

# **HAZWOPER TRAINING: UTILIZING ADVANCED TRAINING TECHNOLOGIES**

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**NIEHS Technical Workshop  
“Computer and Internet-Based Learning Methods for Safety and Health Training”**

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# **HAZWOPER TRAINING: UTILIZING ADVANCED TRAINING TECHNOLOGIES**

## **FOREWORD**

The Superfund Amendment and Re-Authorization Act of 1986 (SARA) established a worker training program to ensure the development of a national workforce trained in hazardous waste operations and emergency response. The program was established within NIEHS as the Worker Education and Training Program (WETP). NIEHS has funded training grants to meet the EPA Superfund program workforce needs for over a decade and, subsequently, has served in an administrative capacity for similar training grants to support the DOE environmental restoration mission. The awardee programs are specifically focused on the extensive training requirements established within the identical Hazardous Waste Operations and Emergency Response regulations promulgated by OSHA and EPA as 29 CFR 1910.120 and 40 CFR 311, respectively. DOE requires contractor compliance with this standard through DOE Order 440.1A (March 27, 1998.)

The NIEHS awardee training programs represent the state-of-the-art in HAZWOPER training. NIEHS has continually sought to improve the training programs and provide consensus guidance criteria to serve that purpose (3, 4, and 12). These guidance criteria have been developed through a national technical workshop approach, with a broad representation of diverse and experienced stakeholders, organized and managed by the National Clearinghouse for Worker Safety and Health Training. NIEHS consensus guidelines have established the national benchmark for HAZWOPER training. The original guideline, termed the “Minimum Criteria”(3), has been adopted as a non-mandatory appendix (1) to the OSHA Hazardous Waste Operations and Emergency Response standard.

The demands of an advancing technology-based national and international economic structure have resulted in extensive new training requirements. Over the past few years, the development and application of “advanced training technologies (ATT)” have proceeded at an explosive pace, and the trend is expected to intensify. The NIEHS awardees have not been unmindful of the trend and many have begun exploring and applying ATT. The unique nature of HAZWOPER training, however, poses a need to maintain the state-of-the-art quality and leadership in this arena that have been the hallmark of the NIEHS program.

In keeping with its traditional approach, NIEHS convened an initial workshop for the purpose of examining where ATT could most appropriately be used in the HAZWOPER training program. The purpose of the April 1999 workshop was to gain a current perspective of ATT and to consider the strengths and weaknesses of ATT specific to the Minimum Criteria upon which the program is based.

A draft of this report served as the “starting point” for that workshop. The document is not intended, however, to be a state-of-the-art review of advanced training technologies. Such a document would be excessively voluminous and, literally, out of date next month. Rather, this document draws from a number of studies which have addressed the pertinent points with particular emphasis on a comprehensive study conducted for DOE in 1994 and published in 1995 by INEL (20).<sup>1</sup> The INEL study was chosen as a focal point as it appears to come the closest to addressing issues and realities that are specifically relevant to the NIEHS HAZWOPER Training Program and its awardees.

This report reflects the interaction and sharing of the workshop experience which served to improve the community’s overall understanding of the strengths and benefits, as well as the weaknesses and drawbacks, of ATT. It is hoped that this attempt at establishing a common understanding will provide a basis for future activities in developing appropriate ATT applications for these training programs.

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<sup>1</sup> The acronyms INEL and INEEL both refer to the DOE Idaho National Engineering and Environmental Laboratory (INEEL), formerly INEL.

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# HAZWOPER TRAINING: UTILIZING ADVANCED TRAINING TECHNOLOGIES

## I. INTRODUCTION

The development and application of Advanced Training Technologies (ATT) are advancing rapidly as computer and communication technology continue to evolve at an unparalleled rate. Computer-based training (CBT), Internet-based training (WBT), distance learning, teleconferencing, multimedia, and courseware applications to training are emerging and often well established. Concurrently, programs based upon the Education Act of 1994, such as the Goals 2000 Program, are already developing the job classifications and curriculum for the ATT technicians and professionals of the next century (5, 6, 25, and 39). While some express caution (23, 24, 26, 30, 34), the ATT and related missions have been launched and are in full flight status. At this time, however, very few, if any, definitive studies have examined the cost-benefits of ATTs. In addition, the application of ATT methodologies to safety and health training is only now beginning to emerge. As a consequence, even less is known about the cost-benefits, or even adequacy, of ATT safety and health applications.

The NIEHS HAZWOPER Training program has developed and funded the premier HAZWOPER worker training programs over the past decade. In the absence of government intervention to establish training criteria, NIEHS has taken the lead in developing these as well. The NIEHS "Minimum Criteria" (3) for HAZWOPER training is the recognized gold standard and has been adopted by OSHA as the non-mandatory training guideline appendix (1) to the HAZWOPER standard. HAZWOPER work, ranging from hazardous materials cleanup to emergency response, is unique in that the workers engaged are employed in one of the most potentially hazardous work environments in the country. The work requires special skills and unique methods. There is, therefore, a major reliance on hands-on training and peer training with an emphasis on unique skills development and demonstration. A later section of the report specifically discusses "Overarching Worker Safety & Health Training Issues" in connection with the development of ATT programs.

Despite the focus of NIEHS awardees on hands-on training and peer training, ATT is gaining increasing attention from a number of NIEHS awardees. Many have applied one or more of the ATT methods. At the time of the Workshop, NIEHS did not have a framework for judging which ATT applications have merit in advancing the training program into the ATT arena. Thus, funding for such applications was not systematic and consistent. There was a need, therefore, for the development of criteria applicable to the HAZWOPER training program specific to the application of ATT methods. The awardees have developed a very effective approach to establishing consensus criteria in the past, as evidenced by the Minimum Criteria Guidelines, among others. To advance this effort, NIEHS

hosted a Technical Workshop on 20-21 April 1999 to develop the initial framework for ATT application criteria.

A draft of this report served as the background document for the workshop. The final report integrates the HAZWOPER-specific training issues that need to be addressed when considering the application of ATT to such training. The report also includes a summary of the workshop breakout team issues, along with a summary of the issues agreed upon by the workshop participants in the closing plenary.

In framing the issues for discussion in this report, the authors did not find a definitive treatment of the ATT sector that provided significant information. Consequently, the analysis focused on HAZWOPER training programs in general and aspects of ATT applications of most relevance to the awardees. The document of greatest potential value was the previously cited INEL report developed for DOE (20). It served as the primary reference, although a number of items were revised or updated to take into consideration advances in technology as well as concerns expressed by the workshop participants.

It is the objective of this report to provide the initial basis for an organized approach to utilization of ATT by the HAZWOPER worker training awardees.

## **IA. OVERARCHING WORKER SAFETY & HEALTH TRAINING ISSUES**

The predominant theme of worker-oriented concerns expressed during the workshop was the need to reconcile the perceived conflict between the goals of ATT and the implications that implementation of ATT programs would inevitably lead to a diminution of worker empowerment and a lessening of workers' ability to participate effectively in the safety and health training that is the cornerstone of protection in the workplace.

There is some suggestion in both the literature and in anecdotal conversation regarding the "marketing" of ATT that the "computer based" training is appropriate as a complete substitute for hands-on and/or classroom instruction.

The workshop consensus was that such an approach is not appropriate for much of the training that is required by 1910.120. Great care must be taken before the wholesale substituting of proven and validated hands-on/instructor-based classroom instruction by a remote or distant training process.

The driving concern is that ATT might lead to a lessening of worker empowerment and workers' abilities to acquire the necessary skills and knowledge to perform particular tasks, because the ATT teaching/training techniques would result in lowered skills requirements for learning done through

ATT as compared to the traditional hands-on instructor focused, small group interactions heavily favored by the NIEHS program.

The virtual unanimity of views expressed by the workshop participants indicates that successful ATT insertion into an NIEHS-type program would require a careful understanding of the relationship between individual skill-based components and hands-on, instructor and worker-oriented training.

The consensus of the workshop participants was that these elements need to be clearly identified and that any ATT enhancements must be clearly shown compatible with these skill objectives for an ATT driven training program to be successful.

Among the consensus issues was the need that ATT programs should be demonstrated and evaluated as pilot activities before any wholesale adoption is contemplated.

That is not to deny the obvious, that ATT programs are growing dramatically and new technology is similarly being developed at a rapid pace. The concern about the loss of the “human equation” part of worker training cut across all of the various breakout groups considering the ATT issues.

The role of instructors is critical to this issue as well as to a second issue, discussed below. The workshop participants felt strongly that personal instruction is a key element in skills development for workers and that the ATT activities needed to be sublimated to the course utilization of peer instructors. The hands on skills training and instructor led training is critical to effective HAZWOPER training because of the particular nature of environmental hazards. In this regard, OSHA’s comments to the U. S. Army Corps of Engineers (USACE) proposal for CBT HAZWOPER Refresher Training indicated a clear commitment to significant instructor presence in such training modules. On the other hand, there was also a consensus from the workshop participants that ATT components are here to stay and have an important role in the developing areas of worker training. Workshop participants were very interested in experimenting with these new techniques and anxious for NIEHS to provide both guidance and funds for their development. NIEHS’s ability to orchestrate and disseminate the results of effectiveness evaluations of these projects is also very important.

The second, and more profound, concern emanating from the workshop was worker ownership and participation in workplace training programs, such as the HAZWOPER grant program. There were a number of participants who expressed concerns that ATT-driven programs would undermine and reduce the worker sense of empowerment that is a cornerstone of the peer trainer, hands-on approach to much of the HAZWOPER program. The participants in some groups felt that many ATT programs function to undercut worker participation and as a result reduce worker empowerment. The key to developing successful ATT program

activities is to address these worker concerns early in the development of the ATT components. Among these concerns are: the need for worker participation<sup>2</sup> in the program development; worker participation and interaction with instructors; and, interaction with fellow trainees. It should be noted that worker participation is a cornerstone requirement for participation in OSHA's VPP program. It is also a critical requirement for compliance with OSHA's pending safety and health program rule.

The following questions represent a synthesis of the significant worker related issues that can be a checklist whenever the use of ATT programs is proposed:<sup>3</sup>

- To what degree is the participant familiar with the ATT being considered?
- To what degree is participant interaction with fellow participants possible?
- To what degree is participant interaction with the facilitator possible?
- To what degree is facilitator interaction with participants possible?
- To what degree are worker trainers able to utilize and be an integral part of the training?
- To what degree can the participant use written forms of educational material?
- To what degree can ATT facilitate hands-on activities?
- What is the role of each type of ATT in the broadly defined training world?
- Can the technology replace the classroom completely?
- Is the appropriate role for the ATT to assist for only a portion of the training time?
- What is the maximum time period that certain technologies should be used?
- Can the technology be used to supplement the training period as a resource?
- How compatible is each element of hardware and software with other resources within the training program?
- How compatible is each element of hardware and software with other resources of other organizations that the training program interacts with?

This report describes a wide variety of types of ATT currently on the market ranging from chat rooms and teleconferencing to web-based and CD-ROM

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<sup>2</sup> Participation may be directly, through the worker's labor union, or through a labor-management participation arrangement.

<sup>3</sup> These questions were used in formulating the issues in the NIEHS RFA, referred to at the end of this report.

programs. Each has disadvantages and advantages, and thus the answers to the checklist questions will vary significantly. Some allow discussion between participants while some by their own definitions have absolutely no communication between participants.

ATT is a new and rapidly changing field, as was clearly demonstrated by the workshop participants' wide range of (in)experience. The level of expertise, hardware, software and practical use, however, varies within each particular ATT. The ability of particular organizations to evaluate each ATT will most probably be limited. Accordingly, the information collected in this report, as emphasized throughout, must be utilized in the framework of the using organization's analysis of its own structure, organizational maturity and training needs. There are no cookie-cutter solutions to ATT development and implementation. The analysis provided in this report does, however, provide a reasoned roadmap to the discerning user.

## **II. BASIC OVERVIEW OF ADVANCED TRAINING TECHNOLOGIES**

Advanced Training Technologies (ATT) employ hardware and software to conduct training and serve educational needs. The globalization of our economy, the rapidly changing dynamics of business, the increased focus on "high tech" job categories, and the costs associated with the inherent training and retraining needed to meet these challenges have fostered an explosive growth in the training and education fields. A major driver is anticipated cost savings from decreased trainee costs associated with travel and non-productive paid time, as well as savings on maintaining training facilities. More recently, studies have attempted to develop measures of increased training effectiveness through the application of ATT. The diverse dimensions of ATT, however, make definitive studies challenging to design and undertake.

A major stimulus to this change is the development of computer-based advanced technologies and the utilization of a host of new delivery means which facilitate expanded training delivery, such as the Internet, teleconferencing, and computer networking. Thus, the major emphasis to date has been on the technical development aspects associated with capturing the diversity and power of these new media for training applications. Relatively little attention has been paid to the more fundamental aspects upon which our traditional training approaches have been structured, such as adult learning, training effectiveness, systematic approaches to training program development, training of instructional professionals, and critical skills training. Indeed, a review of the current literature provides meager perspective on approaches utilizing these new media which address safety and health and hazard-driven skills development.

It is important to develop a perspective on advanced training technologies and a means to assess whether there is value-added in the development of such methods in meeting the organization's training mission. Of critical importance to the

NIEHS Worker Training Program is the extent to which advanced training technologies have or can effectively address the unique aspects associated with training workers and supervisors for high-hazard work where specific skills are needed in addition to hazard recognition and general safety and health considerations.

INEL, with funding from DOE, undertook a comprehensive review and assessment of ATT. The INEL report, "A Study of Advanced Training Technology: Emerging Answers to Tough Questions," (20) focused on many of the issues of importance in considering the value of advanced training approaches in reducing training costs and improving technical competencies (<http://cted.inel.gov/cted/dl/att>). The study structured advanced training technologies into four types, three "distinguished by hardware" and one on "differences in software and instructional strategies."

### **A. Defining ATT**

ATT is the term used to characterize the subject of this document and the National Technical Workshop sponsored by NIEHS and conducted in Estes Park, Colorado on April 20-21, 1999. There are, however, other characterizations used, including:

- distance learning
- distance education
- distributed training
- technology-supported learning
- computer-based learning
- Computer-assisted classroom instruction.

The basic feature of "distance learning," "distance education," and "distributed training" is the physical separation of the instructor and student as compared to classical classroom-based instruction. These approaches involve providing text and/or audio-video tape materials to a student for use in a time frame chosen by the student. Table 2 provides a brief list of benefits and limitations of these basic training approaches.

More recently, "distance learning," "distance education," and "distributed training" have come to encompass additional dimensions beyond the "basic" enhancements through some form of technology. In academic settings, this frequently includes teleconferencing. Other approaches include Internet and Intranet computer networks and technology-enhanced learning tools such as CD-ROM, videodiscs, and computer-based courseware. These additional dimensions are often defined as "technology-supported learning" or "computer-based learning."

In the overview context, ATT includes all of the elements noted, based upon the premise that "advanced" infers the application of new technologies to the learning

or education experience. This includes simple training tool enhancements such as CD-ROMs as replacements for instructional text materials or computer-based access to information/data/references that would otherwise be available in hard copy from references sources or libraries and complex training enhancement tools such as interactive virtual reality process simulations (14).

“ATT” has been chosen as appropriate in the context of this document and the workshop upon which it is based for these reasons, as well as because the term appears the most appropriate to the workshop participants who encompass the NIEHS HAZWOPER awardees. The awardees evidence a broad range in levels of experience with ATT, ranging from very little to relatively extensive. (See Section III.) In addition, because the core of WETP is worker training program development and delivery, the application of ATT must be clearly linked to that training mission and the “core values” embodied within the NIEHS training program. Owing to the diversity of experience with ATT among the awardees, the application of Advanced Training Technologies encompasses a definition that seems relevant to all.

## **B. ATT Categorization**

To consider ATT application to training activities, it is necessary to segment ATT in a manner that allows consideration of specific types of ATT in terms that are helpful to the workshop process. (See Section VIII.) and applicable to the grantee training activities and organizations. Several sub-divisions or categorizations can be used. Table 1 summarizes a few of the various categorizations of ATT.

The category approach used in the pre-workshop document was developed for DOE in 1995 (20). It was selected from several possible alternatives because it offered, in the authors' and Executive Committee's opinion, the most systematic approach considering the range of experience and expertise of the awardee organizations and the issues the workshop breakout groups were tasked to address. In reviewing that decision after the conclusion of the workshop, that approach has been retained.

A review of the additional information generated during the workshop, especially that provided by Hank Payne and the DOE “Business Case,” offered different perspectives (Payne) and more in-depth dimensions to facilitate cost-benefit discussions (DOE) to the categorizations chosen but did not invalidate them from the perspective of the frame of reference in which they were applied.

The technology-based program demonstrations during the evening plenary session at the workshop on April 20, 1999 provided excellent examples of the application of ATT to safety and health training:

- “Electronic Brainstorming” - A computer-based and facilitated group problem-solving process based upon the University of Alabama at Birmingham-CLEAR's unique application of Ventura Corporation's

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- “RTK.Net” - A UAW demonstration of the on-line “Right-to-Know (computer) Network” which provides information sources on toxic chemicals (27)
- “HAZWOPER Standard CBT" developed" by the OENHP
- “On-Line HAZWOPER 8-Hour Refresher CBT," developed by the U.S.Army Corps of Engineers and marketed by STEP, Inc.
- “HAZWOPER-on-the-Web”- A Web-CT based, 40-Hour HAZWOPER training program developed by Doug Feil of Kirkwood Community College
- Netsolutions Corporation - A Web-based multimedia safety and health training system provider ([www.safety-web.com](http://www.safety-web.com)) presented by Dave Gallagher.

### C. What This Overview Is and Is Not

The primary purpose of this document is not to focus on the state-of-the-art of Advanced Training Technologies, but rather to develop and provide information about Advanced Training Technologies to facilitate discussion of potential applications, potential pitfalls, and ATT among the NIEHS HAZWOPER worker-training awardees. Prime among those considerations is the preservation of the core values of the NIEHS Training Program, values that are the “national standard.” The workshop breakout groups focused on a discussion of these topics.

In preparing information about the various ATTs, it became apparent that the approach developed by a DOE contractor to support a DOE policy commitment to the application of ATT within the Complex (20) was sufficiently comprehensive and detailed to serve as a background document for the workshop. That material includes valuable “lessons learned” and several tables of general benefits, limitations, and descriptions of various ATTs. In this post-workshop document, some of this material has been updated and revised based upon new information, results of the presentations and discussions at the workshop, and advances made in ATT over the four years since the DOE report was prepared. Likewise, during the review and revision process, the DOE report tables included in the pre-workshop document were reviewed. That review suggests that those tables, for the purposes of this document, remain valid and useful although somewhat outdated in certain respects. The tables provide a perspective on the details of importance in considering ATT and have not, therefore, been changed. One potential shift which is evident is the listing of “cost” as a benefit or limitation. Some of the tables could be changed based upon these criteria, as costs associated with certain of the technologies have decreased significantly over the intervening

time period. However, the cost factor was not a prime matter of consideration during this initial NIEHS ATT workshop. When cost matters are attributed relevance, the more recent DOE “Technology-Supported Business Case” document provides an excellent and detailed starting point. Two additional tables have been developed: Table 1 summarizes various ATT definition dimensions and Table 2 provides characteristics of Text-Based and Audio/Video-Based cases.

ATT categories used in this document are:

### **Multimedia**

1. CD-ROM (Compact Disc-Read Only Memory)
2. CD-R (Recordable CD)
3. CD-RW (Recordable-Rewritable CD)
4. Digital Videodisc (DVD)

### **Teleconferencing**

1. Audio teleconferencing
2. Audio-graphic teleconferencing
3. Video teleconferencing (telephone -based)
4. Video teleconferencing (satellite 2-way or satellite-audio return)

### **Computer Networking**

1. Intranet
2. Internet
  - a. Telnet
  - b. File Transfer Protocol
  - c. Wide Area Information System (WAIS)
  - d. Gopher (Veronica is one example within Gopher)
  - e. World Wide Web
  - f. E-mail
  - g. Chat
  - h. News Group
  - i. Streaming Audio and Video (Computer conferencing)

### **Courseware Applications**

1. Computer-Managed Instruction (CMI) and Computer-Adaptive Testing: (Computer-Based Training (CBT))
2. Intelligent Tutoring Systems
3. Electronic Performance Support Systems (EPSS)
4. Simulation
5. Virtual Reality
6. Internet multimedia based training

The material which follows briefly describes each of the “types” of ATT and includes referenced examples. ATT characteristics are presented in tables taken directly from the INEL report to DOE (20), in addition to Tables 1 and 2 which

summarize characteristics of ATT from different perspectives and sources and distance learning text-based and audio/video tape based case benefits and limitations, respectively.

#### **D. Multimedia**

The CD-ROM -- which stores a computer-readable program, image, and digital audio data -- is a technological advance from the audio CDs of the 1980's. In order to "read" the CD-ROM, a computer requires connection to a CD-ROM player, either external or internal. CD-ROMs are read by laser, thus they have nearly unlimited life if properly handled. The advantage of the CD-ROM is that it has a very large storage capacity, over 650 megabytes. The ROM acronym denotes that these devices are "read-only." The data on a disc cannot be erased, modified, or updated, nor can information be added to tailor the data to a particular training site/facility application. Typical CD-ROM applications include databases, computer software, reference sources, and entertainment products.

More recent developments have, however, addressed some of the inherent shortcomings of the CD-ROM product. These include the CD-R (recordable) and CD-RW (recordable-rewritable), which permit recording on the CD and modifying content stored in the CD format. Tables 3 and 4 exhibit the strengths and limitations of CD-ROM respectively.<sup>4</sup>

The Digital Videodisc (DVD) (termed the IVD, Interactive Videodisc, in the INEL report and INEL Tables 5, 6, 7, and 8) is a very high capacity compact disc with capacity to store a full-length movie. Reading the DVD requires a DVD disc drive or player. DVD disc drives can also read CD-ROMs and audio CDs. DVD has large storage capacity, 4.7 GB or more. Current second generation DVD players can also read CD-Rs. DVD-Recordable drives will soon be available as well.

Examples of IVD (the INEL report descriptive term for DVDs) applications in the instructional setting are presented in Table 5, while Tables 7 and 8 depict the strengths and limitations of IVD. Multimedia, as that term is emerging today within the context of ATT, includes sound, pictures, animations, video, and, indeed, virtual reality as "enhanced multimedia."

#### **E. Teleconferencing**

Teleconferencing uses telecommunication systems to link two or more locations at the same time for the purpose of interactive discussion and information exchange. There are several versions of teleconferencing based on voice, voice and graphics, and voice and video, each available through a variety of

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<sup>4</sup> . The referenced Tables have been extracted from the ATT Report and are reproduced in Section XI of this document.

telecommunication systems (digital and analog phone lines, satellite, or phone-satellite). While we typically think of teleconferencing as linking two or three locations, such approaches are the basis for very large “distributed classrooms.” The GSAMS (36) in Georgia, for example, links 350 classrooms. Table 9 provides a summary of teleconferencing techniques. Tables 10 and 11 provide an overview of the strengths and limitations of teleconferencing. The National Guard Distance Learning Project, discussed by Workshop Panelist David Fyock, is an example of a large, complex national network characterized as “Dual Multimedia,” because the network includes teleconferencing classrooms and computer-assisted classrooms.

## **F. Computer Networking**

Computer networking, or the connection of two or more computers, includes two basic sub-elements: Intranet networking and Internet networking.

“Intranet networking” includes Local Area Networks (LANs) and Wide Area Networks (WANs). LANs involve the physical connection of multiple computers to a shared file server that holds the application's software, manages file transmissions to individual computers in the system, and may manage printing. The server also contains the hard drive, so computers in the network at workstations do not require this capacity, unless they function as stand-alone units as well. Each does require a network interface card. LANs are tailored to the needs of the user organization and can utilize existing network interface cards. One limitation is that none of the network interface systems is directly compatible.

Wide Area Networks (WANs) are LANs that provide all or part of the network is made available to external clients or customers.

Intranet systems may also include computer networks developed to facilitate information management and communication needs for an organization. They are designed to provide all the services of a traditional computer network, with the added capability of providing network users direct, yet secure, access to the Internet. Intranet systems normally have more limited Internet access, but transfer of information is much faster.

The Internet is comprised of many computers, each essentially serving as an Internet “server” or “client.” Each server has a unique IP (Internet Protocol) address and each “server” provides services. These services may include the World Wide Web, E-mail, FTP, Telnet, Usenet, Gopher, WAIS, etc. These services may be accessed by the “client” from the “server” using a specific Internet Protocol. For example, the World Wide Web is accessed using the Hypertext Transfer Protocol (http), e-mail is accessed using the Simple Mail Transfer Protocol (smtp), etc. The “client,” however, must have appropriate software to use these protocols.

Typical Internet services include:

**Telnet:** Allows one computer to access another computer via the Internet and operate a program on the other computer. Typical applications are accessing large databases, library catalogues, and other information sources.

**File transfer protocol:** This Internet protocol permits viewing, downloading, and uploading of files on remote computers.

**Wide Area Information System:** This is a browsing and searching protocol that permits finding and retrieving text and files. In a WAIS, the user only sees one interface, the program "decides" how to access information on the many different databases. The user gives WAIS a "word" and WAIS searches the Internet to find sources where that word is mentioned.

**Gopher** is a browsing and searching protocol that facilitates finding and retrieving text and files. *Veronica* is one of many Gopher search vehicles.

The **World Wide Web** is a collection of electronic documents loosely knit by a concept termed "hyperlinks." Documents are connected to each other by "clickable" hyperlinks.

**E-mail** refers to text messages sent through a network to a specific address: individual or group. Such messages can also carry attached files. E-mail operates using the smtp protocol.

**Chat** is live communication over the Internet Relay Chat service or an on-line service. Communication between computers is via text and nearly "real time."

**News Group** refers to an area of the Internet reserved for discussion of "topics" posted as messages seeking replies. It operates using a net news transfer protocol.

**Streaming Audio and Video** is a service using http to transfer live audio and video over the Internet.

The Internet is seeing expanding use in training and education applications. Tables 12 and 13 provide an overview of the strengths and limitations of computer networks.

## **G. Courseware Applications**

Courseware is computer software and data specifically designed for instructional purposes. Among the various types of courseware applications are:

*Computer-Managed Instruction (CMI):* CMI takes the student through training modules based upon his/her performance in individual module learning objectives and test results. CMI instruction is self-pacing and permits a number of additional options such as pre-testing to permit advancing to higher level modules.

*Computer Adaptive Testing (CAT):* CAT tests the student at the computer, scores the test, and permits progression to the next module or to successful course completion. This allows rapid feedback to the student, which enhances the learning experience.

*Computer-Based Training (CBT)* is a broad term encompassing many training methods that use computer technology. This includes CMI and CAT, for example.

*Intelligent Tutoring Systems (ITS):* ITS add the artificial intelligence dimension to CBT, extending the CBT-learning experience to model students' learning activities. This is complex and expensive technology which has been successfully applied to highly technical subjects and procedures.

*Electronic Performance Support Systems (EPSS):* This approach involves providing courseware at the job site for workers to use as they deem appropriate, or to obtain assistance for unusual situations. The Department of Defense is developing Virtual Reality extensions to this approach to be used in the maintenance and troubleshooting of complex shipboard systems.

*Simulation:* “Simulators” in pilot training, both commercial and military, are well known. Simulation is particularly useful when teaching about dynamic systems or operations. Simulation courseware is expensive, and that limits its application.

Tables 14 and 15 present some strengths and limitations of courseware.

*Virtual Reality,* from the training perspective, provides a computer-based training vehicle allowing the student to learn within the “virtual” environment. Examples are the Interactive Virtual Reality Process Control, Simulation, and Training System developed by WSRC (14) for a specific complex process technology, and simple fall protection virtual reality training systems which put the student on the I-beam 50 feet above ground with a “virtual” fall if an improper protection system is employed.

*Internet Multimedia-Based Training* has advanced to the point that safety and health training systems are available. These offer Web-based, multimedia safety training, testing, record-keeping, reporting, and reference database searching.

## **H. Evaluation of INEL “Lessons Learned”**

The preparation of the INEL report involved extensive discussions and interviews with different organizations and leaders in the ATT development and applications arena. The report includes a summary of “lessons learned” by these organizations as characterized by the authors of the INEL report. These are considered important to the NIEHS Workshop endeavor and are, therefore, presented here. The “lessons learned” are numbered and in bold, as they are as presented in the INEL report. Those seeking additional discussion of the “lessons learned” section of the INEL can access the report as shown in the reference citation (2). The narrative following each lesson learned is provided by the authors of this document as commentary relevant to the workshop and NIEHS consideration of these issues. These “lessons learned” from the INEL report need to be understood in the context of the discussion in this report relating to the overarching worker safety and health training issues and to Section VIII concerning the technology and organization infrastructure.

### **1. The best technology selections may be a combined or integrated approach including basic or advanced classrooms, multimedia, and distance learning.**

This approach is, it would appear from the preliminary awardee survey, the basic approach utilized in that ATT elements, such as CD-ROM and the Internet, are being utilized to enhance current instructional approaches.

### **2. Consider customizing a media selection model. Then use it to help find the right balance between cost and quality.**

A media selection model is a helpful tool, but must be tailored to the organization's needs, mission, and capacities. The Air Force Model in the INEL report, for example, is tailored to a specific Air Force objective and is not suitable, as it stands, for application to the NIEHS awardee program. For example, classroom instructional approaches are not included in the “results” from the model.

### **3. Get specialized help and empower that help sufficiently to keep proper emphasis on users (OPM, FBI, State).**

This “lesson learned” is directed toward the training environment/facility such as lighting, colors and projection. A basic element, however, is the recognition that one should consider engaging a “media consultant” to maximize the return on the more advanced ATT investments.

**4. Continually review what training organizations in government, military, industry and DOE are doing with technology (i.e., don't develop the center and then think that it will remain state of the art).**

This might appropriately be an NIEHS function, perhaps through the Clearinghouse or a contract with an organization that can keep NIEHS, and thus the awardees, up to date in this rapidly changing arena.

**5. Realize that even advanced technologies incorporated today will be mostly obsolete in three to five years and will need to be upgraded or replaced.**

This is perhaps most important in considering when deciding whether to implement ATT, particularly when such advances are applied in a manner which negates or eliminates the current training infrastructure.

**6. Involve and train the instructors and staff in the use of the technologies (University of Maryland, NRC, NDU-IRM).**

Selection, development, and application of ATT also need to include attention to those within the organization, particularly the instructional staff, who must use and apply the ATT.

**7. Look beyond the current needs to allow for growth and expansion.**

While this is a very desirable attribute, it is less than clear how to meaningfully approach it in the context of the NIEHS Worker Training award program, considering the enormous dynamics of the current ATT surge.

**8. Consider residence-style living quarters (dormitories) for professional development - oriented courses or when extensive travel is involved.**

Many of the awardees have already addressed this concern, particularly in terms of their Master Instructor core and refresher courses. The cost savings are evident.

**9. Consider centralizing infrastructure support of media, information resources, etc.**

This "lesson learned" is focused on large training facilities with multiple classrooms, for example, and the centralization of media support facilities to service those classrooms. Most, if not all, of the awardees do have facilities appropriate to this "lesson."

**10. Out-source most training tasks (with notable exceptions).**

This is focused, again, on large training institutions and may have limited value to the awardee program. The exception could be using expert consultant services to

facilitate the transition of the instructional staff into advanced ATT methods.

**11. Where possible establish college or other credits that can be transferred from the training provided.**

Many of the awardees have or are already addressing this point, although it might be useful to review and understand the individual awardee's experience with specific regard to the impact of ATT.

**12. Support the learner (Air Force Academy, Florida State University).**

The issue addressed here is “learner-centered” systems, such as the development and application of EPSS, to provide training reinforcement or refreshing when it is specifically needed.

**13. Select terminology carefully. The terms "education" or "development" may be more acceptable to mid-level and senior staff than the term "training" (IRS, NDU-IRM, NRC).**

**14. Provide for interactivity in instructional delivery (numerous research studies).**

It is important to focus any ATT to the needs of the learners that the training organization seeks to serve.

**15. Look for ways to leverage the learning type by tapping the knowledge of experts.**

The military, in particular, has devoted substantial effort to tie development of advanced learning approaches to teaching complex skills to inexperienced trainees. Approaches and methodologies that have application to the HAZWOPER training sector may emerge.

**16. Use systems thinking in determining the need for training and technologies to be employed (Florida State University, IRS, NRC).**

This “lesson learned” focused on the long-term goals of training institutions. From the perspective of the potential long-term impact on awardee institutions associated with application of ATT and the potential impact on their existing training infrastructure, the basic point made likely has some merit, although of quite different dimensions for the academic institutions and the labor-based institutions.

**17. First, identify the mission of the center (FAA, IRS, NRC, NDU-IRM).**

Largely applicable to extensive training institutions and infrastructures.

**18. Look carefully at specific lessons learned by others before adopting multimedia and distance learning (FAA, Navy, DAU, NRC).**

The major point, “failures are expensive,” provides most of the message. In the ATT arena, in particular, the cost of failure can be very high, especially if previous institutional resources are jettisoned when ATT arrives.

**19. Get stakeholders involved at the appropriate times (NRC, DAU, IRS).**

A number of institutions have put together advisory boards. With regard to the NIEHS awardee program, these might be useful at the NIEHS level. They could be composed of awardee representatives and an expert external resource or two.

**20. Build evaluation of programs into the quality management process (Air Force Academy, NRC, NDU-IRM).**

The preliminary awardee survey addressed this issue. Several responding organizations indicated that they have either formal or informal evaluation tools/processes. It might be appropriate, within the context of the NIEHS program, to consider development of an ATT-evaluation tool through an NIEHS/Clearinghouse workshop.

**I. ATT Selection**

There are a wide range of Advanced Training Technologies available, and they are continually being extended to additional dimensions. Each of these ATTs has unique characteristics, costs, benefits, and limitations. The selection and application of ATT within the context of an instructional program is not, therefore, a simple matter. Several methodologies have been developed to aid in the selection of ATT. These have been termed “media selection models” or “media-method selection models.” The INEL report (20) provides extensive discussion of these approaches and provides recommendations for the development of a DOE-specific model.

The INEL report, Appendix A, addresses “media selection survey instruments” based upon excerpts from “Distance Learning Curriculum Analysis and Media Selection” developed by the Air University, Maxwell Air Force Base. The INEL-CTED web site extends this material to provide an interactive “media selection guide” containing a “worksheet” and “media selection guide results.” The “worksheet” lists 26 instructional design characteristics, each of ranked on a scale from 0 (irrelevant) to 10 (must have.) Once the “worksheet” is completed, the “media selection guide results” are calculated. Sixteen ATT “characteristics” (type, such as Multi-media/Hypermedia) are provided in ranked order as the output. The “results” do not contain characteristics typical of current NIEHS awardee training programs such as hands-on, skill requirements, peer instructors,

and the like. This is because the Air University Media Guide was designed specifically to aid in the selection of the best media for transitioning live classroom instruction to distance learning.

The basic “media selection model” approach provides an important tool in the consideration of ATT selection and application. The “model,” however, must be carefully constructed to reflect the attributes of the specific instructional program, such as core values and desired instructional outcome. An “ATT Media Selection Model or Method” specific to the NIEHS HAZWOPER training program could be developed. It must, however, specifically consider those characteristics of importance to the program. Sections VII, VIII, and X of this document identify and discuss the essential core values and attributes that these training programs must address. The workshop breakout groups addressed four topics encompassing these essential factors. The summaries of the breakout sessions, reproduced in Section IX, provide additional detail that can aid in developing an NIEHS HAZWOPER Training ATT Selection Model or Method.

### **III. CURRENT STATUS OF ATT APPLICATIONS WITHIN AWARDEE PROGRAMS**

The National Clearinghouse for Worker Safety and Health Training (Clearinghouse) developed a survey instrument (see Appendix A) to assess use of ATT and attitudes about ATT within awardee organizations. This survey was sent to 54 Principle Investigators, trainers, and others associated with the NIEHS program in preparation for the workshop. Twelve surveys were completed and returned by February 16, 1999. Respondents included six universities, five labor organizations, and one government organization (NIOSH).

#### **A. Survey Summary**

- X Eight of the 12 respondents stated that they had experience with ATT within the context of the NIEHS program. (three universities, four labor, and NIOSH)
  
- X Specific ATT use:
  - X
    - AFSCME CD-ROM/DVD
    - Video conferencing
    - Interactive computer-based training
  
  - IAFF Internet-based training
  
  - IUOE Internet-based training
  - Robotic simulators

L-AGC	Internet-based training Interactive computer-based training Computer-aided classroom instruction (tailored computer “game”)
Midwest Consortium	Video conferencing CD-ROM/DVD
NIOSH	CD-ROM/DVD Video Conferencing Interactive training programs Internet-based training programs E-mail
UMass-Lowell	Internet Familiarity
UMDNJ	Video conferencing

X Training courses where ATT had been applied:

Asbestos  
 Confined spaces  
 Emergency response(elements)  
 Emergency response (refresher)  
 Ergonomics  
 HAZWOPER (elements of)  
 Lock-out/tag-out  
 Mine safety  
 Radiation  
 Trenching

X Audiences:

Career and volunteer fire fighters  
 Graduate students  
 HAZWOPER instructors  
 Law enforcement personnel  
 Professionals  
 Stakeholder decision-makers (Town managers, fire chiefs, plant managers, state and federal regulatory officials, etc.)  
 Workers. (HazOps/RCRA-TSD)

X Extent of ATT use (limited response data):

AFSCME                      50%                      Hazmat Technicians

	20%	Hazmat Operations level
IAFF	100%	First Responder Refresher training
L-AGC	10%	HazWaste
	50%	CGI Calibration Course
NIOSH	80%	E-mail/CD-ROM, Internet
	20%	Interactive satellite
	20%	Mine safety course and public health course
UMass-Lowell	5%	Internet: Occ. And Env. Health Web Pages

X Evaluation of course utilizing ATT:

Five organizations do formal or informal evaluations, often with written evaluation instruments.

X Cost-benefit comments:

- X Distance learning methods "still high"
- X Distance learning & CD-ROM costs low compared to "face-to-face"
- X Computer-aided training cost/benefits "high"
- X Internet courses and testing "great cost savings over mail"
- X CD-ROM has excessive start-up costs
- X "Acquisition and retention" lower than face-to-face
- X Group activities difficult to conduct
- X Acquisition and retention "high"
- X Student "evaluations" equal for e-mail courses and on-campus courses

X Internet resources:

Respondents all saw real value in Internet resources

Range of Internet resources noted:

- Bulletin Boards
- Chat rooms
- E-mail
- Government
- Listservers
- New Jersey Fact Sheets
- On-line chemical hazard databases

X Technologies meriting further exploration:

- Combined multi-media/video game programming
- Electronic brainstorming

Hypertext linking training with Internet search capabilities  
Simulators  
Trainee interaction via Internet  
Web-based training aimed at life-long learning

- X What to avoid:
  - X Technologies that are not “interactive”
  - X Isolated, individual only technology-based training
  - X Technologies which do not allow student-student interactions, interaction with instructors, or hands-on activities
  - X Anything that replaces instructor/student and student/student interactions
  - X Video training
  - X Internet based training, as it does not have hands-on activities
  - X Multi-media as a stand-alone (cognitive learning, multi-learner interactions, and problem-based instruction deficiencies)

From the NIEHS perspective, the awardees (excluding NIOSH) who have applied ATT have done so through a focus on particular media sectors which seem consistent with their organizational setting. The labor organizations have focused on computer networking and courseware while the academic organizations have focused on telecommunications. Only one awardee, AFSCME, reports applications in all four media (multimedia/ teleconferencing/ computer networks/courseware) and the Midwest Consortium has applied CD/DVD as well as teleconferencing.

From another perspective, the INEL report discusses the GARTH (Generic Acceptance of and Readiness for Technology Heuristic) model in terms of five levels of characteristics of organizations for ATT readiness. (See Table 30 of the INEL report, which is Table 16 in this report.) It is evident that one major benchmark NIEHS needs to assess in considering ATT applications to HAZWOPER training is the current characteristics of the awardee organizations. According to GARTH criteria, it would appear that most of the awardees are at Level 1 with some movement occurring toward and into Level 2. It is the growth from Level 1 to Level 2 which is often noted as the most difficult, so the current perspective is an encouraging one. Furthermore, the timing seems appropriate for NIEHS to establish criteria for using ATT. It is also clear from the analysis of the survey responses that although the NIEHS awardees do not share a single perspective on the use of ATT, they do evidence a genuine interest in pursuing emerging ATT approaches and appear willing to experiment.

#### **IV. FOUNDATION BENCHMARKS FOR NIEHS TRAINING GRANTS**

An important aspect of the application of ATT to an existing training infrastructure is the comprehensive understanding of the training mission. The application of ATT must be viewed as a means to enhance achievement of the training mission for the institution if it is to be used. This section is devoted to the overview of the NIEHS HAZWOPER training mission requirements; these might be considered as “benchmarks” that HAZWOPER training programs must meet regardless of the training technologies or methodologies employed.

NIEHS was authorized under the Superfund Amendments and Re-Authorization Act of 1986 (SARA) to make awards to non-profit organizations that demonstrated experience in implementing and operating worker health and safety training programs and the ability to reach target populations of workers who are or would be engaged in hazardous materials waste removal/remediation, containment, or emergency response operations. NIEHS made the first grant awards in FY 1987 to 11 organizations.

Concurrently and also as mandated by SARA, OSHA and EPA promulgated worker protection standards, 29 CFR 1910.120 and 40 CFR 311, respectively. The Final OSHA standard, 1910.120, became effective March 6, 1990, while the EPA version became effective June 23, 1989. These identical occupational standards are among the most extensive and detailed performance standards governing worker protection, and include specific and detailed requirements for training of the various categories of activities covered. The training requirements specify minimum training duration for the various training categories. SARA also required that OSHA develop and promulgate an accreditation standard specific to the training programs required within the hazardous waste operations and emergency response standard. OSHA published a notice of proposed rule for such an accreditation standard in 1990 (2).

As these concurrent events were advancing, it became apparent to the NIEHS worker training awardees that a need existed to develop uniform criteria applicable to the worker training programs developed under their NIEHS grants. To that end, a National Technical Workshop was organized and convened in March 1990. The product of that Workshop was the “Minimum Criteria for Worker Health and Safety Training for Hazardous Waste Operations and Emergency Response.” (3) Subsequently, as experience within the awards program developed with the “Minimum Criteria” and OSHA essentially ceased efforts to move the accreditation standard toward a final rulemaking, the awardees saw an advantage to a subsequent workshop to discuss their collective perspectives on the implementation of the “Minimum Criteria.” The awardees held a second workshop in March 1994 and developed and issued the “Interpretive Guidance to the Minimum Criteria” (4) to augment use of the “Minimum Criteria.”

The OSHA-proposed accreditation rule, 29 CFR 1910.121, has not been advanced and is not likely to be promulgated as a final rule in the foreseeable future. In the interim, the “Minimum Criteria” has served as the primary source of the OSHA non-mandatory Appendix E: Training Curriculum Guidelines (1), published in the Federal Register in August 1994, based on a recommendation of the Advisory Committee on Construction Safety and Health to the Assistant Secretary in 1993.

The “Minimum Criteria” is the current nationally recognized benchmark for quality HAZWOPER training programs. As the NIEHS Worker Training Program considers advancing into the dynamic ATT arena, it should do so with full regard to the benchmark criteria established in the “Minimum Criteria.”

The following are highlights of the primary benchmark criteria within the “Minimum Criteria” and the subsequent “Interpretive Guidance.” They have been highlighted for purposes of this document. There are additional criteria, however, within the referenced documents and Appendix E. For a comprehensive understanding of the criteria, these references should be reviewed in full.

**A. HAZWOPER Worker Training Principles Special Considerations (4):**

1. Training must be provided to people with diverse backgrounds and learning experiences. Special attention needs to be paid to the ways in which delivery and evaluation of impact and effectiveness are conducted.
2. The training programs need to effectively address the gap between academic (theoretical) understanding and actual job performance (skill). Academic achievement as evidenced by high test scores is not a good predictor of the ability of the trainee to perform a particular practical task. This is particularly important in many dimensions of HAZWOPER training as the trainees may be expected to work in highly hazardous activities.

**B. General Comments (4):**

1. Quality HAZWOPER core training programs cannot be presented within the minimum hours established in the standard.
2. Refresher training should be conducted only by training providers who offer the relevant core program.
3. Hands-on training is critical and should fill at least 1/3 of training program hours.
4. HAZWOPER training programs also need to consider the settings within which the trainee is expected to work. For example, most hazardous waste clean-up operations are also governed by the OSHA construction standards while the OSHA general industry standards are applicable to most RCRA/TSD facilities.

**C. Minimum General Criteria (1, 3, 4):**

1. The minimum generic (core) training program curriculum is based on the assumption that the trainee already possesses the skills of his/her trade or job classification.
2. On-the-job skills training should not be allowed in a hazardous environment without the proper personal protective equipment (PPE), health and safety training, and the like.
3. Hands-on training must be carried out under the supervision of trained and experienced instructors.
4. Each training program shall be under the direction of an experienced Training Director.
5. Instructors must have successfully completed the course they intend to instruct, a train-the-trainer program, and should, to the extent feasible, be peers of the trainees (worker-trainers).
6. Course materials must be approved by the Training Director and updated and reapproved annually.
7. Trainee/instructor ratios apply to classroom settings. No less than two instructors must be present during hands-on training involving PPE or other equipment, and a ratio of 5:1 is required for hands-on exercises with trainees wearing Level A & B ensembles.
8. Proficiency is to be determined by written tests and/or skills demonstration methods as appropriate to the objectives of the particular course.
9. Written document shall be provided to each trainee successfully completing the course.
10. A training plan is required.
11. A quality control program is required.
12. Appropriate training support staff, facilities, equipment, and the like are required.

**D. Minimum Generic Curriculum Criteria:**

1. General Hazardous Waste Operations
  - a) Regulatory knowledge
  - b) Technical knowledge
  - c) Technical skills
  - d) Refresher training
    - Use relevant trainee experiences
    - Technical updates
    - Review regulatory changes
    - New subject areas
    - Hands-on review
    - Air monitoring
  - e) On site criteria are addressed as well

2. RCRA/TSD Operations
  - a) Regulatory Standard and Employer Safety and Health Program
  - b) Information and training
    - Facility emergency response
    - Hazardous waste handling procedures
    - Hazard communication
    - Medical surveillance
    - Decontamination
    - Training requirements
    - PPE
    - Site-specific (exercises and small group activities noted)
    - Engineering controls
    - Site safety personnel
  
3. Emergency Response

Two specific categories of emergency response are established in the criteria:

- a) Collateral Duty Emergency response, and
- b) Public and Facility (Off-Site) Emergency Response.

The Interpretive Guidance document is the first attempt at separating emergency response into these real-world response categories. Detailed and distinct training criteria are developed in the Interpretive Guidance document.

The Interpretive Guidance to the Minimum Criteria includes Suggested Goals and Suggested Objectives for each curriculum topic. Regardless of the training methodology, these should still be met.

## **V. CHARACTERISTICS OF HAZWOPER WORK**

It is, or should be, apparent that there are many issues of importance to HAZWOPER workers associated with the core and site-specific training they receive in preparation for this dangerous work. The introduction of new training approaches must be considered within this context.

HAZWOPER work is not a minor endeavor. A study by Ruth Ruttenberg and Associates, Inc., for NIEHS and EPA (42) provides a valuable perspective on the industry and the workforce. There are over 1,204 NPL sites (as of 3/11/99), tens of thousands of RCRA/TSD sites, thousands of hazardous waste sites on Department of Defense and Department of Energy facilities, over 295,000 underground storage tanks requiring closure or removal, and as many as 425,000 state and privately owned contaminated sites. Responses to hazardous materials incidents by emergency responders number in the thousands annually. The study

projected that this type of employment would exceed four million work years and that the “best estimate” of the costs exceeds \$750 billion.

HAZWOPER work represents one of the most dangerous jobs in the nation. It encompasses emergency removal of hazardous materials on sites constituting an immediate public health threat, remediation work to eliminate/mitigate the public health threat associated with contaminated sites/facilities, the treatment/storage/disposal facilities that handle hazardous materials, the transportation of hazardous materials, and the response to emergency events involving hazardous materials. Each of these presents the potential for serious, even fatal exposures for workers engaged in the operations associated with the hazardous materials involved. In addition, these workers are exposed to other potentially fatal hazards associated with the protective equipment they must often wear to protect themselves from chemical exposure. These hazards are in addition to “normal” hazards, such as construction hazards, at remediation sites. Emergency response personnel are particularly at risk and the emergency response to hazardous materials incidents has spawned the need to emphasize a “defensive” response mode, which is a major departure from classical emergency responder action.

The hazards faced by the HAZWOPER workforce include “usual” safety and health hazards, acute and chronic health hazards associated with individual and complex mixtures of hazardous materials, exposures by all routes, acute traumatic injury, acute illness associated with the protective equipment often required, and the dangers associated with fire/explosion. It is atypical work for the trades and crafts representing the prime HAZWOPER workforce. It is in recognition of these facts that the HAZWOPER standards devote very specific and detailed attention to training, including minimum training hour requirements.

The HAZWOPER standard generates more interpretation queries than any other OSHA standard. A review of the OSHA HAZWOPER standard violation statistics provides a perspective of those aspects of compliance that require additional attention (9, 10, and 11). Over the period 1993-1997, 5,866 violations were cited, with 4,973 for violation of 1910.120(q) Emergency Response, followed by 207 for S&H Program (Paragraph (b)), 120 paragraph (p) (RCRA/TSDs), and 132 paragraph (g) Controls and PPE. Twenty-one percent of the paragraph (q) citations were for training ( (q)(6)). Of the paragraph (p) (RCRD/TSD) citations, 16% were for training violations and 62% for emergency response program deficiencies. Of further interest, citations for violations of the HAZWOPER standard are usually accompanied by citations for violations of other OSHA standards. For example, HAZWOPER paragraph (p) citations are most commonly accompanied by citations for violations of 29 CFR 1910.37, .134, .132, .147, .151, .157, .178, .212, and .303.

## **VI. U.S. ARMY CORPS OF ENGINEERS (USACE) CASE STUDY**

It is evident that OSHA will become increasingly involved in interpretations involving CBT, WBT, and similar ATT applications as a matter of compliance with training requirements. Analysis in the framework of the HAZWOPER standard is more complex, in some ways, than are other training interpretations, because of the minimum hour requirements, among other factors. Significantly, the OSHA emphasis on hands-on training and immediate response/interaction with a qualified instructor has significant bearing on the matters which are the focus of this document and of importance to NIEHS and its awardees. References 18 and 19, the USACE letter to OSHA and the OSHA response are provided in Appendix D of this document.

USACE has developed a web-based (WBT) 8-hour HAZWOPER refresher training program. On February 10, 1998, the USACE sent a formal request to OSHA seeking concurrence that the course was in compliance with the 8-hour refresher training provisions of 29 CFR 1910.120.(18)

The USACE has developed criteria for determining when WBT meets the intent of the standard. The criteria is based, in part, on the OSHA interpretation letter of 11 October 1994 on Computer-Based Training (CBT). In that response, OSHA indicated that for a CBT course to be compliant, the following must be addressed:

- 1) The course should cover topics relevant to the worker's assigned duties.
- 2) The course should be supplemented by the opportunity to ask questions of a qualified trainer, and
- 3) The course should demonstrate an assessment of worker skill through auditing of hands-on performance of work tasks.

The USACE WBT course addressed these points, and others, in the following manner:

- 1) The course is structured in modules, some of which are mandatory and some of which are optional depending on site-specific conditions. The later modules are selected by the site supervisor.
- 2) The course is self-paced and does not require eight concurrent training hours.
- 3) The course includes tests which can be varied among true/false, multiple choice, matching, and problem-solving. Photographs and graphic images are utilized.

- 4) Reviews and exercises are included in each module.
- 5) Seventy percent of the randomly generated test questions must be correctly answered to pass each module.
- 6) The course offers a feature to permit students to link to Internet resource sites such as OSHA, EPA, and NIOSH.
- 7) The course includes a 24-hour telephone hotline staffed by qualified instructors.
- 8) The course offers a 24-hour response commitment by a qualified instructor via e-mail.
- 9) The course “preamble” states that successful completion of the course must be followed by a supervisor's verification that the student has participated in the following:
  - A. Employer safety meetings relevant to the student’s duties.
  - B. Incident reviews and critiques pertinent to the student’s work assignment.
  - C. Safety meetings or informational programs to address hazards and protective measures for a particular site or task.
  - D. Review of the site-specific health and safety plan and personnel assignments where the student works.
  - E. Hands-on exercises related to PPE selection, use, and maintenance.

OSHA responded to the USACE request on July 31, 1998 (19). In the response, OSHA noted that the Agency does not endorse or approve specific training programs, but did offer an evaluation of the WBT criteria which the USACE described. The salient features of the OSHA response were:

- 1) The WBT course described by the USACE “seems largely consistent” with the requirements in the standard and with previous OSHA interpretations on CBT, “provided that site-specific training elements are incorporated into the training and that students do, in fact, have access to qualified trainers who can respond to student questions as they arise.” (Emphasis added).
- 2) OSHA noted that the effectiveness of training is determined by the Compliance Officer in the field.

- 3) OSHA recommended the following:
- A. The employer must meet the minimum training period requirement in the standard. The USACE approach indicated a minimum of eight hours “working on the course before a certificate of completion can be awarded.” It was unclear whether the time associated with the additional activities is in addition to this eight hours. OSHA suggested that a range of training activities can count toward refresher training, however, and offered suggestions for integrating some of the preamble activities into the 8-hour course.
  - B. OSHA regards hands-on training as a preferred training method. It should be incorporated into the requirement for successful completion of the course. That is, the hands-on aspect must be successfully completed as well. The employer can determine that hands-on is not required, but must meet requirements to assess the employee’s skill level and ensure that the worker is competent to perform his/her duties.
  - C. The USACE indicated that on-site safety and health briefings were in addition to the 8-hour WBT course. OSHA suggested integrating these briefings into the refresher training program, because they are part of refresher training if they cover items in 1910.120 (e)(2 and (e)(4).
  - D. Hands-on training should include relevant health and safety field skills, not just PPE use as the USACE course indicates.
  - E. OSHA was unable to ascertain the time associated with each module nor whether time had been allocated therein for “additional research,” presumably on the Internet. The time associated with work on the Internet was a potential concern, as the time to access and retrieve materials varies substantially among various computer systems, especially when graphics or photographs are involved. The potential impact of the “Internet time” during an 8-hour refresher from an OSHA interpretation perspective was not addressed, however.

Subsequent to the previously described exchange between the USACE and OSHA, at least one additional CBT interpretation has been issued by OSHA. It

specifically impacts the underlined (emphasis added) point above. OSHA responded to Wicklin on January 15, 1999 on the matter of “interactive CBT” and whether an instructor must be physically present in the room while trainees are taking a CBT course on-line.

OSHA response:

- 1) OSHA reaffirmed a previously stated interpretation that a training provider can meet the OSHA requirement for trainees to have access to a qualified instructor through a telephone hotline.
- 2) The instructor available via telephone hotline must be accessible “during training.” That is, the instructor must be available “when the question is asked.”
- 3) E-mail as a means to respond to trainee questions is not acceptable unless the response by a qualified instructor is immediate, per 2) preceding.

The workshop keynote speaker, Hank Payne, reaffirmed “OSHA’s Training Requirements” applicable to safety and health training broadly, not solely applicable to HAZWOPER work. Those requirements are:

1. Availability of instructor to answer student questions during training.
2. Provision to meet site-specific training.
3. Provision for students to demonstrate proficiency.

As the new Director of the OSHA Training Institute, he stated that OSHA “is going to do distance learning.” This offers the potential opportunity for the NIEHS Worker Training Program to work with OSHA in developing and applying ATT to safety and health training.

## **VII: ATT-HAZWOPER TRAINING APPLICATIONS ANALYSIS**

The world of ATT is diverse, complex, dynamic and costly. The application of ATT, in terms of the present state-of-the-art, does not represent a simple progression for the traditional NIEHS HAZWOPER training awardee programs. The adoption of ATT methods challenges the awardees' traditional training methods: classroom-instructor lead, demonstrations, and hands-on skills learning enriched with case studies, video, and similar training enhancements. ATT challenges traditional knowledge and skills teaching methods offering the speculative benefit of enhanced learning, reduced costs, and the like, while reducing or eliminating the current training infrastructure and replacing it with a very different training system. Further, a thrust associated with ATT is the shift of learning responsibility from the instructional professional to the trainee. A training institution’s commitment to ATT can have a negative impact if not

properly and carefully planned with a clear view of what institutional benefits are expected and at what cost.

The NIEHS awardees represent a cadre of special training expertise focused on a unique, highly hazardous industry. Further, this industry is extensively regulated, most particularly with regard to training requirements. The training programs developed and delivered by this group are the state-of-the-art and have established the national quality benchmark. While the HAZWOPER industry is highly hazardous, the relatively low incidence of adverse worker health and well-being consequences is one measure of the success of these training programs.

Specific to ATT, the pre-workshop survey, despite the limited response, did suggest that the awardees have taken two overall approaches in their entry into ATT, based upon their institutional setting. The labor organizations have largely devoted their efforts to computer networks and courseware, while the academic institutions have focused on teleconferencing, a media in which academic institutions are now heavily involved via distance learning and distant classroom initiatives.

In preparation for the workshop, The National Clearinghouse conducted a comprehensive survey (17, 40) of available computer-based and Internet-based safety and health training materials. The survey information is extensive and provides a useful perspective on available materials. However, it is unclear how that information might be used in the more focused context of aiding in ATT decision structuring. This is not unexpected, of course, as the INEL report (20), which is one of the prime sources of information for this document, is, in fact, an example of the complexity and detail necessary simply to set the stage for DOE, in that instance, to decide if and how it should utilize ATT. (The ATT selection method is developed in that report based upon an Air Force Media Selection Model. A Media Selection Model, or a similar structured ATT decision tool, is a potentially important focal point for NIEHS in developing a methodology for the selection and utilization of ATT in the training program). NIEHS and the awardees, in considering the application of ATT, are faced with a complex undertaking as ATT selection models or methods are complex and must be thoughtfully structured to meet the needs of the individual training institution as well as the OSHA training requirements. The Air Force model, for example, is not directly applicable, as its purpose is to identify methods to aid in exporting existing classroom-instructor led courses to a distance learning instructional setting in absence of a need to meet regulatory requirements.

Evidently, there is no existing “ATT selection model” that can be directly applied to the NIEHS HAZWOPER training program, primarily because of the unique regulatory requirements governing the application of ATT. Existing models and methods, however, provide useful guidance with regard to the information that needs to be considered. In addressing the starting point in such an endeavor specific to the NIEHS HAZWOPER training program, the following are relevant:

1. Determination of the core attributes of the HAZWOPER worker training programs. (Section IV. The Minimum Criteria, Interpretive Guidance, and Appendix E);
2. Determination of any special characteristics of the training programs which must be considered in any application of ATT including the OSHA regulations governing HAZWOPER and Video/CBT training. (Section IV, V, and VI);
3. Determination of what elements of the current training programs offer the potential for improvement or enhancement through the application of ATT methods such as CD-ROM/DVD, simulation/gaming, and Internet accessible data/references;
4. Development of an NIEHS HAZWOPER Training Program Specific ATT Media Selection Model/Method;
5. Determination of the institutional capacity of the awardees and program to adopt ATT;
6. Evaluation of the impact of the application of ATT methodologies to current institutional structures;
7. Determination of the cost of implementing ATT and the anticipated benefits (measures of success); and
8. Development and launch of an NIEHS ATT implementation initiative.

Participants at the NIEHS workshop were asked to address the first three points specifically and to consider the implications of points 4, 5, and 6 as the objectives for the workshop.

To address the first three points, the following breakout sessions were conducted:<sup>5</sup>

1. Challenge to Hazmat/Environmental Training

This breakout group concentrated on identifying elements of hands-on training and contrasting issues involved in using ATT with, instead of, or alongside, hands-on training. How can the new

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<sup>5</sup> Details of breakout session discussions are on file at the Clearinghouse.

technologies respond to the need to evaluate skill development and competency?

## 2. Worker/Peer Trainers

The impact on trainees of replacing worker trainers with CD-ROM, videos, Internet-based courses and other interactive technologies.

## 3. 1910.120 Curriculum and New Training Technologies

The impact of using new technologies to teach complex topics, such as health effects and workers' rights.

## 4. The Challenge for Instructors

Developing effective programs to help instructors master new technologies.

The specific matter of the unique requirements imposed by the OSHA HAZWOPER Standard and by OSHA training requirements standards interpretations related to video/CBT are addressed in Sections IV and VI.

# VIII. INFRASTRUCTURE ISSUES

## Technology Infrastructure

An important theme that runs through the ATT issues and which must also be considered, especially by those organizations which have limited means, are those issues which are essential to building and maintaining a training infrastructure. In this case the importance of the technology based infrastructure components include the need to assess the target population, choosing an ATT that matches, and implementing an organization-wide program. Some of the more practical considerations will be keeping materials up to date and equipment the state of the art. These are all elements of recognizing the "comprehensiveness" of a training program utilizing ATT. Specific examples include:

- staff development infrastructure
- curriculum development centers
- wiring of hardware, e.g. WAN, LAN, etc.
- planned upgrades (materials and equipment)
- budgeting-initial and ongoing budgeting is critical to the success of an

### ATT activity

- assessing and evaluating the impact of ATT programs and sharing the experience gained by individual grantees through NIEHS activities such as Forums and Workshops
- instructor development.

### **Building Organization Infrastructure and Developing Organization Support**

A major concern expressed in the workshop breakout reports was the real, as well as perceived, belief that ATT is for the ‘haves’ and that such program enhancements simply continue to widen the gaps between the well-funded, sophisticated and mature training programs and those programs coming from community-based organizations (CBOs) which are still developing training programs and do not have the access to the extensive resources that are needed to work with ATT program activities.

Representatives from CBOs indicated an interest in participating in ATT development and implementation, but also expressed a serious concern that they could not effectively compete. The recommendations from the workshop participants focused on a need to reconcile ATT infrastructure requirements with a lack of resources in many programs that simply do not allow for such creativity. The need to develop the capacity to deal with ATT issues must be a high priority for these organizations in order to ensure that they do not continue to fall further behind as the ATT development continues on its fast pace.

To effectively enable these groups to compete, NIEHS should provide the assistance necessary to identify and strengthen the program infrastructures needed to participate in the ATT forums. This activity will probably require several different approaches including:

1. Capacity building to enable an understanding and management of new hardware and software programs.
2. Special efforts to build instructor capacity to both understand and utilize ATT modules for computer aided classroom instruction.
3. Special efforts to work with prospective trainees from communities and other referral sources who need very basic education assistance as well as low level computer assistance in order to effectively participate. NIEHS should be prepared to provide these resources to develop both pilot programs and full term programs.

4. Recognizing that many members of the target populations will require extra assistance by way of specialized training and other resources in order to be able to take advantage of ATT capabilities.
5. Placing special emphasis on preparing peer instructors to work with ATT activities.
6. Focusing on participants' continued concern over the potential of ATT introduced programs to erode worker empowerment. There are no quick fixes for these concerns; but they also must be recognized as real concerns. Addressing them will require considerable patience and not insignificant resources. Including workers at all stages of the program development will go a long way towards ameliorating potential problems.

## **IX. DISCUSSION AND NEXT STEPS**

Subsequent to the Workshop and prior to issuance of this report, NIEHS concluded that it would move forward in the ATT area by offering competitive supplements for FY99 as well as including ATT criteria in the RFP for program renewals in the forthcoming FY2000 competition. The notice for the competitive supplements included guidance derived from issues presented in the Technical Workshop and reflected in this report. Some of the questions asked of those competing for these supplemental grants are indicative of the issues that NIEHS believes are appropriate to address with respect to ATT at this time:

### **ATT Competitive Supplement Criteria**

Respondents to this request for competitive supplements are encouraged to include applications that pilot the use of advanced training technologies. The pilots should focus on either improvements to the overall training infrastructure or on areas of content that might be delivered using advanced technology. Applications should target improvements in the training infrastructure including areas such as improving the overall ATT knowledge level of training developers, involving worker trainers or course instructors in the development technology-based course development, baselining the status of hardware and software across the health and safety training community, as well as researching and implementing a media selection model for use across an awardee, or group of awardees' health and safety training community.

Delivery pilots of health and safety content should focus on new, technology-based methods for delivering training that improve learning, reduce costs, and can be demonstrated as effective for the specific content for a defined target population. These

technologies include but are not limited to web-based, computer-based, televideo, virtual reality, and combinations of technology. Partnering between organizations is encouraged as proposals for pilots are submitted. Each technology pilot proposal must answer the following questions to be considered:

Organizationally, how is your organization structured to facilitate the introduction of advanced technology? Please identify those that will lead the project and their credentials in the area proposed. If outside parties will be assisting please identify them and their capabilities to facilitate your success.

What type of infrastructure (hardware, software) do you currently have or anticipate acquiring that will be necessary to demonstrate success? Is this equipment well understood by someone on the project team?

What evidence do you have that your audience is ready to use the product of your pilot? If the audience is not ready to use the product what will it take to get them ready? How is this factored into your proposal?

Will the product be useable by other groups? Who have you contacted and what has been their response to your idea? Please identify others that will participate in the pilot or test the product as part of the pilot.

The responses to these questions should be useful in defining the scope of ATT activities to be addressed by NIEHS grants as well as future NIEHS direction. The pilot programs are expected to answer many of the questions posed in the Workshop break-out groups with respect to worker participation, instructor development and hands-on training.

## X. TABLES

<b>Table 1. Distance Learning Text-Based and Audiotape/Video Based Cases*</b>	
<b>TEXT-BASED:</b>	
	<b>Limitations</b>
Self-paced	Delivery: hard copy via mail/delivery services.
Inexpensive	Student reading ability.
Portable	Student questions difficult to answer in timely fashion or easily. (1)
Established effectiveness	Changes inefficient/waste resources.

### AUDIOTAPE/VIDEO-BASED:

	<b>Limitations</b>
Self-paced	“Generic” (canned) (2)
Inexpensive	Costly to update
Portable	Linear sequence
Established effectiveness.	Student questions difficult to answer in timely fashion or easily. (1)

\*Adapted from presentation by Hank Payne, PhD on April 20, 1999.

(1) OSHA training requirements are that an instructor must be “immediately available” to answer student questions. (Applicable to training required by OSHA standards.)

(2) OSHA training requirements are that standards applicable training must be “site-specific” although “generic” audio/video tapes methods may be acceptable as supplemental training aids/tools.

<b>Table 2. Summary of the Characteristics of Various ATT Sub-Categories</b>		
<b>I. Payne, OSHA:*</b>		
<b>Synchronous/Asynchronous:</b>		
	Synchronous:	Real time computer conferencing
		Audio graphics
		Audio Teletraining
		1-way Interactive Video Teletraining
		2-way Video Teleconferencing
	Asynchronous:	Text-based training materials
		Audio/Video tape
		Delayed computer conferencing
		Computer-based training (CD-ROM)
		Inter/Intranet
*Based upon Hank Payne PhD keynote presentation at NIEHS ATT Workshop. See Appendix E for slide text.		
<b>II. National Clearinghouse Grantee Questionnaire: Computer and Internet-Based Learning Methods for Safety and Health Training.</b>		
		CD-ROM/DVD.
		Video conferencing.
		Internet-based.
		Interactive.
		Intranet/Extranet-based.
		Other
<b>III. D. Timmerman, Computer Systems Specialist, OENHP:*</b>		
		Classroom.
		Video conferencing.
		Computer-based:
		CD-ROM
		Web –based
		Hybrid.
*Personal communication.		
<b>IV. Pre-Workshop Draft Document “HAZWOPER Training: Utilizing Advanced Training Technologies.” *</b>		
	Multimedia:	CD-ROM
		CD-R
		CD-RW
		IVD (DVD)
	Teleconferencing:	Audio
		Audio-graphic
		Video (telephone-based)
		Video (2-way)
	Computer Networking:	Local Area Network (Intranet)
		Internet
	Courseware:	Computer-based training (CBT)

<b>Table 2. Summary of the Characteristics of Various ATT Sub-Categories</b>		
		Intelligent tutoring systems
		Electronic performance support systems
		Simulation
		Virtual reality
		Internet multimedia-based
*Based upon minor updates to reference 20.		
<b>V. "Technology-Supported Learning Business Case:"*</b>		
	Interactive Television (ITV)	2-way video, two-way audio
		1-way video, 2-way audio
		1-way video, 2-way audio with data link
		1-way video, 1-way audio (satellite)
	Multimedia/Computer-based.	Slide shows/Linear Computer-Based
		Drill and Practice
		Learner-Selected Branching
		Canned Simulations
		Interactive Simulations
	Internet/Intranet-based	
*DOE Technology-Supported Learning Business Case, April 1997		

## TABLES FROM INEL ATT REPORT

<b>Table 3. Strengths of CD-ROM</b>	
	Impact
Storage capacity	Each disc can store over 650 megabytes of data, graphics or sound. That capacity is equivalent to hundreds of floppy disks.
Portability	Discs are small and lightweight, an ideal medium for transporting data.
Durability	Discs are very durable. Fingerprints and slight scratches will not usually impair their performance. Discs are read with a laser beam, so there is no direct contact or wear on the disc as it is played.
Low cost of replication	Reproduction costs about one dollar per disc after the master is created.
Inexpensive hardware	The cost of CD-ROM drives has decreased dramatically in the past few years. Many computers now feature built-in drives.
Availability of CD-ROM programs	Several thousand commercial titles now available including a wide range of reference materials, multimedia applications, and government documents.
Speed	Although the access time of CD- drives is slower than that of hard drives, the speed of the search compared to manual methods is impressive. Faster CD-ROM drives being introduced regularly (e.g., triple-speed, quadruple-speed).

<b>Table 4. Limitations of CD-ROM</b>	
	Impact
Slow data access	CD-ROM drives can access data in about 150 milliseconds (double-speed CD-ROM), but this is still 10 times slower than a hard drive.
Cost of subscriptions	Some CD-ROM programs, including education and training applications, require a subscription fee for updates. These fees can often be as much or more than the original purchase and should be budgeted as a life cycle cost.
Limited scope	Even though CD-ROMs hold an enormous amount of information, they are limited. If an application requires more than one disc, a multiple-disc player is required.
Read only	CD-ROM discs cannot be changed. Although this may sometimes be an advantage, it complicates the revision and update process.

**Table 5. Application and Instructional Value of CD-ROM**

	Instructional Value
Interactive Tutorials	IVD programs are designed with a tutorial strategy wherein new information is introduced and questions or other interactions are included. With IVD's ability to branch easily to any segment on the disc, a student is not locked into a particular sequence. This strategy has been extremely effective. Studies show that IVD tutorials provide a higher mastery rate and retention level than traditional classroom instruction (Fletcher, 1990).
Instructional Games	Instructors know the challenge of maintaining the interest of a generation of learners who have grown up with video arcade games and the MTV channel on television. Educational games usually offer a variety of special effects and motivate learners with the challenge of solving a mystery or beating the clock or the computer.
Simulations	Simulation programs can be used for problem-solving scenarios or role playing. In some cases, a procedure such as an engine replacement or a chemistry experiment may be simulated because it is too dangerous or expensive for the student to experience in person. In other cases, the student may make decisions and view the results of the decision enacted.
Visual and Multimedia Databases	A visual or multimedia database is a videodisc made up primarily of individual pictures, video clips, sounds, maps, technical drawings, and text. These applications are not designed to teach at least not in the customary tutorial fashion. Instead, they offer a wide array of interrelated information available to assist the instructor. Because up to 54,000 frames may be on a videodisc, visual databases can offer access to an enormous amount of visual material.
Linear Documentary Presentations	Videodiscs can easily replace 16mm film libraries, at a fraction of the cost, without worries about sprocket holes and rewinding. Videodiscs do not wear out or degenerate with repeated use. In addition, many educational films, documentaries, even commercial movies are available on videodisc at lower prices than on videotapes. Also, by using the SEARCH option, any location on the disc can be accessed almost instantly.

Table 6. IVD Interactivity Levels			
			Notes
I	Student's control similar to that of VCR user	Monitor, video player, videodisc, optional remote or barcode controller.	Player has no memory or processing power. Used mostly for entertainment applications.
II	Increased interactivity	Monitor, videodisc player with built-in programmable memory, videodisc which includes a controlling program.	Increased flexibility over Level I. Offers simple branching: player stops on multiple choice questions, student makes choice, player goes to specific frame for feedback. Problems: program will not operate on all IVD players, control program on disc cannot be changed.
III	Flexible, sophisticated interaction	Computer, videodisc player, monitor, related peripherals.	Videodisc player is essentially a computer peripheral. Student can access a term, image or video. Level III also uses computer to note and store student performance.
IV	Flexible, sophisticated interaction	Computer, videodisc player, monitor. (Videodisc can store digital data as well as analog video and sound.)	Computer-videodisc system in which videodisc is used to store digital data as well as analog. Thus the videodisc player serves as an added optical storage device to the computer.

<b>Table 7. Strengths of Videodiscs</b>	
	Impact
Access	Fast and precise. Frames and segments can be identified for presentation through use of a computer, a remote control, or a barcode reader.
Cost of Programs	Many commercially-available videodisc programs are less expensive than those on videotape or film. (Range: \$50-700)
Durability	Images on the disc do not degenerate with use. After years of use, the video will look as clean and sharp as it did the first time.
Quality	Videodiscs are generally recorded with 350 lines of resolution. VHS and Beta videotapes are recorded with only 200 to 250 lines of resolution. Videodiscs have a sharper appearance and better-quality picture.
Storage	Videodiscs are easy to store, take very little shelf space and will not warp.
Interactivity	Unlike videotape or film, it is relatively easy to control a videodisc with a computer. Level III videodisc programs provide the interactivity and instant feedback of computer-assisted instruction with visual and audio realism.
Still frame	Still frames can be halted for hours with no damage. This provides individual access to every frame on the disc.
Dual audio tracks	The two audio tracks on all videodiscs can be creatively used for applications such as bilingual narrations or stereo sound.
Format standards	Although there are two different video formats (CLV and CAV), all videodisc players can play all laser standard videodiscs.
Great utility	Instructors can use videodisc programs developed, can program them for individual or group use, and can select segments for classroom audiovisual aids. Videodiscs also serve as research and reference databases.

<b>Table 8. Limitations of Videodiscs</b>	
	<b>Impact</b>
Cost of Programs	Front-end design and development costs for quality programs can be expensive.
Cost of Hardware	Players that interface with computers and provide remote control units currently cost about \$700. However, the cost of videodisc players continues to decline.
Maintenance Costs	As with all equipment, an annual maintenance budget is part of life-cycle costs.
Lack of Interface Standards	Connecting a computer to a videodisc player can be frustrating. Different players require different interface cables and speak different languages. Software programs must contain appropriate drivers, and baud rates have to be set correctly.
Read Only	Videodiscs are read-only; the user cannot record on the disc. This is a disadvantage in that student productions or other creations cannot be recorded or copied.
Difficult for Group Instruction	Without expensive video projection equipment, a video display is limited to the video monitor size. Level III delivery with two monitors also has the problem of projecting the computer screen for group instruction.
Computer Storage Requirements	If a Level III videodisc program is to be used, computer software will be needed to run the program. In some cases, the amount of storage space required on a hard drive approaches 10 megabytes.
Lack of Computer Compatibility	Before a Level III program is purchased, check carefully to determine which computer family it requires. As with other software programs, if it is written for the Macintosh, it will not run on an IBM, and vice versa.
Limited Motion Sequences	Up to 54,000 still frames is a tremendous capacity for videodisc, but when this is translated into motion sequences, the limit is 30 minutes, much less than a videotape's capacity.
Lack of Instructional Materials	To date, instructional materials to support the use of videodisc programs are scarce. In many cases, instructors are left to personal initiative and creativity to integrate the programs into the curriculum.
Discontinuation of products by most manufacturers	IVDs are being phased out and may not even be manufactured within a short time frame.

<b>Table 9. Teleconferencing Techniques</b>			
			Video
Features	Two-way audio	Two-way audio	Two-way audio
		Two-way still images	One-way or Two-way video images
Course Content	Highly Verbal	Verbal/Visual	Visual
Teacher Training	Slight	Moderate	Extensive
Planning	Five days	One month	One year
Class Location	One or many	Two sites	One or many sites
Student Interaction	Verbal	Verbal or still image	Verbal or video
% of Total Class Time	10-15	30-60	75-100
Relative Costs	Low	Moderate	High

<b>Table 10. Strengths of Teleconferencing</b>	
	Impact
Cost steadily declining	The future of teleconferencing is bright, especially as the logistics, availability and overall cost-requirements continue to drop.
Live classroom interaction	Perhaps the primary strength of teleconferencing is its ability to create a virtual classroom with participants located throughout the country or world. Many of the interactions that have made classroom teaching so powerful (at times) are preserved even though the students are not in the same physical space. When the students have questions they can ask them, real time. Similarly, instructors can ask for input from the entire class or specific students. Canned instructional material may lack this real-time interaction.
Video	If video is used, it provides the ability to communicate visually. Body language of the instructor may be useful in maintaining interest. Graphics and other visuals may be broadcast real-time.
Pacing	One of the strengths of much classroom instruction is that it moves students along.
Sense of community	Teleconferencing is remarkably powerful at bringing virtual classes together, sometimes even better than in co-located classes.

**Table 11. Limitations of Teleconferencing**

	Impact
Teacher comfort and skill	A major limitation is the time and effort required to create smooth and well-polished courses. Instructors not used to teaching via teleconferencing must learn to accommodate to this new medium. Some instructors never adjust.
Scheduling	All participants are required to meet synchronously (at the same time). For nation or world-wide classes the number of time zones represented pose some serious scheduling challenges, especially for lengthy courses or meetings. Videotaping and replaying the videotapes defeats many of the other strengths.
Glitches	Frequently there are unexpected problems with the hardware or communications networks. The reliability seems to be improving, however.
Logistics, facilities, and facilitators	The logistics and overall cost is also a limitation. Various forms of teleconferencing are cheaper than others but all forms require some special equipment, instructor training, technical support, and assistance at both the sending and the receiving ends. Fortunately, costs are coming down steadily.
Preparation	Extensive preparation of visuals, scripts, and handouts are often required.

**Table 12. Strengths of Computer Networks**

	Impact
Connectivity	Networks offer efficiency through connectivity. All network workstations can share hardware and software resources, including printers, programs and information in databases. Massive improvements are possible in accessing databases, files, other remote computers, etc.
Centralized management of learners	If computers are used in an instructional setting, the network allows a centralized approach to managing the learning process. A courseware management program allows an instructor to evaluate the progress of any learner. Notes can be left for individual learners, and teachers can interact directly with learners who are currently working on the network.
Integration of various elements of instruction	Resources can be orchestrated through a form of computer managed instruction over the network.
Control of software against pirating	Because all applications software programs are stored and managed through the file server, network management software controls access to the software. It is even possible to install diskless workstations that make it impossible to copy programs or to infect the system w with computer viruses.
Ease of updating or adding	Software is easy to update or change because only one copy of each program exists on the file server. Only the file server copy need be updated. All workstations use that single copy of the software.
Convenience	Computer networking rates high on convenience because the classes can be taken right to the learner's workstation or home office or kitchen table.
Supports abstract and verbal-oriented content	The abstract nature of the written text makes computer-mediated communications more compatible with the more verbally-oriented topics such as literature, history, psychology, philosophy, etc., that are already text-based.
Computer conferencing is self-documenting	Because everything communicated is transmitted and stored as text, an entire dialog is captured as it takes place.
Computer conferencing allows equal opportunity	In addition to not requiring everyone to be together at the same time or place, computer networking tends to be a leveler in that everyone has an equal opportunity to enter their ideas and responses into the group conversation.
Networking can foster group and interpersonal interactions	The ability to preserve many of the positive aspects of live classes in terms of learning from and interacting with peers and an instructor is actually a major strength that computer-mediated communication has over standalone (IVD or CD-ROM) multimedia.

**Table 13. Limitations of Computer Networks**

	Impact
File server failure	Perhaps the greatest weakness in any LAN is that a failure in the file server will stop the whole system. Proper attention to LAN maintenance will prevent most serious problems from happening.
Cable damage	Problems with network cables can cause anything from minor interruptions to failures. Large, complex LANs might require complex diagnostic tools to locate and correct cable problems.
Daily system management	Networks need daily management. New users must be registered before they can use the LAN. Software must be updated or added on a regular basis. Minor problems with printers must be corrected before unmanageable backlogs of print requests accumulate. These are maintenance requirements to be planned for.
High initial installation cost	A network can be expensive to install. The apparent high price of a LAN can be misleading, though, because the actual cost of operating the same number of unconnected computers is usually even higher.
Competition for resources	Many Internet resources such as Veronica, a master index of Gopher server file contents around the world, have become so overused that it may be almost impossible to access them.
Rapid change	Internet users are frequently in for surprises as features die away while new ones seem to burst suddenly onto the scene. It is constantly changing. New information is being added all the time but old hosts are pulling back.
Text-based computer conferencing must be facility	Experience has shown that unlike many other Internet interactions which are chaotic and self-governing, computer networking-based courses must have expert moderators to move the classes along, provoke and facilitate discussion, and help prevent and resolve flare-up induced problems that are common to this type of communication. Peopleware (good facilitator help) is often harder to acquire than the hardware, software, or courseware. Additionally, courses that have been taught live or even via correspondence sometimes require considerable modification when taught via computer conferencing or E-mail.
Connection to the Internet	The Internet is growing rapidly and access is improving but it is still far from universal (as with the telephone, many classrooms simply do not have access). It is possible that services through the Internet that are now available on an unlimited basis for one low monthly rate may become more costly, especially if a pay per use system is widely instituted.
Text-base computer conferencing news groups, and E-mail, communications may require extended periods of time	Running courses or carrying on group conversations via the network can be tediously slow compared to live courses or even multimedia-based courses. These courses require a significant amount of reading.

**Table 14. Strengths of Various Courseware Applications**

	Impact
Hypermedia is relatively inexpensive	In comparison with comparable computer software, hypermedia programs are inexpensive \$100 to \$300, with discounts for educators and learners. In many cases, the price includes the rights to distribute created programs.
Hypermedia is relatively easy to learn	Sophisticated hypermedia programs can be created with fields, buttons, and graphic objects, without requiring the scripting component. With only a few hours invested, most users can create lessons and presentations.
Hypermedia presentations are easy to store Multimedia links are supported	Computer-based slide shows created with hypermedia are easy to store and modify. Hypermedia programs offer easy links to graphics, sound video, and CD-ROM.
Hypermedia can be motivational	Instructors have the power to create motivating, interactive programs.
Exploration and association	Hypermedia applications allow users to build their own associations between bits of information, based on their interests. Well-designed hypermedia programs can both motivate and assist learners to explore a topic.
CMI and CAT can save time	Can reduce the amount of time required by students to go through a course by branching around previously learned material.
AMI can reduce administrative cost	With the computer managing the record keeping, fewer administrative staff may be required.
Mastery-based	CBT can provide the right amount of practice to the student by enforcing mastery requirements. Some learners need lots of examples and practice to learn a new concept or fact while others may need very little.
Psychologically sound	ITSSs can often help diagnose the precise cognitive errors that the learners are having and help them address these problems directly.
Safety	Dry-lab simulations are often much safer than wet-labs, especially when combustibles, explosives or radioactive materials are being simulated.
Multiple viewpoints	Advanced CBT (and multimedia) can present the same content from several viewpoints enabling students to more fully grasp the new material.
Cost-effectiveness	Most all courseware applications can reduce learning time and improve retention and transfer of training over traditional classroom lectures.

**Table 15. Limitations of Courseware Applications**

	Impact
Confusion	Poorly-designed hypermedia and other programs can easily turn into hyperchaos, where the user has too many choices and gets lost. Research is continuing to determine the optimal number of selections per screen and the best methods to promote learning in a hypermedia environment.
Complex to learn at scripting level	Although the object level (buttons, fields, etc.) is relatively easy to learn, novices can quickly get lost and frustrated with scripting languages.
Difficult to project	One of the applications for hypermedia is to create interactive, dynamic computer slide shows. The problem is that many schools do not have the equipment to project the shows for presentations.
Level of expertise required for development or customization	Many courseware applications are very complex and require a high level of expertise to develop or customize. Special authoring tools are required to create the courseware.
Cost	Cost of development of the more advanced courseware application options can be high.
Testing	The more complex the courseware, the more testing and validation/verification is required. It becomes very much like software in this regard.
Overwhelming	Without teacher-support, students can become overwhelmed and discouraged rather easily.
Platform-specific	Most courseware applications are generally restricted to one platform. If you create a slide show with the ToolBook authoring system, it will require an IBM computer with Microsoft Windows to run the program.
Delivery fees and files	In some cases, a developer may be required to pay a publication fee for delivery of an application. In other cases, the delivery files are free, but may be extremely large, making them difficult to distribute on floppy diskettes.

**Table 30. Characteristics of General Acceptance and Readiness for Technology Heuristic (GARTH)**

					Technology Applications
5 New World	Better paradigm-seeking Strategic	Organizational learning (System creation) effortlessly move from training/ learning to operational/ maintenance modes as needed at a moments notice, with excellent technical support tools	Self-directed, cross-trained, flexible work force that can		
4 Performance Enhancement	Strategic (long term, dynamic)	Wisdom hidden (less obvious) dynamic interactions (systems level understanding) coupled with the courage act.	Productivity improvement through the empowerment and effective involvement of teams and to individuals is primary concern	Overall system performance enhancement with proper emphasis on utilization of uniquely human capabilities	Intelligent, collaborative work support and just-in- time training systems
3 Technological Advancement	Tactical and Strategic (mid term)	Knowledge interrelationships (Principles understanding the whys and causes and effects)	Effectiveness is primary concern. Customers (stakeholders) are very pleased with products and support	Career development/ life-long learning. Cooperative development efforts with consortiums	Integration of technology (e.g., distance learning, networked multimedia) and information services
2 Centralization and Integration	Logistical and Tactical(short term)	Information, patterns, trends, organized catalogs (Categorical and conceptual)	Improved efficiency and infrastructure are paramount. Processes are understood and repeatable.	Professional competence, qualifications, certification	Localized technology-assisted efforts. Centralized repository (e.g., multimedia, downloading)
1 Initial	Logistical (immediate survival)	Raw data (factual)	Out of control	Mandatory training	Traditional low-tech instructor-led classes

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## **XII. APPENDICES**

- A. Clearinghouse ATT Survey Instrument
- B. Workshop Agenda
- C. Workshop Participants List
- D. Exchange of letters between Robert E. Sout, USACE, 2/10/98, and John G. Miles, Jr., Directorate of Compliance Programs, OSHA, 7/31/98 regarding Computer-Based HAZWOPER Training
- E. Workshop Plenary Presentation by Henry Payne, OTI Director, Talking Points
- F. Workshop Plenary Presentation by David Fyock, Chairman and CEO, MountainTop Technologies, Talking Points
- G. Workshop Plenary Presentation by Robert E. Stout, USACE