Recommendations On The Use Of Interactive Instruction For Training Shipyard Trade Skills

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RECOMMENDATIONS ON THE USE OF INTERACTIVE INSTRUCTION FOR TRAINING SHIPYARD TRADE SKILLS

Prepared for
NATIONAL SHIPBUILDING RESEARCH PROGRAM
SP-9 EDUCATION AND TRAINING PANEL

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ABSTRACT

The report describes a National Shipbuilding Research Program investigation into the feasibility of using interactive instructional technologies to teach shipyard skilled trades. Interactive instruction evokes the active involvement of each trainee in his or her own computer-controlled audio-visual instruction. It exchanges information with the trainee on a personal basis, processes the trainee's responses to generate appropriate rewards or remediation, and measures, evaluates, and documents the trainee's learning performance. Project investigators reviewed the interactive multimedia industry and surveyed American shipyards to determine what trades are being taught, and if Interactive multimedia are being used. The report provides an overview of interactive instruction, including its applications and cost-effectiveness; describes the characteristics of shipyard trade training; identifies commercial interactive courseware applicable to trade training; discusses the potential use of authoring systems by shipyards; provides guidance for the integration of interactive instruction into existing shipyard training programs; and concludes with detailed recommendations for the development of a two-lesson demonstration of interactive instruction for trade training to be presented to shipyard management and training personnel.

FOREWORD

This document is the final report of a National Shipbuilding Research Program (NSRP) project to investigate the feasibility of using interactive instructional technologies to meet-shipyard training needs. The project was performed under the direction of the Ship Production Committee, Education and Training Panel (SP-9) of NSRP. It was managed by Mr. William E. Wilson, National Steel and Shipbuilding Company, and technically supervised by Mr. John W. Hartigan, Director of Shipyard Training, Naval Sea Systems Command. The work was performed by Ship Analytics, Incorporated, North Stonington, Connecticut under the direction of Mr. Richard B. Cooper.

The report submitted as Deliverable 7.4 (draft) and 7.5 (final) of the contract provides information to shipyards on the use of interactive instruction for skilled-trade training, and recommends to NSRP the development of two interactive instruction lessons that will demonstrate to shipyard management and training personnel the cost-effectiveness and benefits of interactive instruction for shipyard training.

The report also contains the conclusions, recommendations, and most of the data presented in two earlier project reports, "Interactive Instructional Technologies for Use in Shipyard Trades' Training and Proposed Shipyard Survey Instrument," December 1990; and "Report on the Existing Use of Interactive Instruction for Shipyard Trades' Training," March 1991.

ACKNOWLEDGMENTS

Any project of this magnitude, especially one that involves high technology such as the multimedia industry and complex environments such as shipyard training, can only be successful if it accepts the help and advice of individuals knowledgeable and active in these fields. This project was fortunate to have just such assistance and the authors are indeed grateful to these individuals for the contributions they made.

We would particularly like to thank Mr. William E. Wilson, National Steel and Shipbuilding Company, who managed the NSRP project; Mr. John W. Hartigan, Director of Shipyard Training, NAVSEA, who provided technical supervision; and Professor Howard M. Bunch, University of Michigan Transportation Research Institute, Chairman of the Education and Training Panel (SP-9).

The authors wish to extend their sincere appreciation and thanks to all members of the SP-9 panel and to the following individuals who took significant time (and, in most cases, their staff's time) to provide us with the information so essential to this project:

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Mr. Terry J. Reel, NAVSEA Shipyard Instructional Design Center

To the many shipyard training personnel and interactive multimedia industry representatives we contacted" by telephone or met individually, we would like to express our deepest gratitude and hope that this report accurately and fairly describes our discussions.

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EXECUTIVE SUMMARY

The National Shipbuilding Research Program (NSRp) is a cooperative effort of the U.S. Navy, the shipbuilding industry, the Maritime Administration, and selected academic institutions. It is dedicated to assisting the U.S. shipbuilding and ship repair industry in improving its productivity. This project was sponsored by the Education and Training Panel (SP-9) of NSRP. Its purpose was to investigate the feasibility of using interactive instructional technologies to train skilled trades in American shipyards. The project was accomplished by reviewing the interactive multimedia industry that provides such technologies, and surveying existing training activities and training requirements in the shipyards.

Interactive instruction evokes the active involvement of each trainee in his or her own computer-controlled audio-visual instruction. Interactive instruction exchanges information with the trainee on a personal basis, processes the trainee's responses to generate appropriate rewards or remediation, and measures, evaluates, and documents the trainee's learning performance. Interactive instruction uses such systems as interactive videodisc (IVD), compact disc read-only-memory (CD-ROM) compact disc-interactive (CD-I), and digital video interactive (DVI) with touchscreens, mouse, or keyboard controls. Such systems are referred to collectively as "interactive multimedia."

The goal of the multimedia industry review was to determine what new interactive instructional technologies are available for shipyard trade training and how these technologies can by applied. The review addressed commercially-available and shipyard-developed interactive courseware, types and characteristics of interactive courseware authoring systems, and the various technologies and components of hardware delivery systems.

The survey of American shipyards was conducted by a questionnaire mailed to shipyard training departments, followed by visits to selected yards. The questionnaire was used to determine (1) what trades are currently being taught by shipyards, (2) whether they are taught by conventional or interactive methods, (3) the interactive instruction system, if any, that is being used by the shipyard, (4) the shipyard's knowledge, experience, and opinions of interactive instruction for trade training, and (5) what computer hardware is available at the shipyard for trade training purposes.

Training personnel were interviewed during the follow-up shipyard visits to (1) discuss existing or potential applications of interactive instruction for trade training, (2) determine what problems or advantages, if any, the yard had derived from the use of interactive instruction and (3) identify two shipyard trade tasks for which interactive lessons could be developed that would demonstrate the benefits and cost-effectiveness of interactive instruction.

The following is a brief summary of conclusions and recommendations that resulted from the project:

At least 47 independent studies have shown that interactive instruction, when it is appropriately applied, designed, and administered, is a highly effective method of training and education.

The tools of interactive instruction consist of a "delivery system" (desk-top computer; monitor; interaction device such as a touchscreen, mouse, or keyboard; and media storage device such as a videodisc, compact-disc, or hard drive); its "interactive courseware" which contains the computer program and documentation to administer the lesson; and an "authoring system" which is used to develop or modify the interactive courseware. A description of these tools is presented in the report.

The survey of 271 private and naval shipyards revealed that most American shipyards are not sufficiently familiar with interactive instruction to fully appreciate its potential cost savings and training benefits. However, most of the yards indicated a willingness to participate in demonstrations of interactive instruction and possibly receive assistance in its implementation.

There is currently available from commercial training course developers a substantial amount of interactive courseware on subjects relating to industry trades and practices. The products these developers offer are described in their own and independently published catalogs, many of which are listed in the report.

One disadvantage of commercial courseware is that it usually either omits shipbuilding-specific tasks or includes tasks that are not used in shipbuilding. This has caused some shipyard training departments who have evaluated the courseware to reject it. Most developers of interactive courseware, however, will (for a fee) modify or tailor their courseware to accommodate special needs.

"Cost" was the most frequently cited disadvantage of interactive instruction by shipyards. The second most frequently cited disadvantage was the shipyard's own lack of knowledge about interactive instruction. 8ased upon this finding, it was concluded that most shipyards are not aware of the continuously falling price of interactive delivery systems and the increasing simplicity of authoring systems for developing interactive courseware. This increasing simplicity could permit training department personnel to develop their own interactive courseware instead of relying upon a commercial product.

Many authoring systems are currently available that are suited to the shipyard trade training environment. A significant advancement in authoring systems has been their ability to accommodate differences in authors' experience by providing multiple authoring levels such as "novice," "intermediate," and 'advanced." This does much to encourage training organizations to adopt these systems, knowing that the systems can be operated by a broad spectrum of their personnel and that the personnel can grow to use the power of the systems.

Adequate tools and guidance do exist for shipyards either to purchase commercialIy-avail able courseware or to develop their own interactive courseware with the use of an authoring system and their own in-house instructional development expertise. There are also many independent professionals available to assist in the development of courseware for shipyards. The report lists names and addresses of organizations, periodicals, and documents where the tools and guidance can be obtained.

Several private shipyards have undertaken development of their own interactive courseware to demonstrate its applications, capabilities, and benefits to their management, training personnel, and customers. This courseware, although somewhat in its infancy, shows great promise for certain shipyard orientation and training programs.

There are specific criteria for the application of interactive multimedia systems to ensure that when applied, interactive multimedia are the most cost-effective and appropriate modes of instruction. These criteria are listed in the report. There are many skilled-trade tasks being taught in shipyards that meet these criteria. Few shipyards, however, have the resources available to investigate the applications on their own.

Interactive instruction could be integrated Into shipyard trade training programs (1) wherever training is required on an individual basis, such as where only one trainee requires instruction; where trainees learn at different rates; or where trainees start or complete at different levels; (2). where interactive instruction can replace home study; (3) where such training can be used to heighten the effectiveness of lecture and other conventional methods; and (4) where self-initiated instruction is used to achieve advancement, cross-train for reassignment, or simply improve and expand one’s own capabilities.

It is strongly recommended that NSRP pursue the development of an interactive instruction demonstration to be presented to shipyard training personnel in a symposium setting and/or on-site in the shipyard environment. The purpose of this demonstration will be to familiarize shipyard training personnel with the applications, benefits, and cost-effectiveness of interactive instruction. The NSRP demonstration would also demonstrate the ease of interactive courseware development by shipyard training personnel and the methods by which these interactive courses can be integrated into existing shipyard trade training programs.

The most frequently taught trades in both private and naval shipyards are Shipfitter, Welder, Pipefitter, Painter, and Carpenter. If the demonstration of interactive instruction is to be developed and exhibited to all shipyards, then the lesson should instruct a task performed by one or more of these trades.

The seven "most recommended" tasks for a demonstration of interactive instruction to shipyard management and training personnel are the Wire Flame Spray Process, Arc Drawn Stud Welding, Plasma Arc Cutting and Gouging, Mechanical Flange or Union Joint Make-Up, Rigging, Material Handling Equipment Operation and Maintenance, and Stage and Scaffold Building. These and other recommended shipyard trade tasks are described in the report.

The criteria for selecting two trade tasks for the demonstration should be based upon (1) how well the task permits the capabilities and advantages of interactive instruction to be demonstrated, (2) how easily shipyard management and training personnel can relate to the lessons being taught, and (3) how easy and expensive the interactive lessons are to produce.

IVD should be used for the demonstration instead of CD-I or DVI. This recommendation is based upon the conclusion that CD-I and DVI, although possibly the "wave of the future," do not at this time meet many of the goals of the demonstration. A review of these technologies and rationale for the selection of IVD is presented in the report.

Twelve authoring systems are suggested that could achieve the demonstration requirements and that are within the demonstration price range. It is recommended that further evaluation of these authoring systems be performed with the assistance of a shipyard video production organization and several shipyard training personnel. The evaluation would address specifically whether the authoring system would adequately support the development of interactive courseware for the two lessons to be demonstrated, and whether shipyard training personnel would be able to use the authoring system to develop courseware solely by drawing upon their instructional design experience and familiarity with personal computers.

It is currently possible to obtain all the tools needed for an interactive instruction development for less than $10,000. Delivery systems adequate for shipyard training sell for approximately $5,000. Interactive courseware for industrial training varies in price depending upon subject matter, length of lesson, and lesson quality; but many trade-related subjects retail for only $1,000 per lesson. Authoring systems vary extensively in their power and ease of use, but those that are adequate for shipyard training sell for only $3,000. A current price breakdown of individual multimedia components is presented in the report.

NSRP should fund the development of an interactive instruction demonstration that uses two lessons and an authoring system to demonstrate (1) the benefits of interactive instruction for shipyard trade training, and (2) the ability of shipyard training personnel to develop their own courseware. A contract to accomplish both of these objectives is estimated to cost between $63,000 and $115,000, depending upon the following:

- Cost of purchasing the authoring system and required license(s)
  Extent of subject-matter expertise required by the contractor
- Amount of video production required by the contractor
- Quantity of video, graphics, and text required
- Quantity and type of remediation and reward required
  Depth of branching and length of the lesson
- Sources and methods of narration and music
  Extent of contractor involvement in performing the demonstration

These new interactive instruction technologies offer great promise to American shipyards for the rapid and effective inculcation of vital skills in shipyard craftsman, thereby enabling shipyards to get the job done right the first time.

Section 1

INTRODUCTION TO THE PROJECT

1.1 Background

Except in naval shipyards and the largest of America's private shipyards, formal training of craftsmen is characterized more by its absence than its presence. Traditionally, when formal training has existed in small private shipyards, this training has tended to be limited to short-term entry level instruction in the rudiments of key trades. The lack of formal training in smaller yards can be attributed to the high rates of personnel turnover that render doubtful a return on a yard's investment in such training.

The naval shipyards and most large private yards, however, recognize that a well-trained workforce is essential to maintenance of a competitive advantage. They recognize that because their industry is more labor-intensive than most other industries, an effective, highly skilled workforce must be established and maintained. The shipyards are striving to accomplish this in many ways, among them the implementation of formalized training programs such as apprenticeships. The shipyards further recognize that in today's conditions of heavy competition for a shrinking workload, they must continuously understand, evaluate, and apply advancements in instructional technologies that, in addition to establishing and maintaining employee proflclency, enhance the overall well-being of the workforce, promote quality of the product, and improve the corporate profit margin. With these instructional technologies proliferating and the complexity of shipyard operations and costs continuously rising, it has become evident that the industry might welcome some much-needed assistance in understanding and integrating some of these new technologies.

In recent years, the use of instructional technologies in most shipyards has been limited to linear videotape presentations and some computer based training. Shipyards using these technologies claim improvements both in skill performance among their craftsmen and in lowered overall training costs. Today, shipyard training departments are being confronted with a another instructional technology called "interactive instruction." This type of instruction uses a computer processor (usually a desk-top computer), one or more display screens, and some type of human interface device such as a keyboard, touchscreen, mouse, trackball, or joy-stick. The system operates from software that exchanges information with the trainee on a personal basis; processes the trainee's response to generate an appropriate reward or remediation; and measures, evaluates, and documents the trainee's learning performance. In addition, an instructional developer creating lessons ("courseware") to be administered on the system must have it loaded with a kind of software called an "author language" or "authoring system."

There are currently two different technologies for the presentation of interactive instruction. The first is "analog motion video," provided either by VHS video tape or interactive videodisc (IVD). These systems use their computers to access and display segments of video from VHS tape decks

or laser-disc players. The second technology is "digital motion video, " currently provided either by a compact disc interactive (CD-I) or a digital video interactive (DVI) system. These systems use their computers to access and display segments of digital video from compact disc read-only-memory (CD-ROM) or large-capacity hard drives. All provide the necessary ingredients for interactive instruction such as text, graphics, bitmaps, still and motion video, audio, and the interactive interface. The characteristics of their cost, availability, and operation, however, differ extensively.

1.2 Purpose

Due to the variety of interactive instruction systems and their relatively high initial cost, it has not been easy for shipyard training departments to perform their own evaluations of these systems. Also, many shipyard training departments do not fully appreciate the potential applications of these new technologies, and there is little objective guidance available to increase their understanding.

To correct this situation, the Education and Training Panel (SP-9) of the National Shipbuilding Research Program (NSRP) has embarked on this project to investigate the feasibility of using interactive instructional technologies in meeting shipyard trade training needs. A major goal of the project has been to determine to what extent shipyards dre currently using interactive instruction for trade training, whether they have found it to be cost-effective, and, if so, what can be done to further promote its use.

1.3 General Approach

In February 1991, a questionnaire was mailed to 271 private and naval shipyards in the United States. This questionnaire was designed specifically to elicit from each shipyard:

a. A determination of what trades are currently being taught by the shipyard; how they are taught (i.e., by conventional training methods or interactive instruction); and who is teaching them (i.e., the shipyard, a union organization or an academic institution).

b. A description of the interactive instruction system, if any, that is currently being used by the shipyard for trade training; including the identification of courseware employed.

c. A description of the shipyard's knowledge, experience, and opinions of interactive instruction as they apply to shipyard trade training.

d. A determination of what computer hardware is available at the shipyard for trade training purposes.

Names of individuals in the shipyards who were sent questionnaires were derived from Ship Analytics' industry directory, the roster of NSRP panel members, participants in an earlier (1983) NSRP shipyard survey, The Motor Ship Directory (1990), and the Marine Log's "U.S. Shipyards" (1990).

There were two separate mailings of questionnaires. A longer-form questionnaire was sent to 19 selected private shipyards and 8 naval shipyards. This questionnaire and the cover letter that accompanied it are presented in Appendix A. In all cases, the individuals to whom these questionnaires were sent were first contacted by telephone to elicit their participation. Of the total that were mailed, 21 or approximately 78% were completed and returned. A shorter questionnaire was sent to the remaining 244 private shipyards. This questionnaire and the cover letter that accompanied it are presented in Appendix B. The individuals to whom these questionnaires were sent were not contacted prior to the mailing. Of the total of these questionnaires, only 23 or approximately 10% were returned.

1.4 Application of Results

The results of the questionnaire are presented in Section 7 of this report. These results were used to determine which five shipyards to visit in order to further investigate the potential application of interactive instruction to shipyard trade training. The shipyards visited were Bath Iron Works, National Steel and Shipbuilding Company, Newport News Shipbuilding Company, the Norfolk Naval Shipyard, and the Portsmouth Naval Shipyard.

During each visit, training personnel were interviewed to obtain information unique to their shipyard's training program that could not be obtained by questionnaire. Such information included a description of the instructional methods and technology used by the shipyard, the capabilities of training personnel to develop their own interactive instruction, and how best to integrate interactive instruction into the existing shipyard training program. In addition, the interview also sought suggestions for two shipyard trade training tasks that could be used to demonstrate the benefits of interactive instruction to shipyard personnel.

The selection of shipyards that were visited was based upon (1) the shipyard's existing trade training activities, (2) its experience with or knowledge of interactive instruction for trade training, and (3) its expressed willingness to participate in the project. From these visits, the results of the questionnaires, and information from the interactive multimedia industry, the project investigators were able to:

a. Evaluate commercially-available interactive courseware and determine which courseware has potential for use in shipyard trade training.

b. Recommend interactive authoring systems and delivery systems for interactive courseware development that can be used for shipyard trade training.

c. Recommend integration strategies for incorporating interactive instruction into existing shipyard trade training programs.

d. Plan for a demonstration of interactive instruction to shipyard management and training personnel to familiarize them with the training benefits and cost-effectiveness of interactive instruction.

Section 2

OVERVIEW OF INTERACTIVE INSTRUCTIONAL TECHNOLOGIES

The term "interactive multimedia" is generally associated with the overall computerized media industry. One promising application of interactive multimedia is in the area of training and education. Here, interactive technology may be used as a total learning system to plan, coordinate, administer, and evaluate training; or it may be used simply as a educational tool to heighten the effectiveness of lecture and other conventional methods.

"Interactive instructional technologies," as the name implies, is the application of combined audio, visual, and computer technology to the education process in such a way that the trainee becomes an interacting element of the entire instruction system. In simpler terms, interactive instruction generally involves the linking of an audio and video presentation system to a microcomputer, and the introduction of courseware that is specifically designed to react to each trainee's individual needs. This interactive delivery system establishes a personal relationship between the trainee and the subject matter to be learned. It is the combination of sight, sound, personal interaction, and computer control that provides this highly effective learning environment.

2.1 Components of an Interactive Instruction System

The typical interactive instruction system in most common use today is the interactive videodisc (IVD) system: It consists of the following components:

a. A microcomputer, also called a "desk-top," "personal computer," or "PC" that processes trainee responses, and initiates the instructional features of the courseware such as control options, query, feedback, and trainee evaluation.

b. A video interface board (CGA, EGA, VGA, etc.) that permits the display of video and computer graphics on the monitor. This capability comes resident in some computers.

c. A monitor, also called a "display" or "video screen," for the presentation of visual information. This hardware presents information from both the computer and the video player, either in a serial mode (one and then the other) or in an overlay mode (one combined with the other). For some delivery systems, two displays are used in tandem, one dedicated to controlling the lesson and the other dedicated to the lesson presentation.

d. Any number of "interaction" or input devices may be included with the delivery system depending on the type of computer that is used and the requirements of the software program. Examples of interaction devices are: keyboard, touch screen, mouse, light pen, sound recognition device, and others. The current most successful

interaction device for use by "computer naive" trainees is the touch screen.

e. A laser optical disc player, also called a "videodisc player," that instantly retrieves visual and audio information from a 12-inch optical disc. The information to be retrieved and the process of retrieval by the video player is controlled by the computer.

f. Software is a broad term for a variety of different types of computer programs which control the interactive instruction or that facilitate the development of programs to control interactive instruction. There are three types of software used in interactive instruction that are noteworthy. They are "courseware," "authoring systems," and "author language."

Industry glossaries [Reference 1, Reference 2] define courseware as "instructional software including all discs, tapes, books, charts and computer programs necessary to deliver a complete instructional module or course." Courseware is commercially available for an enormous variety of subjects, and can be located in various interactive video industry directories and compendiums [3, 4, 5]. Much courseware is also developed for private or government use and is not available for public use.

The glossaries [1, 2] further define authoring system as "specialized computer software which helps its users design interactive courseware in everyday language, without the painstaking detail of computer programming." In an authoring system, the instructional logic and content are separate. An effective authoring system provides both structure and flexibility for the access and manipulation of information during courseware generation.

- A less "friendly" software, but one which also permits non-programmers to develop interactive courseware, is author languages. Author languages combine program logic and content provide more capabilities and greater flexibility than an authoring system. The major limitation of author languages is that the user is required to memorize commands and syntax.

g. Media that contain interactive courseware include videodiscs for interactive videodisc (IVD) systems, compact discs for compact disc-interactive (CD-I) systems, and large capacity hard drives for digital video interactive (DVI) systems. Both CD-I and DVI systems are relatively new to the industry and are being developed to use a variety of media. There are also many different video tape systems that are inexpensive and somewhat effective for certain applications. Each of these media requires different players and has unique capabilities for courseware development and operation.

Currently, the interactive videodisc system enjoys the greatest popularity, but this may be because it has been in use for over a

decade and much interactive courseware has been developed for it. CD-I is becoming increasingly accepted because of the public's familiarity with CD-Audio and because of the use of CD-ROM by training and documentation professions. Compact discs are also easier to handle, store, and manufacture.

The power of DVI is its vast data capacity and the ability to author (including video) directly to the system. In general DVI is expected to provide significantly more flexibility to an instruction delivery system, particularly as a multimedia integrator.

This brief discussion of laser optical disc characteristics is intended not for comparison between systems, but only to acquaint the reader with some of the more contemporary issues involved in the selection of interactive instruction systems.

The types of components just described make Up a typical interactive instruction system. From a physical standpoint, interactive systems that perform similar functions may look different. This is because some manufactures of interactive systems have chosen to combine certain functions in the same package, while others provide only a single component that may be attached-to or disconnected-from the system as required. The group of components that are put together to accommodate the courseware is called the "delivery system" or "platform." Some courseware operates on many different delivery systems. Other courseware operates only on specific ones. The delivery system requirements are usually described in the courseware advertising literature and accompanying documentation.

Another factor that determines the components of the delivery system is the "level" of interactivity of the training. The Nebraska Videodisc Design/Production Group defines these levels as follows:

- A "Level One System" is usually a consumer-model videodisc player with still/freeze frame, picture stop, chapter stop, frame address, and dual-channel audio, but with limited memory and limited processing power.

- A "Level Two System" is an industrial-model videodisc player with the capabilities of Level One, plus on-board programmable memory and improved access time.

- A "Level Three System" contains Level One or Level Two players interfaced to an external computer and other peripheral processing devices.

Additional levels (e.g., four and five) include advanced digital and interface technologies; however, these levels are not well-defined. The level most commonly used for interactive instruction is Level Three.

2.2 Unique Characteristics of Interactive Instruction

Although other types of interactive instruction such as group interaction systems and automated interactive classroom systems do exist and can be effective, this project focused only on the one-to-one, individual trainee working alone at a workstation.

An important characteristic of one-to-one interactive instruction is its personal relationship with the trainee. During a course of instruction, each trainee usually has his or her own workstation complete with display, computer, interface device, and courseware. While some systems may use a central computer, each workstation has its own display and interface:

The commonly used interface device for interactive instruction systems is the keyboard, due mainly to its unlimited capability in communicating with the computer. Gaining rapid acceptance, and in many applications surpassing the keyboard, are "touchscreens" and the "mouse." Like the keyboard, the mouse requires some learned skill in order to perfect its use. The touch screen, on the other hand, is almost intuitive to use and, if properly designed, is easy to master. Obviously the keyboard is most efficient for entering text or long strings of data. The mouse and touchscreen are limited to the functions that the courseware assign to them.

2.3 Applications of Interactive Instruction

One of the most effective kinds of interactive instruction is "simulation." [6]. Here, pictures of actual hardware can be shown, the trainee can touch the picture to simulate the hardware's operation, and the picture will change in response to the interaction. In this way, the trainee can be guided through complex operations by the system, can experience the consequences of his or her actions, can be tested for purposes of certification or qualification, and can receive remediation to achieve and maintain proficiency.

Another excellent use of interactive instruction is where tasks can be "practiced" by the trainee to learn to recognize situations, make decisions, follow procedures, and evaluate results. Simulation and practice are both very cost-effective applications of interactive instruction because they ensure a very efficient use of the trainee's time and because they do not "tie up" other personnel or equipment.

2.4 Benefits of Interactive Instruction

Interactive instruction is now gaining widespread acceptance within the education and training community for the following reasons:

a. Reduced Learning Time. Studies compiled to date have found that interactive instruction reduces learning time requirements by an

average of fifty percent. This time reduction can be attributed to a variety of factors, including

- Self-paced instruction that encourages trainees to take the most efficient path to content mastery, skipping areas of strength, while investing time in areas of weakness.

- The visual information in the form of computer graphics and still/motion video reinforces the audio narration and vice versa.

- Immediate interaction and feedback provides constant, highly effective reinforcement of concepts and content.

- Personalized instruction accommodates different learning styles to maximize trainee learning efficiency.

b. Reduced Cost. The primary costs of interactive instruction lie in lnltlal design and production, not replication, distribution, and delivery. The cost-per-trainee is reduced as more trainees use the same program. with conventional instructional methods, the costs of instruction lie primarily in the delivery (e.g., instructor salaries, overhead, etc.) and remain constant or even increase as more trainees place greater demands on fixed resources.

A typical cost-per-trainee break even point for a custom interactive program occurs when 100 to 200 trainees use a program. Beyond that number, savings build dramatically. In one example, Federal Express expects to save over $100 million by using interactive instruction for employee training.

c. Instructional Consistency. Technology-based interactive instruction does not have bad days or tire at the end of a long day. Instruction is delivered in a consistently reliable fashion that does not vary in quality from instructor to instructor.

d. Privacy. With one-to-one interactive instruction, trainees are free to ask questions and explore ideas that might cause embarrassment in group situations. Also, interactive instruction encourages trainees to persist in asking questions and reviewing materials until real mastery is achieved or natural curiosity is appeased.

e. Mastery of Learning. Unlike a normal classroom situation, interactive instruction does not present new material until current material is mastered. This ensures that trainees have strong foundations for continued learning.

f. Increased Retention. The process of interaction provides a strong learning reinforcement that siqnificantly increases content retention over time. Studies have shown significant improvements in retention through the use of interactive instruction.

g. Increased Safety. With interactive instruction, trainees can explore potentially hazardous subjects or dangerous activities without risk. These include personal dangers such as electric shock or burns, as well as equipment or system damage.

h. Increased Motivation. Interactive instruction provides a level of responsible feedback and individual involvement that has proven to be highly motivating in both individual and classroom environments. Interactive instruction focuses the trainees' attention, thereby reducing the potential for distraction or disruption.

i. Increased Access. Interactive instruction can provide greater and more equal access to quality education. Systems can produce a training environment in locations where trainee populations are insufficient to support full-time instructors or where qualified instructors are unavailable. Interactive instruction is also used to simulate equipment that is too expensive or otherwise too difficult to make available to trainees.

j. Trainees Become Active Learners. Interactive instruction requires trainees to take greater control and responsibility for their own learning process. As they become more accomplished learners, they become fully active participants in the learning process, not just passive recipients of instruction.

k. Ideally Suited to Industrial Training. With particular regard to shipyard trade training and other industrial training, interactive instruction is ideally suited for

Improvement of all participants, regardless of their expertise.

Follow-up exercises on the production floor, with new problems, indicate that knowledge rather than rote memory, was transferred.

Simulation to refresh troubleshooting skills which otherwise might be forgotten.

Practice to refresh and "sharpen" recognition, decision making, procedural, and evaluation skills.

- 24 Hour-a-day training, which is extremely important in a production environment that operates round-the-clock shifts. The scheduling of interactive instruction can minimize impact on production.

2.5 Sources of Information on Interactive Instruction

The interactive multimedia industry is well represented by professional organizations and publications. Almost all interactive courseware developers and vendors publish catalogs describing their products, and most authoring system developers and vendors provide computer demonstrations of their systems. In addition, there are numerous directories, guides, and listings available from them and independent publishers.

2.5.1 Interactive Multimedia Organizations

The following organizations are recommended sources of information on interactive instruction and multimedia:

Interactive Multimedia Association (IMA)
800K Street, N.W., Suite 240
Washington, DC 20001
202-408-1000, FAX 202-408-0361

Society for Applied Learning Tchnology (SALT)
50 Culpeper Street
Warrenton, VA 22186
703-347-0055, FAX 703-349-3169

Hational Society for Performance and Instruction
1300 L Street, N.W., Suite 1250
Washington, DC 20005
202-408-7969, FAX 202-408-7972

Association for Educational Communications and Technology
1025 Vermont Street, N.W., Suite 820
Washington, DC 20036
202-347-7834, FAX 202-347-7839

Institute for the Transfer of Technology to Education
National School Boards Association
1680 Duke Street
Alexandria, VA 22314
703-838-6219, FAX 703-683-7590

International Communications Industry Association
3150 Spring Street
Fairfax, VA 22031-2399
703-273-7200, FAX 703-728-8082

International Society for Technology in Education
University of Oregon
1787 Agate Street
Eugene, OR 97403-1923
503-346-4414, FAX 503-346-5890

International Interactive Communications Society (IICS)
P.O. BOX 1862
Lake Oswego, OR 97036

National Demonstration Laboratory (NDL)
Smithsonian Institution
Arts and Industries Building, Room 1130
Washington, DC 20560
202-357-4749, FAX 202-786-2304

Tech 2000, The Industry Showcase for Multimedia Applications
Techworld Plaza
800K Street, N.W.
Washington, DC 20001
202-842-0500, FAX 202-842-0502

2.5.2 Interactive Multimedia Periodicals

The following periodicals are recommended sources of information on interactive instruction and multimedia:

The Videodisc Monitor
Monitor Information Services
P.O. BOX 26
Falls Church, VA 22046-0026
703-241-1799 or 800-323-DISC

Instruction Delivery Systems
The Magazine of Interactive Multimedia Computing
50 Culpeper St.
Warrenton, VA 22186
703-347-0055, FAX 703-349-3169

CBT Directions
Weingarten Publications
38 Chauncy Street
Boston, MA 02111
617-542-0146

New Media Age
P.O. Box 1771
Riverton, NJ 08077-9771
415-573-5170, FAX 415-573-5131

The Interactive Exchange
Monitor Information Services
P.O. BOX 26
Falls Church, VA 22040-0026
703-241-1799 or 800-323-DISC

Multimedia Review
The Journal of Multimedia Computing
Meckler Corporation
11 Ferry Lane West
Westport, CT 06880
203-226-6967, FAX 203-454-5840

Media and Methods
1429 Walnut Street
Philadelphia, PA 19102
215-563-3501, FAX 215-563-1588

Emerging Technologies Bulletin
U.S. Army Training Support Center
Army Extension Training Directorate
ATTN: ATIC-ETS-PE
Fort Eustis, VA 23604-5168
804-878-4815

Journal of Educational Technology Systems
50 Culpeper Street
Warrenton, VA 22186
703-347-0055, FAX 703-349-3169

T.H.E. Journal
150 Camino Real, #112
Tustin, CA 92680-9833
714-730-4011

Training Magazine
Lakewood Publications
50 S. Ninth Street
Minneapolis, MN 55402
612-333-0471

The Chronicle of Higher Education
1255 23rd Street, N.W.
Washington, DC 20037
202-466-1080, FAX 202-296-2691

Classroom Computer Learning Technology on Campus
2451 East River Road
Dayton, OH 45439
800-523-4625, FAX 513-294-7840

Curriculum Product News
992 High Ridge Road
Stamford, CT 06905
203-322-1300

Electronic Learning
730 Broadway
New York, NY 10003
212-505-3000

Interact
International Interactive Communications Society
College of Communications
California State University - Chico
Chico, CA 95929-0504
916-898-4048

National Training Programs News
National Training Programs Service
2425 Wilson Boulevard, Suite 457
Arlington, VA 22201
703-243-1657, FAX 703-243-1659

Optical Information Systems and Optical Information Systems Update
Meckler Publishing Corporation
11 Ferry Lane West
Westport, CT 06880
203-226-6967, FAX 203-454-5840

2.5.3 Interactive Multimedia Documents

The following documents are recommended sources of information on interactive instruction and multimedia:

The Videodisc Compendium for Education and Training
Emerging Technology Consultants
P.O. BOX 12444
St. Paul, MN 55112
612-639-3973

The Multimedia Directory
Monitor Information Services
P.O. BOX 26
Falls Church, VA 22040-0026
703-241-1799 or 800-323-DISC

"Biennial Guide to Authoring Systems"
Instruction Delivery Systems, March/April 1991
50 Culpeper St.
Warrenton, VA 22186
703-347-0055, FAX 703-349-3169

"Annual Buyers Guide"
Instruction Delivery Systems, May/June 1991
50 Culpeper St.
Warrenton, VA 22186
703-347-0055
FAX 703-349-3169

1991 Guide to CBT Authoring Systems
Weingarten Publications
38 Chauncy Street
Boston, MA 02111
617-542-0146

Authoring Systems, A Guide for Interactive Videodisc Authors
Peter Crowell, Meckler Publishing
- Available from Future Systems, Inc.
  P.O. Box 26
  Falls Church, VA 22046-9990
  703-241-1799 or 800-232-DISC

Journal of Interactive Instruction
Communicative Technology Corporation
50 Culpeper St.
Warrenton, VA 22186
703-347-0055, FAX 703-349-3169

"Selecting an Authoring Tool"
CBT Directions, June 1991
Weingarten Publications
38 Chauncy Street
Boston, MA 02111
617-542-0146

The Complete Interactive Video Courseware Directory
Convergent Technologies Associates
97 Devonshire Drive
New Hyde Park, NY 11040
516-248-5984

Interactive Video Industry Directory
Interactive Multimedia Association (IMA)
Suite 240
800K Street, N.W.
Washington, DC 20001
202-408-1000, FAX 202-408-0361

The Educator's Handbook to Interactive Videodisc
Association for Educational Communications and Technology
- Available from Future Systems, Inc.
  P.O. Box 26
  Falls Church, VA 22046-9990
  703-241-1799 or 800-232-DISC

Interactive Multimedia
Microsoft Press
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Interactive Video
Richard Schwier, Educational Technology Publications
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Interactive Video Directory
Applied Video Technology
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

A Practical Guide to Interactive Video Design
Nicholas V. Iuppa, Knowledge Industry Publications
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Advanced Interactive Video Design
Nicholas V. Iuppa, Knowledge Industry Publications
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Multimedia and Related Technologies, A Glossary of Terms
Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

The Videodisc Book (A Guide and Directory)
John Wiley and Sons
Edited by Rod Daynes and Beverly Butler
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Compatibility of Interactive Videodisc Systems
ockley Miller
- Available from Future Systems, Inc.
P.O. Box 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

The US Videodisc Market, Analysis and Forecasts to 1990
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Use and Effectiveness of Videodisc Training
Michael DeBloois
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Videodisc Training: A Cost Analysis, A Guide and Workbook for Choosing Your Courseware Delivery System
Richard Brandt
- Available from Future Systems, Inc.
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Improve Your Interactive Design Skills
Joseph Arwady and Diane Gayeski'
- Available from Future Systems, Inc.
P.O. Box 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Interactive Video Directory
Charles Kindleberger, Applied Video Technology
- Available from Future Systems, Inc.
P.O. Box 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Interactive Discs in Education
ZTEK Company
P.O. BOX 952
Louisville, KY 40201
800-247-1603

The International Directory of Authoring Systems
Monitor Information Services
P.O. BOX 26
Falls Church, VA 22046-9990
703-241-1799 or 800-232-DISC

Section 3

REVIEW OF INTERACTIVE COURSEWARE

Considering the relatively slow initial acceptance of interactive instruction by industrial training organizations, there is a remarkable amount of industrial trade courseware that has been generated for sale on the commercial market. In addition, the U.S. Government and several large corporations have, and continue to develop, some high quality but usually very specialized courseware.

3.1 Commercially-Available Trade Training Courseware

Vendor inventories of commercial and specially developed interactive courseware suggest that there may be courseware already available that is suitable for application to certain shipyard trade training programs.

Project personnel conducted a cursory review of industry directories and compendia to determine if such courseware exists. This review used the 1990-1991 edition of the "Videodisc Compendium" [Reference 3], the "Buyers Guide to Interactive Videodisc Products and Services" [4], the 1990 edition of the "Complete Interactive Video Courseware Directory" [5], and various catalogs from the courseware developers themselves. This shipyard trade training related interactive courseware is listed in alphabetical order by course title in Table 3-1.

The names and addresses of the courseware developers and vendors can be obtained from one of the directories indicated or by contacting an industry organization listed in Section 2.5.

Criteria for the selection of courseware on this list are:

a. Whether the courseware subject and material are directly relevant to shipyard trade training.

b. Whether the courseware subject and material are relevant to peripheral trade training such as counseling and employee orientation.

c. Whether the courseware holds potential for application to future shipyard trade training.

d. Whether the courseware has been purchased or is in use by shipyards for trade training.

3.2 Shipyard-Developed Courseware

Results of the survey of shipyards indicate that-little interactive courseware has been developed by American shipyards. Newport News Shipbuilding Company has installed an advanced technology classroom that provides for student interaction in a classroom environment. Newport News is currently developing interactive courseware for this system in support of

TABLE 3-1. TRADE TRAINING RELATED INTERACTIVE COURSEWARE

Courseware Title	Directory*
Advanced Troubleshooting in Electronics Systems	ETC
Aids	CTA
Air Compressor Repair	CTA, ETC
Alcohol and Human Physiology	ETC
Alcohol . ..Drugs...and Kids	ETC
Application System: as Concepts and Facilities	ETC
Applied Fundamentals: AC/DC	ETC
Applied Industrial Mathematics	CTA
Asbestos Abatement	ETC
Asbestos Training System	CTA
Ask Any Dummy - Seat Belts Make Sense	ETC
Back Safety	CTA, ETC
Back Safety	CTA
Basic Electronic Components and Their Measurements	ETC
Basic Mechanical Concepts	CTA
Basic Troubleshooting in Electronic Systems	ETC
Bearings	CTA
Belt Drive Systems	CTA
Business & Industry Safety	CTA
CPR: The New Basic Procedures	ETC
Centrifugal Pump Repair	CTA, ETC
Chain DriveSystems	CTA
Chemical Hazards	ETC
Classroom Discipline: A Simulation Approach	ETC
Classroom Management: A Case Study Approach	ETC
Clutches and Brakes	CTA
Cocaine and Human Physiology	ETC
Complete Drive Packages	CTA
Controller Tuning	ETC
DU1l - The Price is Too High	ETC
Defensive Driving Tactics	ETC
Designer Drugs and Human Phys: Crack Cocaine, Metha.	ETC
Designer Drugs and Human Phys: PCP, Ecstasy, Fentanyl	ETC
Digital Circuits, Part 1: Fundamentals	ETC
Digital Electronic Theory	ETC
Do I Ask Effective Questions?	ETC
Drugs, Alcohol, and Your Body	ETC
Drugs, Drinking, and Driving	ETC
Education Safety	CTA
Effective Teaching Series	ETC
Electrical Safety	CTA
Electrical Safety	CTA
Electrical Safety	ETC
Electrical/Electronic Skills	ETC
Electrical/Electronic Theory	ETC
Electronic Circuits	ETC
Elements of Instruction: A Videodisc Workshop	ETC

TABLE 3-1. TRADE TRAINING RELATED INTERACTIVE COURSEWARE (Cont.)

Courseware Title	Directory*
Essential Teaching Skills	ETC
Experimental Mechanics of Composite Materials	CTA
Fetal Development: an Nine-Month Journey	ETC
Fire Safety	CTA, ETC
Fire Safety	CTA
Forklift Truck Training	ETC
Fundamental Study Skills - Mathematics	CTA
Fundamental Study Skills - Reading	CTA
Fundamentals of Industrial Measurement Series	ETC
Gaging	ETC
Gaging Practices	CTA
Gears and Gear Systems	CTA
Gould 584 Maintenance	CTA
Gould 584 Maintenance	ETC
Government Employee Safety	CTA
Hand Tools and Measuring Instruments	CTA, ETC
Hazard Communication	CTA
Hazard Conmnication Compliance	CTA, ETC
Health Care Safety	CTA
Health Hazards in the Workplace	ETC
Health Hazards in the Workplace	CTA
Heroin and Human Physiology	ETC
Highway Driving Tactics	ETC
Hospitality Industry Safety	CTA
Hydraulic Interactive Series	CTA
Hydraulic Power Basics	CTA
Hydraulic Power Components	CTA
Hydraulic Power Systems and Troubleshooting	CTA
Hydraulic Series	ETC
IBM InfoCourse Fundamentals of Discrete Manufacturing	ETC
Improving Teacher Effectiveness: An IVD Mini-course	ETC
Industrial Hydraulic Power	CTA, ETC
Industrial Hydraulics	CTA
Industrial Pneumatics	CTA
Industrial Process Control Series	ETC
InfoCourse: Fundamentals of Discrete Mfgrg.	CTA
Instrument Calibration	ETC
Instrument Calibration Series	ETC
Interact	IDS89
Interpreting Process Control Diagrams	ETC
Introduction to Industrial Control	CTA, ETC
Introduction to Programmable Control	CTA, ETC
Introduction to Servo-Robotics	CTA, ETC
Kraft Pulping: A Key to Quality Production	CTA
Kraft Recovery	CTA
Ladder Logic	CTA, ETC
Lift Truck Operator	ETC

TABLE 3-1. TRADE TRAINING RELATED INTERACTIVE COURSEMARE (Cont.)

Courseware Title	Directory*
Lift Truck Operator Training	CTA
Lubrication	CTA
Marijuana and Human Physiology	ETC
McGruff's Drug Alert	ETC
Mechanical Print Reading	CTA
Modicon 984 Basic Training	ETC
Papermaking - The Process and the Product	CTA
Pipefitting	CTA, ETC
Prevention of Occupational Exposure to the Aids Virus	ETC
Programmable Controllers	ETC
Refresher Defensive Driving	ETC
Respirator Training	ETC
Respiratory Protection	CTA, ETC
Rigging and Lifting	CTA, ETC
Rotating Equipment Predictive Maint. and Alignment	CTA, ETC
Seals	CTA
Servomotors	CTA
Shaft Joining and Coupling Devices	CTA
Statistical Process Control	CTA, ETC
The Heimlich Maneuver	ETC
The Social Drinker and the Anti-Social Drinker	ETC
The Survey Disc: Using the Rod and Level	ETC
Tobacco and Human Physiology	ETC
Total Quality Control: Manufacturing	ETC
Total Quality Control: Service	ETC
Troubleshooting Series	ETC
Truck Driving-Commercial Driver License	ETC
Valve Repair	CTA, ETC

* Directory Code

CTA = "The Complete Interactive Video Courseware Directory," Convergent Technologies Associates.

ETC = "The Videodisc Compendium," Emerging Technologies Consultants, Incorporated.

JIID = "Journal of Interactive Instruction," Communicative Technology Corporation.

IDS89 = "Instruction Delivery Systems," Volume 3, Number 2, Communicative Technology Corporation, March/April 1989.

IDS90 = "Instruction Delivery Systems," Volume 4, Number 3, Communicative Technology Corporation, May/June 1990.

its radiological-control (RADCON) training. It is one of Newport News' goals that through the use of this technology., the yard will be able to demonstrate to workers, management, and trainlng personnel the advantages and capabilities of interactive instruction.

Another shipyard, Bath Iron Works, has embarked on a demonstration of interactive instruction through the use of Apple "Hypertext" to create an interactive "information network" for use in familiarization, training, and retrieval of information on the DDG-51 AEGIS destroyer. This system, although currently in its infancy, is expected to incorporate full multimedia capabilities such as bitmaps, graphics, animation, audio, and video before its completion.

Both of these systems show a concerted effort by the shipyards to demonstrate the benefits of interactive instruction to their management and incorporate interactive instruction in their training programs.

Section 4

REVIEW OF INTERACTIVE AUTHORING SYSTEMS

Project personnel identified more than one hundred interactive courseware authoring systems that are commercially available from developers and vendors. These authoring systems were obtained from interactive multimedia directories and compendiums, some of which are listed in Section 2.5 of this report.

Crowell [Reference 7] defines authoring as "a term used in the interactive multimedia industry to refer to the person who enters the information that allows the computer to present an interactive program to the end-user." Authoring may be performed by conventional computer programming, with a higher-order "author language," or with an "authoring system."

Authoring systems permit courseware developers who are not computer programmers to use menus and pointing devices to design interactive lessons. Crowell further states that "authoring languages and systems available today are so powerful that they offer 90% or more of the services developers require." Authoring systems provide for all peripheral interactions among the computer, disc players, memory drives, interface devices, etc. They also provide a systematic process for constructing the courseware, as well as for operating it during training. In addition to a wide variety of presentations, interaction capabilities, testing and branching, some authoring systems also provide "answer analysis" and "trainee management" to register, track and evaluate trainee performance.

Author language, unlike authoring systems, require developers to use commands and syntax instead of menus and Pointinq devices for the development of interactive courseware. While "this may produce greater flexibility during development and in the design of the courseware, it also requires the developer to assume many of the functions and responsibilities of a computer programmer. These include knowledge of the language, rules and procedures.

Depending upon their complexity and capabilities, both authoring systems and author languages may take considerable learning prior to effective mastery by the developer. The advantage of an authoring system is that if it is especially selected to accommodate the requirements of the courseware and if the developer is not well versed in the development of interactive courseware, the authoring system will be more efficient than would be an author language.

4.1 Authoring System Checklist

Authoring systems vary extensively in (1) the type of hardware they require, (2) the interface they provide, (3) their lesson features, (4) the capabilities of their answer analyses, (5) their management features, and (6) their cost. Authoring system requirements are frequently published as "checklists" for use in selecting an appropriate authoring system.

Two noteworthy checklists have been published by Berdel, Locatus, Weisberg, and Carr [8] and by Muller, Levy, Nelson and Dean [9]; but good checklists are also frequently published in periodicals and organization journals. A checklist is only as good as its ability to identify all of the characteristics that are required for its application. Muller [9] lists more than 80 "Desired Characteristics of Computer Based Interactive Videodisc Authoring Systems" under the following categories:

Text Editing Capabilities
Student Input
Author Input
Interface Capabilities
S o u n d
Branching
Tests
Data Recorded on Individual Student Performance
Final Editing of Lesson
Authoring Aids
Programming Code
Miscellaneous

In addition to the above characteristics, Muller also discusses a number of other important criteria. These include:

a. Provisions for reinforcement. Some authoring systems provide for a variety of different types of reinforcers for the trainee. This eliminates boredom.

b. Use of Response Latency. Response latency is the speed with which the trainee responds. It is a primary indicator of competency and can be used to accelerate or slow the pace of instruction.

c. Reinforcement of Successive Approximations. In the initial stages of learning, close approximations to the correct answer should be positively reinforced. In the later stages, the response standard should be raised. Some authoring systems permit the specification of boundaries of and acceptable response.

d. Cueing. Cueing is an artificial means of producing a desired response, such as a hint or clue. Some authoring systems provide for the controlled insertion and fading of clues based upon the trainee's performance.

e. Diagnosis and Remediation. Diagnosis and remediation are two of the most critical features of interactive instruction. The ideal authoring system permits remediation during all phases of instruction, and ensures that it is more than the simple re-looping back through the original instruction. Some authoring systems provide the developer with options for basing remediation upon the a variety of response qualities. Good authoring systems also provide for a large amount of remediation sequences.

f. Pace of Instruction. Some authoring systems permit the developer to control the pace of the instruction, both presentation and remediation, as a function of trainee performance.

g. Chaining. Since most tasks that are taught by interactive instruction are made up of chains of events, it is important that the instruction system both teach and evaluate these chains based upon the trainee's precision and speed, and the criticality of events. Authoring systems that are used to develop courseware for these types of tasks should have special provisions to address chaining behavior.

h. Review. The ideal authoring system provides frequent and timely review of areas that were most difficult for the trainee to learn.

i. Evaluation. The evaluation of trainee performance is also one of the most valuable functions of interactive instruction. This evaluation is necessary to ensure that only trainees who have mastered the subject are permitted to exit the instruction. This ensures and, in some cases, documents that the trainee has achieved a predetermined competency in the subject matter. All re-tests of failed portions of the instruction should be comprised of new items or at least be rearranged with alternative responses.

j. Open-ended Responses. Two types of trainee responses that are accommodated by authoring systems are "recognition of correct responses" and "trainee-produced responses." Recognition is the most common type, since it is easy for the system to recognize and evaluate the response against a standard. Recognition responses include multiple-choice, true/false, and "point-to" interactions. Trainee produced responses may be entered by keyboard, voice recognition or other open-ended interface. The difficulty in evaluating trainee produced responses is in determining whether the response falls within the limits required to achieve a standard. The ideal authoring system accommodates trainee produced responses by judging the appropriateness or correctness or the response.

k. Group Training. Interactive instruction can be administered individually or to groups, depending on the objectives of the training and the tasks to be learned. Team training, in which two or more individuals must communicate with one another, is well suited to interactive instruction. Additionally, studies [10] have shown that "group-based interactive instruction may be more effective than individualized instruction" for certain applications. Good authoring systems provide the capability of receiving and analyzing multiple-trainee inputs, thereby permitting group-based training.

l. Performance and Interaction. Authoring systems should allow the courseware to make use of new performance measures and new interactive technologies. Some of the most promising of these technologies include voice recognition and physiological sensors such as glove, helmet and eye control.

m. Alternative Instructional Models. The premise that interactive Instruction employs "sound principles of learning and instruction" is based upon the model within which the courseware operates. Joyce [11] describes models used in interactive videodisc instruction that stem from a "training model." These Models function through the use of algorithms within the courseware. The algorithms establish rules and requirements of the courseware and thereby dictate its operation. Each model requires its own algorithms, organization of algorithms, and sequencing of algorithms. A good authoring system helps organize the authoring activities the same way the courseware model will be used. The ideal authoring system would provide the courseware developer the opportunity to select a model that is best suited for the instructional objective.

It should be noted that many of these criteria significantly increase the cost and/or complexity of an authoring system. In such cases, it is best to determine if the capability is really required for developing the courseware and if it will be used in the courseware.

Section 2.5.3 lists several good, contemporary references on how to select the appropriate authoring system. These references can be identified by their title.

4.2 Authoring System Review

As part of the interactive multimedia industry review, project investigators obtained more than 20 demonstration discs and documented descriptions of commercially available authoring systems that could be used for developing interactive courseware for shipyard trade training. A checklist was then constructed, based upon predictions of how the authoring system would be used in the shipyards. The checklist also took into account that the authoring system would be used to develop a two-lesson (simulation and practice) demonstration of interactive instruction for shipyard trade training. The authoring system checklist is presented in Appendix C. It pays particular attention to the following:

a. The hardware that is required

b. The visual presentation such as text and graphics

c. The video presentation

d. The auditory presentation

e. The courseware development environment (ease of use by the author)

f. Management and student evaluation capabilities

g. Its cost

h. Vendor support

The results of the checklist review are discussed in Section 9.4. Essentially, there was no conclusive evidence to support the choice of only one authoring system for shipyard use. Instead, the report lists 12 candidates for use in the demonstration and proposes that the choice be narrowed down during the NSRP demonstration development effort.

Section 5

INTERACTIVE INSTRUCTION FOR SHIPYARD TRADE TRAINING

5.1 Characteristics of Shipyard Training

The American shipbuilding and ship repair industry consists of approximately 315 private and eight naval shipyards [Shipbuilders Council of America]. These yards vary extensively in many ways, but of primary concern to training issues are the type of work the shipyards perform, the capabilities of the personnel they employ, and the organization of their training departments. Employment levels fluctuate extensively within the private yards, while naval shipyards tend to maintain a more stable workforce. In addition, some private shipyards concentrate mainly on shipbuilding, while naval shipyards and more than 200 yards of varying sizes and capabilities specialize only in ship repair and overhaul.

Shipbuilding and ship repair are extremely labor-intensive. Because ship repair is involved with small numbers of like parts and because much of the work is performed aboard ship, the opportunity for automation in ship repair is significantly less than for shipbuilding. The skills used in shipbuilding and ship repair are basically similar, but their mix is different. Shipbuilding requires more of the structural trades, while ship repair usually requires more outfitting trades.

Employment in all but the naval shipyards and a few of the private shipyards tends to be cyclical, depending upon the amount and type of work being performed. Storch [Reference 12] states that "Higher involuntary turnover induces higher voluntary turnover which is exacerbated by generally poorer work conditions and lower pay relative to other industries." Shipyards which experience employment cycles tend to avoid instituting costly training programs lest they lose this investment. On the other hand, because they experience higher turnover, training is essential to their survival.

Naval shipyards must be able to respond quickly to requirements for repair on short notice. Recognizing this, the Navy has instituted an employee training program that ranks among the best in the country. Storch [12] credits this investment in training as an "important factor in attracting and retaining quality personnel."

For shipyards that are faced with a shortage of skilled craftsmen, the availability of this resource can be considered "unpredictable" at best. Skilled craftsmen can be recruited from other shipyards or from similar industries, depending upon the shipyard's location, the type of craftsmen that are needed, and the local economic climate. Only occasionally are craftsmen recruited from outside the local labor market, and then only for highly skilled workers.

The alternative to skill recruitment is training, and this does not satisfy a short-term requirement. Short-term skill development must be achieved by on-the-job or special, often individualized, training courses.

The formal training of a journeyman may take up to six years, possibly longer than the length of time the skill is required.

Private shipyards that have a relatively stable workforce or an isolated labor supply usually maintain an ongoing apprentice training program. Parts of this apprentice program may be taught by a community college or other educational institution, but the majority of instruction is administered through on-the-job training by trade instructors. Apprentice programs, if properly administered, are extremely beneficial; producing a competent workforce, instilling pride within the trade, and generally promoting employee retention.

5.2 Training Organization

The organization of training in naval shipyards varies. Training at the Portsmouth Naval Shipyard provides “centralized” training for the Production Department under Code 980. Other naval shipyards permit the individual shops to develop and administer their own training under Code 180. Private shipyard training organization also varies, but all of the large private yards maintain a centralized training department that reports directly to corporate management.

This implication is important with respect to introducing interactive instruction into existing shipyard trade training programs. The impact of the training organization in the shipyard could significantly effect how the demonstration of interactive instruction is carried out and how the advantages of interactive instruction to trade training are best communicated to those who will appreciate them.

Aside from organization, there are other issues involved in shipyard training and how that training is accomplished. Naval shipyards, unlike private shipyards, coordinate many of their trade training activities among yards. In addition, they use cooperative facilities such as the Naval Sea Systems Command’s Shipyard Instructional Design Center (SIDC) that develops and distributes “linear video" and other audio-visual materials for shipyard training. Linear video, unlike "interactive video," contains video motion sequences that are designed only to be played from beginning to end without stops or branching.

Some of the large private shipyards such as Bath Iron works and Newport News Shipbuilding also operate their own video production facilities. These facilities are well equipped and professionally staffed, and produce very high quality VHS tapes.

A large selection of video tapes generated by both the Navy and the private sector can be obtained from NSRP'S Audio Visual Material Available for Shipyard Training (AVMAST) library. Information regarding AVMAST and the service it provides may be obtained from the AVMAST Coordinator, Transportation Research Institute, University of Michigan, 2901 Baxter Road, Ann Arbor, MI 48109-215O, or by calling 313-936-1051.

Training programs in private shipyards are traditionally not coordinated among shipyards, although customer requirements sometimes dictate the establishment of minimum training standards. Some of the larger private shipyards do maintain apprentice programs, as well as helper-to-intermediate programs, specialized equipment or procedures-related programs, safety and hazardous waste handling programs, and human resources training programs. The characteristics of these training programs and the types of trades that are included vary extensively between the yards.

5.3 Need for a Survey of Shipyards

A 1983 study by NSRP [131 identified "core" trades common to almost all shipyards, and additional trades that are "site-unique" to certain shipyards. These core trades are listed in Table 5-1. The site-unique trades are listed in Table 5-2. Prior to the current study, it was unknown which shipyards employ these trades and which trades are taught by the shipyards. In order to determine if and how interactive instruction might be used, it became necessary to survey the shipyards. The survey was conducted in two parts. The first part was a questionnaire to all private and naval shipyard training personnel, and the second part was a follow-up visit to those shipyards that either used interactive instruction or indicated a specific interest in its application. Detailed descriptions of the shipyard survey and its results are presented in Sections 7 and 8.

5.4 Criteria for the Application of Interactive Instruction

Section 2.4 provided a description of the benefits of interactive instruction in general. One of the primary purposes of this project was to identify where, in shipyard trade training, these technologies can be best utilized and how they can be best integrated into existing shipyard training programs. To do this, project investigators established a set of criteria that, if met, indicate which shipyard trade tasks should be considered as candidates for interactive instruction. These criteria were were also used during the shipyard visits to aid the training personnel in identifying which trade tasks should be used in the NSRP demonstration of interactive instruction for shipyard trade training. These criteria are listed in Table 5-3.

TABLE 5-1. SHIPYARD CORE TRADES

Air Conditioning Equipment Mechanic
B1 aster
Boilermaker
Carpenter
Chipper/Grinder
Electrician, General, Marine or Maintenance
Electrician, Inside
Electrician, Outside
Electronics Mechanic
Electroplate
Insulator
Joiner
Loftsman
Machinist, General or Marine
Machinist, Inside
Machinist, Outside
Molder
Ordinance Equipment Mechanic
Painter
Patternmaker
Pipefitter
Pipewelder
Rigger/Crane Operator
Sheetmetal Mechanic
Shipfitter
Shipwright
Tacker/Burner
Toolmaker
Toolroom Mechanic
Welder

TABLE 5-2. SHIPYARD SITE-UNIQUE TRADES

Automotive Mechanic
Blacksmith
Boiler Plant Equipment Mechanic
Drafter
Electronic Equipment Inspector
Electrical Equipment Repairer
Electric Power Controller
Electronic Mechanic Fire Control
Electronic Indicator Controls Mechanic
Electronics Integrated Systems Mechanic
Electronics Measurement Equipment Mechanic
Equipment Mechanic
Fabric Worker
Forger/Heat Treater
Heavy Metal Fabricator
Heavy Mobile Equipment Mechanic
Heavy Mobile Equipment Repair Inspector
Industrial Electronics Control Mechanic
Instrument Mechanic
Lead Bonder
Maintenance Machinist
Mel ter
Metals Inspector
Milling Worker
Millwright
Optical Instrument Repairer
Painter/Decorator
Pipehanger
Plastic Fabricator
Plastic Molder
Production Machinery Mechanic
Toolmaker
Toolroom Mechanic
Welding Equipment Repairer
Wharfbuilder
Woodcrafter
Wood and Plastic Installer

TABLE 5-3. CRITERIA FOR THE APPLICATION OF INTERACTIVE INSTRUCTION

The following is a list of criteria to determine whether interactive instruction should be used for a specific training course or lesson. These criteria were used by project investigators during their shipyard visits to identify which trade task(s) should be taught during the demonstration of interactive instruction

INTERACTIVE INSTRUCTION IS MOST EFFECTIVE WHEN:

Facility and Cost Factors

- the conventional training method could endanger personnel or equipment, and the loss would be critical or the probability of the loss is high.

- flexibility in the scheduling of training and length of training is desirable.

  conventional training requires special or additional personnel, equipment, material, or capabilities.

  conventional training consumes products or materials, and the cost of the consumable is high or the clean-up/recovery effort is extensive.

- the conventional training site is costly, ineffective, undesirable, or hazardous.

- the training site must be movable or portable so as to be easily accessible to the trainee.

Trainee Factors

  individualized training is desirable in order to maintain trainee privacy or minimize external influences.

- large numbers of personnel must be trained, but they may be instructed on an individual basis; and the cost of purchasing or developing the interactive instruction program is less than the conventional training program.

- there are wide or unknown variations in trainee learning abilities or trainee motivations vary.

TABLE 5-3. CRITERIA FOR THE APPLICATION OF INTER. INST. (Cont.)

consistency and standardization of the training is required, as defined by training objectives or established training materials.

it is desirable that the trainee select his or her own characteristics of the instruction such as type of presentation, type of interaction, type of remediation, etc.

- learning is by VERBAL ASSOCIATION, i.e., a word, phrase, statement, etc. is linked to an identification, action, function, etc.

- learning is by CONCEPT FORMULATION, i.e., the linkage is by identification, action, function, etc.

- learning is by PRINCIPLES AND RULES, i.e., if rule "A" applies, then "B" must follow.

- learning is by PROBLEM SOLVING, i.e., if no rule or conflicting rules apply, than "B" must be determined.

- learning is by MOTOR SKILLS, i.e., the use of psychomotor facilities to accomplish an activity.

Subject Factors

the skill/knowledge must achieve an established competency or proficiency level.

verification of the skill/knowledge is required, such as testing prior to training to determine entry level, testing during training to evaluate progress, or testing after training to determine proficiency level.

verification of the skill/knowledge must be documented such as for personnel screening, advancement, qualification/certification, record keeping, etc.

consistency and standardization of the skill/knowledge is required such as by defined learning objectives or defined proficiency levels.

- the skill/knowledge is both critical to the task and perishable, i.e., easy to lose if not frequently reinforced.

it is desired to increase retention of the subject matter more than is achieved by conventional training.

TABLE 5-3. CRITERIA FOR THE APPLICATION OF INTER. INST. (Cont.)

it is desired to reduce the learning time required by conventional training.

skill/knowledge is common across many trades or locations.

conventional training aids are not cost-effective or are otherwise impractical.

the task being trained requires visual/auditory skill such as search, identification, and tracking; visual/auditory discrimination or comparison, or hand-eye coordination.

General Factors

a large collection or mixture of multimedia material such as still and motion photography, graphics, anmation,etc. is required for the instruction.

instructors with subject matter expertise are in short supply.

simulation of equipment is required.

the subject trained is "perishable" or it requires continuous practice.

- the subject trained is relatively stable and does not frequently change.
- the training involves such skills as problem solving and decision making.

it is determined that "there must be a better way than books and papers."

Section 6

COST-EFFECTIVENESS OF INTERACTIVE INSTRUCTION

The most cost-effective application of interactive instruction is in teaching those tasks that meet the criteria listed in Table 5.3 (the previous section). Brandt [Reference 14], in his cost analysis of videodisc training, condenses this list into the following ten rules. He concludes that when interactive instruction is applied under these circumstances, its cost-effectiveness is relatively easy to calculate and is almost always assured.

a. When it is used to gather together a large collection of multimedia material, such as still and motion photographs, video, animation, graphics, text, etc.

b. When there are a large number of students distributed over time and/or place.

c. When instructors with subject-matter expertise are expensive or difficult to obtain.

d. When the simulation of equipment, procedures, or activities is required.

e. When potentially hazardous (to equipment and personnel) procedures or activities are taught.

f. When the training requires continuous practice, restraining, or re-qualification.

g. When the subject matter is relatively stable over time.

h. When the training involves such skills as problem solving and decision making.

i. When the students vary in experience or skill level and/or when their proficiency must be documented.

j. When interactive instruction has inherent advantages over the conventional paper and pencil method for certain subjects. Examples of such subjects include language instruction and subjects requiring tactile responses.

Interactive instruction that uses courseware developed by the shipyards themselves can be expected to be cost-effective. This is attributed to the relatively low initial cost to start an interactive program (less than $10,000 for both the delivery system and authoring system) and the fact that the in-house development of interactive courseware would replace the development of conventional courseware.

Brandt [14] has published a sophisticated cost-analysis workbook to calculate the cost-effectiveness of interactive instruction on a course-by-course basis. Many studies, however, such as the 47 reviewed by Fletcher [15] "indicate that videodisc instruction is both more effective and less costly than conventional instruction" when appropriately applied.

Considering all of the factors inherent in shipyard trade training such as requirements of the tasks to be trained, capabilities and resources of the training department, and characteristics of the individuals to be trained, the project investigators conclude that the cost-effectiveness of interactive instruction for trade training will be directly proportional to the extent to which the criteria listed above apply to the task.

It is particularly noteworthy that one of the most cost-effective uses of interactive instruction would occur in small shipyards where the cost of establishing a formal training program is prohibitive. Here employees could receive individualized training on a time-available basis and at a level commensurate with each employee's abilities. Interactive instruction would significantly increase and maintain the shipyard's capabilities and at relatively small initial and recurring cost.

Section 7

SURVEY OF SHIPYARDS

7.1 Existing Trade Training

Questionnaires were sent to shipyards to determine (1) what trades are currently being taught by shipyards, (2) whether they are taught by conventional or interactive methods, (3) the interactive instruction system, if any, that is being used by the shipyard, (4) the shipyard's knowledge, experience, and opinions of interactive instruction for trade training, and (5) what computer hardware is available at the shipyard for trade training purposes.

Responses are illustrated in Tables 7-1, 7-2, and 7-3. Each questionnaire contained a list of trades that are employed in private and naval shipyards. The list included both core trades that exist in almost all yards, and site-unique trades that exist as a result of specialty work in shipyards. Respondents were asked to review the list of trades and indicate by a checkmark which ones are currently taught by their company. In addition, certain selected shipyards were asked to indicate who taught these trades; the shipyard itself, a union organization, or an academic institution such as a community college. These shipyards were specially selected because they were believed to have large training departments with possible experience in interactive instruction.

For those trades that are taught by their company, respondents were asked to indicate whether or not interactive instruction is used; and, if so, to list at what level (OJT, apprentice, mechanic/journeyman or manager). The title and name of the interactive courseware developer was also requested.

A cursory comparison of the resulting tables reveals that the majority of trade training is performed by naval shipyards, but that certain of the larger private shipyards also do extensive trade training. Because the primary objective of the question was to determine the most frequently taught trades, the measure used is "percentage of responding shipyards training this trade." For example, if all shipyards that returned their questionnaires indicated that they taught a "Welder" course, than that trade would be shown as 100%. A trade that is taught by only half the shipyards responding to the survey would be shown as 50%, and so forth. Table 7-4 lists the "top ten" most frequently taught trades among American shipyards.

7.2 Familiarity with Interactive Instruction

A major objective of the questionnaire was to determine how familiar shipyard training departments are with interactive instruction, its applications, and its benefits. This was determined by asking the question, "How would you characterize your trade training department’s familiarity and knowledge of interactive instruction systems and their use?" Respondents were permitted a choice of "completely unfamiliar," "mostly unfamiliar," "quite knowledgable," or "very knowledgeable."

TABLE 7-1. TRADES TRAINED BY SELECTED PRIVATE SHIPYARDS*

Trade	Taught by the Shipyard
Air Conditioning Equipment	50%
Automotive Mechanic	30%
Blacksmith	20%
B1 aster	50%
Boiler Plant Equipment	20%
Boilermaker	20%
Carpenter	50%
Chipper/Grinder	50%
Drafter	60%
Electric Power Controller	30%
Electrical Equipment	30%
Electrician, General, Marine or Maint.	60%
Electrician, Inside	70%
Electrician, Outside	70%
Electronic Equipment Inspector	50%
Electronic Indicator Controls Mechanic	20%
Electronic Mechanic Fire Control	20%
Electronics Integrated Systems Mechanic	30%
Electronics Measurement Equipment Mechanic	20%
Electronics Mechanic	20%
Electroplate	1 0%
Equipment Mechanic	30%
Fabric worker	10%
Forger/Heat Treater	20%
Heavy Metal Fabricator	30%
Heavy Mobile Equipment Mechanic	30%
Heavy Mobile Equipment Repair Inspector	30%
Industrial Electronics Control Mechanic	20%
Instrument Mechanic	20%
Insulation Worker	50%
Insulator	50%
Joiner	30%
Lead Bonder	30%
Loftsman	50%
Machinist, General or Marine	50%
Machinist, Inside	70%
Machinist, Outside	80%
Maintenance Machinist	20%
Maintenance	60%
Marine Machinery Mechanic	20%

* Percentage of responding shipyards training this trade.

TABLE 7-1. TRADES TRAINED BY SELECTED PRIVATE SHIPYARDS* (Cont.)

Trade	Taught by the Shipyard
Melter	10%
Metals Inspector	50%
Milling Worker	10%
Millwright	10%
Mold Loftsman	20%
Molder	10%
Optical Instrument Repairer	10%
Ordinance Equipment Mechanic	20%
Painter	90%
Painter/Decorator	20%
Patternmaker	20%
Pipecoverer	40%
Pipefitter	90%
Pipehanger	40%
Pipewelder	80%
Plastic Fabricator	0%
Plastic Molder	
Production Machinery Mechanic	20%
Rigger/Crane Operator	60%
Sheetmetal Mechanic	60%
Shipfitter	80%
Shipwright	30%
Tacker/Burner	60%
Toolmaker	10%
Toolroom Mechanic	20%
Welder	90%
Welding Equipment Repairer	40%
Wharfbuilder	10%
Wood and Plastic Installer	30%
Woodcrafter	20%
ALL TRADES, Safety and Health	80%
ALL TRADES, Quality Assurance	80%
ALL TRADES, Management and Personnel	60%
ALL TRADES, Basic Academics & Tech. Fund.	50%
OTHER	0%

* Percentage of responding shipyards training this trade.

TABLE 7-2. TRADES TRAINED BY OTHER PRIVATE SHIPYARDS*

Trade	Taught by the Shipyard
Air Conditioning Equipment	4%
Blaster	39%
Boilermaker	35%
Carpenter	22%
Chipper/Grinder	17%
Electrician, General, Marine or Maint	39%
Electrician, Inside	4%
Electrician, Outside	0%
Electronics Mechanic	4%
Electroplate	0%
Insulator	13%
Joiner	17%
Loftsman	22%
Machinist, General or Marine	39%
Machinist, Inside	44%
Machinist, Outside	44%
Molder	0%
Ordinance Equipment Mechanic	0%
Painter	57%
Patternmaker	4%
Pipefitter	44%
Pipewelder	44%
Rigger/Crane Operator	52%
Sheetmetal Mechanic	9%
Shipfitter	61%
Shipwright	13%
Tacker/Burner	26%
Welder	57%
ALL TRADES, Safety and Health	74%
ALL TRADES, Quality Assurance	52%
ALL TRADES, Management and Personnel	35%
ALL TRADES, Basic Academics & Tech Fund	13%
OTHER	0%

* Percentage of responding shipyards training this trade.

TABLE 7-3. TRADES TRAINED BY NAVAL SHIPYARDS*

Trade	Taught by the Shipyard
Air Conditioning Equipment	88%
Automotive Mechanic	50%
Blacksmith	38%
B1aster	63%
Boiler Plant Equipment	75%
Boilermaker	88%
Carpenter	88%
Chipper/Grinder	38%
Drafter	50%
Electric Power Controller	63%
Electrical Equipment	75%
Electrician, General, Marine or Maint.	100%
Electrician, Inside	75%
Electrician, Outside	63%
Electronic Equipment Inspector	75%
Electronic Indicator Controls Mechanic	38%
Electronic Mechanic Fire Control	50%
Electronics Integrated Systems Mechanic	75%
Electronics Measurement Equipment Mechanic	63%
Electronics Mechanic	88%
Electroplate	88%
Equipment Mechanic	88%
Fabric Worker	88%
Forger/Heat Treater	63%
Heavy Metal Fabricator	38%
Heavy Mobile Equipment Mechanic	100%
Heavy Mobile Equipment Repair Inspector	50%
Industrial Electronics Control Mechanic	75%
Instrument Mechanic	63%
Insulation Worker	50%
Insulator	100%
Joiner	38%
Lead Bonder	38%
Loftsman	63%
Machinist, General or Marine	88%
Machinist, Inside	100%
Machinist, Outside	88%
Maintenance Machinist	75%
Maintenance	25%
Marine Machinery Mechanic	100%

* Percentage of responding shipyards training this trade.

TABLE 7-3. TRADES TRAINED BY NAVAL SHIPYARDS* (Cont.)

Trade	Taught by the Shipyard
Melter	38%
Metals Inspector	75%
Milling Worker	50%
Millwright	25%
Mold Loftsman	38%
Molder	7W%
Optical Instrument Repairer	63%
Ordinance Equipment Mechanic	63%
Painter	100%
Painter/Decorator	13%
Patternmaker	88%
Pipecoverer	50%
Pipefitter	100%
Pipehanger	25%
Pipewelder	38%
Plastic Fabricator	63%
Plastic Molder	38%
Production Machinery Mechanic	75%
Rigger/Crane Operator	88%
Sheetmetal Mechanic	100%
Shipfitter	100%
Shipwright	100%
Tacker/Burner	25%
Toolmaker	88%
Toolroom Mechanic	75%
Welder	100%
Welding Equipment Repairer	38%
Wharfbuilder	13%
Wood and Plastic Installer	25%
Woodcrafter	63%
ALL TRADES, Safety and Health	100%
ALL TRADES, Quality Assurance	88%
ALL TRADES, Management and Personnel	75%
ALL TRADES; Basic Academics & Tech. Fund.	88%
OTHER	13%

* Percentage of responding shipyards training this trade.

TABLE 7-4. LIST OF THE MOST FREQUENTLY TAUGHT TRADES

The following is a list of the ten most frequently taught trades in private and naval shipyards. This list is derived from an analysis of Tables 7-1, 7-2, and 7-3, but they are not listed' in the order of their frequency.

MOST FREQUENTLY TAUGHT IN:

Private Shipyards	Naval Shipyards
Shipfitter	Shipfitter
Welder	Welder
Pipefitter	Pipefitter
Painter	Painter
Carpenter	Carpenter
Machinist, Outside	Electrician, General, Marine, or Maint.
Pipewelder	Insulator
Quality Assurance	Machinist, Inside
Rigger/Crane Operator	Sheetmetal Mechanic
Tacker/Burner	Shipwright

In addition to the above trades, Safety and Health and Quality Assurance courses are also taught by a large majority both types of shipyards. These courses, however, are not considered as candidates for the demonstration of interactive instruction for shipyard trade training.

Table 7-5 shows the results of this question for all private shipyards that responded and for all naval shipyards. Considering that interactive instruction has been in use by the training and education community for more than a decade, it is surprising that shipyard training departments do not have a greater knowledge of it than they do. This finding reinforces the need to make information on interactive instruction more available to them.

7.3 Opinions on the Use of Interactive Multimedia for Instruction

In an attempt to determine the general consensus among shipyard training personnel on the use of interactive instruction for training and education purposes, the respondents were asked to best describe their personal opinion of interactive multimedia for (1) general training and education purposes, and (2) training shipyard trade skills. The term "interactive multimedia" was intentionally used in the question to imply all types of interactive training devices, including computer based training systems, interactive classrooms, simulators, and trainers.

Many of the opinions reflected respondents' impressions of negative aspects of interactive instruction. Of those opinions listed below, many are either untrue or can be overcome through proper courseware and system design:

a. "It is ineffective for teaching trade skills." "It would have to be limited to basic trade theory." "It is not good for motor-skill training."

b. "It is not good where shift difficulties or language barriers exist, or where employee education levels are low."

c. "It is good only if combined with on-the-job-training." "It must be tailored to each shipyard's needs."

d. "It is time consuming, both to develop and administer." "It is effective but expensive." "Too costly."

e. "It is hardware dependent." "Equipment is highly specialized and can be used for one-to-one training only."

f. "The subject matter cannot easily be changed, revised, or updated."

g. "The instructor or facilitator must have a strong knowledge of subject matter and a computer background." "Computer programming knowledge is required."

h. "There is no need to improve upon my existing training program."

i. "Instructors generally have difficulty grasping its concept."

j. "Its application is very limited." "It does not reach as many people (trainees) as classroom instruction does."

TABLE 7-5. RESPONSES TO THE FAMILIARITY QUESTION*

QUESTION:

"How would you characterize your training department's familiarity and knowledge of INTERACTIVE INSTRUCTION SYSTEMS and their use?"

RESPONSES:	Private Shipyards	Naval Shipyards
Completely unfamiliar	67%	0%
Mostly unfamiliar	23%	86%
Quite knowledgeable	10%	14%
Very knowledgeable	0%	0%

* Percentage of responding shipyards training this trade.

Many of these comments are indicative of the problems that interactive instruction has had in gaining acceptance by the training and education community. The majority of these problems do not exist where interactive instruction is properly marketed, designed, and implemented.

A correlation between the familiarity measure and the negativity of the comment suggests that the less knowledgeable the respondent was about interactive instruction, the less favorable the respondent's opinion of interactive instruction.

No obvious difference was noted, however, in responses between the "opinion of 'interactive multimedia' for general training and education purposes" and the "opinion of 'interactive multimedia' for training shipyard trade skills." It is hypothesized that the respondents may not have been sufficiently knowledgeable of interactive instruction to recognize the differences in these applications.

A list of typical comments from the two opinion questions is presented in Table 7-b.

7.4 Existing Use of Interactive Instruction

Results of the questionnaire confirmed what SP-9 panel members and most members of the shipyard training community had alleged, that few shipyards are using interactive instruction for skilled trade training. This is attributed to many factors, among them the perceived high initial cost of courseware and delivery systems, the fact that conventional training organizations are already in place, and failure of the interactive multimedia industry to communicate the applications and benefits of interactive instruction to shipyards.

Of the 271 shipyards that were sent questionnaires, only six indicated that they currently use some type of interactive instruction for their trade training. All agreed that it does provide major cost savings and training effectiveness benefits, but only for narrow applications. Most shipyards have found that commercially-available courseware is not as cost-effective as they would like. The courseware contains too much subject matter not relevant to the trainee's task, thereby wasting much of the trainee's learning time. Granted, true interactive instruction should permit the trainee (or instructor in cases of group interaction) to circumvent non-relevant subject matter, but in this case the shipyards perceive they are paying for this "unnecessary" subject matter.

Commercial interactive courseware has proven effective in some shipyards for safety, academics (e.g., mathematics, reading, measurement, etc.), human resources, and management training courses. The general conclusion from those few shipyards that have developed their own interactive courseware, is that the best application of this type of instruction to trade training is in areas so specialized, that no commercial courseware is available. This is what led them to develop their own courseware, and what can be expected to require them to continue in-house courseware development.

TABLE 7-6. OPINIONS ON THE USE OF INTERACTIVE MULTIMEDIA

QUESTION:

"What few words best describe your personal opinion of 'interactive multimedia' for general training and education purposes?"

TYPICAL RESPONSES : (grouped)

- I know very little about it, its use, or its benefits. It is excellent for standardizing training and education. It is only as good as its design and application, including the way the instructor uses it. For the right problem, it is the only solution.

- It can be effective, but it is too costly. It is not cost effective if a program is already in place. It provides an opportunity for training and education cost savings.

- It is excellent for both individualized (including after-hours) and classroom environments. It is excellent where space is limited and time constraints are imposed.

QUESTION:

"What few words best describe your personal opinion of 'interactive multimedia' for training shipyard trade skills?"

TYPICAL RESPONSES : (grouped)

- I know very little about it, however I cannot imagine how it could be applied to trade skill training. I have not formed an opinion due to my limited knowledge about it.

- Existing shipyard training programs, including the use of linear video, are adequate ("hard to beat") at this time. It could only be applied in a few trade training areas, and therefore is not worth the initial cost.

- I do not know how it would accommodate shift difficulties and language problems such as experienced in our yard. We have tried it, but with limited success because the subject matter was not 100% related to the shipyard task.

- It is good for this type of training. It is excellent when properly applied. A good idea from what I have heard, but I have not yet seen "anything." It is in the future; shipyards must understand that automated and individualized training are superior to instructor-led group training for some applications.

Table 7-7 lists the interactive courseware currently in use by those shipyards that responded to the questionnaire. Commercially available vs. in-house developed courseware is so indicated.

7.5 Shipyards' Willingness to Accept Assistance

In addition to questioning shipyards' knowledge of interactive instruction, the questionnaire also elicited from each respondent whether the shipyard would welcome assistance in applying and/or evaluating interactive instruction for its trade training. This question, and answers to the question are indicated in Table 7-8 by "percentage of responding shipyards."

It is noted that the majority of shipyards who responded to the questionnaire would welcome assistance in the application of interactive instruction to trade training, but that they are also eager to see the applications and benefits demonstrated to them prior to any commitment.

A few shipyards indicated that they are eager to accept assistance in integrating interactive instruction and know exactly where they would apply it. Some are not interested in any assistance at all.

In correlating these results with the the familiarity measure (Section 7.2), it was found that the shipyards who were more knowledgable of interactive instruction were also more eager to accept assistance.

7.6 Computer Systems Available for Training

In response to the question, "What types of desk-top or Personal Computers do you use or have available for trades training purposes," more than 50% of all shipyards that responded indicated that they have some type of desk-top personal computer available for use by training personnel. Systems named included IBM PC and compatibles, Macintosh, Zenith, Digital, NCR, and Tandy. The most common to private shipyards were IBM compatibles.

This finding suggests that even though many shipyards do not use computer systems for actual hands-on training (i.e., computer based training), their proficiency in the use of computers may be sufficient to enable them to author simple interactive courseware. It also indicates that they may be able to convert existing computer systems to interactive instruction delivery systems at minimal cost.

7.7 Survey Findings

The percentage of shipyards that responded to the questionnaires (78% of shipyards that were contacted by telephone prior to the survey and 10% of those shipyards that were not contacted by telephone) is believed to be adequate to derive conclusions. This is based on the fact that the shipyards contacted were most likely to have trade training programs and therefore possible experience with interactive instruction. Shipyards that were not telephoned, were less likely to have such experience.

TABLE 7-7. LIST OF INTERACTIVE COURSEWARE USED IN SHIPYARDS

The following is a list of possible interactive courseware in use by one or more of the shipyards that were surveyed. It is unknown whether all of this courseware is interactive; however, it does indicate that some American shipyards are applying, or have applied, computer based training to their trade instruction.

Trade	Courseware	Developer/Vendor	Shipyard
Air Conditioning Mech.	HVAC Repair	(unknown)	Bath Iron Works
Drafter	Medusa Trainer	Prime Systems	Tacoma Boatbuilding
Electrician/Electronics	Electronic Maint./Repair	Data General	Bath Iron Works
Loftsman	Auto-CAD	Autodesk	Bay Shipbuilding
Loftsman	Smart CAM	Point Control	Bay Shipbuilding
Mold Loftsman	CAD Designer Training	Auto Ron, Inc.	Bath Iron Works
Pipefitter	Statistical Methods for Improving Performance	(unknown)	Peterson Builders
Safety and Health	Safety, OSHA Regulations	OSHA-Soft, Inc.	Bath Iron Works
Safety and Health	Safety Inspector Training	Data Chem, Inc.	Bath Iron Works
All TRADES, Academics	Mathematics	Applied Learning	Pearl Harbor NSY
OTHER, Computer Systems	PC Training, DOS Intro.	Intro Software	Bath Iron Works
OTHER, RADCON	RADCON - Nuclear Trades	(in-house)	Newport News Shipbuilding
OTHER, Hydraulic Systems	Hydraulic Systems	ITC	(unidentified)

TABLE 7-8. RESPONSES TO THE ACCEPTANCE QUESTION*

QUESTION:

"If NSRP were to assist your shipyard in implementing INTERACTIVE INSTRUCTION in your trades training programs, you would . . ..."

RESPONSES:	Private Shipyards	Naval Shipyards
Welcome the assistance and know exactly where to apply the INTERACTIVE INSTRUCTION.	3%	0%
Welcome the assistance but not know where to apply the INTERACTIVE INSTRUCTION.	13%	43%
Possibly welcome the assistance after the advantages and application of INTERACTION INSTRUCTION have been demonstrated.	64%	57%
Not be interested in NSRP'S assistance with INTERACTIVE INSTRUCTION for shipyard trades training.	20%	0%

* Percentage of responding shipyards training this trade.

The following conclusions were derived from the analysis of questionnaire responses and discussions with shipyard training personnel:

a. Few shipyards, private or naval, currently use interactive instruction for skilled-trade training. Most of those that do, however, continue to develop, implement, and evaluate their systems, and expand their interactive instruction applications.

b. Training departments in most shipyards are relatively unfamiliar with the characteristics, uses and benefits of interactive instruction. However, departments with a greater familiarity with interactive instruction indicated a greater willingness to participate in demonstrations of its application and possibly receive assistance in its implementation.

c. The most frequently taught trades in private and naval shipyards are Shipfitter, Welder, Pipefitter, Painter, and Carpenter. If a demonstration of interactive instruction were to be developed and exhibited to shipyards, the highest priority should be given to developing a course for one or more of these trades.

d. The most frequently cited “disadvantage” of interactive instruction by shipyards is its cost. The second most frequently cited, is the shipyards' lack of knowledge about interactive instruction. Based upon this finding, it is concluded that most shipyards may not be aware of the continuously decreasing cost of delivery systems (hardware) and increasing simplicity of authoring systems for developing courseware. This increasing simplicity could permit training department personnel to develop their own interactive courseware quite inexpensively.

Section 8

INTEGRATION INTO EXISTING TRADE TRAINING PROGRAMS

The results of this project indicate that interactive instruction can be effectively integrated into existing shipyard training programs in at least four ways.

a. The first possible way of integrating interactive instruction into shipyard trade training is to use it to supplement and enhance lectures and other conventional training methods. At least one shipyard is experiencing marked success using a group-interactive system. Group-interactive instruction uses a classroom system in which instructor-controlled multimedia (e. g., video, graphics, photographs, audio, etc.)'is used to present information, and trainee answer pads (one at each desk) are used to record and analyze individual trainee responses. Systems such as these are proving useful, but might require extensive re-design of a shipyard's conventional training program in order to be effectively integrated. Group-interactive instruction was not a subject of this project and is not further addressed in this report.

   Individualized interactive instruction, that which is addressed in this project is being used by several other shipyards, also with marked success. This type of instruction is delivered on a one-to-one basis (trainee and interactive system) with minimal instructor intervention but close instructor supervision. To be truly effective as a supplement to the training program, the instructor must ensure that both the interactive instruction materials and method of presentation are appropriate, and that the answer analysis provided by the system is properly used to evaluate the trainee's performance.

   In many cases, commercially-available interactive courseware cannot be directly integrated-into a shipyard trade course. This is because the commercial courseware may omit certain essential subject matter or may contain too much subject matter not relevant to the shipyard trade. In these cases, interactive courseware will have to he developed in-house. This development need not be costly, however, particularly if the instructional design has al ready been accomplished for a conventional course, and if the instructor (i.e., the courseware author) is relatively familiar with the operation of desk-top, personal computers. In this case, the instructor would use an authoring system to create interactive courseware from the established instructional design. The author might even have access to a video production facility or existing linear video that could be "re-purposed." Re-purposing is the conversion of existing linear video for use in interactive courseware.

b. The second and easiest means of integration is for the interactive instruction of trainees on an individual or private basis. This

would occur where there is only one trainee who requires the instruction, where the subject matter is such that different trainees learn at different rates, or where trainees may be required to start or complete their training at different levels. In such instances, interactive instruction would replace the classroom presentation and would allow the trainee to proceed without having to wait until there were enough candidates to begin the class. The interactive instruction delivery system would be set up in a location convenient to the trainee, and the courseware would be prescribed and scheduled by the training department.

c. The third, and also relatively easy, approach to integration of interactive instruction is a replacement for home study. Many shipyard training programs use home study guides with self-administered tests that allow trainees to learn on their own time. This method, however, is only marginally successful, due, possibly, to the many distractions found at home. It is suggested that interactive instruction delivery systems could be set up in readily accessible locations around the shipyard and that trainees could schedule themselves to use these systems instead of relying upon workbooks. Interactive instruction, if properly designed, will provide more effective and therefore faster learning, added control of the training process and, most important, documented evidence that the trainee has learned the subject matter.

d. The final recommended approach to integration of interactive instruction into the shipyard program is to use it in self-initiated instruction, such as courses to achieve advancement, cross-training for reassignment, or other shipyard-sponsored self-improvement courses. Included in this category are certification, qualification, and licensing programs that relate to the employee's trade; programs such as health/safety, management skills; and academics that enhance the employee's stature. This instruction would also use interactive instruction delivery systems located around the shipyard, but would be developed and managed by the training department.

In general, project investigators conclude that interactive instruction can be integrated into most existing shipyard training programs. In some cases, interactive instruction would replace existing conventional lessons. In other cases, it would be used to supplement conventional training. In all cases, if properly designed and implemented, it can be expected to produce more knowledgeable, better skilled craftsmen.

Section 9

DEVELOPMENT OF AN INTERACTIVE INSTRUCTION DEMONSTRATION

9.1 Need for a Demonstration of Interactive Instruction

The results of the shipyard survey indicate that most American shipyards, both private and naval, have a limited knowledge of interactive instruction, including its uses and its benefits. This limitation, however, is coupled with the shipyards' willingness to accept assistance either in the application of interactive instruction to their own trade training or as a demonstration of interactive instruction for general trade training.

Results of the shipyard survey also indicate that while there is some skepticism within the shipyards regarding the cost and effectiveness of interactive instruction, the majority of this concern is from those shipyards who indicated the least familiarity with interactive instruction.

Project investigators recommend that the National Shipbuilding Research Program (NSRP) pursue an effort to inform American shipyards of the significant training and cost benefits that could be derived by integrating interactive instruction Into their shipyard trade training programs. The effort would procure for NSRP, an interactive training system consisting of an authoring system (courseware development software), an appropriate license, and a complete delivery system (hardware). The authoring system would be designed to be used by shipyard instructor personnel with a minimal amount of computer programming knowledge. The delivery system would be commercial off-the-shelf hardware of proven availability, performance, and reliability.

The NSRP effort would develop interactive courseware for the instruction of two shipyard trade tasks; one task to be taught by instruction and simulation, and the other task to be taught by instruction and practice. The effort would then transport the authoring system, delivery system and interactive courseware consisting of two trade lessons to the Ship Production Symposium or other appropriate forum for demonstration to shipyard management and training personnel. In addition, the complete system would become available for NSRP to lend to various shipyards for their own on-site demonstrations of interactive instruction.

The NSRP demonstration would benefit the shipbuilding and ship repair industry by proving the existence of more effective, less costly, and more convenient alternatives to classroom instruction; and by proving that off-line practice of shipyard production tasks can improval overall productivity. The effort would demonstrate the ability of advanced training technologies to satisfy training needs common to all shipyards, large and small, construction and repair, private and naval. A corollary benefit would be the indication to vendors of the commercial potential for development of shipyard training materials using advanced-technology delivery media.

The final results of the NSRP demonstration would be (1) two lessons contained on interactive media (e.g., optical disc, hard drive, floppy disc, etc., including required duplication), and (2) the delivery system and authoring system on which the lessons were developed and administered. The courseware, delivery system, and authoring system would be the property of NSRP and would be used for continuing on-site demonstrations of the merits of interactive instruction for shipyard training.

9.2 Selection of Lessons for the Demonstration

During the survey of shipyards, training personnel were asked to suggest several skilled trade tasks for which lessons could be developed to demonstrate the benefits of interactive instruction. Of primary interest were tasks associated with the most frequently taught shipyard trades, particularly Shipfitter, Welder, Pipefitter, Painter, and Carpenter. The lessons were also selected based upon how well they satisfied the criteria for the application of interactive instruction as described in Table 5-3.

The following trade tasks were suggested by shipyard training personnel for use in the demonstration. It is recommended that two of these tasks be chosen for the demonstration prior to initiating its development, and that the tasks be selected based upon (1) how well they wil 1 permit the capabilities and advantages of interactive instruction to be demonstrated, (2) how easily shipyard management and training personnel can rel ate to the lessons being taught, and (3) how easy the interactive lessons are to produce (i.e., the availability of existing video and lesson plans vs. the production of all new video and new lesson plans.

9.2.1 Most Recommended Lessons

The following lessons are most recommended for the demonstration because they easily lend themselves to instruction by simulation and because they were were most frequently suggested for the demonstration by the shipyards.

a. WIRE FLAME SPRAY PROCESS - Wire flame spray is only one of several Thermal Spray Processes that could be "introduced" by interactive instruction. The demonstration would instruct all aspects of wire flame spray from fundamental theory through the inspection process. The instruction could also include Flame Arc and Electric Arc coating processes. SIDC has a request to produce linear video for the wire flame spray process, but has not yet begun to develop it. Bath Iron Works has produced a linear video that is available through its Transfer of Training Program. Both may be able to make this video available to NSRP for re-purposing or for reference purposes. Almost all yards are using or expect to use wire flame spray in the near future and they have many concerns regarding safety (e.g., fumes and burns) and quality assurance issues.

b. ARC DRAWN STUD WELDING - One recommended interactive lesson would teach procedural steps of arc drawn stud welding such as what equipment to select, how to obtain and check it, removal of flammables (clear the area), inform ship's force, set-up of

equipment, shoot and test welds, dismantle, leave the area, return equipment, and complete paperwork. Arc drawn stud welding will be increasing in use as its technology advances *(such* as dual-gun power sources).

c. PLASMA ARC CUTTING AND GOUGING - This process involves the use of a high-velocity jet of ionized gas to "blow away" molten metal. Equipment may be portable or stationary. There are many different uses for plasma arc cutting and many different types of equipment. Some equipment is very complicated to set-up and operate, but little guidance is provided by the equipment manufacturers. The operator requires a knowledge of plasma cutting fundamentals, procedures, equipment operation, and safety precautions before any "hands-on" skil1 training can begin. Several yards considered this "introduction" a good application of interactive instruction.

d. MECHANICAL FLANGE JOINT and/or UNION JOINT MAKE-UP - Naval shipyards are having problems with O-ring unions and high-pressure gasket joints as a result of deficiencies in installation, torquing, and inspection. Problems associated with hanger identification, material selection, and installation also are widespread. It is believed by at least one of the yards, that much could be accomplished through the use of interactive instruction to remedy these deficiencies. Additionally, interactive instruction could be used to ensure (and document) that NAVSEA instructions for joint make-up are known and understood.

e. RIGGING - Rigging involves the preparation of ship parts for movement by material handling equipment. It includes the movement of materials from smal1 piece parts to complete ship units. Considerations must include shipyard material handling capabilities, structural integrity of objects to be moved, required temporary and permanent reinforcement, pick points for lifts, and procedures for turnover. The rigging process itself varies from the simple attachment of crane hooks to lifting pads using shackles, wire rope, or chain; to the attachment of multiple cranes through beams *or* lift rigs. The safety of personnel and avoidance of damage are critical factors in rigging.

Linear video is in use *by* some yards to teach rigging. The effectiveness of this training, it is believed, could be improved through the use of interactive instruction that provides simulation and decision making opportunities. In addition, interactive instruction could be used to verify the competence of riggers prior to their assignment.

f. MATERIAL HANDLING EQUIpMENT OPERATION and/or MAINTENANCE - An interactive lesson on the use of material handling equipment such as conveyors, cranes and hoists, industrial vehicles, and containers could be designed for training material handling equipment operators, or as an orientation course for all trades that work with material handling equipment. The objective of the lesson would determine the

content and detail of the lesson, and whether or not simulation would be used.

A "conveyor lesson" might include conveyor design, selection, assembly, maintenance, disassembly, and precautions. A "crane lesson" might include operation and/or maintenance of bridge cranes, jib cranes, gantry cranes, and mobile cranes. An "industrial vehicle lesson" might include the application, operation, and/or maintenance of various types of fork lift trucks, crawlers, rollers, rail$_{waY}$ trucks, skids, etc. A "container lesson" might include the application and use of various types of containers such as boxes, barrels, drums, and pallets.

While there is some commercial interactive courseware available on this subject, individuals that have reviewed it have determined that it is too limited in scope for shipyard training applications. Linear video also exists for this subject, but primarily addresses only the safety aspects of material handling. One linear video addresses decision making by crane operators such as the route of travel and communications.

9. STAGE AND SCAFFOLD BUILDING - This trade builds and removes temporary or movable structures to support workers, equipment, and materials during the shipbuilding or repair process. The trade has an enormous responsibility for safety and the efficiency with which staging and scaffolding is used has a major impact on overall productivity. Workers interface with a large variety of systems such as scaffolds, staging, platforms, dock arms, chain towers, baskets, etc; and they are required to know assembly, disassembly, and relocation procedures for each of these systems. Interactive instruction is particularly well suited to training this trade because of its animation and trainee response capabilities. With interactive instruction it is possible to verify (and document) the competency of each worker prior to assignment.

Stage and scaffold assembly linear videos exist, but are limited in scope and do not verify that the subject matter is learned.

9.2.2 Less Recommended Lessons

The following lessons are also recommended for the demonstration because they easily lend themselves to instruction by practice and because they were suggested for the demonstration by the shipyards.

a. FLUOROCARBON and/or NITROGEN HANDLING PROCEDURES - Fluorocarbon (Freon) handling in shipyards is very hazardous and requires special training and qualification/re-qualification. Procedures are precise and critical, and the design of equipment is often complex and non-standard. Safety precautions and emergency procedures are essential.

Liquid nitrogen conversion equipment is used by some yards. Its design is usually vendor-unique and requires special procedures and precautions. Vendor participation in the use of this equipment varies extensively, so a shipyard must be capable of total operation maintenance, and control. Interactive instruction could provide the necessary.

General safety precautions for handling nitrogen and related equipment during different evolutions as well as procedures for tank operations, interpretation of manuals, and properties of nitrogen all could be taught by interactive instruction.

b. SHIP'S NOMENCLATURE - An interactive lesson to be administered to all new employees whose work is associated with ships might include terminology, nomenclature, and systems of identifying ship areas and components. The lesson could include a glossary of terms used in planning, scheduling, engineering, and production. One shipyard is in the process of developing a computer-based training program along this line that it would administer to its new employees and that could be used as an information aid to existing employees. This program is currently limited and is intended only for demonstration purposes. Linear video already exists on this subject, but interactive instruction would provide assurance that the subject matter is retained.

It was also suggested that interactive instruction could be used to teach a literacy course that specifically addresses ship, shipyard, and shipbuilding/ship repair terminology and nomenclature. This is absent from all commercial interactive literacy courses.

c. FIBER-OPTICS INSTALLATION - Interactive instruction could demonstrate a lesson on fiber-optics fundamentals, precautions, how to run cables, hook-up cables, and test cables. These are relatively new processes with many new procedures and precautions, but they may be applicable only to yards with Navy contracts.

d. RIP-OUT AND RE-ENTRY CONTROL - Much in the way of teaching procedures, checks, and documentation during rip-out and re-entry of shipboard piping systems (bagging, tagging, and shipping) could be achieved through interactive instruction. There are many problems in the yards due to complicated and inconsistent rip-out and re-entry requirements.

e. SYSTEM INSPECTION AND GROOMING - Much pipefitting work must be re-done because pipefitters do not know what inspectors "look for." Interactive instruction could be used to instill (a mental checklist) the attributes of good inspection and grooming.

f. OPERATING CREW TRAINING - An interactive instruction lesson would provide procedural guidance and simulator operation for "first-time" operation of shipboard consoles by shipyard personnel. This could include casualty control and weapons system tests as well as ship

system "light-off" and testing. Interactive simulation would provide the operating crew with the opportunity to practice procedures and contingencies prior to operating the actual equipment.

g. FUEL LOADING - Interactive instruction could be used to familiarize personnel with the procedures and special precautions involved in the "first-time" loading of ship's fuel, jet fuel, other potentially hazardous fluids or gases, and possibly weapons.

h. FLAME CUTTER BASIC TRAINING - Use as the initial (introductory) part of the existing Flame Cutter Course to teach flame cutter responsibilities, required equipment, hook-up procedures, operations involved, and leak test (including procedures, safety practices, fire prevention, piercing holes, etc.). Linear video is currently available, but the instructor has no way of knowing what information the trainee has retained.

i. HYDRAULICS - Trade theory on basic hydraulic principles and how they are used in shipboard situations. Interactive courseware on basic hydraulics is available commercially and is given by at least one yard to many of its shops and its public works department during initial training.

9.2.3 Other Recommended Lessons

The following additional lessons were suggested for the demonstration by shipyards and should be considered if none of the others are used.

a. RESPIRATORS - A lesson introducing respirator use and describing all types of respirators encountered in the shipyard.

b. REMOVAL OF POTENTIALLY CONTAMINATED PAINTS - A lesson describing the hazards, methods, and equipment for the removal of potentially contaminated paints, coatings, and other materials.

c. LEAD AND MERCURY HANDLING - A lesson describing lead and mercury handling procedures and precautions as they apply to shipyard use.

d. WETTED CARBON STEEL PIPING - Instruction of special precautions/ techniques in the handling of wetted carbon steel piping and PPC.

e. BLASTING - Interactive instruction of blast grit hazards to be administered to all trades associated with blasting.

f. NON-DESTRUCTIVE TESTING (NDT) - Interactive instruction of X-ray hazards to be administered to all trades associated with NDT.

g. NON-NUCLEAR TEST EQUIPMENT - General orientation and familiarization on the identification, selection, and use of non-nuclear test equipment as an introduction lesson for trades that will use this equipment.

h. GENERATOR OPERATION - Interactive instruction of the local operation of generators, pumps, and other motor-systems prior to and following shipboard installation.

i. VALVES,TUBES, AND FITTINGS - Introduction, theory, nomenclature, procedures, precautions, etc. specific to valves, tubes and fittings used in ships.

j. SPECIAL HULL TREATMENT - A lesson introducing hull treatment processes, and describing theory, precautions, and surface preparation.

k. TURRET LATHE OPERATION - A lesson to introduce turret lathe operation, including terminology, procedures, precautions, etc.

1. BURNING MACHINES - A lesson to introduce burning machine operation, including terminology, procedures, precautions, etc.

m. PROPERTIES OF COLOR - A lesson describing the fundamentals of color perception and properties of color for shipyard painters.

9.3 Selection of a Technology for the Demonstration

There are currently two different technologies available for the demonstration of interactive instruction. The first is "analog motion video," currently provided either by VHS video tape or interactive videodisc (IVD). The second is "digital motion video," currently provided either by compact disc-interactive (CD-I) or digital video interactive (DVI). All provide the necessary ingredients for an interactive instruction presentation such as text, graphics, bitmaps, still and motion video, audio, and user interface. The control and operation of the presentation, however, varies between these technologies. For example, VHS and IVD text, graphics and bitmaps are "overlaid" on the video. CD-I and DVI text, graphics and bitmaps are "integrated" into the video. These differences can be obvious to the user.

9.3.1 VHS Video Tape

The least expensive technology, but also the least powerful, is "randomly accessible" VHS video tape. These systems use a variety of schemes for accessing standard VHS tapes, the most common of which is modifying the tape for synchronization with computer software. Prudent design of the video sequences and techniques that mask search-time significantly improve this technology's effectiveness; but there are severe limitations of VHS such as slow speed, noisy operation, and the amounts and kinds of interaction and branching that can be implemented. There are systems available that overcome some of these limitations, but at substantial cost.

It is concluded, based upon these limitations and other factors, that the use of interactive VHS video tape systems would not be appropriate for *a* demonstration of interactive instruction of shipyard trade training.

9.3.2 Compact Disc Interactive (CD-I)

Of the two digital motion video technologies currently offered by the interactive multimedia industry, CD-I shows the greater immediate promise for future training applications. CD-I systems are being promoted by Philips, Sony and Panasonic as a logical, eventual replacement for IVD. This is attributed to the low cost and high public acceptance of compact-disc technology, as well as the ability of compact discs to store immense amounts of information. The CD-I industry has also gone to great effort to standardize the compact disc format internationally. The greatest benefit to CD-I will be realized during large-volume production runs and from the other benefits of compact disc technology such as size, ruggedness, digital storage capacity, etc.

Because compact discs contain a great deal of information, they permit combinations of high quality audio (trade-offs UP to 16 channels), high quality computer text and graphic overlays, and high quality photographic images.

A major disadvantage of CD-I to the NSRP demonstration is CD-I's current lack of full motion, full screen video. Although this is expected to be overcome eventually, the reduction in size of the video screen and the number of frames per second renders the presentation somewhat less than effective for certain types of training. In fact, upon viewing CD-I video motion it was concluded that CD-I probably would not achieve the "simulation" goals of the NSRP demonstration.

Additionally, little was uncovered in the way of an authoring system for CD-I. OptImage Interactive Services and Script Systems, Inc. appear to be among the few currently developing CD-I authoring systems. The general consensus within the interactive multimedia industry is that "CD-I has just came out this year and, as with IVD, it will take a little while to develop good authoring systems for it. It is concluded that there is no authoring system currently available for CD-I that could be used by someone without substantila authoring system knowledge.

The cost of a CD-I delivery system is not much greater (currently about 20%) than an IVD system. However, for the NSRP demonstration, the decision would have to be made whether to use a compact disc "emulator" with its limitations or to have the courseware compact discs mastered. This decision could also significantly impact the cost of the demonstration.

In general, based upon observations and discussions with CD-I representatives, it is concluded that although CD-I technology may be the "wave of the future" (possibly 2 to 3 years), it will not at this time meet many of the goals and objectives of the NSRP demonstration. An emulator is a temporary hardware/software substitute for a compact disc.

9.3.3 Digital Video Interactive (DVI)

"DVI" means different things to different people. Several years ago David Mandala defined DVI as "a compression algorithm combined with a

digitizer that runs on a computer and compresses real time video files that can be stored, expanded and displayed. " The current review of DVI concludes that this is still a valid definition.

DVI technology does not appear to be standardized although Intel Corporation and IBM Corporation are producing and promoting delivery systems that are touted as "DVI." For the above reasons, the concept of DVI was reviewed rather than any delivery system in particular.

Some major advantages of DVI over the other technologies are evident.

a. Because it is digital, DVI courseware is expected to be delivered or transferred on a CD-RO14, SCSI tape or streaming tape. CD-ROM's are significantly less expensive than videodiscs when manufactured in large quantities, and they are also more "inviting" to use. Problems related to data storage capacity and the data rate of current CD-RON drives are expected to be overcome by compression of the video stream.

b. DVI video can be shot directly onto a hard drive. Prototyping, editing and changes can be made (and used) prior to pressing a CD-ROM. In fact, both authoring and training can be conducted directly from the hard drive without the need for a CD-ROM.

c. Digital motion video is immediately compatible with text, graphics, bitmap and audio signals in the computer. It is also anticipated that DVI will eventually be transportable over local-area networks.

Some major disadvantages of DVI are as follows:

a. DVI delivery systems and development systems are currently more expensive than other interactive technologies. A very large hard drive is required. There is also an initial high cost associated with CD-ROM production.

b. The effectiveness of DVI video compression techniques have not yet been fully proven. Some of the compression techniques significantly increase the complexity of authoring, and require trade-offs in the quality of the digital motion video.

c. A prepackaged DVI authoring system for use by non-programmers is not yet available.

d. The lack of standardization of DVI could be a major deterrent to its acceptance by the education and training community.

It is concluded that while DVI may show promise for future interactive instruction applications, the DVI technology is not yet sufficiently developed to demonstrate it to the shipbuilding and ship repair industry as a standard product. No DVI authoring system currently exists that accommodates the "ease of use" requirements of the NSRP demonstration. Not only would it be impossible to demonstrate authoring by non-programmer personnel, but the cost of developing the demonstration courseware could be

prohibitive. Re-purposing of existing video for use in the NSRp demonstration also could be difficult.

9.3.4 Interactive Videodisc (IVD)

The presentation of analog motion video by videodisc is currently the most popular method of interactive instruction. This is evident by the large amount of IVD courseware, authoring system, and delivery system manufacturers/vendors that exist within the interactive multimedia industry.

The popularity of IVD is attributed to its relatively low cost, easy availability, standardization, and a generally increasing confidence in IVD capabilities. Hundreds of courseware titles are currently available on IVD; and authoring systems are continuing to appear, to be improved, and to be expanded to accommodate both flexibility and ease of use.

The review of IVD technology focused primarily on the capabilities of authoring systems, improvements to delivery system hardware, and new techniques for presenting and evaluating interactive instruction. A major concern was the cost trade-off of these capabilities and improvements such that a good trade training demonstration could be produced within the NSRP budget. The following assumptions were made:

a. The authoring system, demonstration courseware, and delivery system will be purchased by NSRP. This courseware, authoring system, and delivery system will be used by NSRP to demonstrate the benefits of interactive instruction for training shipyard trade skills. The demonstration will be conducted initially in a symposium environment, and subsequently in various shipyard trade training environments.

b. The authoring system will be used to develop the courseware that will demonstrate the interactive instruction of two skilled trade tasks. The authoring system must also be sufficiently easy to use such that shipyard trade training personnel with no programming skills can author the courseware and can demonstrate its ease-of-authoring.

   Licensing requirements of the authoring system must accommodate its intended use which is the development of two courses to demonstrate interactive instruction, and the use of the system to perform the authoring demonstration.

c. NSRP will use the authoring system to develop the interactive courseware prior to the demonstration. This courseware will then be used at a symposium to demonstrate the advantages of interactive instruction such as self-paced learning, simulation and practice, reinforcement (reward and remediation), performance evaluation and tracking (testing and analysis), personnel and equipment safety, cost-reduction, instructional consistency, privacy, etc.

   Courseware for training the first of the two trade tasks will include instruction and a simulation application. Courseware for training the second task will include instruction and practice.

d. The delivery system will be used by NSRP both *to develop* the courseware and to demonstrate the interactive instruction o-f the trade tasks.

e. The intended use of the courseware for demonstration purposes will require only one "check" disc only. A need to press multiple optical discs is not anticipated.

It is concluded that if the IVD technology is selected for the demonstration of interactive instruction, it will be relatively easy both to obtain the appropriate authoring and delivery systems, and to develop the necessary courseware for use during the demonstration.

9.3.5 Recommended Technology for the Demonstration

It is the conclusion of this project that the best technology for demonstrating the benefits of interactive instruction for shipyard trade training and the ability of shipyards to author their own courseware, is the technology that has a proven record of reliability, effectiveness, and standardization; and that has been used by the education and training community for more than a decade. This technology is interactive videodisc (IVD). The conclusion is supported by the following:

a. The large variety of authoring *systems* for IVD that accommodate the requirements of the NSRP demonstration, particularly ease of use by non-programmers.

b. The greater likelihood that the developer of the demonstration courseware (two tasks) will be more familiar with IVD courseware, development systems, and delivery systems than with the other technologies.

c. The greater likelihood that shipyards or their training support organizations (such as academic institutions) may already have all or many of the components of IVD development and delivery systems.

d. The higher quality motion and full-screen video of IVD for use during the NSRP "simulation" demonstration.

e. The ability to perform the NSRp demonstration using a "check" optical disc and Development License. No need for a "final" optical disc or runtime license is envisioned.

f. The generally lower cost and larger variety of IVD delivery systems (basic hardware plus options).

g. The general ease and lower cost of producing and distributing IVD courseware packages (videodiscs and licenses) for use by the shipyards, following the NSRP demonstrations; the ease with which shipyards could obtain and operate their own IVD development and delivery systems.

h. The greater certainty with which IVD technology (authoring systems and delivery systems) can be recommended based upon availability, manufacturer/vendor support, reliability, ease-of-installation and operation, familiarity, proven effectiveness, etc.

i. The avai- ability of experienced video production and recording studios 1 including SIDC) for video and photographic "capture," transfer, narration, editing, etc. The ease with which re-purposed video can be incorporated into IVD.

j. The fact that this project has an immediate requirement to demonstrate an existing capability as soon as possible, points to the need for a "ready" technology. While it is acknowledged that CD-I and DVI may eventually replace IVD, it is also recognized that for a relatively lower start-up cost, IVD would do the most, within the next year or two, to demonstrate the benefits of interactive instruction and the ease of interactive courseware authoring by non-programmer personnel.

9.4 Selection of an Authoring System for the Demonstration

The project investigators' brief review of interactive authoring systems concludes that there are at least ten major factors to be considered when selecting an authoring system for shipyard trade training. These characteristics are, in no particular order, (1) ease of use by training department personnel with a minimum knowledge of desk-top, personal computers and no previous interactive courseware authoring experience; (2) adequate flexibility and "power" to permit the development of professional-appearing, comprehensive lessons; (3) the ability to support, as a minimum, interactive videodisc, graphic overlay, and touchscreen hardware, (4) ability to operate on a low-to-moderate cost, commercially available, desk-top personal computer standard, commercially available operating system, (5). nominal charac~eristics of the visual , video, and auditory presentation, (6) adequate capabilities of the courseware development program, (7) full capabilities of a trainee management and evaluation program, (8) low-to-moderate cost of the authoring system, its development tense and its runtime license, (9) adequate availability of the authoming system, and (10) appropriate vendor support including documentation, training, warranty, and service such as assistance, upgrades, etc.

Other factors also deserving consideration include the recommendations of current users regarding the reputation of the develover/vendor, reliability of the product, cooperation exhibited by the oper/vendor during the selection process, widespread use and popular of the product (will it still be "around" in the future), and the denmenter use of human factors engineering and learning theory in its design

All of the above issues are relevant, must to some extent, in the selection of an authoring system for NSRP emonstration of interactive instruction. Predominant, however, is ability of shipyard training personnel such as instructors and course deslopers to use the authoring

system without prior computer programming experience or undergoing extensive training. For this reason, one of the primary issues discussed during the shipyard visits was the capability of training personnel with regard to personal computer (PC) familiarity. Of all the shipyards visited, it was found that at least one member of the training staff (and in most cases many more) does have sufficient knowledge and experience with PC's and PC software to operate even the more "powerful" interactive authoring systems that are currently available.

The review of interactive authoring systems described in Section 4 revealed that many contemporary authoring systems can now be used by individuals with various levels of authoring experience. These systems permit an initial selection of "novice, "intermediate," or "experienced;" and then provide authoring system capabilities and a method of operation that best accommodate that experience.

In addition, the review of authoring systems also revealed that the more powerful authoring systems, those with greater flexibility, capabilities, . and professional presentation, are also more complicated to use. This is generally because of their requirement for selecting more options. The more simplistic authoring systems are more straightforward and easier to use, but at the sacrifice of power. Some authoring systems severely limit the choice of colors, fonts, formats, editing, and graphics capabilities, etc. The major differences among authoring systems, however, are the way the author must operate them. For example: Are the systems menu-driven or command-driven? Is flowcharting provided? What methods of integration, script development, answer analysis, and project management are provided? What is the availability of online help, glossaries, and databases? Most of these characteristics and their advantages/disadvantages are discussed in the documents listed in Section 2.5.3.

A major concern of this project with regard to recommending an authoring system for the demonstration is that any authoring system that is not sufficiently powerful will soon be out-grown by the user. For this reason, and because the survey of shipyards did reveal the existence of computer-knowl edgable personnel in their training departments, project investigators conclude that a more powerful authoring system, one with several levels of author experience, would be most appropriate for the demonstration of interactive instruction for shipyard trade training.

Project investigators therefore recommend that a further evaluation of authoring systems be performed with the assistance of a video production organization and several shipyard training personnel prior to the selection of a single authoring system. This evaluation should address whether the authoring system will adequately support the development of interactive courseware for the two lessons to be demonstrated, and whether shipyard training personnel will be able to use the authoring system by drawing upon their previous instructional design and PC experience.

The project investigators also suggest that, at a minimum, the following authoring systems be considered as candidates in this evaluation. These authoring systems generally fall within the parameters previously stated

and all are within the cost range estimated for the NSRP demonstration.

a. AUTHOLOGY including SRM (Student Record Manager) from CEIT Systems (Computer Enhanced Interactive Technology), Suite 200, 4800 Great American Parkway, Santa Clara, CA 95954. Contact Tony Vega at 408-986-1101.

b. COURSEPLUS from Softwords, 4252 Commerce Circle, Victoria, British Columbia, Canada V8Z 4M2. Contact Rosario Passos at 604-727-6522.

c. ICONAUTHOR from AimTech (Advanced Interactive Media), 20 Trafalgar Square, Nashua, NH 03063-1973. Contact Meredith Harshaw at 603-883-0220 or 800-289-2884.

d. IMAGES from CKI (Computer Knowledge International), Suite 210/212, Liberty Commons, 1300 Wethervane Lane, Akron, OH 44313. Contact Brian Martucci at 216-836-1866.

e. QUEST from Allen Communication, 140 Lakeside Plaza II, 5225 Wiley Post Way, Salt Lake City, UT 84116. Contact Steve Allen at 801-537-7800.

f. SAM from TAG (Technology Applications Group), Suite 265, 1700 West Big Beaver Road, Troy, MI 48048. Contact Kathy Fasczewski at 313-649-4477.

g. SUMMIT from Conceptual Systems, Inc., Suite 1420, 1010 Wayne Avenue, Silver Spring, MD 20910. Contact Steven Okonski at 301-589-1800.

h. SYLLABUS from TBC (Teaching By Computer), 25vRegent Circle, Brookline, MA 02146. Contact Thomas Nakopoulou at 617-734-2128.

i. TBTAUTHOR from HyperGraphics, 308 North Carroll Boulevard, Denton, TX 76201. Contact HyperGraphics at 817-565-0004 or 800-438-6537.

j. TENCORE PRODUCER from Computer Teaching Corporation, 1713 South State Street, Champaign, IL 61820. Contact David Stone at 217-352-6363.

k. TIE from Global Systems Technology, Inc., 1800 Woodfield Drive, Savoy, IL 61874-9505. Contact Daniel Lorenc at 217-352-1165.

l. TRAINER 4000 from CSR (Computer Systems Research, Inc.,) Avon Park South, P.O. Box 45, Avon, CT 06001. Contact Ben Graves at 203-678-1212.

9.5 Purchase of Components for the Demonstration

The capabilities and availability of interactive instruction delivery systems continue to increase while their cost is gradually decreasing. In addition, authoring systems and commercially available courseware now operate on a wider variety of delivery systems and components than in the past. The cost of an interactive instruction delivery system that will operate the majority of commercial courseware and authoring systems suited to shipyard trade training is approximately seven thousand dollars ($7,000). This equipment can usually be purchased as a complete (and tested) system from the authoring system vendor, or as individual components directly from the manufacturer or distributor. Add to the delivery system a reasonably priced but suitable authoring system, and the cost of a complete interactive instruction development system is approximately ten thousand dollars ($10,000).

Table 9-1 lists some of the the more popular components used in present-day interactive videodisc (IVD) delivery systems. Prior to selecting components, however, the purchaser should consult with the authoring system or courseware developer/vendor to verify that the software will properly run on the equipment. Note that delivery systems are available either as "individual" components or are "pre-packaged."

Some costs in addition to the author's time are incurred during the development of interactive courseware. These costs include shooting and editing the video portion of the interactive instruction; the cost of a check disc, master disc, and production discs; and the cost of licenses both to author the lesson and to distribute or administer the lesson. Obviously the cost of video production will vary extensively depending upon the amount and quality of video that is required. It is the general consensus among successful users of interactive instruction that a large part, if not all of, the interactive display segments should be presented as video, and that aside from minimal text, graphics, and possibly animation, the function of the computer should be dedicated to controlling the instruction. The type of video presentation that is selected for the interactive lesson, whether it is a documentary of the actual event, a didactic presentation by a narrator or commentator, a dramatic presentation, or animated graphics, will affect the cost of the video production significantly. Simple "act-out" or demonstration treatments are often much less costly than full productions, but they may appear *so* unprofessional as to be distracting or not credible.

The figure generally used for estimating the cost of high quality video production is between two and three thousand dollars ($2,000 - $3,000) per minute of edited final video. This effort results in a l-inch or 3/4-inch master video tape from which a check disc, and subsequently the master disc, are manufactured. Tape format and timing specifications are available from the disc manufacturer. Certified recording centers perform the complete editing and disc mastering process. The cost of obtaining a check disc from a master tape is nominal, usually less than one hundred dollars ($100). However, check discs are intended only for use during courseware authoring and are not suitable for training purposes. The cost of a master disc from

TABLE 9-1. SOME POPULAR IVD DELIVERY SYSTEM COMPONENTS

Individual Components - Select one in each group*	Estimated Price
COMPUTER	
IBM PC/XT/AT or IBM compatible	Less than $2,000
- 80286 (12 MHz) or 80386 (16 MHz) microprocessor	
- 40 Meg or more hard drive	
- 1 Meg or more RAM	
- 1 or more floppy drives (1.44" and/or 1.2")	
- serial/parallel/mouse ports and expansion slots	
- keyboard	
IBM PS/2 Models	Less than $3,000
MacIntosh IIx, IIcx or SE Models with Apple monitor	On request
COLOR MONITOR - 14" monitor, 640 X 480 minimum	
IBM 8515	$ 800
Mitsubishi AUM 1381	$ 600
NEC Multisync 3D	$ 800
Sony CDP 1302	$ 800
Zenith ZCM 1492 Flatscreen	$ 700
Sony Trinitron	On request
TOUCHSCREEN	
Electrographics 13" SAW (installed)	$ 900
MicroTouch 13" (installed)	$ 900
VIDEO INTERFACE BOARDS	
Microkey Mark 10	$1,300
M-Motion Video Adapter with InfoWindow Emulation	$2,100
Sony 3081 VGA with InfoWindow Emulation	$2,000
Video Logic DVA 4000	$2,600
Video Windows VGA	$1,900
Visage 1910 VGA with InfoWindow Emulation	$2,000
VIDEODISC PLAYER	
Pioneer LD-V4200	$1,000
Pioneer LD-V6000A	$1,900
Pioneer LD-V8000	$2,200
Sony LDP-1450	$ 800
Sony LDP-1550	$1,500
Sony LDP-2000	$2 500
MISCELLANEOUS (many brands available)	Varies
mouse, CD player, digital audio, audio/speech synthesizer	
trackball, tape drive, digital video, digitizer	
lightpen, printer, audio amplifier, scanner	

* Before selection, make sure the component(s) will support your courseware, authoring system, and training requirements.

TABLE 9-1. SOME POPULAR IVD DELIVERY SYSTEM COMPONENTS (Cont.)

Pre-Packaged Components - Select a whole group*	Estimated Price
IBM M-Motion - IBM PS/2 Model 50 (1 Meg RAM, 40 Meg) - Zenith ZCM 1492 Flatscreen monitor - M-Motion video adapter - Pioneer LDV 4200 videodisc player	$6,000
SonyView VIW-5000 - Integrated Computer and Videodisc Player (640 K RAM, 40 Meg, 1 floppy drive) - NEC Multisync 3D monitor	$6,800
Sony VGA - IBM Compatible AT (1 Meg RAM, 40 Meg, 2 floppy drives) - NEC Multisync 3D monitor - Sony video interface SMI 3081 VGA - Sony LDP 1450 videodisc player	$5,100
VAL EGA - IBM Compatible AT (1 Meg RAM, 40 Meg, 2 floppy drives) - Mitsubishi AUM 1381 monitor - Microkey Mark 10 video interface - Sony LDP 1450 videodisc player	$4,200
Video Logic - IBM Compatible AT (1 Meg RAM, 40 Meg, 2 floppy drives) - NEC Multisync 3D monitor - Video Logic DVA 4000 video interface - Sony LDP 1450 videodisc player	$5,700
Visage VGA - IBM Compatible AT (1 Meg RAM, 40 Meg, 2 floppy drives) - Mitsubishi AUM 1381 monitor - Visage V:link 1910 VGA video interface - Pioneer LDV 4200 videodisc player	$5,100

* Before selection, make sure the component(s) will support your courseware, authoring system, and training requirements.

which training discs are pressed is approximately two thousand dollars ($2,000.) Each subsequently pressed training disc is then approximately twenty-five dollars ($25).

The cost of the video portion of interactive courseware is predominantly a one-time cost for video production. This cost can be reduced by thorough preparation and documentation prior to shouing the video, and by the use of experienced professionals and modern facilities during both the shooting and editing.

Re-purposing, the use c visting liner video training tapes to provide the video for interactive aware, has many drawbacks. Each case should be weighed on an indivici. asis because great cost savings can be realized, but extreme care II taken not to allow the existence of re-purposed video to dictate t h e the interactive course.

9.6 Estimated Cost of the Demonstration.

Table 9-2 provides a rough estimate of the cost for contractor development and administration of the demonstration of interactiv, instruction for shipyard trade training. This pricing is based upon estimates for contractor involvement in the selection and purchase of components, development of two interactive lessons, and assistance in demonstrating the use of authoring systems at a symposium or other forum. Factors affecting the cost include:

a. The authoring system that is used for the demonstration
   cost of purchasing the authoring system
   - license for development and runtime (if required)

b. Courseware requirements
   amount of video/graphics/text
   amount and type of interaction
   amount and type of remediation/reward
   - depth of brancning
   - length of the lesson

c. Video production
   whether provided by NSRP or performed by the contractor
   amount of video re-purposed from existing sources, if any

d. Narration and music
   whether Drovided by NSRP or performed by the contractor
   amount o; audio "re-purposed" from existing sources, if any

e. Final disc pressing, if IVD system used and if required for the demo

f. Extent of contractor participation in the demonstration

TABLE 9-2. COST OF CONTRACTOR INVOLVEMENT IN THE DEMONSTRATION

Items	Estimated Cost (in $) Depending Upon the Factors Described
Purchase authoring system and license	3K - 5K
Purchase delivery system	5K - 10K
TASK 1 courseware development	20K - 40K
TASK 2 courseware development	30K - 50K
Participate in demonstration	5K - 10K
TOTAL	63K - 115K

Section 10

PROJECT CONCLUSIONS AND RECOMMENDATIONS

The project described in this report was performed for the National Shipbuilding Research program (NSRP) for the purpose of investigating the feasibility of using interactive instruction to train trade skills in American shipyards. The term "interactive multimedia," generally associated with the overall computerized media industry, encompasses interactive instruction as one of its prominent applications.

The conclusions and recommendations presented in this report are based upon (1) a review of interactive instructional technologies that included commercially-available and shipyard-developed interactive courseware, authoring systems, and delivery systems; and (2) a survey of American shipyards to determine their requirements for skilled trade training including the ability of shipyard training personnel to develop their own interactive courseware.

At least 47 independent studies have shown that interactive instruction, when it is appropriately applied, designed, and administered is an effective method of training and education. Interactive instruction has been in use by many major industries and professions for over a decade and, as its cost decreases and availability increases, shows great promise for future applications in many other industries. Interactive instruction provides many benefits, such as reduced learning time, increased retention, high motivation, trainee performance recording and analysis, instructional consistency, trainee privacy, self-paced learning, and to increase personnel safety and decreased equipment damage.

The project investigators specifically addressed one-to-one (trainee to computer) interactive instruction which consists of a "delivery system" (desk-top computer, monitor, interaction device such as a touchscreen, mouse, or keyboard; and media storage device such as a videodisc, compact disc, or hard drive); its interactive courseware" which contains the computer program and documentation to administer the lesson; and an "authoring system," which is used to develop or modify the interactive courseware. A detailed description of interactive instruction components was presented in Section 2.1.

A shipyard survey was conducted, consisting of a questionnaire sent to 271 American private and naval shipyards, and a visit by project investigators to five selected shipyards. 78% of all questionnaires were returned from shipyards that were contacted by telephone. 10% were returned by the others. The selection of shipyards to be visited was based upon (1) their existing trade training activities, (2) their experience with or knowledge of interactive instruction for trade training, and (3) their willingness to participate in the project. The shipyards, in the order visited, were National Steel and Shipbuilding Company, San Diego, CA; the Portsmouth Naval Shipyard, Portsmouth, NH; Bath Iron Works, Bath, ME; Newport News Shipbuilding Company, Newport News, VA; and the Norfolk Naval

Shipyard, Portsmouth, VA. Detailed results of the shipyard survey were discussed in Sections 7 and 8.

A major finding of the shipyard survey is that most shipyards are not sufficiently familiar with interactive instruction to fully appreciate its potential cost savings and training benefits. However, most of the yards indicated a willingness to participate in demonstrations of interactive instruction and possibly receive assistance in its implementation.

There is currently available from commercial training course developers a substantial amount of interactive courseware on subjects relating to industry trades and practices. The products these developers offer are described in their own and independently published catalogs. Courseware developers provide training packages complete with hardware, software, and documentation; as well as individual lessons for specially-developed programs. Some lessons are general in nature, such as "piping and valve maintenance" or "electrical controls and circuits" that apply to many industries. Others may be task-specific such as "gate valve repair" or "circuit breaker testing" that apply to few industries. One disadvantage of commercially-available courseware is that, its material usually either omits specific shipbuilding related tasks or includes tasks that are not practiced in shipbuilding. This has caused shipyard training departments that have reviewed interactive courseware. to conclude that they would be paying for incomplete or unnecessary subJect matter, and that the training would therefore be inefficient.

Most developers of interactive courseware will, for a fee, modify or tailor their courseware to accommodate special shipyard needs. The results could be well worth the additional cost, and shipyard training departments are encouraged to examine all commercial avenues prior to engaging in their own interactive courseware development. Table 3-1 provides a current list of commercially available interactive courseware and the directory or catalog in which it is found.

"cost," on the shipyard questionnaires, was the most frequently cited disadvantage of interactive instruction. Second, was the the shipyard's own lack of knowledge about interactive instruction. Based upon this finding, it is concluded that most shipyards are not aware of the continuously falling price of interactive delivery systems and the increasing simplicity of authoring systems for developing interactive courseware. This increasing simplicity could permit training department personnel to develop their own interactive courseware instead of relying upon the commercial alternative.

Many authoring systems are currently available that are suited to the shipyard trade training environment. Previously, authoring systems used to develop interactive courseware were of two general categories: (1) those that were easy to use with minimal experience but also relatively limited in their flexibility and capabilities, and (2) those that required special traininq and possibly some computer knowledge but that were extremely flexible and provided-many capabilities. In the past several years, through the use of icons, windows, pop-up/pop-down menus, promptlines, and text editors, authoring systems have significantly improved to close this gap.

Also, the use of personal computers (pC'S) has become widespread within shipyard training departments and training personnel are now better acquainted with their use. A significant advancement in authoring systems has been their ability to accommodate differences in authors' experience by providing multiple authoring levels such as "novice," "intermediate," and "advanced." This does much to encourage training organizations to adopt these systems, knowing that the systems can be operated by a broad spectrum of their personnel and that the personnel can grow to use the power of the systems.

Project personnel used the checklist presented in Appendix C to review existing authoring systems with regard to 80 desired characteristics and other selection criteria. The review which resulted in the selection of 12 candidate authoring systems for a demonstration of interactive instruction for shipyard trade training, were described in Section 4.

Most shipyard training personnel consider themselves sufficiently knowledgeable and experienced to perform the instructional design analysis and flowcharting required to develop interactive lessons. These same individuals, however, are somewhat less confident of their ability to program interactive courseware using an authoring system. This is probably due to their lack of familiarity with authoring systems, not a lack of experience with PC's and PC software. Training personnel in most shipyard training departments currently have access to PC'S and use them on a routine basis.

The development of interactive courseware by the shipyards themselves has, to date, been undertaken primarily for the purpose of demonstrating the characteristics and benefits of interactive instruction to shipyard management and its customers. Newport News Shipbuilding Company has installed an advanced technology classroom that permits the use of instructor controlled multimedia from a "smart" podium and individual trainee feedback by way of specially designed, desk-top keypads. Newport News has found the interactivity of the system to be rewarding in many aspects, particularly for documenting trainee performance and evaluating course content. Newport News is currently developing interactive courseware in support of its RADCON training.

Bath Iron Works is developing its own interactive courseware for the demonstration of an orientation .course and information retrieval system. The system is interactive and w1ll eventually integrate multimedia beyond its current use of graphics, bitmaps, and limited animation. Bath's courseware, if successful, will extend well beyond its present description of the DDG-51 AEGIS destroyer program.

No other development of interactive courseware or use of interactive authoring systems by shipyards was discovered during the survey.

Project investigators conclude that adequate tools and guidance do exist for shipyards either to purchase commercially-available courseware where suitable, or to pursue the development of their own interactive courseware using an authoring system and their own in-house instructional development

expertise. Guidance by interactive multimedia consulting firms is also available and is highly recommended especially during system selection and courseware development. Section 2.5 listed names, addresses, telephone, and FAX numbers of organizations, periodicals, and documents where these tools and this guidance can be obtained.

There are specific criteria for the application of interactive instruction that, when met, ensure that it is appropriate. These criteria were listed in Table 5-3. There are many skilled trade tasks being taught in shipyards that meet these criteria. Shipyard training personnel are able to understand and appreciate the value of interactive instruction for these applications, but they would be more confident in their ability to develop the courseware and integrate it into their program if they could first participate in its demonstration. Few shipyards have the resources available to investigate, on their own, the applications and benefits of interactive instruction.

It is specifically recommended that interactive instruction be integrated into shipyard trade training programs (1) wherever training is required on an individual basis, such as where only one trainee requires instruction; where trainees learn at different rates; and where trainees start or complete at different levels; (2) where interactive instruction can replace home study; (3) where such training can be used to heighten the effectiveness of lecture and other conventional methods; and (4) where self-initiated instruction is used to achieve advancement, cross-train for reassignment, or simply improve and expand one's own capabilities. The discussion in Section 8 indicated that interactive instruction can be integrated into most exis+tiong shipyard train-in-g programs with no adverse effect on the existing training process or training department personnel.

It is recommended that NSRP pursue the development of an interactive instruction demonstration to be presented to shipyard training personnel in a symposium setting and/or on-site in the shipyard training environment. The primary purpose of this demonstration will be to familiarize shipyard training personnel with the applications, benefits, and cost-effectiveness of interactive instruction. The NSRP effort will also demonstrate the ease of interactive courseware development by shipyard training personnel and the methods by which these interactive courses can be integrated into existing shipyard trade training programs.

The most frequently taught trades in both private and naval shipyards are Shipfitter, Welder, Pipefitter, Painter, and Carpenter. If the demonstration of interactive instruction is to be developed and exhibited to all shipyards, then the lesson should instruct a task performed by one or more of these trades. These and other less frequently taught trades were listed in Table 7-4.

Following discussions with shipyard training personnel regarding the most appropriate applications of interactive instruction, these groups suggested a total of 29 skilled trade tasks for which interactive lessons could be developed for the NSRP demonstration. Of these 29 tasks, the seven most recommended for the demonstration were the Wire Flame Spray Process, Arc

Drawn Stud Welding, Plasma Arc Cutting and Gouging, Mechanical Flange or Union Joint Make-Up, Rigging, Material Handling Equipment Operation and Maintenance, and Stage and Scaffold Building. These and other tasks also recommended for the demonstration were described in Section 9.2.

It is suggested that at least one of the demonstration lessons include simulation and that it be chosen from the "most recommended" group. The criteria for this selection should be (1) how well the task permits the capabilities and advantages of interactive instruction to be demonstrated; (2) how easily shipyard management and training personnel can relate to the lessons being taught; and (3) how easy the interactive lessons are to produce (i.e., the availability of existing video and lesson plans versus the production of all new video and lesson plans).

A review of interactive technologies currently on the market, particularly analog motion video and digital motion Video, resulted in the recommendation to use interactive videodisc (IVD) for the demonstration of interactive instruction for shipyard trade training. This recommendation is based upon the conclusion that compact disc interactive (CD-I) and digital video interactive (DVI), although possibly the "wave of the future," do not at this time meet many of the goals and objectives of the proposed NSRP demonstration. A review of these interactive instructional technologies and the rationale for selecting IVD for the demonstration were discussed in Section 9.3.

No single authoring system is recommended for use in the NSRP demonstration of interactive instruction for shipyard trade training. Instead the report lists 12 authoring systems that fall within the parameters for the shipyard training application and that are within the price range of the proposed NSRP demonstration. These authoring systems are AUTHOLOGY from Computer Enhanced Interactive Technology (CEIT) Systems, COURSEPLUS from Softwords, ICONAUTHOR from Advanced Interactive Media (AIMTECH), IMAGES from Computer Knowledge International (CKI), QUEST from Allen Communication, SAM from Technology Applications Group (TAG), SUMMIT from Conceptual Systems, Inc., SYLLABUS from Teaching By Computer (TBC), TBTAUTHOR from HyperGraphics, TENCORE from Computer Teaching Corporation, TIE from Global Systems Technology, and TRAINER 4000 from Computer Systems Research, Inc. (CSR). Addresses and telephone numbers of these companies were presented in Section 9.4.

It is recommended that a further evaluation of authoring systems be performed with the assistance of the Naval Sea Systems Command's Shipyard Instructional Design Center (SIDC), or other shipyard video production organization, along with several shipyard training personnel. This evaluation would address, specifically, whether the authoring system will adequately support the development of interactive courseware for the two lessons to be demonstrated, and whether shipyard training personnel will be able to use the authoring system to develop courseware by drawing upon their previous instructional design experience and familiarity with PC'S.

Delivery systems adequate for shipyard training sell for approximately $7,000 and are avail able either as individual components or are

pre-packaged. Commercially-available interactive courseware for industrial training varies in price depending upon the subject matter, length of lesson, and lesson quality. Many shipyard trade-related subjects retail for approximately $1,000 per lesson, of which multiple lessons may be required for a complete course. Authoring systems vary extensively in their power and ease of use. Authoring systems adequate for shipyard training sell for approximately $3,000. It is currently possible to obtain all the tools for an interactive instruction program for less than $10,000. A price breakdown of interactive instruction components was presented in Section 9.5.

This report recommends that NSRP fund the development of an interactive instruction demonstration that uses two lessons and an interactive authoring system to (1) demonstrate the benefits of interactive instruction for shipyard trade training, and (2) demonstrate the ability of shipyard training personnel to develop their own courseware. It has been shown over and over that only through hands-on experience can all of the capabilities and benefits of interactive instruction be expediently and effectively communicated to its potential users. A contract for NSRP to accomplish this objective is estimated to cost between $63,000 and $115,000, depending upon the requirements of the demonstration as outllned in Section 9.6.

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Appendix A

Questionnaire for Selected Private and Naval Shipyards

QUESTIONNAIRE COVER LETTER

(date)

(address)

Dear (name):

Ship Analytics, Incorporated has been tasked by the National Shipbuilding Research Program (NSRP) to provide guidance to the U.S. shipbuilding and ship repair industry on the use of computer-based interactive instruction for shipyard trades' training. NSRP is a cooperative effort of the Maritime Administration, U.S. Navy, the shipbuilding industry, and selected academic research institutions. It is dedicated to assisting the U.S. shipbuilding and ship repair industry in improving its productivity. The project is sponsored by the Education and Training panel (SP-g), Ship Production Committee of the Society of Naval Architects and Marine Engineers. Results of the project will be made available at no cost to all NSRP-member shipyards and to all organizations that provide information to the project.

Interactive instruction or "interactive multimedia" as it is often called evokes the active involvement of each trainee to direct the flow of his or her own computer controlled audio-visual instruction. Interactive instruction exchanges information with the trainee on a personal basis, processes the trainee's response to generate an appropriate reward or remediation, guides the trainee at his or her own pace, and measures, evaluates and documents the trainee's learning performance. Interactive instruction uses such systems as interactive videodisc (IVD), compact disc-read-only-memory (CD-ROM), compact disc-interactive (CD-I), and digital video interactive (WI) with touch-screens, mouse or keyboard controls. This type of equipment and the courseware that it uses is defined by the project as an "INTERACTIVE INSTRUCTION SYSTEM."

The goal of this project is to determine if shipyards are currently using interactive instruction for training, whether or not they have found it to be cost-effective, and if so what can be done by NSRP to further promote its use. In 1983, NSRP conducted a similar study to help shipyards improve their traditional training at the apprentice, mechanic and management levels. The current project is extending this help to include the use of interactive instruction. We are asking YOU to please complete the attached questionnaire and return it to us in the. enclosed envelope by February 15, 1991. Although the list of shipyard trades appears to be quite lengthy, we have attempted to include all types. Please address only those trades that are taught by your yard. If you have a catalog of courses that are offered by your yard, it might be easier to mark your catalo9 with the requested information and return it to us. Also, if you wish to discuss the project or YOU have any questions regarding the questionnaire, please feel free to cal1 me at 203-535-3092. Thank you very much for your help.

Sincerely,

Richard B. Cooper, Project Manager

For each of the following trades, please indicate by a checkmark ( ) whether it is taught as a training course by the shipyard, by a union organization, or by an academic institution; and whether the course uses traditional training methods and/or an INTERACTIVE INSTRUCTION SYSTEM as defined in the letter.

For each check placed in the right column, please complete a line on SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
1	Air Conditioning Equipment Mechanic	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
2	Automotive Mechanic	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
3	Blacksmith	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
4	Blaster	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
5	Boiler Plant Equipment Mechanic	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
6	Boilermaker	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
7	Carpenter	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
8	Chipper/Grinder	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *
9	Drafter	Shipyard	___	___ *
		Union	___	___ *
		Academic	___	___ *

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
10	Electric Power Controller	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
11	Electrical Equipment Repairer	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
12	Electrician, General, Marine or Maintenance	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
13	Electrician, Inside	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
14	Electrician, Outside	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
15	Electronic Equipment Inspector	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
16	Electronic Indicator Controls Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
17	Electronic Mechanic Fire Control	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
18	Electronics Integrated Systems Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
19	Electronics Measurer Equipment Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
20	Electronics Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
21	Electroplater	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
22	Equipment Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
23	Fabric Worker	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
24	Forger/Heat Treater	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
25	Heavy Metal Fabricator	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
26	Heavy Mobile Equipment Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
27	Heavy Mobile Equipment Repair Inspector	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
28	Industrial Electronics Control	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
29	Instrument Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
30	Insulation Worker	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
31	Insulator	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
32	Joiner	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
33	Lead Bonder	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
34	Loftsman	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
35	Machinist, General or Marine	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
36	Machinist, Inside	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
37	Machinist, Outside	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
38	Maintenance Machinist	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
39	Maintenence	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
40	Marine Machinery Mechanic	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
41	Melter	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___
42	Metals Inspector	Shipyard	___	*
		Union	___	___*
		Academic	___	___*
			___	___

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
43	Milling Worker	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
44	Millwright	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
45	Mold Loftsman	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
46	Molder	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
47	Optical Instrument Repairer	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
48	Ordinance Equipment Mechanic	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
49	Painter	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
50	Painter/Decorator	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
51	Patternmaker	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
52	Pipecoverer	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
53	Pipefitter	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
54	Pipehanger	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
55	Pipewelder	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
56	Plastic Fabricator	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
57	Plastic Molder	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
58	Production Machinery Mechanic	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
59	Rigger/Crane Operator	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
60	Sheetmetal Mechanic	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
61	Shipfitter	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
62	Shipwright	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
63	Tacker/Burner	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___
64	Toolmaker	Shipyard		*
		Union	___	___*
		Academic	___	___*
			___	___

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

Trade ID#	Trade Name	Taught by	Uses traditional training methods	Uses an INTERACTIVE INSTRUCTION SYSTEM
65	Toolroom Mechanic	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
66	Welder	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
67	Welding Equipment Repairer	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
68	Wharfbuilder	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
69	Wood and Plastic Installer	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
70	Woodcrafter	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
71	ALL TRADES - Safety and Health	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
72	ALL TRADES - Quality Assurance	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
73	ALL TRADES - Management and Personnel	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
74	ALL TRADES - Basic Academics and Technical Fundamentals	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*
75	OTHER	Shipyard	___	___*
		Union	___	___*
		Academic	___	___*

* IF THIS SPACE IS CHECKED, PLEASE COMPLETE A LINE ON SHEET 2.

How would you characterize your trades' training department's familiarity and knowledge of INTERACTIVE INSTRUCTION SYSTEMS and their use? Please check one

_ Completely unfamiliar

_ Mostly unfamiliar

_ Quite knowledgeable

_ Very knowledgeable

If NSRP were to assist your shipyard in implementing INTERACTIVE INSTRUCTION in your trades' training programs, you would...:. Please check one

_ Welcome the assistance and know exactly where to apply the INTERACTIVE INSTRUCTION.

_ Welcome the assistance but not know where to apply the INTERACTIVE INSTRUCTION.

_ Possibly welcome the assistance after the advantages and application of INTERACTION INSTRUCTION have been demonstrated.

_ Not be interested in NSRP'S assistance with INTERACTIVE INSTRUCTION for shipyard trades' training.

whatty few words best describe your personal opinion of "interaCtiVe multimedia" for general training and education purposes?

What few words best describe your personal opinion of "interactive multimedia" for training shipyard trade skills?

Please PRINT your name and telephone number below, and return SHEETS J and 2 in the self-addressed, stamped envelope. Thank you very much for your help.

(Name) (Title) , ( ) (Tel ephone Number)

Use the "Trade ID#" on Sheet 1 to identify each training course that uses an INTERACTIVE INSTRUCTION sYSTEMS then describe on that line the INTERACTIVE COURSEWARE that it uses. Please be sure to indicate the "Level" of the course as Apprentice, Mechanic/Journeyman, or Manager).

Trade ID# (from SHEET 1)	Shipyard Course Name	Course "Level"	INTERACTIVE COURSEWARE Title	INTERACTIVE COURSEWARE Developer/Vendor	Hours

YOU MAY USE THE BACK OF THE SHEETS IF MORE WRITING SPACE IS NEEDED.

Appendix B

Questionnaire for Other Private Shipyards

QUESTIONNAIRE COVER LETTER

(date)

(address)

Dear (name):

Ship Analytics, Incorporated has been tasked by the National Shipbuilding Research Program (NSRP) to provide guidance to the U.S. shipbuilding and ship repair industry on the use of computer-based INTERACTIVE INSTRUCTION for shipyard trades' training. NSRP is a cooperative effort of the Maritime Administration, U.S. Navy, the shipbuilding industry, and selected academic research institutions. It is dedicated to assisting the U.S. shipbuilding and ship repair industry in improving its productivity. The project is sponsored by the Education and Training Panel (SP-9), Ship productio$_n$ Committee of the Society of Naval Architects and Marine Engineers. Results of the project will pe made availaple at no cost to all NSRP-member shipyards and to all organizations that provide Information to the project.

Interactive instruction or "interactive multimedia" as it is often called evokes the active involvement of each trainee to direct the flow of his or her own computer controlled audio-visual instruction. Interactive instruction exchanges information with the trainee on a personal basis, processes the trainee's response *to* generate an appropriate reward or remediation, guides the trainee at his or her own pace, and measures, evaluates and documents the trainee's learning performance. Interactive instruction uses such systems as interactive videodisc (IVD), compact disc-read-only-memory (CD-ROM), compact disc-interactive (CD-I), and digital video interactive (DVI) with touch-screens, mouse or keyboard controls. This type of equipment and the courseware that it uses is defined by the project as an INTERACTIVE INSTRUCTION SYSTEM.

The goal of this project is to determine if shipyards are currently using interactive instruction for trades' training, whether or not they have found it to be cost-effective, and if so what can be done by NSRP to further promote its use within the industry. We are asking you to please complete the attached questionnaire and return it to ~s.in the enclosed envelope by February 25, 1991. We recognize that the training programs in your yard may not be extensive and may not use interactive instruction; however, we are trying to determine which yards do use interactive instruction, what successes they have had to date, and what problems they have encountered. If you wish to discuss the project *or* if you have any questions about our request, please call me at 203-535-3092. Thank you very much for your help.

Sincerely,

Richard B. Cooper, Project Manager

Please indicate by a checkmark ( ) in the left column which skilled trades are currently taught by your company. This includes any formal training such as OJT, apprenticeship, mechanic/journeyman, or trade manager training. In the right column, please indicate by a checkmark ( ) which of these trades, if any, are taught using an INTERACTIVE INSTRUCTION SYSTEM *as* defined in the letter.

For each check placed in the right column, please complete a line on SHEET 2.

Trade ID#	Trade Name	Taught by the Company	Training Uses an INTERACTIVE INSTRUCTION SYSTEM
1	Air Conditioning Equipment Mechanic		*
4	Blaster		*
6	Boilermaker		*
7	Carpenter		*
8	Chipper/Grinder		*
12	Electrician, General or Marine		*
13	Electrician, Inside		*
14	Electrician, Outside		*
20	Electronics Mechanic		*
21	Electroplate		*
31	Insulator		*
32	Joiner		*
34	Loftsman		*
35	Machinist, General or Marine		*
36	Machinist, Inside		*
37	Machinist, Outside		*
46	Molder		*
48	Ordinance Equipment Mechanic		*
49	Painter		*
51	Patternmaker		*
53	Pipefitter		*
55	Pipewelder		*
59	Rigger/Crane Operator		*
60	Sheetmetal Mechanic		*
61	Shipfitter		*
62	Shipwright		*
63	Tacker/Burner		*
66	Welder		*
71	ALL TRADES - Safety and Health		*
72	ALL TRADES - Quality Assurance		*
73	ALL TRADES - Management and Personnel		*
74	ALL TRADES - Basic/Fundamental Academics		*
75	(other) _____		*
76	(other) _____		*
77	(other) _____		*

* IF THIS SPACE IS CHECKED, PLEASE COMPLETEA LINE ON SHEET 2.

How would you characterize your trades' training department's familiarity and knowledge of INTERACTIVE INSTRUCTION SYSTEMS and their use? Please check one

__ Completely unfamiliar
__ Mostly unfamiliar
__ Quite knowledgable
__ Very knowledgable

If NSRP were to assist your shipyard in implementing INTERACTIVE INSTRUCTION in your trades' training programs, you would..... Please check one

__ Welcome the assistance and know exactly where to apply the INTERACTIVE INSTRUCTION.
__ Welcome the assistance but not know where to apply the INTERACTIVE INSTRUCTION.
__ Possibly welcome the assistance after the advantages and application of INTERACTION INSTRUCTION have been demonstrated.
__ Not be interested in NSRP's assistance with INTERACTIVE INSTRUCTION for shipyard trades'training.

What types of desk-top or Personal Computers do you use or have available for trades' training purposes?

What few words best describe your personal opinion of "interactive multimedia" for general training and education purposes?

What few words best describe your personal opinion of "interactive multimedia" for training shipyard trade skills?

Please PRINT your name, company and telephone number below, and return SHEETS 1 and 2 in the self-addressed, stamped envelope. Thank you very much for your help.

_____, _____, ( )_____
(Name) (Company) (Telephone Number)

Use the "Trade ID#" on Sheet 1 to identify each training course that uses an INTERACTIVE INSTRUCTION SYSTEM, then describe on that line the INTERACTIVE COURSEWARE that it uses. Please be sure to indicate the "Level" of the course as Apprentice, Mechanic/Journeyman, or Manager).

Trade ID# (from SHEET 1)	Shipyard Course Name	Course "Level"	INTERACTIVE COURSEWARE Title	INTERACTIVE COURSEWARE Developer/Vendor	Hours

YOU MAY USE THE BACK OF THE SHEETS IF MORE WRITING SPACE IS NEEDED.

Appendix C

Authoring System Selection Checklist

Date of review: ___/___/___

AUTHORING SYSTEM CHECKLIST

Title: _____ Vendor/Developer: _____

Version: _____ Contact: _____

Score each of the categories indicated, according to the following criteria:

CAPABILITY score
1 = no capabilities exist
2 = MAJOR capabilities are missing
3 = MINOR capabilities are missing
4 = all capabilities exist

COMPLEXITY score
1 = extensive computer programmer knowledge required
2 = some computer programmer knowledge required
3 = basic PC user knowledge required
4 = no prior PC user knowledge required

QUALITY score
1 = Appears/operates archaically, too rudimentary, confused
2 = Appears/operates somewhat awkwardly, elementary
3 = Appears/operates state-of-the-art, professional, adult
4 = Appears/operates extremely advanced, highly professional

GENERAL score
1 = poor, unacceptable
2 = worse than average, marginally acceptable
3 = better than average
4 = excellent, preferred

Hardware Environment

a. Operating system required - PC or MS-DOS, Apple/Mac, Unix, etc. (PC or MS-DOS is mandatory, Apple/Mac is desired)

CAPABILITY ___

b. Graphics modes, memory and storage requirements - CGA/EGA/VGA, RAM, etc. (minimal requirements are desired)

GENERAL ___

c. Support of peripheral devices - VCR, videodisc player, CD-ROM, CD-Audio, printer, etc. (videodisc player is mandatory)

GENERAL ___

d. Support of interactive devices - touch-screen, mouse, keyboard, joystick, track-ball, light pen, etc. (touch-screen is mandatory)

GENERAL ___

Visual Presentation Environment

a. Display capabilities - text, graphics, video, bitmaps, animation, simulation, multiple screens/multiple windows, etc. (text, graphics and video is mandatory)

CAPABILITY ___

b. Text characteristics - variety of fonts, colors, highlights, case, characters, symbols, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

c. Text editing capabilities - creation, cut/paste, globals, spelling check, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

d. Variety of graphics designs - shapes, sizes, locations, colors, shading, dimensions, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

e. Graphics capabilities - methods of creating, changing, implementing, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

Video Presentation Environment

a. Variety of video operating characteristics - play, freeze, fast/slow, fade, zoom, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

Auditory Presentation Environment

a. Variety of auditory generators - computer, analog on video, analog on tape, digitized, CD-Audio, etc. (analog on video is mandatory)

CAPABILITY ___ QUALITY ___ GENERAL ___

b. Control and implementation

CAPABILITY ___ QUALITY ___ GENERAL ___

c. Expanded capabilities - voice recognition, synthesized speech, etc.

CAPABILITY ___ QUALITY ___ GENERAL ___

Courseware Development Environment

a. Type of system is easy to understand and use - menu, command, icons, pull-downs, windows, key words, etc.

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

b. Ease of lesson design - sequence diagramming, tracking lesson development, etc.

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

c. Ease of screen design - initial composition and editing of all screens

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

d. Ease of chain design - branching or sequencing by condition time and direction

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

e. Availability of aids - help screens, prompts, tutorial, examples, etc.

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

Management and Student Evaluation Environment

a. Testing capabilities - true/false, multiple choice, exact match, short answer, etc.

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

b. Answer analysis

CAPABILITY ___ COMPLEXITY ___ QUALITY ___ GENERAL ___

c. Performance recording and reporting - results and history of of answer analysis

CAPABILITY COMPLEXITY QUALITY GENERAL

d. Security provisions

CAPABILITY COMPLEXITY QUALITY GENERAL

Cost Environment

a. Cost of courseware development - authoring system, development license, development hardware, personnel requirements, support requirements. duration, etc.

GENERAL

b. Cost of presentation - runtime license, presentation hardware, personnel requirements, support requirements, etc. (include only costs unique to the authoring system, not costs attributed to instruction in general)

GENERAL

c. Hidden costs - maintenance, warranty, upgrades, retraining, etc.

GENERAL

Vendor Support Environment

a. Vendor-provided training - site, availability, additional cost, etc.

CAPABILITY GENERAL

b. Documentation - users manuals, system guides, reference manuals, etc.

CAPABILITY GENERAL

b. Vendor assistance - follow-up, telephone assistar aditional cost, etc.

CAPABILITY GENERAL

c. Vendor warranties and upgrades - coverage, additional cost, etc.

CAPABILITY GENERAL

Other Factors Relevant to the Proposed Application

a. Trade-off of "power" and flexibility vs. ease-of-use - as determined from the demo review and independent users

GENERAL ___

b. Developer/vendor cooperation - as determined from initial "demo" contacts

GENERAL ___

c. Product usage, popularity, support and reputation - from independent sources

GENERAL ___

d. Developer-demonstrated knowledge of interactive instruction in demo

GENERAL ___

e. Developer-demonstrated knowledge of human factors engineering in demo

GENERAL ___

f. STRONGEST feature, characteristic or capability of the product with regard to the proposed application:

g. WEAKEST feature, characteristic or capability of the product with regard to the proposed application:

QUESTIONS FOR DEVELOPER/VENDOR:

Evaluator: _____

Additional copies of this report can be obtained from the National Shipbuilding Research Program Coordinator of the Bibliography of Publications and Microfiche Index. You can call or write to the address or phone number listed below.

NSRP (hordinator
The University of Michigan
Transportation Reseamh Institute
Marine Systems Division
2901 Baxter Rd.
Ann Arbor, MI 48109-2150
Phone: (313) 763-2465
Fax (313) 936-1081