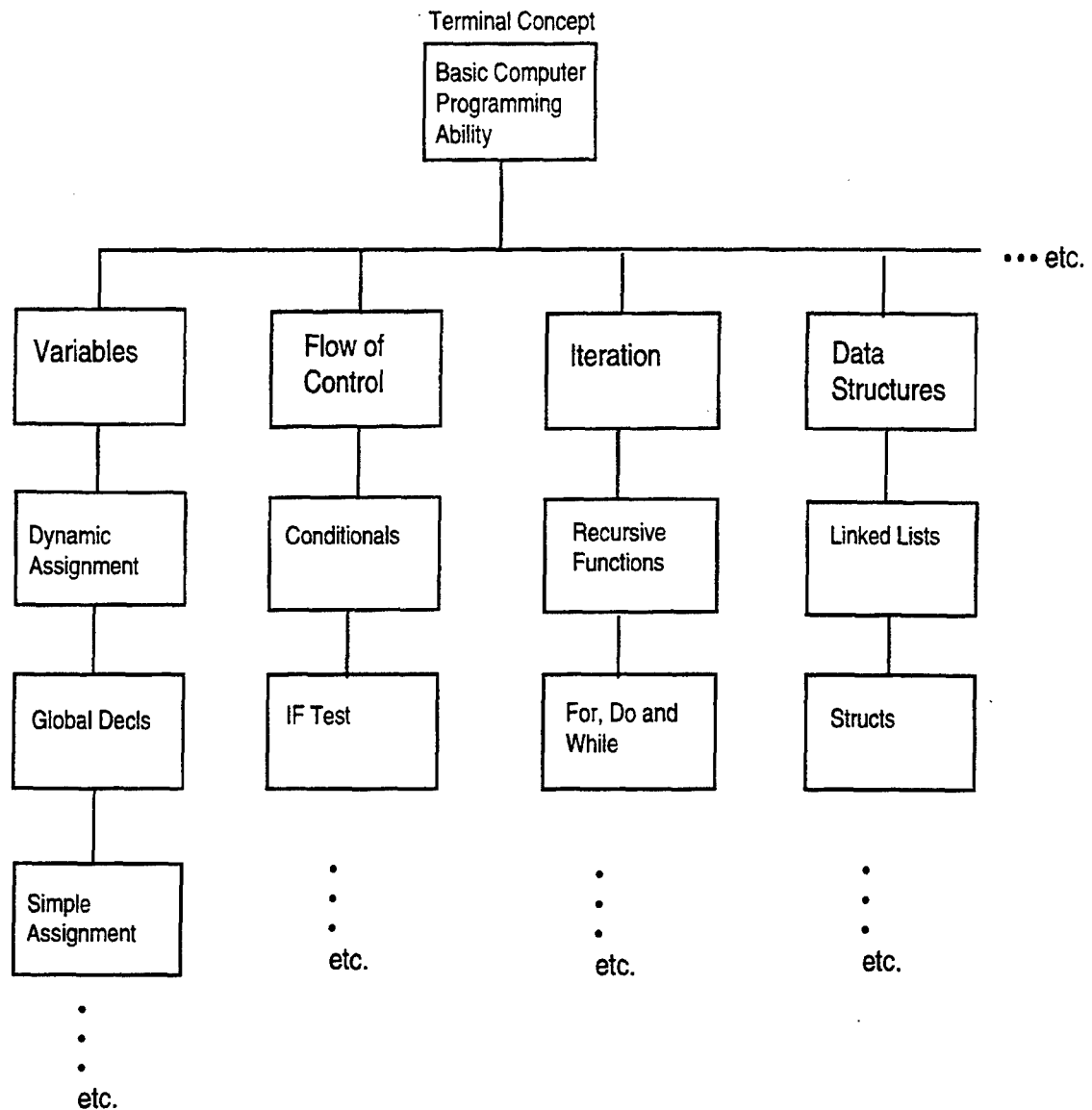


Figure 4: Concept Map

A.2 Example for a Specific Course

As a first example, consider critical competency 1 shown in Figure 5. This critical competency is focused on Bloom's level 1 as the target cognitive implementation level. The objectives for this competency are also listed in Figure 5. To create a more detailed picture of the classroom implementation of the critical competency and how it relates to Bloom, there must be a precise description of the activities carried out by the students.

1. Risk Management

Critical competency 1: to identify typical software-acquisition risks for systems, select appropriate risk-mitigation strategies, and evaluate the relative merits of those strategies

Top-level enabler 1: the ability to evaluate acquisition programs, identify risks, identify associated risk-mitigation approaches, and adjust acquisition plans to incorporate risk-mitigation approaches

Enabling knowledge

- 1K1: concept of "risk"
- 1K2: risk-identification processes
- 1K3: risk-assessment processes
- 1K4: risk-reduction strategies
- 1K5: problem-solving techniques.
- 1K6: laws, regulations, and DoD policies pertaining to the acquisition of software-intensive weapon systems; command, control, communications, and intelligence (C3I) systems; and automated information systems (AISs)
- 1K7: common software-acquisition risks
- 1K8: role of working groups in risk management
- 1K9: software development processes
- 1K10: risk-management organization

Enabling skills

- 1S1: identifying sources and types of risks in software-intensive system acquisitions
- 1S2: identifying the causes of known software-acquisition risks
- 1S3: establishing and applying a process for recognition and awareness of software-acquisition risk
- 1S4: evaluating contractor risk-management processes to determine the extent to which they are consistent with and support the program risk-management strategy
- 1S5: predicting the effect and consequence of a risk event
- 1S6: estimating the probability of a software-acquisition risk event
- 1S7: developing software-acquisition risk-reduction strategy
- 1S8: evaluating software-acquisition problem-solving techniques to determine the extent of their effectiveness in reducing program risk

Figure 5: Sample Objectives for a Course in Risk Management

Given the "enabling knowledge" provided from items 1K1 through 1K10, what will be the exact actions and success criteria expected of students when they carry out enabling skill *1S1: identifying sources and types of risks in software-intensive system acquisitions*? We can assume that there is more than one way of assessing software acquisition risks. Is there more than one way of assessing student proficiency at doing so? Therefore, the exact nature of an in-class exercise must be specified, not only to meet the requirements of the ISD model, but in the case of the use of interactive technologies, to provide information to developers.

A.2.1 Technology and a Classroom Example

A further breakdown of knowledge requires the following further clarification:

Learning Objectives 1S1K1L

The student shall list four sources of software-intensive system cost-estimation risk and for each source identify the a) associated possible risk events, b) probability of those risk events, and c) possible consequences of the occurrence of each risk event.

The instructional method listed for this objective is: "class discussion followed by student participation in providing 4 or 5 examples to complete the following outline on the white board." The "white board" example is as follows:

Source	Possible Risk Event	Probability	Possible Consequences
Ambiguous statement of work	Cost estimation low by a factor of 4	High	Contractor exhausts management reserve. Reduced capability in delivery system. Late initial operational capability Program manager relieved

Table A-1: Cost-Estimation Risks

A.2.2 Samples of Instructional Technology Application

Given the requirements specified above, a learning technology developer must ask several questions:

1. Given the nature of the classroom interaction, is there a practical role for learning technologies in this scenario?
2. If technology is to be used, how will it serve the content?
3. Which technology best serves the need?

Assuming that we determine that some form of instructional technology will be used, we begin to look for answers to question number 2. To use any form of instructional technology, we must at the outset determine its role from the standpoint of logistics. Will it assist the instructor, or do we actually wish to offload portions of the overall curriculum entirely?

A.2.2.1 Satellite

As stated earlier, satellite offers many of the features of a normal face-to-face interaction with an instructor, depending on the capability of the satellite system. Satellite capability has a range that permits full two-way audio and video potential, one-way video/two-way audio, or just one-way video and audio. In almost any current classroom use of satellite, the most likely configuration will be one-way video/two-way audio, because of the expense of full-duplex satellite and the inadequacy of one-way usage.

With either of the interactive satellite configurations, the interaction between instructor and class could be carried out more or less in a fashion like classroom lecture and discussion. Because the instructor is separated by distance and will in most cases have no visibility into the classroom, this presents some obvious limitations. For example, in the likely case of one-way video/two-way audio, the instructor will have to keep a list of the students' names to refer to during instruction. Obviously this is less conducive of interaction than line-of-sight visibility.

A.2.2.2 Interactive Multimedia-Based Solutions

Interactive multimedia opens the door to many options for the classroom. The following paragraphs describe potential levels of multimedia implementation for classroom support.

Classroom Support

For instructors who are not particularly comfortable with group dynamics, performance support can be engineered to assist the teacher in real time. One relatively simple use of this technology is as a video repository. As an example, the instructor could select a video segment showing a form of environmental hazard, followed by a question to the class: "What is the proper procedure for disposing of this class A hazard?" Students and instructor would then discuss a solution. The instructor could then demonstrate the effects of the students' selections.

Using interactive multimedia in this way is no different from using videotape as classroom support with the following important exception: The computer permits real-time classroom interaction because of its rapid random-access capability. Videotape is simply too slow. If the instructor were to try to use a standard videotape to recreate this level of interactivity, not only would all the appropriate tracks have to be indexed, but the instructor would be left to find them all using the fast-forward button on the VCR—the class waits as the VCR scrolls tape. Using the computer's rapid access time and database features, the instructor could predefine paths through video segments that contain useful illustrations of concepts that would otherwise be difficult to explain or demonstrate.

In this example, one of the procedures selected by students could easily cause (in video) an explosion, acid spill, contamination of the water table, and so on—experiences no one wishes to see played out in life. This kind of dramatic example provides rich opportunities for further discussion and debate in class. To those with experience in videodisc or video instruction, this kind of classroom multimedia is not new, but it is effective, and the random-access capability permitted by the computer makes using video in this way practical and easy.

This basic form of classroom assistance using interactive multimedia is among the least complex and least costly to produce. Nonetheless, as with all multimedia, there will be greater initial expense than with traditional classroom approaches. As with any course development effort, however, multimedia development should begin with an initial assessment of the needs and requirements of the system in which the proposed instruction is to be used. This analysis is called a *front-end analysis* or *needs assessment*.

Using the sample course objective on page 43, the emphasis for an interactive multimedia system would be to provide a resource for instructors to enliven the activity of populating the

whiteboard diagram. For example, the instructor could create a repository to play out various crisis scenarios related to poor cost-estimation practices. These could be illustrated in video or by using photos, illustrations, animations, or any other combination from the multimedia armamentarium. These scenarios could be stored on either a compact disc or computer hard drive. With the addition of a user interface, the instructor could provide the class with cost-estimation scenarios and ask for student opinions about "What would happen in the case where I would have 'ambiguous statements of work'? What are some of the problems I might encounter?" Working together to create a usable interface and to capture the appropriate variables in the cost estimation domain, the developer and instructor could create a repository of powerful examples that could be made available to teachers and students on demand.

In the case of cost estimation, instead of merely populating a whiteboard with appropriate entries, the class would now be able to propose strategies and witness some of the unfortunate consequences associated with poor cost estimation, and to discuss them with an expert instructor in class, thereby avoiding crises in real life. This approach is strong from the educational point of view, because the more realistic the instructional experience, the more likely it is to be remembered.

The main limitation to creating multimedia tools is the expense of producing specialized video, images, and animations, as well as the accompanying programming. Clearly, any analysis preceding this form of development has to consider the shelf life of the educational product and the nature of the materials being produced: How generic are they?

A classroom-support video repository such as the repository I have described would allow the possibility of materials being shared and reused, as well as the creation of a generic interface that could allow instructors to define their own specialized load-and-play curricula.

The question instructors should ask themselves in approaching interactive multimedia is "What would instantaneous access to graphics, sound, and video do for me in my classroom?"

Instructors are often their own best technical engineers. A recent article in *Multimedia Today* [IBM 95] describes Dr. Jack Wilson's use of multimedia in his physics class at Rensselaer Polytechnic. Dr. Wilson describes the following scenario utilizing various technological elements in the classroom:

During our acceleration-due-to-gravity session, we videotaped a student throwing a ball. We digitized the video directly into the computer and made it available to every student workstation over the network. Students then analyzed the motion using the online scientific tools. Next, students created a spreadsheet illustrating the ball's position versus time data, and then plotted their results on computerized graphs. All in one, two-hour block.

Joe Molino, the IBM consultant with Rensselaer, is quoted as saying, "Rather than separating the functions of lecture, recitation and laboratory, the new physics format allows instructors to move freely from one mode to another" [IBM 95].

To create multimedia tools to assist in the classroom presentation, decisions must be made about the kinds of illustrations that would enhance the students' grasp of the content. As suggested, the best examples are drawn from real life. Such decisions are most often made at a creative meeting between the developer of the multimedia tool and the content developer.

The Just-in-Time (JIT) Approach to Interactive Multimedia

Using the JIT approach would simply entail recording the lectures of the instructors with a video camera, digitizing them, and indexing their content according to a topic outline prepared by the instructor. The lecture and indexes would then be incorporated into a user environment that permits electronic mail to the instructor (or assistant) so the students could ask questions. The system performs a first-pass analysis on the student's question to determine whether it has been asked and answered in the past using certain natural-language analysis techniques. If the question has been asked in the past, the system answers it automatically, using the answer already stored in its database of answers created by the instructor. If the question has not been asked before (or the system cannot analyze it accurately), the system passes it along to the instructor to answer in electronic mail.

Of course this method does not provide for any real-time classroom dialogue with the instructor, and therefore lacks the benefit of these dynamics. Relative to more elaborate uses of multimedia, this approach is inexpensive to produce, allows for network connectivity, provides a direct link to the instructor by electronic mail, and provides a consistent reference for course information through the stored lecture.

Stand-Alone Interactive Multimedia Systems

Any stand-alone, computer-based instruction derives its strength from the curriculum and the richness of the intellectual content. When a stand-alone system is created, the effort *must* be a collaboration between the programmer, graphics specialist, instructional designer, project manager, and primary content developers. To be effective, stand-alone systems must be engaging and task intensive. These systems are used to best effect when they simulate events and ideas that are difficult to express in words alone. To achieve a high level of effectiveness using this medium, there must be an exacting analysis of the conceptual content of the course, planning of the illustrations of the tasks and presentations, and creative brainstorming to determine an overall approach to teaching the curriculum. This effort requires a complete translation of the curriculum from a facilitated discussion or lecture into a wholly different paradigm.

Given the example provided on page 42, there would be a need to determine how best to get across *ideas* at the level of the "top-level enabler." The question to ask for enabler number 1 would be "What presentations and activities will best support the student's understanding of risk management?" At first, there is a need to know whether risk management has subparts. Are there other enablers beneath risk management that constitute prerequisite understandings? If we assume that risk management is the fundamental concept for the student to grasp, then the developers must work in conjunction with the content experts to determine an approach to teaching it.

For example, one approach might use video segments, graphics, animations, or audio to present a simulated environment. One such system, produced by Allen Communications, places the student in the position of managing a railroad. The learner must make decisions about real-estate purchases, right of way, legal considerations, budget decisions, competitors, and so on. The idea behind the system is to present the student with a realistic representation of the variables affecting a manager in real life, using an entertaining backdrop. In this simulation, students sometimes achieve great success and sometimes go bankrupt, depending on their judgments about new rail purchases or construction, contracts obtained, and so on.

For the risk management example, a series of video scenarios could be compiled illustrating the effects of certain variables and risk. The possibilities for stand-alone interactive multimedia systems are many, given the following set of enabling skills:

IS1: identifying sources and types of risks

IS2: identifying the known causes of software-acquisition risks

IS3: establishing and applying a software risk recognition and awareness process

IS4: predicting the consequences of a software-acquisition risk event

IS5: estimating the probability of a software risk-acquisition risk event

IS6: developing risk-reduction strategies for software acquisition

IS7: evaluating software-acquisition problem-solving techniques

Having identified the enabling skills, the next question to ask, according to the instructional systems design model [Dick 85], is "What instructional strategy will be used?" Using interactive computer-based multimedia, the instructor has a new set of possibilities available. Given the enabling skills above, the instructor attempts to capture the best way to "situate" the learner's experience such that it will have the greatest meaning and transfer of ability into the actual work context. Obviously, one way of accomplishing this is to simulate an actual acquisition environment. The task would be to create a scenario in which the learner would be put into a context, perhaps using video to accomplish this, and be forced to make decisions according to the risks that arise.

This approach creates a surrogate experience, allowing the user to make mistakes and see the consequences of those mistakes played out in a form that causes no disasters, but which is memorable to the student.

Consider the following scenario:

A student takes a seat in front of a terminal in an office. The system is running from a LAN, and all that is required of the student to begin instruction is to type a user identification and password. After the student logs in, the system invites the student to answer some questions concerning organizational affiliation, branch of service, type of assignment, and so on. After

conducting this interactive questionnaire, the system loads a scenario appropriate to the user's assignment and branch of service, based on pre-established curriculum requirements.

For this example, the student is assigned as a captain in the systems program office (SPO) for COBRA STARS, a fictitious airborne surveillance aircraft. Colonel Brighton is the program director, and the user will be assigned as a software division chief. In this role, the captain will be approached, on video, by a Mr. Johnson from THC Systems Inc. THC was tasked with producing a radar data processor (RDP) for COBRA STARS. The RDP is actually an integrated set of processors, each with a specific function relative to the signal-processing and decoding task, each processor having its own specialized software modules to drive it. THC named these individual processors *AMPS*.

In the original software requirements specification (SRS) for the system, all processors were to have 50 percent of capacity idle at all times during system use. Today there is a problem: The captain notices that in many instances, performance measures of the processors in the RDP are functioning at levels well over 50 percent. At the same time, Mr. Johnson assures the captain that the RDP is running within the specifications provided to THC by the Air Force.

In video, Colonel Brighton angrily demands that the captain get to the bottom of this problem, as he is convinced that the contractor is attempting to renegotiate the original specifications.

After this presentation of the conditions within the SPO, the captain (student user) is shown a menu of options representing possible courses to be taken given these circumstances. Among the possibilities are

- request for specifications for the RDP
- performance measures

The student may choose one or both of the options listed. Depending on whether one or both have been selected, the student is approached by an animated figure who suggests that analyzing the original performance specifications might provide some useful clues. However, if only one of the possibilities is chosen in the absence of the other, the student is simply presented with the opportunity to schedule a meeting. The possibilities given the student for this meeting include

- Meet with Colonel Brighton to discuss specifications.
- Meet with the contractor to discuss the specifications and performance measures.

For the case in which the student has not selected the opportunity to review the performance measures, and must now schedule a meeting, the captain is in effect walking into a trap. Whether the meeting takes place with the colonel or the contractor, questions will be posed by either the contractor or the colonel that will expose the captain's lack of preparation.

For the case in which "Meet with Colonel Brighton" has been selected, the colonel (in video) will ask, "What do the comparisons say?" If the student at the workstation provides no answer within a given timeout threshold or selects a menu option such as "I have not yet requested

that information," the colonel dismisses the captain brusquely with, "At least next time prepare yourself before you waste my time, Captain!"

Of course, other options would provide a series of other complex experiences. The "right answer," in the case above, would be to have chosen both the performance measures and specifications, which in turn would have made other data-gathering opportunities available to the captain. As the captain made more decisions pertaining to data gathering, options such as "examine individual RDP component performance measures" would reveal themselves in the context of the captain's investigation, with subsequent scenarios and opportunities played out in video or animations, simulating the consequences of making those decisions as realistically as possible.¹³

Sidebar (fyi): In the true story on which the above example was based, the aggregated performance of the processors within the RDP left more than 50 percent idle capacity for the RDP considered as a whole. The government, however, asserted that each processor (AMP) was to have 50 percent idle capacity, not the RDP. The software runs on the AMPs, and there is no high-order language or compiler for the RDP. An investigation over the meaning of the word "processor" in the original specification ensued because of the government's assertion. In light of the government's actual specification, the aggregated performance measures used by the contractor were irrelevant.

The details of an interactive implementation of such a scenario are as varied as one can imagine, considering the many possible ways of utilizing video, audio, animation, and so on to create a poignant instructional experience for the student. Incorporating enabling skills and knowledge is a matter of specifying a mapping between the types of tasks assigned to the student and those enablers in the context of the multimedia interaction. In the simple example above, the student is presented with a scenario in which choices must be made about courses of action in investigating a situation in which risk has already become crisis. By being thrust into the situation, the student must necessarily "identify sources and types of risks...", "establish and apply a software acquisition and awareness process..." and so on. The precision and degree with which the course enablers are fulfilled depends upon the creativity and analysis of the combined team of content and multimedia developers.

A.2.3 Classroom Technology Decision Points

The landscape of educational decision making has changed with advances in instructional technology. If the ISD model (or other variation) is assumed as the basis for course development, then not only can we say that the decisions themselves have changed, but the timing as to when the decisions are made has also changed in reference to this model.

No longer must one ask whether instructional technology is usable in the classroom—it is. The question to ask is whether one *prefers* to use technology at all in the context of the curriculum, and if so, how? In terms of the instructional-design model in Figure A-1 on page 51, this means

¹³ Special thanks to Joe Besselman and Colonel Thomas Miller for providing the substance of this example from real life.

that it is now possible to ask whether or not to use instructional technology at the same time that instructional goals are considered, as opposed to waiting until we reach *Develop Instructional Strategy* or *Develop and Select Instructional Materials*. This is a big change over past practice, in which the use of instructional technology would have been considered only well after the objectives of the course were determined.

A Common Instructional Systems Design Process Model

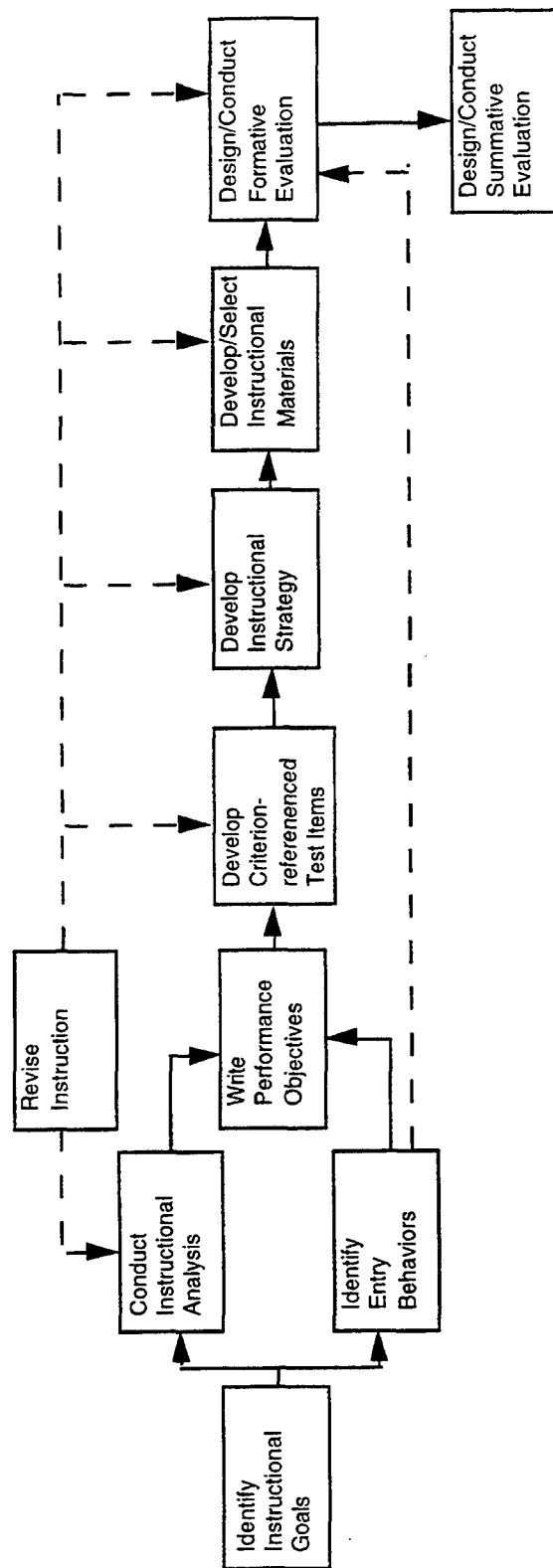


Figure 6: A Common Instructional Systems Design Process Model

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provide these benefits over long distances. This report will show that with today's computer-based instructional technology, the question is no longer *whether* to use the technology, but rather *how* to use it.

Electronic References

Internet Locations

Note: The following URLs are current as of the date of publication

Crew System Ergonomics Information Analysis Center (CSERIAC) -

<http://www.dtic.mil/iac/cseriac/cseriac.html>

CSERIAC is the gateway to worldwide sources of up-to-date human factors information for designers, engineers, researchers, and human factors specialists. CSERIAC provides a variety of products and services to government, industry, and academia to promote the use of ergonomics in the design of human-operated equipment. CSERIAC is one of more than 20 Information Analysis Centers (IAC), that provide technical information services in a variety of subject areas.

Defense Department Education Gateway - *<http://www.acq.osd.mil/ddre/edugate/>*

Over the last 50 years the Military Services and Defense Agencies have developed wide-ranging, independently evolved programs that support science and engineering education.

Defense Manpower Data Center (DMDC): Defense Instructional Technology Information System (DITIS) -

<http://www.dmdc.osd.mil/ditis/>

The DMDC Defense Instructional Technology Information System (DITIS) is a Department of Defense (DoD) database in support of DoD Instruction 1322.20, "Development and Management of Interactive Courseware (ICW) for Military Training."

Defense Modeling and Simulation Office (DMSO) - *<http://www.dmsomil/>*

DMSO, a staff activity reporting to the DDR&E Office of the USD(A&T), was established to serve as the executive secretariat for the EXCIMS and to provide a full-time focal point for information concerning Department of Defense (DoD) Modeling and Simulation (M&S) activities. Currently the DMSO promulgates M&S policy, initiatives, and guidance to promote cooperation among DoD components to maximize efficiency and effectiveness.

Defense Modeling, Simulation, and Tactical Technology Information Analysis Center (DMSTTIAC) -

<http://dmsttiac.hq.iitri.com/>

DMSTTIAC is a member of the Defense Technical Information Center (DTIC) Information Resource Web of Information Analysis Centers (IACs). DMSTTIAC is sponsored by DTIC and the Defense Modeling and Simulation Office (DMSO), and is supported by the Army Materiel Command, Smart Weapons Management Office (SWMO), and the Office of the Under Secretary of Defense Acquisition and Technology, (OUSD(A&T)). DMSTTIAC is operated for DTIC, IAC Program Office (DTIC-AI), by IIT Research Institute (IITRI). DMSTTIAC was established to access, acquire, collect, analyze, synthesize, generate, and disseminate scientific and technical information in the area of modeling and simulation, tactical warfare technology, test and evaluation, and special operations forces in order to: (1) support the DoD research, development, test and acquisition activities; (2) assist DoD components/offices, other government agencies, academia, government contractors, and U.S. industry, as authorized, in the analysis and dissemination of information within the DoD modeling and simulation, tactical warfare technology, test and evaluation, and special operations force activities; and (3) promote the exchange of technical information within the DMSTTIAC subject areas throughout DoD's research, development and acquisition communities.

Defense Technical Information Center (DTIC): MATRIS Office - *<http://dticam.dtic.mil/>*

The Manpower and Training Research Information System (MATRIS), a specialized database of the Defense Technical Information Center (DTIC), collects, stores, updates, retrieves and disseminates information on people-related research within the Department of Defense (DoD). Research areas covered include manpower and personnel, training technology, and human factors engineering (MPT/HF).

Air Force 333d Training Squadron, Qualification Training Flight - <http://qflight.kee.aetc.af.mil/>

The 333d Training Squadron, Qualification Training Flight, Production Element, develops standardized, high-quality, exportable, on-the-job-training (OJT) programs for 28 different enlisted specialties in the Command, Control, Communications, and Computers (C4) area, producing over 650 Air Force Job Qualification Standards (AFJQS) and Air Force Qualification Training Packages (AFQTP), with more than 250 currently in use.

Air Force Rome Laboratory: Distributed Interactive Simulation (DIS) For Tactical C3I - <http://www.rl.af.mil/Lab/IR/IRAE/Efforts/TIS.back.DIS4TC3I.html>

Rome Lab's Intelligence Technology Branch (RL/IRAE) provides modeling and simulation support to a variety of intelligence consumers and analysts, across a wide spectrum of application areas. This support includes basic and applied R&D in the enabling technologies of Modeling and Simulation, proof-of-concept and feasibility prototype development efforts, system and component design support, and ultimate transition to field exercises and operational sites. One particular area of interest is that of Distributed Interactive Simulation (DIS).

Air Force Institute of Technology: Distance Learning Directorate - <http://www.afit.af.mil/schools/EN/ENG/LABS/GRAPHICS/veprojects/ve.html>

This specialized facility at the Air Force Institute of Technology fosters research in the design and implementation of virtual environments, distributed interactive simulations, and advanced distributed simulations for military and medical uses. Research is in the areas of 3D medical imaging, applications of multimedia to the training and simulation missions, and design and application of advanced computer architectures for virtual environments. The Directorate's mission includes conducting seminars, workshops, in-house demonstrations, classes and on-site demonstrations of lab research products.

Air Force Warrior Preparation Center - <http://www.wpc.af.mil/>

The Air Force Warrior Preparation Center provides commanders and their staffs, joint and combined, an operational-level exercise environment.

AFMC Modeling and Simulation (TPIPT): Distributed Interactive Simulation - <http://www.afbmd.laafb.af.mil/xre/m&s/>

[See Defense Modeling and Simulation Office (DMSO)]

Army Armament Research Development and Engineering Center(ARDEC): Distributed Interactive Simulation (DIS) - <http://dis.pica.army.mil/>

The concept of networked simulation was first developed in the SIMNET (SIMulation NETwork) program, sponsored by Defense Advanced Research Projects Agency (DARPA). This extended concept of networked simulation is called Distributed Interactive Simulation (DIS) – a virtual environment within which humans may interact through simulation at multiple sites that are networked, using compliant architecture, modeling, protocols, standards and databases.

Army STRICOM: DIS Simulator/Simulation Infrastructure - <http://www.stricom.army.mil/STRICOM/PM-DIS/>

Advanced Distributed Simulation Technology (ADST) — Because Distributed Interactive Simulation (DIS) cuts across traditional functional domains and organizational boundaries in the Army, a unique management structure has been developed. PM DIS is the Army's designated technical manager, the creator and keeper of the Army's DIS capabilities. PM DIS makes these capabilities available to government, industry and academic researchers, through its subordinate structure, i.e., APM DIS, APM STOW and PM CAAN.

Army TRAC Verification and Validation - <http://www-tracvv.army.mil/>

Army Training and Doctrine Command Analysis Center Verification and Validation Office at Ft. Leavenworth, KS, projects include the Workshop on the Interoperability of Distributed Simulations. Under the joint sponsorship of the Defense Modeling and Simulation Office (DMSO) and the Army Simulation, Training and Instrumentation Command (STRICOM), the primary purpose of the DIS workshop is to develop standards for the use of DIS. Specifically, the focus is on exercise configuration management, exercise control and feedback requirements and database management.

Marine Corps Modeling & Simulation Management Office - <http://138.156.4.23/>

The Marine Corps Modeling & Simulation Management Office mission is to create a heterogenous simulation environment, while meeting all training and analysis, modeling and architecture requirements, seeking to successfully interoperate live, virtual and constructive simulation entities, and establishing distributed interactive simulation standards to physically support distributed participation.

Naval Air Warfare Center: Center of Excellence for Simulation and Training Technology - <http://www.ntsc.navy.mil/>

Simulation and training technology in Orlando is on the brink of a new era brought about by combining the strengths of the military, academic, and industrial communities with State and local endorsements under the Center of Excellence banner.

Navy Education and Training Program Management Support Activity - <http://www.cnet.navy.mil/cgi-bin/netpmsa/>

NETPMSA provides the Naval Service with quality products and services to support and enhance education, training, career development and personnel advancement.

Modeling & Simulation Resource Repository (MSRR) - <http://mercury-www4.nosc.mil/msrr/>

The MSRR, sponsored by the Defense Modeling & Simulation Office (DMSO), is envisioned as a collection of computer resources and information which will assist the Modeling & Simulation Community in communication and information sharing. The MSRR project is a prototype effort which leverages existing technology developments in inter-networking, such as the World-Wide-Web (WWW), to provide an interim capability and to assist in deriving the requirements for the future MSRR system. The MSRR node for the Simulation Directories allows you to browse descriptions of the models and simulations maintained by various defense agencies.

Stanford University: Stanford Research Institute - <http://www.erg.sri.com/>

Stanford Research Institute's International Information, Telecommunications, and Automation Division (ITAD) is dedicated to research, development, and technology exploitation. It maintains core competencies in the areas of: Applied Artificial Intelligence, Automation, Distributed Information Processing, Information Systems Integration, Product Design and Development, Technology Transfer, and Telecommunications. ITAD's strong multidisciplinary team's mission is dedicated to advancing information processing, telecommunications, and automation technologies, to implementing advanced technologies in new products and systems for their clients, and to using their research as leverage for technology transfer within and between public- and private-sector communities.

Training and Simulation Technology Consortium (TSTC) - <http://www.techware.com/tstc/>

The Training & Simulation Technology Consortium (TSTC), established in 1993 by NASA's Kennedy Space Center, the Naval Air Warfare Training Center System Division, the Army's Simulation Training and Instrumentation Command, and the University of Excellence, joining with industry partners —IBM/LORAL/Lockheed, Analysis and Technology, Inc., Dual, Incorporated, and Dynamics Research Corporation — seeks commercial, other government, and educational applications for the simulation and advanced learner-centered technologies developed by the defense and space industry. Leaders in developing world-class training and simulation technologies, the Consortium provides a variety of products and services that include advanced learning and training technologies, decision support systems, large-scale logistics models, and synthetic environments. They include high-end simulation and interactive electronic tutoring that uses computer-based multimedia technology, virtual reality and artificial intelligence. Products are developed with state-of-the-art multimedia application tools on a wide range of platforms which may be used in a networked or stand-alone environment.

University of Central Florida: Information Technology Service Center (ITSC) - <http://www.sc.ist.ucf.edu/>

The ITSC was established to bring a permanent, central resource for a wide range of information services to the community. Operated by the Institute for Simulation & Training (IST), the Center's orientation is on clients, allowing each to provide its customers with a unique perspective according to their own design.

Interactive Courseware (ICW) - http://ott.sc.ist.ucf.edu/1_2/index.htm

ICW is computer-controlled courseware that relies on trainee input to determine the pace, sequence, and content of training delivery, using more than one type medium to convey the content of instruction. ICW can link a combination of media, to include but not be limited to: programmed instruction, video tapes, slides, film, television, text, graphics, digital audio, animation, and up to full-motion video to enhance the learning process.

University of Pennsylvania: Distributed Systems Laboratory (DSL) - <http://www.cis.upenn.edu/~dsl/dsl.html>

The DSL is an academic and research facility investigating advanced networking technologies, and is part of the Computer and Information Science and the Electrical Engineering departments of the School of Engineering and Applied Science at the University of Pennsylvania.

Virginia Tech, Department of Computer Science: Simulation and Software Engineering Laboratory - <http://manta.cs.vt.edu/s&seLab/>

One of the largest research focuses of this Laboratory was the development of the Visual Simulation Environment (VSE) at Virginia Tech under funding from the U.S. Navy between 1983 and 1995. The VSE was developed using the NEXTSTEP object-oriented software engineering environment. This made possible the creation of the currently available VSE commercial Version 1.0 at Orca Computer, Inc.

*Visit DTIC on the Internet at:
<http://www.dtic.mil>*

Additional References

Note: Refer to the order form following the bibliographies for ordering information.

AD-A322 053

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA(U) Internetworking: Economical Storage and Retrieval of
Digital Audio and Video for Distance Learning.

DESCRIPTIVE NOTE: Master's thesis.

SEP 96 118P

PERSONAL AUTHORS: Tiddy, Michael E.

UNCLASSIFIED REPORT

ABSTRACT: (U) Previous research has shown that it is possible to use the Internet's Multicast Backbone (MBone) and associated audio/video software for the purpose of Distance Learning. As more education is performed online, the need arises to be able to view the content at the user's convenience. Through experimental testing, this thesis investigates the usefulness and feasibility of applying networked recording and storage of digitized audio and video, all via the MBone for distance learning. Large, distributed organizations such as the Naval Service can economically benefit from use of the MBone and its associated tools. To date, Navy and Marine Corps projects using video teleconferencing have not exploited the vast possibilities provided by the Internet and the MBone. This thesis takes distance learning one step farther and combines MBone audio/video with the new recording tool called the Multicast Backbone Video Conference Recorder (MBone VCR). This enables distance learning as a viable replacement to on-site training. It is technically feasible and economically supportable to record the digital media that results from an MBone session used for a distance learning program. That stored information can then be used repeatedly and easily updated to support changing curricula and information. Problems and network accessible solutions are demonstrated in this case study on use of the MBone VCR as a usable remote educational tool.

DESCRIPTORS: (U) *COMPUTER COMMUNICATIONS, *INTERNET, *CONFERENCING (COMMUNICATIONS), SOFTWARE ENGINEERING, THESES, OPTICAL COMMUNICATIONS, INFORMATION RETRIEVAL, MEDIA, ONLINE SYSTEMS, DATA LINKS, DIGITAL COMMUNICATIONS, VIDEO SIGNALS, BUFFER STORAGE, NAVAL TRAINING, VIDEO RECORDING, DIGITAL RECORDING SYSTEMS, CONDITIONING (LEARNING).

IDENTIFIERS: (U) DISTANCE LEARNING, MBONE (MULTICAST BACKBONE), WORLD WIDE WEB, TELECONFERENCING.

AD-A322 044

ARMY RESEARCH INST FOR THE BEHAVIORAL AND
SOCIAL SCIENCES
ALEXANDRIA, VA

(U) Standardizing Army After Action Review Systems.

DESCRIPTIVE NOTE: Final rept. Oct 95-May 96.

OCT 96 87P

PERSONAL AUTHORS: Meliza, Larry L.

UNCLASSIFIED REPORT

ABSTRACT: (U) The After Action Review (AAR) is the Army's approach for providing feedback to units after collective training exercises. AAR systems should support the goals of analyzing what happened during an exercise, deciding why it happened, and identifying potential corrective actions. In an effort to reduce duplication of efforts, the Army is developing a Standardized Army AAR System (STAARS) for application across the live, virtual, and constructive environments. This report presents lessons learned about the AAR process, operational AAR systems, and prototype AAR systems that provide input for specifying STAARS capabilities or identifying technical or behavioral issues to be addressed by research and development.

DESCRIPTORS: (U) *ARMY TRAINING, *DISTRIBUTED INTERACTIVE SIMULATION, MILITARY REQUIREMENTS, LESSONS LEARNED, ARMY PERSONNEL, INTEROPERABILITY, HUMAN FACTORS ENGINEERING, MILITARY EXERCISES, WAR GAMES, MAN COMPUTER INTERFACE, USER FRIENDLY, VIRTUAL REALITY.

IDENTIFIERS: (U) AAR (AFTER ACTION REVIEW).

AD-A321 573

AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH(U) Solar System Modeler: A Distributed, Virtual
Environment for Space Visualization and GPS Navigation.

DESCRIPTIVE NOTE: Master's thesis.

DEC 96 101P

PERSONAL AUTHORS: Williams, Gary E.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Solar System Modeler (SM) extends the Space Modeler developed in 1994. It provides a virtual environment enabling an explorer to dynamically investigate near Earth satellites, deep space probes, planets, moons, and other celestial phenomena. The explorer navigates the virtual environment via mouse selected options from menu panels while wearing a tracked, head mounted display (HMD). Alternatively, a monitor may replace the HMD and keyboard controls replace head tracking. The SM's functionality is extended by the ability to broadcast simulated GPS satellite transmissions in compliance with Distributed Interactive Simulation (DIS) protocol standards. The transmissions include information found in true GPS broadcasts that is required for a receiver to determine its location. The Virtual GPS Receiver (VGPSR) receives the GPS transmissions from the SM and computes the receiver's position with a realistic error based on numerous variables simulating those encountered in the real GPS system. The VGPSR is designed as a plug-in module for simulations requiring virtual navigation. The receiver's client application provides the VGPSR with the simulation time and the true position of the receiver. In return the application receives a GPS indicated position.

DESCRIPTORS: (U) *GLOBAL POSITIONING SYSTEM, *SPACE NAVIGATION, SIMULATION, POSITION (LOCATION), PANELS, TRACKING, MODULAR CONSTRUCTION, DISPLAY SYSTEMS, TIME RECEIVERS, NAVIGATION SATELLITES, ARTIFICIAL SATELLITES, KEYBOARDS, MICE, EARTH (PLANET), DEEP SPACE, MENU, VIRTUAL REALITY, MOON, HEAD UP DISPLAYS, SOLAR SYSTEM, SPACE PROBES, PLUG IN UNITS, DISTRIBUTED INTERACTIVE SIMULATION.

AD-A321 343

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA(U) Internetworking: Multicast and ATM Network
Prerequisites for Distance Learning.

DESCRIPTIVE NOTE: Master's thesis.

SEP 96 147P

PERSONAL AUTHORS: Tamer, Murat T.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Internet, the World Wide Web and the Multicast Backbone (MBone) have been used in a variety of ways for distance learning. Video Teleconferencing (VTC) classrooms have obvious value and utility but they are limited to communicate with only a small number of similar VTC facilities. We are most interested in open solutions which take advantage of the global Internet. Therefore, the problem addressed by this thesis is to evaluate the specific benefits and drawbacks of Internet technologies in support of distance learning. This thesis includes a detailed examination of MBone, Asynchronous Transfer Mode (ATM) and the Distributed Interactive Simulation (DIS) protocol from the perspective of distance learning. An innovative design for a low-cost Web/MBone-capable classroom is presented. Experimental results include globally multicasting the IEEE Autonomous Underwater Vehicle conference and digitally recording the 1996 Monterey Bay Web Content and Access Workshop. One result we found is that MBone can be used successfully for distance learning purposes despite common constraints of limited (128 Kbps) bandwidth. A further result is that an MBone classroom can be 42% as expensive as a VTC classroom if an SGI Indy is used and 12% as expensive as a VTC classroom if a PC is used in the classroom. Consequently, many schools can afford Internet-based distance learning using the solutions presented in this thesis even though they cannot afford VTC rooms.

DESCRIPTORS: (U) *COURSES (EDUCATION), *INTERNET, *CONFERENCING (COMMUNICATIONS), INTEGRATED SYSTEMS, INFORMATION EXCHANGE, COST EFFECTIVENESS, COMPUTER COMMUNICATIONS, ASYNCHRONOUS SYSTEMS, LOCAL AREA NETWORKS, THESES, OPTICAL COMMUNICATIONS, MAN COMPUTER INTERFACE, DATA LINKS, DIGITAL COMMUNICATIONS, VIDEO SIGNALS, GLOBAL COMMUNICATIONS, CONDITIONING (LEARNING), DISTRIBUTED INTERACTIVE SIMULATION.

IDENTIFIERS: (U) ATM (ASYNCHRONOUS TRANSFER MODE), DISTANCE LEARNING, WORLD WIDE WEB, VTC (VIDEO TELECONFERENCING).

AD-A321 230

INSTITUTE FOR DEFENSE ANALYSES
ALEXANDRIA VA

(U) Distance Learning and the Reserve Components.

DESCRIPTIVE NOTE: Final rept. Aug 95-Nov 96.

DEC 96 80P

PERSONAL AUTHORS: Metzko, U.; Redding, G. A.;
Fletcher, J. D.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report summarizes and evaluates Service plans to adopt distance learning (DL) technologies submitted in response to tasking by the Deputy Secretary of Defense. The evaluation includes consideration of information exchanged in joint-Service/OSD (Office of the Secretary of Defense) groups that have been reviewing Service training requirements and training technology. The evaluation of DL plans resulted in the following major findings: (1) DL has the potential to provide effective training and to reduce costs; (2) DL is little used by DoD today; (3) converting to DL requires sizable up-front investments; (4) the Services plan to convert about one in five courses to DL; (5) joint management of DL is needed to maximize savings; and (6) data gaps preclude intelligent DL investment decisions.

DESCRIPTORS: (U) *MILITARY RESERVES,
*EDUCATION, *MILITARY TRAINING,
REQUIREMENTS, DEPARTMENT OF DEFENSE,
INVESTMENTS, INFORMATION EXCHANGE,
ECONOMICS, COSTS, COMPUTER AIDED
INSTRUCTION, TRAINING MANAGEMENT.

IDENTIFIERS: (U) DISTANCE LEARNING.

AD-A320 912

AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH(U) Dynamic Relevance Filtering in Asynchronous Transfer
Mode-Based Distributed Interactive Simulation Exercises.

DESCRIPTIVE NOTE: Master's thesis.

DEC 96 98P

PERSONAL AUTHORS: Hightower, David T.

UNCLASSIFIED REPORT

ABSTRACT: (U) As Distributed Interactive Simulation (DIS) exercises continue to grow in scale, the need to support a large number of players has become apparent. The demands on the network and the simulation hosts in large exercises, though, have proved to be prohibitive, requiring significant computational overhead to filter through the information and extract what is relevant to a particular simulation. Some mechanism is needed to reduce irrelevant network traffic received by a system, while increasing the bandwidth available for the DIS exercise. Previous research efforts in this area have centered primarily on fixed geographic partitions of the battlespace to reduce the traffic at a given host. This geographic partitioning cannot adapt to the changing battlespace, and requires relatively significant preexercise setup and coordination. Our research has been to implement a DIS exercise system using native ATM interfaces, and to determine if a dynamic partitioning system is feasible and will provide a sufficient reduction in network traffic to allow DIS exercises to scale to the target 100,000 entities. A support infrastructure for DIS over ATM was developed and tested with current AFIT DIS applications, and a prototype dynamic partitioning system using geographic criteria was implemented.

DESCRIPTORS: (U) *LOCAL AREA NETWORKS,
*DISTRIBUTED INTERACTIVE SIMULATION,
SYSTEMS ENGINEERING, DATA MANAGEMENT,
INFORMATION TRANSFER, HOST COMPUTERS,
DISTRIBUTED DATA PROCESSING, COMPUTER
COMMUNICATIONS, COMMUNICATIONS TRAFFIC,
THESES, INPUT OUTPUT PROCESSING, MILITARY
EXERCISES, WAR GAMES, DATA RATE, DYNAMIC
PROGRAMMING, DATA LINKS, BUFFER STORAGE.

IDENTIFIERS: (U) COMMUNICATIONS PROTOCOLS,
ATM (ASYNCHRONOUS TRANSFER MODE).

AD-A320 899

INTERSTATE ELECTRONICS CORP
ANAHEIM CA

(U) Distance Learning Environment Demonstration.

DESCRIPTIVE NOTE: Final rept. Sep 94-Mar 96.

NOV 96 49P

PERSONAL AUTHORS: Viren, Catherine.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Distance Learning Environment Demonstration (DLED) was a comparative study of distributed multimedia computer-based training using low cost high performance technologies. An all Pentium PC network ported to Novell/Ethernet and ATM/SONET (Asynchronous Transfer Mode/Synchronous Optical Network) environments used heterogeneous Commercial-Off-The-Shelf (COTS) products for computer-based training, multimedia communications, networking, and measurement. The DLED project provides baseline research in the effective use of distance learning and multimedia communications over a wide area ATM/SONET network. The network performance of the NYNet using COTS software was examined along with a Local Area Network (LAN) migration path to the high bandwidth Wide Area Network (WAN) Infosphere.

DESCRIPTORS: (U) *WIDE AREA NETWORKS, *COMPUTER AIDED INSTRUCTION, *CONDITIONING (LEARNING), SOFTWARE ENGINEERING, INFORMATION TRANSFER, COMPUTER COMMUNICATIONS, LOCAL AREA NETWORKS, OFF THE SHELF EQUIPMENT, OPTICAL COMMUNICATIONS, COURSES (EDUCATION), MICROCOMPUTERS, MAN COMPUTER INTERFACE.

IDENTIFIERS: (U) DISTANCE LEARNING, ATM (ASYNCHRONOUS TRANSFER MODE).

AD-A319 584

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

(U) LeatherNet: An Evaluation as a Mission Planning and Briefing Tool.

DESCRIPTIVE NOTE: Master's thesis.

SEP 96 95P

PERSONAL AUTHORS: Hague, Tracy R.

UNCLASSIFIED REPORT

ABSTRACT: (U) The author evaluates LeatherNet, a Distributed Interactive Simulation compliant, virtual simulation system being developed by the Advanced Research Projects Agency to demonstrate Modeling and Simulation (M&S) technologies and to partially fulfill the U.S. Marine Corps M&S goals. The research focuses on evaluation of LeatherNet as a mission planning and briefing tool for Marine infantry company commanders, staff, and subordinate leaders. Evaluation is based on user perception and user performance on a live fire range subsequent to using the system. The user surveys indicate high user acceptance and belief that LeatherNet is a valuable mission planning and briefing tool and that LeatherNet has a good potential to be an effective training tool for commanders and their staffs. User performance, evaluated by subject matter experts on a live fire range, showed no statistically significant improvement for groups exposed to LeatherNet when compared to groups that did not use LeatherNet. The author explains why true differences, even if they do exist, would be difficult to detect due to the lack of experimental control and recommends action to be taken by the Marine Corps to conduct further testing with greater experimental control. The author also suggests steps the Marine Corps can take to optimize its investment in M&S.

DESCRIPTORS: (U) *MISSION PROFILES, *MARINE CORPS PLANNING, *MILITARY APPLICATIONS, *DISTRIBUTED INTERACTIVE SIMULATION, CONTROL, TRAINING DEVICES, PERFORMANCE (HUMAN), INFANTRY, FIRING TESTS (ORDNANCE), ELASTIC PROPERTIES, SURVEYS, USER NEEDS, COMPANY LEVEL ORGANIZATIONS, MARINE CORPS PERSONNEL, MILITARY COMMANDERS, PERCEPTION, ACCEPTABILITY.

IDENTIFIERS: (U) VIRTUAL SIMULATION.

AD-A319 100

COLORADO UNIV AT BOULDER

(U) Research and Preparation of Video Demonstrations and Evaluation of Their Effectiveness.

DEC 96 117P

PERSONAL AUTHORS: Kull, Kristen R.

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper is the culmination of a six month project begun in May 1996. The project involved researching, testing, and evaluating chemical demonstrations for a series of video tapes for a General Chemistry course. It was to be offered only a short 3 months from the original undertaking of the project. In fall 1996, the University of Colorado at Denver offered for the first time an extended studies distance learning course for General Chemistry. The students who enrolled received seven video tapes which contained lecture material, demonstrations and visual aids. In addition, students received a course outline and printed lecture notes. The students were required to use a general chemistry text to accompany the course, but the course was designed so any general chemistry text would suffice. The students visited campus seven times during the semester for a long day of labs and testing. On-line help sessions were regularly scheduled with the instructor so the students could receive help working problems and understanding concepts. The advantages of a course like this are many. (1) It allows individuals to work at their own pace reviewing material when necessary and moving quickly through material with which they are comfortable. (2) With the many requirements of work and personal lives, students can work around complex family and employment schedules. (3) For parents who stay at home with their children, no sitter is required while the parent 'goes to class'. (4) Since many students live and/or work a great distance from campus, the travel time is significantly reduced by only having to come to campus seven times for this course. The disadvantages are the lack of external motivation from the regular presence of an instructor and the sometimes slower feedback loop.

DESCRIPTORS: (U) *DEMONSTRATIONS, *INSTRUCTIONAL MATERIALS, *CHEMISTRY, *COURSES (EDUCATION), *VIDEO TAPES, REQUIREMENTS, PREPARATION, STUDENTS, CHEMICALS, MATERIALS, FEEDBACK, EXTERNAL, MOTIVATION, RANGE (DISTANCE), PRINTING, VIDEO SIGNALS, LOOPS, CHILDREN, TRAVEL TIME, VISUAL AIDS, LECTURES.

AD-A318 070

ARMY RESEARCH INST FOR THE BEHAVIORAL AND SOCIAL SCIENCES
ALEXANDRIA VA

(U) Individual Combatant Simulation System (ICSS) Assessment Plan.

DESCRIPTIVE NOTE: Final rept. Mar-Dec 95.

AUG 96 46P

PERSONAL AUTHORS: Knerr, Bruce W.

UNCLASSIFIED REPORT

ABSTRACT: (U) The objectives of the ICSS program were to: insert the individual combatant into the Distributed Interactive Simulation (DIS) compliant virtual environment; develop a more accurate representation of hostile combatants, neutrals, and friendlies in a dynamic synthetic environment; and develop a more realistic human interface. This report describes the assessment plan for the ICSS. Included are descriptions of the objectives of the ICSS program, its components, the objectives of the ICSS assessment, and the scope of the assessment (in terms of the ICSS tasks that are included). Time constraints and assessment approaches are presented. The approach for the development of lessons learned, which applies to all ICSS tasks, is then described. Each ICSS task (and where appropriate, subtasks) is described along with the assessment issues, general assessment approach, type of approach, scenario, performance measures, and tasks necessary to conduct the assessment. The computer resources and requirements and resources of the participating organizations are then presented. Finally, a labor and cost estimate is provided for each task.

DESCRIPTORS: (U) *SCENARIOS, *MILITARY APPLICATIONS, SIMULATION, ENVIRONMENTS, LESSONS LEARNED, HUMANS, SYNTHESIS, COMPUTERS, DYNAMICS, INTERFACES, ACCURACY, COST ESTIMATES, RESOURCES, DISTRIBUTED INTERACTIVE SIMULATION.

IDENTIFIERS: (U) ICSS (INDIVIDUAL COMBATANT SIMULATION SYSTEM), COMPUTER GENERATED FORCES, VOICE RECOGNITION, VIRTUAL ENVIRONMENTS.

AD-A317 745

INSTITUTE FOR DEFENSE ANALYSES
ALEXANDRIA VA(U) Innovative Analytic Techniques for Distributed
Interactive Simulation (DIS).

DESCRIPTIVE NOTE: Final rept.

SEP 96 51P

PERSONAL AUTHORS: Schwartz, R. E.; Stahl, M. M.

UNCLASSIFIED REPORT

ABSTRACT: (U) The use of distributed interactive simulation (DIS) for analytic purposes is relatively new and few analytic tools and techniques have been developed. This paper describes three techniques for analyzing data from SIMNET or DIS exercises beginning with a case study describing the use of SIMNET data to evaluate fiber optic guided weapon concepts. From the work, three techniques for analyzing data tapes from SIMNET or DIS exercises have evolved. The techniques are: statistical data analysis, imposing a model on DIS data, and replaying an exercise to a crew in a simulator. These techniques can be used to extend results from a DIS exercise (for example, sensitivity analyses can be produced) or they can be used to exploit data from previously recorded DIS exercises to produce results from issues other than those for which the exercise was originally conducted. The paper describes each technique in detail and illustrates each with a series of examples to demonstrate that, for some systems and some issues, one can develop interesting insights and results from archived SIMNET or DIS exercises.

DESCRIPTORS: (U) *METHODOLOGY, *DISTRIBUTED INTERACTIVE SIMULATION, SIMULATORS, MODELS, WEAPON SYSTEMS PROCESSING, CASE STUDIES, MATHEMATICAL ANALYSIS, COMPUTER NETWORKS, MANNED.

IDENTIFIERS: (U) DIS (DISTRIBUTED INTERACTIVE SIMULATION), FOG (FIBER OPTIC GUIDED).

AD-A317 347

ONYX SCIENCES CORP
CAMBRIDGE MA

(U) Scalable Processing for Distributed Simulation and Scene Generation.

DESCRIPTIVE NOTE: Technical rept. Apr-Oct 94.

JUL 95 45P

PERSONAL AUTHORS: Rhodes, Brahm A.; Bronson, Steve D.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report details the results of researching and evaluating massively parallel architectures and visualization techniques. The main focus of this project was to evaluate and determine the potential of parallel computing systems for visual simulation applications, such as distributed interactive simulation, scene generation, visualization and others. This report summarizes results of our performance tests; describes scenarios and architectures that exploit parallel processors for visual simulation applications; discusses the state of the parallel computing industry; and presents recommendations for further research and development. Furthermore, this document describes a prototype toolkit to explore various options for using parallel processors for visual simulation.

DESCRIPTORS: (U) *PARALLEL PROCESSING, *DISTRIBUTED INTERACTIVE SIMULATION, DATA BASES, ALGORITHMS, SOFTWARE ENGINEERING, SCENARIOS, DATA MANAGEMENT, DISTRIBUTED DATA PROCESSING, COMPUTER COMMUNICATIONS, COMPUTER ARCHITECTURE, INPUT OUTPUT PROCESSING, PARALLEL PROCESSORS, COMPUTER GRAPHICS, MULTIPROCESSORS, SYSTEMS ANALYSIS, COMPUTER NETWORKS, OBJECT ORIENTED PROGRAMMING.

IDENTIFIERS: (U) SIMD (SINGLE INSTRUCTION MULTIPLE DATA).

AD-A317 289

SCIENCE AND TECHNOLOGY CORP
HAMPTON VA

(U) Natural Environmental Effects in Military Models and Simulations: Part III - An Analysis of Requirements Versus Capabilities.

DESCRIPTIVE NOTE: Scientific rept. no. 2.

AUG 96 48P

PERSONAL AUTHORS: Burgeson, John C.; Piwowar, Thomas M.; Try, Paul D.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Defense Modeling and Simulation Office has sponsored the Environmental Effects for Distributed Interactive Simulation (E2DIS) Project, which is composed of eight tasks including the Survey Task. The Survey Task had three objectives: to develop a baseline of the Military Services' current requirements for incorporation of the atmosphere and near space environment and their effects in military models and simulations (the Requirements Survey), to identify atmospheric and nearspace-environment models and databases and environmental effects models and databases that are currently available from the Services (the Capabilities Survey), and to compare the results from both survey efforts and make appropriate recommendations. This report, Part III of a three-part series, describes the results of a comparative analysis of the two surveys, whose results are reported in Part I (the Requirements Survey) and Part II (the Capabilities Survey). The analysis focuses on the eight most-needed types of environmental data, as determined from the Requirements Survey, and shows that the capabilities for providing these data, especially at high fidelity, are deficient. Requirements and capabilities are compared in terms of their horizontal, vertical, and temporal fidelity. Capabilities are deficient if they satisfy less than 75 percent of the requirements. The most significant deficiencies are found in models and databases of aerosols, fog, humidity, and visibility.

DESCRIPTORS: (U) *MILITARY OPERATIONS, *SIMULATION, *ENVIRONMENTAL IMPACT, *MILITARY CAPABILITIES, *ATMOSPHERE MODELS, DATA BASES, AEROSOLS, SPACE ENVIRONMENTS, SURVEYS, FOG, DEFICIENCIES, VISIBILITY, HUMIDITY, DISTRIBUTED INTERACTIVE SIMULATION.

IDENTIFIERS: (U) CAPABILITIES SURVEY, ATMOSPHERIC EFFECTS, DMSO (DEFENSE MODELING AND SIMULATION OFFICE), DEFENSE MODELING AND SIMULATION OFFICE, E2DIS (ENVIRONMENTAL EFFECTS FOR DISTRIBUTED INTERACTIVE SIMULATION), ENVIRONMENTAL EFFECTS FOR DISTRIBUTED INTERACTIVE SIMULATION, NEAR SPACE ENVIRONMENT EFFECTS.

AD-A317 148

SCIENCE AND TECHNOLOGY CORP
HAMPTON VA

(U) Natural Environmental Effects in Military Models and Simulations: Part II-A Survey of Capabilities.

DESCRIPTIVE NOTE: Scientific rept. no. 3.

AUG 96 320P

PERSONAL AUTHORS: Burgeson, John C.; Piwowar, Thomas M.; Try, Paul D.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Defense Modeling and Simulation Office (DMSO) has sponsored the Environmental Effects for Distributed Interactive Simulation (E2DIS) Project, which is composed of eight tasks including the Survey Task. The Survey Task had three objectives: to develop a baseline of the Military Services' current requirements for incorporation of the atmosphere and nearspace environment and their effects in military models and simulations (the Requirements Survey), to identify atmospheric and near-space environmental models and databases and effects models and databases that are currently available from the Services (the Capabilities Survey), and to compare the results from both survey efforts and make appropriate recommendations. In a series of three reports, Part I describes the results and findings from the Requirements Survey; this report, Part II, describes the results and findings from the Capabilities Survey; and Part III compares and assesses the results of both surveys. The Survey Team received questionnaires for 152 models and databases that were quality controlled and entered into an automated database management system for analysis. The results of the analysis are presented in this report. Both the Capabilities Survey database and the Requirements Survey database are available from PL/GPAA.

DESCRIPTORS: (U) *DATA BASES, *ENVIRONMENTAL IMPACT, *ATMOSPHERE MODELS, *DISTRIBUTED INTERACTIVE SIMULATION, MILITARY FORCES (UNITED STATES), SIMULATION, MILITARY REQUIREMENTS, AUTOMATION, ENVIRONMENTS, DEFENSE SYSTEMS, DATA MANAGEMENT, MILITARY EQUIPMENT, TEAMS (PERSONNEL), SURVEYS, QUESTIONNAIRES, SPACE COMMUNICATIONS.

IDENTIFIERS: (U) E2DIS (ENVIRONMENTAL EFFECTS FOR DISTRIBUTED INTERACTIVE SIMULATION), M&S (MODELING AND SIMULATION), CAPABILITIES SURVEY, NEAR SPACE ENVIRONMENTS, MEL (MASTER ENVIRONMENTAL LIBRARY).

AD-A316 889

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

(U) A Network Software Architecture for Large Scale Virtual Environments.

DESCRIPTIVE NOTE: Doctoral thesis.

JUN 95 255P

PERSONAL AUTHORS: Macedonia, Michael R.

UNCLASSIFIED REPORT

ABSTRACT: (U) We present a network software architecture for solving the problem of scaling large distributed simulations. The motivation for our effort is to expand the capability of virtual environments to serve large numbers (more than 1,000) of simultaneous users. The fundamental idea of our approach is to logically partition virtual environments by associating spatial, temporal, and functionally related entity classes with network multicast groups. Furthermore, we exploit the actual characteristics of the real-world large-scale environments that are simulated by focusing or restricting an entity's processing and network resources to its area of interest via a local Area of Interest Manager (AOIM) and a persistent object protocol. We first discuss related work in the area of networked virtual environments and the problems of developing scalable VEs. The dissertation also provides a taxonomy for discussing VEs in terms of communication methods, data, processes, and views. Moreover, we describe the Distributed Interactive Simulation (DIS) efforts and the limits of DIS today. Finally, we present our theory and the results of simulations using the AOIM. We used data from the U.S. Army National Training Center and the Janus combat model to show how the movement rates and densities of thousands of combat systems allow the use of the AOIM by a military entity to limit network traffic and simulation computation, maintain acceptable reliability, and minimize the effects of latency.

DESCRIPTORS: (U) *SOFTWARE ENGINEERING, *COMPUTER ARCHITECTURE, COMPUTER NETWORKS, WARFARE, COMPUTATIONS, ENVIRONMENTS, MODELS, TRAFFIC, WEAPON SYSTEMS, RATES, THREE DIMENSIONAL, RELIABILITY, SCALING FACTOR, RESOURCES, COMMUNICATION AND RADIO SYSTEMS, SYNCHRONISM, INTERACTIVE GRAPHICS, TAXONOMY, DISTRIBUTED INTERACTIVE SIMULATION.

IDENTIFIERS: (U) *VIRTUAL ENVIRONMENTS, VW (VIRTUAL WORLDS), MBONE (MULTICAST BACKBONE).

AD-A314 241

RAND CORP
SANTA MONICA CA

(U) Understanding the Air Force's Capability to Effectively Apply Advanced Distributed Simulation for Analysis. An Interim Report.

DESCRIPTIVE NOTE: Interim rept.

96 85P

PERSONAL AUTHORS: Kerchner, Robert; Friel, John; Lucas, Tom.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report presents our preliminary findings and observations on how the Air Force can more effectively apply Advanced Distributed Simulation (ADS) technologies for analysis. We discussed ADS with the analysis and ADS communities, and participated in several ADS efforts, including the Synthetic Theater of War Europe (STOW-E), a Ballistic Missile Defense Organization (BMDO) technical engineering demonstration (TED), and the Airborne Laser (AEL) Test Series 7. As a result, we have identified several advantages and challenges ADS presents analysts. This report reviews several general ADS analysis issues, as well as several specific points. The emphasis of the report is on the improvements that are required in ADS in order to allow credible analysis. Note also that while our emphasis is analysis, several of these suggested improvements relate in part, or even in their entirety.

DESCRIPTORS: (U) *MILITARY APPLICATIONS, *AIR FORCE PLANNING, *DISTRIBUTED INTERACTIVE SIMULATION, DATA PROCESSING, AERONAUTICS.

IDENTIFIERS: (U) PROJECT AIR FORCE, ADS (ADVANCED DISTRIBUTED SIMULATION), STOW E (SYNTHETIC THEATER OF WAR EUROPE).

AD-A313 522

BDM FEDERAL INC
SEASIDE CA

(U) Building the Analytic Foundation for DIS Tool: A Planning Tool for Users of Distributed Interactive Simulation (DIS).

DESCRIPTIVE NOTE: Final rept. Sep 93-Jun 94.

JUN 96 46P

PERSONAL AUTHORS: Winsch, Beverly; Clifton, Timothy; Atwood, Nancy.

UNCLASSIFIED REPORT

ABSTRACT: (U) Distributed Interactive Simulation (DIS) provides a potentially cost effective environment for collective, combined arms, and joint training and combat developments testing. DIS costs are kept low, in part, by using computer generated forces (CGF) to serve as the opposition force and as part of the friendly force. To realize the potential benefits of DIS it is critical to have measures of performance for manned units, and the behavior of the CGF must be sensitive to the same variables that influence the behavior of manned units. Both performance measurement and CGF behavior have been based heavily on physical attributes of weapon systems and battlefield environments with little or no attention to perceptual and cognitive variables. This report describes the broad concept for automated DIS Taxonomy of On and Off-line (DIS TOOL) performance variables to support the needs of a wide range of users including combat developers, training developers, CGF developers, materiel developers, and operational testers and evaluators.

DESCRIPTORS: (U) *COST EFFECTIVENESS, *ARMY TRAINING, *TOOLS, *USER NEEDS, *COMPUTER AIDED INSTRUCTION, *ARMY PLANNING, *DISTRIBUTED INTERACTIVE SIMULATION, MEASUREMENT, WARFARE, MATERIEL, ENVIRONMENTS, TRAINING, BATTLEFIELDS, WEAPON SYSTEMS, COGNITION, TEST EQUIPMENT, VARIABLES, COSTS, PLANNING, RANGE (EXTREMES), BENEFITS, MANNED, TAXONOMY.

IDENTIFIERS: (U) CGF (COMPUTER GENERATED FORCES), CCF (CRITICAL COMBAT FUNCTIONS).

AD-A311 369

MEI TECHNOLOGY CORP
SAN ANTONIO TX

(U) Characteristics of Distance Learning in Academia, Business, and Government.

DESCRIPTIVE NOTE: Final rept. Nov 92-May 94.

JUN 96 155P

PERSONAL AUTHORS: Walsh, William U.; Gibson, Elizabeth G.; Miller, Todd M.; Hsieh, Patricia Y.; Gettman, Dennis.

UNCLASSIFIED REPORT

ABSTRACT: (U) Distance learning is defined as: any method of presenting training that is interactive and in which the students are physically separate from the instructor. This research effort focused on the impact of distance learning on the curriculum, types of student instructor interaction, student interaction with the instructional materials, and on the preparation of faculty and staff for conducting distance learning. A primary goal was to determine if there are specific categories of objectives, task characteristics, or instructional strategies which lend themselves to particular distance learning technologies. This report also details the development, composition and distribution of a distance learning survey and summarizes the results associated with the data analysis.

DESCRIPTORS: (U) *TEACHING METHODS, *RANGE (DISTANCE), *LEARNING, DATA PROCESSING, STRATEGY, PREPARATION, STUDENTS, INTERACTIONS, INSTRUCTIONAL MATERIALS, SURVEYS INSTRUCTORS.

AD-A311 367

ARMSTRONG LAB
AIRCREW TRAINING RESEARCH DIV
WILLIAMS AFB AZ

(U) Armstrong Laboratory's Participation in the Warfighter95
Technical Integration Evaluation: A Summary Report.

DESCRIPTIVE NOTE: Final technical rept. Dec 95-Mar 96.
JUL 96 25P
PERSONAL AUTHORS: Clasen, Robert J.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report describes the participation of Armstrong Laboratory's Aircrew Training Research Division in the Warfighter95 (WF95) Technical Integration Evaluation (TIE) which was held 4 and 5 December 1995. Other participants included representatives from the Air Force, Army, and Navy. The TIE had three main objectives: (a) to test the WP95 architecture, including connectivity issues and the merging of multiple simulations; (b) to evaluate the enhancements offered by advanced distributed simulation technology; including linking operational and tactical levels of simulation and using simulation to drive real-world systems; and (c) to record lessons learned. The nine participating sites were located throughout the continental United States, and were interconnected via a communications network. The WF95 TIE resulted in several significant technological achievements, including upgrading the Air Warfare Simulation (AWSIM) constructive simulation to be compatible with Distributed Interactive Simulation (DIS) protocols and stimulating command and control equipment with simulation data.

DESCRIPTORS: (U) *COMPUTER ARCHITECTURE, *FLIGHT SIMULATION, *DISTRIBUTED INTERACTIVE SIMULATION, SIMULATION, AIR FORCE, UNITED STATES, LESSONS LEARNED, DISTRIBUTION, INTEGRATION, AERIAL WARFARE, COMMAND AND CONTROL SYSTEMS, COMMUNICATIONS NETWORKS, DRIVES, FLIGHT SIMULATORS.

AD-A309 765

NAVAL AIR WARFARE CENTER, AIRCRAFT DIV
PATUXENT RIVER MD

(U) Air Combat Environment Test and Evaluation Facility
(ACETEF) Support for Multi-Sensor, Multi-Spectral Sensor
Fusion Testing.

MAY 96 22P
PERSONAL AUTHORS: Macone, Dan.

UNCLASSIFIED REPORT

ABSTRACT: (U) This paper presents an outline of the following: Description of ACETEF Multi-Sensor/Multispectral Sensor Fusion Testing Issues; Example Applications; Distributed Training and Test Applications; Summary.

DESCRIPTORS: (U) *DATA FUSION, *MULTISENSORY, DETECTORS, TEACHING METHODS, AERIAL WARFARE, MULTISPECTRAL.

IDENTIFIERS: (U) ACETEF (AIR COMBAT ENVIRONMENT TEST AND EVALUATION FACILITY).

♦ AD-A308 992

ARMY WAR COLL
CARLISLE BARRACKS PA

(U) Application of Distance Learning Technology to Strategic Education.

DESCRIPTIVE NOTE: Strategy research project.

FEB 96 35P

PERSONAL AUTHORS: Mitchell, Greig W.

UNCLASSIFIED REPORT

ABSTRACT: (U) Rapid advances in computer and communication technology present opportunities for the Army War College to enhance and expand strategic knowledge throughout the force. This paper examines the concept and theory of distance learning, briefly traces the history of its development and describes technology currently available. It discusses issues of quality and institutional planning and management and suggests some potential applications at the Army War College. It argues that, through the application of distance learning technology, the Army War College core missions of instruction, research, and outreach can be enhanced to meet the challenges of increased need for strategic knowledge at all levels, limited or declining resources, and the changing needs of students.

DESCRIPTORS: (U) *EDUCATION, *COMPUTER COMMUNICATIONS, *LEARNING, MANAGEMENT PLANNING AND CONTROL, STRATEGY, STUDENTS, THEORY, COMMUNICATION AND RADIO SYSTEMS, RANGE (DISTANCE).

AD-A308 013

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) Videoteletraining Delivery of a Quality Assurance Course with a Computer Laboratory.

DESCRIPTIVE NOTE: Interim rept.

APR 96 80P

PERSONAL AUTHORS: Wetzel, C. D.; Pugh, H. L.; Van Matre, Nick; Parchman, Steven W.

UNCLASSIFIED REPORT

ABSTRACT: (U) A Quality Assurance (QA) course containing a student computer laboratory was delivered by videoteletraining (VTT). Two primary treatment groups were compared during four class convenings with a total of 100 students: (1) a VTT local classroom with an instructor and students, and (2) a VTT remote classroom where students were connected to the local classroom by a two-way audio and video VTT system. There were no significant group differences on a final examination and the scores were comparable with those for 133 students from traditional classrooms. Local and remote students were not significantly different on a quiz of facts on operating the computer program to produce a QA report in the laboratory. Few group differences were found on a student questionnaire. Small but significant differences were found on topics concerning the visibility of instructional aids, access to or attention from the instructor, and problems encountered during the computer laboratory. Remote students were less likely than local students to initiate interactions over the VTT network, but they participated equally when they were identified in instructor questions. The course was successfully delivered by VTT and could be expanded to other training sites. A cost analysis for two projected delivery sites indicated avoided student travel cost would be in excess of the combined costs for VTT classroom usage and computer equipment. VTT delivery techniques illustrated in this work include enhanced preparation of remote students prior to performing their laboratory work and the use of portable laptop computers with a wireless network that allowed the use of existing VTT classrooms.

DESCRIPTORS: (U) *QUALITY ASSURANCE, *COMPUTER AIDED INSTRUCTION, *TELEVISION DISPLAY SYSTEMS, COMPUTER PROGRAMS, PORTABLE EQUIPMENT, DELIVERY, SCHOOLS, STUDENTS COST ANALYSIS, INSTRUCTIONAL MATERIALS, SITES, COSTS.

IDENTIFIERS: (U) VTT (VIDEOTELETRAINING), CNET (CHIEF OF NAVAL EDUCATION AND TRAINING).

♦ AD-A308 012

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) Distributed Training Technology Project: Final Report.

DESCRIPTIVE NDTE: Final rept.

APR 96 53P

PERSONAL AUTHORS: Wetzel, C. D.

UNCLASSIFIED REPORT

ABSTRACT: (U) The objective of the Distributed Training Technology project was to extend the use of videoteletraining (VTT) beyond lecture-based courses traditionally given by VTT to courses with interactive or hands-on laboratory environments. Lessons learned and guidelines resulting from the effort were derived for this final project report. The project formally evaluated the feasibility of using VTT to deliver training in four course content areas representing different challenges for VTT: Celestial Navigation, Navy Leadership, Fiber Optic Cable Repair, and a computer laboratory in a Quality Assurance course. A combination of three approaches has the greatest generality for implementing VTT laboratory courses: (1) students can be better prepared prior to performing laboratory work, (2) support at the remote site can be increased by providing a surrogate for the instructor in order to supervise students and conduct laboratory activities, and (3) video technology can be used to increase the visibility of activities between sites. An increased level of effort is required to convert and deliver VTT laboratory courses. Training equipment adapted for portability allows classrooms to be used by other VTT courses. Courses must be selected for student throughput sufficient to provide savings in travel costs.

DESCRIPTORS: (U) *TRAINING DEVICES, *TELEVISION DISPLAY SYSTEMS, ENVIRONMENTS, LESSONS LEARNED, LEADERSHIP, STUDENTS, TRAINING, NAVAL PERSONNEL, DISTRIBUTION, INTERACTIONS, COMPUTERS, SITES, REPORTS, COSTS, REPAIR, FIBER OPTICS TRANSMISSION LINES, THROUGHPUT, LABORATORY PROCEDURES, LABORATORIES, REMOTE AREAS, CELESTIAL NAVIGATION.

IDENTIFIERS: (U) VTT (VIDEOTELETRAINING), DTT (DISTRIBUTED TRAINING TECHNOLOGY), CNET (CHIEF OF NAVAL EDUCATION AND TRAINING), CESN (CNET ELECTRONIC SCHOOLHOUSE NETWORK).

AD-A307 657

CAE-LINK CORP
FALLS CHURCH VA

(U) Development and Engineering of a Distributed Interactive Simulation System.

DESCRIPTIVE NOTE: Final rept.

MAR 96 84P

PERSONAL AUTHORS: Bouwens, C. L.; Ching, H. L.;
Pierce, L. G.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Depth and Simultaneous Attack (D&SA) Battle Lab and the Fort Sill Field Element of the Human Research and Engineering Directorate (HRED), U.S. Army Research Laboratory (ARL), collaborated to establish a fire support command and control (FSC2) test bed. The core of the FSC2 test bed is an interface that allows fire support command and control tactical equipment to interact in a seamless manner with computer-generated equipment and forces on the synthetic battlefield. The interface was accomplished using communications protocols that comply with the requirements outlined in the distributed interactive simulation (DIS) protocol data unit (PDU) standards 2.0.3. The objective of the project was to establish an environment that could be used to support the development of simulations-based training initiatives and to support the concept development process, and the research, development and acquisition phase of the materiel acquisition process through the development of a methodology for testing and evaluating materiel, organizational, and doctrinal alternatives during depth and simultaneous attack. Included in this report is a description of the design and development of the FSC2 test bed and an interface control document that describes in detail the hardware and software necessary to establish the interface.

DESCRIPTORS: (U) *COMMAND AND CONTROL SYSTEMS, *DISTRIBUTED INTERACTIVE SIMULATION, SOFTWARE ENGINEERING, SCENARIOS, DIGITAL SYSTEMS, MILITARY REQUIREMENTS, THEATER LEVEL OPERATIONS, SYSTEMS ENGINEERING, ARMY RESEARCH, DATA MANAGEMENT, INFORMATION TRANSFER, DISTRIBUTED DATA PROCESSING, COMPUTER COMMUNICATIONS, LOCAL AREA NETWORKS, TRAINING DEVICES, ARMY TRAINING, BATTLEFIELDS, OFF THE SHELF EQUIPMENT, COMPATIBILITY, WIDE AREA NETWORKS, COMPUTER GRAPHICS, MILITARY EXERCISES, WAR GAMES, INTERACTIVE GRAPHICS, ONLINE SYSTEMS, DESIGN CRITERIA, MESSAGE PROCESSING, FIRE SUPPORT, TACTICAL DATA.

IDENTIFIERS: (U) PDU (PROTOCOL DATA UNITS),
PROTOCOLS.

♦ Included in *The DTIC Review*, June 1997

AD-A306 986

RAND CORP
SANTA MONICA CA

(U) Credible Uses of the Distributed Interactive Simulation (DIS) System.

DESCRIPTIVE NOTE: Research rept.

96 91P

PERSONAL AUTHORS: Dewar, James A.; Bankes, Steven C.; Hodges, James S.; Lucas, Thomas; Saunders-Newton, Desmon K.

UNCLASSIFIED REPORT

ABSTRACT: (U) The Distributed Interactive Simulation (DIS) system is an ambitious effort to take advantage of the tools of the information age to help improve the efficiency and effectiveness of the U.S. military services. It involves serious challenges in the areas of technology, interservice coordination, and verification validation and accreditation (VV&A). The U.S. Army TRADOC Analysis Center (TRAC) has lead responsibility among the Services for VV&A of the DIS system. As part of that responsibility, TRAC is sponsoring four efforts aimed at exploring the issues of VV&A of DIS. This report documents one of those four efforts commissioned by the TRAC Director, Mr. Michael Bauman, and is intended to take advantage of previous work done at RAND on exploratory modeling and on validation of models and simulations. The research was conducted in the Force Development and Technology Program of RAND's Arroyo Center, a federally-funded research and development center sponsored by the United States Army. The intent of this work is to develop a framework that encompasses all of the potential uses of the DIS system and illuminates the validation or credibility requirements for each type of use. Because of the breadth of the potential uses of DIS, the resulting framework is general enough to address any military application of models and simulations. As such, it should be useful not only to the DIS community, but to developers, users, and consumers of models and simulations throughout the military services.

DESCRIPTORS: (U) *MILITARY APPLICATIONS, *UTILIZATION, *DISTRIBUTED INTERACTIVE SIMULATION, MILITARY FORCES (UNITED STATES), COMBAT EFFECTIVENESS, DISTRIBUTED DATA PROCESSING, VERIFICATION, VALIDATION, MODELS, CONSUMERS.

IDENTIFIERS: (U) VV&A (VERIFICATION VALIDATION AND ACCREDITATION).

AD-A306 773

ROME LAB
GRIFFISS AFB NY

(U) SYNBAD: A Distributed Interactive Simulation (DIS) Environment for C3I Capability Assessment.

DESCRIPTIVE NOTE: Rept. for Apr-Jun 95.

JAN 96 21P

PERSONAL AUTHORS: Sisti, Alex F.; Trott, Kevin C.

UNCLASSIFIED REPORT

ABSTRACT: (U) The SYNthetic BATTLEfield Development (SYNBAD) Environment is being developed at the Air Force's Rome Laboratory, and is based on current community standards and the protocols of the burgeoning world of Distributed Interactive Simulation (DIS). This report discusses its design and potential usage, describes the progress in its implementation and makes some recommendations and predictions for its future.

DESCRIPTORS: (U) *COMMAND CONTROL COMMUNICATIONS, *AIR FORCE RESEARCH, *BATTLEFIELDS, *DISTRIBUTED INTERACTIVE SIMULATION, MILITARY INTELLIGENCE, COMMUNITIES, STANDARDS.

IDENTIFIERS: (U) C3I (COMMAND CONTROL COMMUNICATIONS AND INTELLIGENCE), SYNBAD (SYNTHETIC BATTLEFIELD DEVELOPMENT), ECES (ELECTRONIC COMBAT EFFECTIVENESS STUDY), ADISC2 (AIR DEFENSE INITIATIVE SIMULATION FOR COMMAND AND CONTROL).

AD-A305 754

AIR FORCE INST OF TECH, SCHOOL OF
ENGINEERING
WRIGHT-PATTERSON AFB OH

(U) The Automated Wingman: An Airborne Companion for
Users of DIS Compatible Flight Simulators.

DESCRIPTIVE NOTE: Master's thesis.

DEC 95 117P

PERSONAL AUTHORS: Edwards, Mark M.

UNCLASSIFIED REPORT

ABSTRACT: (U) A major problem encountered by users of distributed virtual environments is the lack of simulators available to populate these environments. This problem is usually remedied by using computer generated entities. Unfortunately, these entities often lack adequate human behavior and are readily identified as nonhuman. This violates the realism premise of distributed virtual reality and is a major problem, especially in training situations. This thesis addresses the problem by presenting a computer-generated entity called the Automated Wingman. The Automated Wingman is a semiautomated computer-generated aircraft simulator that operates under the control of a designated lead simulator and integrates distributed virtual environments with intelligence. Access to distributed virtual environments is provided through the DIS protocol suite while human behavior is obtained through the use of a fuzzy expert system and a voice interface. The fuzzy expert system is designed around a hierarchy of knowledge bases. Each of these knowledge bases contains a set of fuzzy logic based linguistic variables that control the actions of the Automated Wingman. The voice interface allows the pilot of the lead simulator to direct the activity of the Automated Wingman. This thesis describes the design of the Automated Wingman and presents the current status of its implementation.

DESCRIPTORS: (U) *FLIGHT SIMULATORS, *VIRTUAL REALITY, *DISTRIBUTED INTERACTIVE SIMULATION, TRAINING, HUMANS, INTERFACES, THESES, EXPERT SYSTEMS, BEHAVIOR, ARCHITECTURE, VOICE COMMUNICATIONS.

IDENTIFIERS: (U) VC (VIRTUAL COCKPIT), AUTOMATED WINGMAN.

AD-A304 089

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) Delivery of a Fiber Optic Cable Repair Course by
Videoteletraining.

DESCRIPTIVE NOTE: Interim rept.

JAN 96 123P

PERSONAL AUTHORS: Wetzal, C. D.; Radtke, Paul H.;
Parchman, Steven W.; Seymour, George E.

UNCLASSIFIED REPORT

ABSTRACT: (U) The feasibility of using videoteletraining (VTT) to deliver a hands-on laboratory course on fiber optic cable repair was evaluated to explore the potential for extending the use of VTT beyond lecture based courses. Three treatment groups were compared with a total of 50 students: (1) traditional classrooms, (2) VTT local classrooms with an instructor and students, and (3) VTT remote classrooms where students were connected to the local classroom by a two-way audio and video VTT system. There were no significant differences between groups on procedural errors during two connector repair laboratory tasks or on observer ratings of safety and the quality of student work. There were also no significant group differences on a troubleshooting performance test and a written examination. There was a slight trend for remote students to need greater assistance and for their laboratories to take longer. Few differences were found on a student questionnaire. An interaction tally of instructor and student questions showed little differences between groups. The evaluation showed that it was feasible to deliver the course by VTT, given the extra support requirements and marginal travel cost savings for small numbers of students. Findings relevant to delivering other laboratory courses by VTT are discussed and enhanced preparation of remote students prior to performing their laboratory work is suggested as one method to offset the reduced assistance available to remote students.

DESCRIPTORS: (U) *FIBER OPTICS, *JOB TRAINING, *TRAINING DEVICES, *CABLES, *REPAIR, *COURSES (EDUCATION), *REMOTE AREAS, *NAVAL TRAINING, AUDIOVISUAL AIDS, *TELEVISION DISPLAY SYSTEMS, OBSERVERS, COST EFFECTIVENESS, STUDENTS, NAVAL PERSONNEL, COMPARISON, INSTRUCTIONAL MATERIALS, QUALITY, FEASIBILITY STUDIES, PATTERNS.

IDENTIFIERS: (U) *INSTRUCTIONAL TELEVISION, VTT (VIDEOTELETRAINING), CNET (CHIEF OF NAVAL EDUCATION & TRAINING), CESN (CNET ELECTRONIC SCHOOLHOUSE NETWORK) INTERACTIVE TELEVISION.

* AD-A303 504

AD-A303 348

ARMY SCIENCE BOARD
WASHINGTON DCDEFENSE MANPOWER DATA CENTER
MONTEREY CA

(U) Army Science Board Ad Hoc Study: Use of Technologies in Education and Training.

(U) The Use of Simulation in Military Training: Value, Investment, and Potential.

DESCRIPTIVE NOTE: Final rept. Jun 94-May 95.

DESCRIPTIVE NOTE: Final rept.

DEC 95 92P

JUN 95 41P

PERSONAL AUTHORS: Grum, Allen F.; Campbell, Crystal C.; Montgomery, A. B.; Shields, Joyce L.; Thomas, Marlin U.

PERSONAL AUTHORS: Simpson, Henry; West, William D.; Gleisner, Dave.

UNCLASSIFIED REPORT

UNCLASSIFIED REPORT

ABSTRACT: (U) This study examines the Army's use of technology in education, here defined as the material presented by the Training and Doctrine Command (TRADOC) at the Officer Basic and Advanced Courses, the Combined Arms and Services Staff School (CAS), and the Command and General Staff Officer Course (CGSOC). Currently there is a near revolution in the means of delivering education, video, CDROMs, and other devices, along with new learning techniques such as simulations and gaming. Experimental learning, group learning, and structured pathing are enhancing the students' learning experience. Perhaps one of the most significant educational advances for the Army will be the use of distance learning, especially as resource constraints and Base Realignment and Closure (BRAC) activities limit conventional educational opportunities.

ABSTRACT: (U) A study was conducted to assess capabilities and limitations of simulation for military training; DoD investments, plans, and programs for simulation; and cost-saving potential. Findings were (1) simulation technology is advancing, but faces a number of technical challenges; (2) the Services accept and use live, stand-alone single-system, and constructive simulations, and are making increasing use of virtual simulation; (3) cost data on simulation are not reported regularly or consistently but approximate relative levels of investment can be estimated; and (4) the Services have a multitude of simulation programs, with much of their planned technology development work in the areas of virtual simulation and range instrumentation.

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION, *MILITARY FORCES (UNITED STATES), *PERSONNEL DEVELOPMENT, COMPUTER PROGRAMS, DEPARTMENT OF DEFENSE, MILITARY FACILITIES, LESSONS LEARNED, INFORMATION EXCHANGE, SCHOOLS, EDUCATION, SKILLS, INSTRUCTIONAL MATERIALS, TEACHING METHODS, PATHS, CONTRACTORS, LONG RANGE (DISTANCE), COMMUNICATIONS NETWORKS, JOINT MILITARY ACTIVITIES, ACTIVE DUTY, KNOWLEDGE BASED SYSTEMS, WAR GAMES, MILITARY TRAINING, TELECOMMUNICATIONS, OFFICER PERSONNEL, COMPUTER AIDED INSTRUCTION, LEARNING, PROGRAMMED INSTRUCTION, LEADERSHIP TRAINING, VIDEO RECORDING, GEOGRAPHIC DISTRIBUTION, ELECTRONIC MAIL, STRUCTURED PROGRAMMING, RETRAINING, DISTRIBUTED INTERACTIVE SIMULATION.

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION, *WAR GAMES, *MILITARY TRAINING, COMMAND CONTROL COMMUNICATIONS, DEPARTMENT OF DEFENSE, MILITARY REQUIREMENTS, OPTIMIZATION, COST EFFECTIVENESS, REAL TIME, TRAINING DEVICES, COMBAT READINESS, COST ESTIMATES, JOINT MILITARY ACTIVITIES, MILITARY EXERCISES, FLIGHT SIMULATORS, MILITARY TACTICS, VIRTUAL REALITY, DISTRIBUTED INTERACTIVE SIMULATION.

IDENTIFIERS: (U) DIS (DISTRIBUTED INTERACTIVE SIMULATION).

AD-A302 799

INSTITUTE FOR DEFENSE ANALYSES
ALEXANDRIA VA

(U) SIMNET Applications to Peacekeeping Missions.

DESCRIPTIVE NOTE: Final rept.

SEP 95 41p

PERSONAL AUTHORS: DeRiggi, Dennis F.; Barnett, D. S.;
Hersh, Matthew.

UNCLASSIFIED REPORT

ABSTRACT: (U) The goal of this project was to demonstrate the utility of distributed simulation for an area of active research in IDA's Strategy, Forces and Resources Division (SF&RD). For the purpose of this project, distributed simulation is synonymous with the Simulation Network (SIMNET), or its more current name, Distributed Interactive Simulation (DIS). After surveying SF&RD activities, the study team focused on research into the use of advanced sensors and information processing systems to support peacekeeping missions, an ongoing task for which SIMNET/DIS seemed well suited. The team conducted 18 trials to determine SIMNET's applicability as a tool for comparing the utility of different types of sensors, sensor deployment strategies, and strategies for deploying peacekeeping and security teams. The tests were not conducted under tightly controlled conditions, nor were they executed in accordance with a carefully designed test plan. The intent was not to draw inferences, but to explore SIMNET's utility in analyses of peacekeeping issues by running excursions under widely varying conditions.

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION, *COMPUTER APPLICATIONS, *COMPUTER NETWORKS, *PEACEKEEPING, TEST AND EVALUATION, CONTROL, DEPLOYMENT, DETECTORS, STRATEGY, DISTRIBUTION, INTERACTIONS, SECURITY, TEAMS (PERSONNEL), PLANNING INFORMATION PROCESSING.

IDENTIFIERS: (U) SIMNET (SIMULATION NETWORK), DIS (DISTRIBUTED INTERACTIVE SIMULATION).

* AD-A302 723

INSTITUTE FOR DEFENSE ANALYSES
ALEXANDRIA VA

(U) Distance Learning: Part of the National Performance Review Initiative on Education.

DESCRIPTIVE NOTE: Final rept.

SEP 95 35P

PERSONAL AUTHORS: Hansen, Laura J.; Schoenberger,
Dale.

UNCLASSIFIED REPORT

ABSTRACT: (U) This study of the National Information Infrastructure (NII) was conducted as part of IDA's Central Research Program. Education, to include distance learning, is one of seven key initiatives that the Clinton administration's National Performance Review (NPR) found could be impacted through the implementation of advanced information technology. Distance Learning is a general term used to cover the broad range of teaching and learning events in which the student is separated from the instructor, or other students, by distance and/or time. It includes such scenarios as computers in the classroom or work place, local area networks on a college campus, remote training, and access to educational opportunities from the home. Numerous agencies within the government, private, and public sectors are committed to improving the overall educational process in this country through the implementation of advanced information technology. The objective of this paper is to enhance IDA's understanding of the activities, organizations, and issues related to the application of distance learning, as part of the NII.

DESCRIPTORS: (U) *EDUCATION, *TELECOMMUNICATIONS, *RANGE (DISTANCE), *COMPUTER AIDED INSTRUCTION, *LEARNING, DEPARTMENT OF DEFENSE, POLICIES, ORGANIZATIONS, SCHOOLS, STUDENTS, TRAINING, LOCAL AREA NETWORKS, TASK FORCES, INSTRUCTIONAL MATERIALS, SECURITY, TEACHING METHODS, COSTS, LIMITATIONS, BARRIERS, ACCESS, REMOTE AREAS, REGULATIONS, LIBRARIES, CULTURE, INFRASTRUCTURE.

* Included in *The DTIC Review*, June 1997

AD-A302 159

MARINE CORPS
WASHINGTON DC

(U) Marine Corps Modeling and Simulation.

APR 95

191P

UNCLASSIFIED REPORT

ABSTRACT: (U) The Marine Corps Modeling and Simulation Investment Strategy (MCMSIS) is a Total Force Plan that serves as a guide for developing Marine Corps modeling and simulation (M&S) capabilities through Fiscal Year (FY) 2010. It defines enabling M&S capabilities and provides an integrated plan for attaining the eight end states delineated in the Marine Corps Modeling and Simulation Master Plan (M&S Master Plan). This is not a requirements document, but rather a strategy for implementing advanced modeling and simulation, to include distributed simulation, throughout the Marine Corps and across all functional areas. It provides a strategy for taking advantage of the opportunity for the use of M&S provided by technological advances that permit the internetting of various models and simulators with a common synthetic environment to create an interactive distributed simulation. It contains sufficient information to establish a framework wherein the different components required to attain the Marine Corps M&S end states can be developed or obtained. The MCMSIS is written to support program managers and other decision makers involved with the Combat Development Process (CDP) and the Planning, Programming, and Budgeting System (PPBS).

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION, *MODELS, *MARINE CORPS PLANNING, *PLANNING PROGRAMMING BUDGETING, SIMULATORS, WARFARE, INTEGRATED SYSTEMS, ENVIRONMENTS, DECISION MAKING, STRATEGY, INVESTMENTS, INTERACTIONS, NAVAL BUDGETS.

IDENTIFIERS: (U) MCMSIS (MARINE CORPS MODELING AND SIMULATION INVESTMENT STRATEGY), TOTAL FORCE STRATEGY, CDP (COMBAT DEVELOPMENT PROCESS), PPBS (PLANNING PROGRAMMING AND BUDGETING SYSTEM).

AD-A301 491

NAVAL COMMAND CONTROL AND OCEAN
SURVEILLANCE CENTER RDT AND E DIV
SAN DIEGO CA

(U) Constructive and Virtual Interoperation: A Technical Challenge.

DESCRIPTIVE NOTE: Professional paper.

AUG 95

7P

PERSONAL AUTHORS: Hardy, D.; Healy, M.

UNCLASSIFIED REPORT

AVAILABILITY: Pub. in Proceeding of the Conference on Computer Generated Forces and Behavior Representation (4th), p503-507, 5 May 94. Available only to DTIC users. No copies furnished by NTIS.

ABSTRACT: (U) This paper reports the technical issues surrounding the integration of constructive (aggregate unit-based) simulations to virtual (individual entity-based) simulators.

DESCRIPTORS: (U) *VIRTUAL REALITY, *DISTRIBUTED INTERACTIVE SIMULATION, SOFTWARE ENGINEERING, SCENARIOS, REPRINTS, DISTRIBUTED DATA PROCESSING, COMPUTER COMMUNICATIONS, REAL TIME, BATTALION LEVEL ORGANIZATIONS, BRIGADE LEVEL ORGANIZATIONS, INTEROPERABILITY, COMMAND AND CONTROL SYSTEMS, COMBAT VEHICLES, WORK STATIONS, MILITARY EXERCISES, MILITARY TRAINING, INTERACTIVE GRAPHICS, COMPUTER NETWORKS, BATTLES.

IDENTIFIERS: (U) PDU (PROTOCOL DATA UNITS).

AD-A301 067

FLORIDA UNIV
GAINESVILLE, FL

(U) Proceedings of the Annual Conference on AI, Simulation, and Planning in High Autonomy Systems, Distributed Interactive Simulation Environments (5th) Held in Gainesville, Florida on December 7-9, 1994.

OCT 95 296P

PERSONAL AUTHORS: Fishwick, Paul A.

UNCLASSIFIED REPORT

ABSTRACT: (U) This represents the Fifth AI, Simulation, and Planning Conference for high autonomy systems. High autonomy systems are large scale dynamic systems involving many interacting intelligent or controlled entities. Past conferences were held in Tucson (Arizona), Cocoa Beach (Florida), and Perth, Australia. Large scale simulation models are increasingly executed within parallel and distributed computing environments. Distributed Interactive Simulation (DIS) directly involves the human in the simulation loop, and contains the real-time communication of heterogeneous simulators spread throughout wide geographical areas. Research in distributed simulation has taken place across many fronts: (1) Military DIS IEEE standard and workshops; (2) Continuous model parallelization; and (3) Discrete model (PDES) parallelization. The purpose of this conference is to focus on basic research problems in the overall area of distributed simulation with an emphasis on problems occurring in interactive environments.

DESCRIPTORS: (U) *SYMPOSIA, *ARTIFICIAL INTELLIGENCE, *SYSTEMS APPROACH, *DISTRIBUTED INTERACTIVE SIMULATION, SIMULATORS, ENVIRONMENTS, DECISION MAKING, DISTRIBUTED DATA PROCESSING, REAL TIME, INTERACTIONS, REASONING, PLANNING, HETEROGENEITY, COMMUNICATION AND RADIO SYSTEMS, HYBRID SYSTEMS, ARIZONA, GEOGRAPHIC AREAS, AUSTRALIA, LOOPS, BEACHES, FLORIDA, WORKSHOPS, TERRAIN MODELS.

AD-A300 925

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) Evaluation of a Celestial Navigation Refresher Course Delivered by Videoteletraining.

DESCRIPTIVE NOTE: Interim rept.

OCT 95 78P

PERSONAL AUTHORS: Wetzel, C. D.

UNCLASSIFIED REPORT

ABSTRACT: (U) The use of videoteletraining (VTT) to deliver a Celestial Navigation course was evaluated. Three treatment groups were compared with a total of 279 students: (1) traditional classrooms; (2) VTT local classrooms with an instructor and students, and (3) VTT remote classrooms where students were connected to the local classroom by a two-way audio and video VTT system. Student performance on homework during the week was similar among groups, VTT remote students were slightly lower than local students on a final examination, but similar numbers of students passed the course. An interaction tally of instructor and student questions showed slightly fewer interactions per hour for VTT remote sites than for the local site where there were more students. However, there was no disadvantage for VTT remote students when examined on a per student per hour basis. Responses on a student questionnaire were generally positive and remote site students responded only slightly less favorably than local site students. Remote students were more favorable toward the use of a picture-in-picture display showing both an instructor and visuals during lengthy periods when the instructor would have been off screen. The evaluation showed that delivery of the course by videoteletraining has been successful and can be expanded to other sites in order to reduce travel costs.

DESCRIPTORS: (U) *TELEVISION SYSTEMS, *NAVAL TRAINING, *CELESTIAL NAVIGATION, TRAINING, NAVAL PERSONNEL, DISPLAY SYSTEMS, COURSES (EDUCATION), MEAN, QUESTIONNAIRES, STANDARD DEVIATION, TRAINING FILMS.

IDENTIFIERS: (U) VIDEO TELETRAINING.

*AD-A300 233

CARNEGIE-MELLON UNIV, SOFTWARE
ENGINEERING INST
PITTSBURGH PA

(U) Report on Distance Learning Technologies.

DESCRIPTIVE NOTE: Final rept.

SEP 95 62P

PERSONAL AUTHORS: Capell, Peter.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report provides a wide view of the costs, risks, and benefits associated with instructional technology alternatives. The number and variety of possible paths to learning through this technology have increased markedly in recent years with the advent of interactive multimedia, satellite communications, and the Internet. More than ever before, learning technologies have created new educational possibilities for people and organizations. In this era of increasing financial stringency, we are obligated to examine these new possibilities in light of their obvious advantages: replication of high-quality instruction, lower overall costs, increased quality in educational outcomes, and the ability to provide these benefits over long distances. This report will show that with today's computer-based instructional technology, the question is no longer whether to use the technology, but rather how to use it.

DESCRIPTORS: (U) *TEACHING METHODS,
*SYSTEMS APPROACH, *COMPUTER AIDED
INSTRUCTION, *LEARNING, INTERACTIONS, PATHS,
COSTS, SATELLITE COMMUNICATIONS, MEDIA,
RANGE (DISTANCE).

IDENTIFIERS: (U) *MULTIMEDIA, *INTERACTIVE
MEDIA.

AD-A298 758

ARMSTRONG LAB, HUMAN RESOURCES
DIRECTORATE
WRIGHT-PATTERSON AFB OH

(U) Maintenance Simulation: Research and Applications.

DESCRIPTIVE NOTE: Interim rept. Aug 91-Jul 95.

JUL 95 25P

PERSONAL AUTHORS: Ianni, John D.

UNCLASSIFIED REPORT

ABSTRACT: (U) Animated human figure models (HFM)s allow maintenance activity to be visualized on computer-aided design (CAD) geometry. These visual simulations have made it possible to simulate a much fuller range of human motion. Armstrong Laboratory's (AL) Design Evaluation for Personnel, Training, and Human Factors (DEPTH) project is taking advantage of these new technologies to improve weapon system design analysis, maintenance training, and logistics support analysis. DEPTH HFMs can be controlled with motion tracking devices (for hands and full body) or with models of maintenance tasks. Other DEPTH developments include Distributed Interactive Simulation (DIS) support, allowing DEPTH to communicate with other simulations and logistics document generation, for automated creation of technical manuals and support requirements.

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION,
*COMPUTER AIDED DESIGN, *VIRTUAL REALITY,
DATA BASES, ALGORITHMS, SOFTWARE
ENGINEERING, IMAGE PROCESSING, SCENARIOS
LOGISTICS SUPPORT, AUTOMATION, DATA
MANAGEMENT, DOB TRAINING, AIRCRAFT
MAINTENANCE, DISTRIBUTED DATA PROCESSING,
LOCAL AREA NETWORKS, WEAPON SYSTEMS,
HUMAN FACTORS ENGINEERING, THREE
DIMENSIONAL, WIDE AREA NETWORKS, ARTIFICIAL
INTELLIGENCE, MAINTENANCE MANAGEMENT,
COMPUTER VISION, INTERACTIVE GRAPHICS,
FLIGHT SIMULATORS.

IDENTIFIERS: (U) *DIS (DISTRIBUTED INTERACTIVE
SIMULATION), ANIMATION.

AD-A298 632

RENSSELAER POLYTECHNIC INST,
DEPT OF ELECTRICAL COMPUTER AND SYSTEMS
ENGINEERING
TROY NY

(U) Development of a Testbed for Investigation of ATMBased
Packet Video Concepts.

DESCRIPTIVE NOTE: Final technical rept. Sep 93-Sep 94.
JUN 95 20P
PERSONAL AUTHORS: Modestino, James W.; Vastola,
Kenneth S.

UNCLASSIFIED REPORT

ABSTRACT: (U) This report documents the accomplishments of a program to implement and utilize an ATM (Asynchronous Transfer Mode) testbed at Rensselaer Polytechnic Institute. The testbed is part of a variety of ongoing projects in the Center for Image Processing Research (CIPR). Two examples of projects employing the testbed are described in detail. The first is the development of innovative approaches to distributed distance learning using multimedia. The second is the realistic evaluation of promising approaches to the delivery of multimedia over ATM-based Broadband ISDN Networks.

DESCRIPTORS: (U) *IMAGE PROCESSING, *TEST BEDS, IMAGE PROCESSING, SYSTEMS ENGINEERING, ASYNCHRONOUS SYSTEMS, DISTRIBUTION, MEDIA, TRANSFER, RANGE (DISTANCE), LEARNING.

IDENTIFIERS: (U) *MULTIMEDIA, ATM (ASYNCHRONOUS TRANSFER MODE).

AD-A298 374

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) The Use of Videoteletraining to Deliver Chief and Leading Petty Officer Navy Leadership Training: Evaluation and Summary.

DESCRIPTIVE NOTE: Interim rept.
AUG 95 80P
PERSONAL AUTHORS: Wetzel, C. D.; Simpson, Henry;
Seymour, George E.

UNCLASSIFIED REPORT

ABSTRACT: (U) The feasibility of using videoteletraining (VTT) to deliver Navy leadership (NAVLEAD) training was tested in Leading Petty Officer (LPO) and Chief Petty Officer (CPO) courses. Three student treatment groups were compared: (1) traditional classrooms; (2) VTT local classrooms with an instructor and students, and (3) VTT remote classrooms where students were connected to the local classroom by a two-way audio and video VTT system. Student responses on questionnaires tended to favor traditional instruction slightly, but differences were not large. Subject matter expert ratings of various aspects of the course were higher for traditional instruction than VTT. Lower student and observer ratings for VTT were generally on topics pertaining to interaction and participation. However, student performance on a simulated activity revealed no significant differences among treatment groups. Results of a class participation tally were analyzed in conjunction with previous results of a Division Officer course. Traditional and VTT local classes interacted at similar levels, and VTT remote classes were about two thirds this level. The overall results of both these evaluations are also summarized. These first trials of the courses show it was possible to deliver NAVLEAD on VTT with some reduction in participation and interaction. Regular offerings of the course by VTT might lead to further adaptations to the VTT medium and could yield cost savings associated with travel and instructors.

DESCRIPTORS: (U) *NAVAL PERSONNEL, *TEACHING METHODS, *OFFICER PERSONNEL, *LEADERSHIP TRAINING, OBSERVERS, SIMULATION, LEADERSHIP, SCHOOLS, STUDENTS, PERFORMANCE (HUMAN), COSTS, FEASIBILITY STUDIES, RESPONSE RATINGS, INSTRUCTORS, VIDEO SIGNALS, QUESTIONNAIRES.

IDENTIFIERS: (U) *VIDEOTELETRAINING, VTT (VIDEOTELETRAINING), DTT (DISTRIBUTED TRAINING TECHNOLOGY).

AD-A298 102

NAVY PERSONNEL RESEARCH AND DEVELOPMENT
CENTER
SAN DIEGO CA

(U) Delivery of Division Officer Navy Leadership Training
by Videoteletraining: Initial Concept Test and Evaluation.

DESCRIPTIVE NOTE: Interim rept.

AUG 95 68P

PERSONAL AUTHORS: Simpson, Henry; Wetzel, C. D.;
Pugh, H.

UNCLASSIFIED REPORT

ABSTRACT: (U) The feasibility of using videoteletraining (VTT) to deliver Navy leadership (NAVLEAD) training was tested in the Division Officer basic leadership course. Three treatment groups were compared: (1) traditional classrooms; (2) VTT local classrooms with students and an instructor, and (3) VTT remote classrooms where students were connected to the local classroom by a two-way audio and video VTT system. Student responses on questionnaires tended to favor traditional instruction slightly, but differences were small. Subject matter expert ratings of various dimensions of the course were higher for traditional instruction than VTT. Lower student and observer ratings for VTT were on items pertaining to interaction and participation issues. Somewhat less interaction was recorded on a participation tally in VTT classes than in traditional classes. However, a test of knowledge gained in the course revealed no differences among traditional, local or remote students. This first trial run of NAVLEAD on VTT showed it was possible to deliver the course with some reduction in interaction and participation. The use of VTT for similar relatively short, high throughput courses has led to cost savings associated with travel and instructors. This is the first of two reports, the second evaluated Chief and Leading Petty Officer leadership courses.

DESCRIPTORS: (U) *NAVAL PERSONNEL,
*LEADERSHIP TRAINING, OBSERVERS, LEADERSHIP,
SCHOOLS, STUDENTS, COSTS, RATINGS,
INSTRUCTORS, QUESTIONNAIRES.

IDENTIFIERS: (U) VTT (VIDEOTELETRAINING),
NAVLEAD (NAVY LEADERSHIP).

AD-A298 053

ARMY RESEARCH LAB
ABERDEEN PROVING GROUND MD

(U) Distributed Interactive Simulation (DIS) Network
Manager.

DESCRIPTIVE NOTE: Summary rept. 1-31 Dec 94.

JUN 95 44P

PERSONAL AUTHORS: Smith, Kenneth G.

UNCLASSIFIED REPORT

ABSTRACT: (U) Current Department of Defense simulation research centers on real-time, interactive simulation of realistic, complex, "virtual worlds" represent the coalescence of a diverse set of virtual, constructive, and live simulations occurring at various locations throughout the world. This effort is collectively known as Distributed Interactive Simulation (DIS). Its purpose is to allow dissimilar autonomous simulation nodes to interoperate in real-time, interactive, distributed simulations. Internode communication is achieved by exchanging DIS protocol data units (PDU). To facilitate the development of simulation application programs that use the DIS protocol, the Simulation Methodology Branch of the Advanced Computational and Informational Sciences Directorate, U.S. Army Research Laboratory (ARL), developed a set of DIS software management programs, collectively referred to as the DIS Network Manager. It employs a client-server based architecture, providing a library of software routines to client application programs for creating, handling, sending, and receiving DIS protocol data units.

DESCRIPTORS: (U) *COMPUTERIZED SIMULATION,
*NETWORK ANALYSIS (MANAGEMENT),
*INTERACTIVE GRAPHICS, *COMPUTER NETWORKS,
*SYSTEMS MANAGEMENT, COMPUTER PROGRAMS,
METHODOLOGY, COMPUTATIONS, ARMY RESEARCH,
REAL TIME, INTERFACES, COMPUTER
ARCHITECTURE, NODES, MILITARY RESEARCH,
SELF OPERATION, LIBRARIES.

IDENTIFIERS: (U) DIS (DISTRIBUTED INTERACTIVE
SIMULATION), PDU (PROTOCOL DATA UNITS).

AD-A297 515

NAVAL POSTGRADUATE SCHOOL, DEPT OF
MATHEMATICS
MONTEREY CA

(U) Janus Modeling for the Environmental Effects for
Distributed Interactive Simulation (E2DIS) Program.

DESCRIPTIVE NOTE: Technical rept. Act 93-Feb 94.
APR 95 18P
PERSONAL AUTHORS: Mansager, Bard K.

UNCLASSIFIED REPORT

SUPPLEMENTARY NOTE: Original contains color plates;
All DTIC/NTIS reproductions will be in black and white.

ABSTRACT: (U) The Defense Modeling and Simulation Office (DMSO) has initiated a research effort to promote joint service standards for physics based environmental effects in the existing distributed modeling and simulation networks. Collectively, the project is known as Environmental Effects for Distributed Interactive Simulation (E2DIS). Research detailed in this report was within the E2DIS Demonstration Task effort. This effort used the Janus (A) combat model to simulate the environmental effects on weapons systems and study the resultant force-on-force interplay. In order to do this, a scenario was developed using Fort Hunter Liggett, California terrain. In this scenario, Unmanned Aerial Vehicles (UAVs) were used to search for a Ground Launched Cruise Missiles (GLCM) and SCUD Theater Ballistic Missiles (TBMs) and Transporter Erector Launchers (TELs). Once located, a Fiber Optic Guided Missile (FOG-M) was fired at the TEL. Weather parameters were changed and the scenario was repeated. Differences between the number of TEL detections in different weather conditions were recorded.

DESCRIPTORS: (U) *ENVIRONMENTAL IMPACT,
*INTERACTIVE GRAPHICS, *GUIDED MISSILE
SIMULATORS, *GUIDED MISSILE DETECTION, FIBER
OPTICS, GUIDED MISSILES, SCENARIOS,
SIMULATION, WARFARE, THEATER LEVEL
OPERATIONS, AIRCRAFT, DEFENSE SYSTEMS,
WEATHER, MODELS, DISTRIBUTION, INTERACTIONS,
WEAPON SYSTEMS, PARAMETERS, TERRAIN,
PHYSICS, CRUISE MISSILES, JOINT MILITARY
ACTIVITIES, UNMANNED, STANDARDS,
CALIFORNIA, SURFACE TO SURFACE MISSILES.

IDENTIFIERS: (U) E2DIS (ENVIRONMENTAL EFFECTS
FOR DISTRIBUTED INTERACTIVE SIMULATION), DIS
(DISTRIBUTED INTERACTIVE SIMULATION), JANUS
COMBAT SIMULATION, UAV (UNMANNED AERIAL
VEHICLES), GLCM (GROUND LAUNCHED CRUISE
MISSILE), SCUD MISSILES, TBM (THEATER
BALLISTIC MISSILES), FOG-M (FIBER OPTIC GUIDED
MISSILE), TEL (TRANSPORTER ERECTOR
LAUNCHERS).

AD-A293 451

CALIFORNIA STATE UNTV, CHICO COLL OF
COMMUNICATION

(U) A Study of Interaction in Distance Learning.

DESCRIPTIVE NOTE: Final rept. Jun-Aug 94.
MAR 95 22P
PERSONAL AUTHORS: Main, Robert G.; Rise, Eric O.

UNCLASSIFIED REPORT

ABSTRACT: (U) To answer the numerous questions concerning interaction in distance learning, a better definition of the variable interaction is needed. This study attempts to qualify the concept of interaction by applying various dimensions such as AMOUNT, TIMELINESS, METHOD, SPONTANEITY, and QUALITY. In turn, these dimensions of interaction lend themselves to the creation of a taxonomy for research and evaluation purposes.

DESCRIPTORS: (U) *INTERACTIONS, *LEARNING,
VARIABLES, RANGE (DISTANCE), TIMELINESS,
TAXONOMY.

AD-A293 314

NAVAL POSTGRADUATE SCHOOL
MONTEREY CA

(U) Understanding Videoteleducation: An Overview.

DESCRIPTIVE NOTE: Technical rept. Oct 94-Jan 95.

JAN 95 51P

PERSONAL AUTHORS: Suchan, Jim; Crawford, Alice.

UNCLASSIFIED REPORT

ABSTRACT: (U) This research examined selected distance learning and videoteleducation (VTE) literature to determine the factors Navy health care executives, administrators, and instructors should consider before implementing VTE technology. The literature and interview with VTE users revealed the lack of an explicit theoretical framework or conceptual scheme to root VTE research findings. To remedy this fundamental problem, this report provides a conceptual scheme of VTE use based on administrators' and instructors' conceptualization of VTE; VTE measures of effectiveness; and the rules that evolve about VTE and its uses. Finally, the report provides five major lessons learned about VTE that are derived from the literature review.

DESCRIPTORS: (U) *MILITARY MEDICINE, *MEDICAL RESEARCH, *LEARNING, *VIDEO FRAMES, LESSONS LEARNED, HUMAN RESOURCES, LITERATURE SURVEYS, ADMINISTRATIVE PERSONNEL, INSTRUCTORS, RANGE (DISTANCE), HOSPITALS, HEALTH CARE FACILITIES.

IDENTIFIERS: (U) VTE (VIDEOTELEDUCATION).

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