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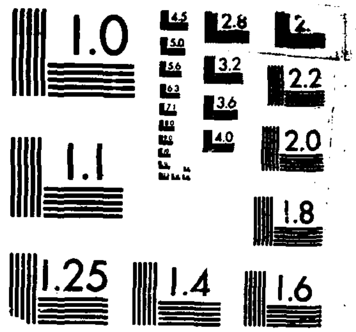

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THESIS

NAVAL COMPUTER-BASED INSTRUCTION: COST,
IMPLEMENTATION AND EFFECTIVENESS ISSUES

by

David W. Coleman

March 1988

Thesis Advisor: Barry A. Frew

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Naval Computer-Based Instruction: Cost, Implementation and Effectiveness Issues

by

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ABSTRACT

This thesis examines Computer-Based Instruction (CBI) in the Navy, with reference to other military usage. Many literature sources were examined. Numerous military and civilian personnel working on current CBI projects were interviewed; in person, by electronic mail and by phone. Main points covered include: basic definitions of types of instruction; advantages and disadvantages of instruction relating to computers; a short history of Naval CBI; CBI costs; factors in CBI cost effectiveness; simulators and computers; CBI use for on site training; implementation and usage problems; methods to improve CBI implementation and usage in the Navy; what makes an effective course; improving CBI and conventional instruction effectiveness. Conclusions focus on: improving instructional quality; standardizing CBI course materials; using a standard computer for CBI; improving computer literacy Navy wide; automating CBI writing materials; putting good CBI courses on ships in the fleet.

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I. INTRODUCTION

This thesis is about learning and how computers can and are helping us to learn.

> Capacity to learn may be passed on from parents to the off spring, however, knowledge and skill are not. Every generation is faced with the same problem of transferring an accumulated body of information--one that is growing and expanding at an unprecedented rate--to a new generation of workers who enter the workforce unprepared to assume the responsibilities awaiting them. (DeBloois, M. and Others, 1984, p. 1)

Computers have come to be an integral part of our lives whether we realize it or not. They can help us learn this growing body of knowledge. For our technological society computer literacy is perhaps as basic to society as reading and writing. Computers have been making inroads in the educational field. The military has been in the forefront of the computer revolution not only for administrative and business type applications but for educational purposes too. "Most of the early work in computer-based instruction was either accomplished by military organizations or supported by the military." (Fletcher, J.D. and Rockway, M.R., 1986, p. 171)

When computers first appeared on the educational scene a lot of grand and ambitious predictions were made about the impact they would have in education. Many people saw the dramatic changes that came about in business and scientific communities and predicted great things for computers in education. The advent of the computer has been compared to the advent, adoption and use of pencils or books which changed education dramatically.

A computer is simply a tool, like the pencil or slide rule and needs to be learned to be useful. We need to find out how to use them as effectively as possible from a learning and a cost standpoint. We are still learning how to use the computer and are finding resistance from people who are afraid of them. Computer use in the education field is changing rapidly as we discover more about learning styles.

The ability to interact with the learning situation facilitates learning. It follows that the facilitation should increase as the learners activity or involvement increases. Examples of interaction are: answering questions quickly (as they come up), immediate correction of errors, positive reinforcement of correct responses and repetition of material that is not understood.

It was suggested that the immediate interaction between a student and a computer would be better than a teacher. In some areas it is obvious that no teacher can be with 25-30 students all at the same time and give immediate feedback to all of them. It was once predicted that the computer would be the end of a lot of teaching positions. Teachers could become practically obsolete. Computer enthusiasts predicted that students would learn much better and much faster with a computer rather than a human teacher. These concepts were obviously not something that teachers wanted to hear. As a result many teachers were, and still are, against computers for use in the educational arena. Like so many predictions, these have not come to fruition.

There have always been the detractors saying computers would never work well in the education field. According to most of the literature and education specialists, software development for educational uses is still in its infancy and not, in a lot of cases, very good. Much of the initial software written for our military and civilian schools, which greatly affects people's perception of it today in any milieu, was written by teachers who had little or no programming experience or by programmers with no educational experience. Though still not perfect the computer-based training written for industry, the military and public education today is much better than it once was. We are still learning how we learn, which makes writing good educational software difficult.

The true situation is quite different from either the completely negative or optimistic viewpoints. This thesis will examine some of the reasons the predictions were wrong. Computers have brought to light many problem areas we did not know we had. We have discovered for example that we don't even know how to measure some of the areas necessary for a fair evaluation of either conventional or computer-based instruction (CBI).

The Navy has become increasingly dependent on the work of computers. Our growing dependence on computers is not slowing down but increasing rapidly. Computer-based instruction has increased in importance right along with business and scientific uses of computers. The armed services, in particular the Navy and Air Force because of their dependency on high technology equipment, need to use whatever means they can to increase the readiness of their people for combat.

> Military training is large in scope. On any day, about 200,000 individuals are involved in formal training, as students, as instructors, or in support roles. (Department of Defense, 1985)

The 200,000 mentioned is just the active duty personnel involved in formal training. If people can be trained faster and the more consistently, then the military can improve readiness and the ability to respond to a national crisis.

The Navy began to use computers at training commands approximately 20 years ago. Navy computer usage in weapons systems and training is increasing every year. Usage is not likely to decrease any time in the near future. Naval Reserves are also using computer-based instruction. This will become more common as the microcomputer becomes more prevalent and more microcomputer CBI has been developed. CBI can be a great boon to the Reserves of all services especially for the people whose civilian occupation has no relation whatsoever to their military job.

This research is primarily concerned with the Navy's use of computer-based instruction in the 1970's and 1980's. The most recent information has been sought out in all cases. This thesis consists of a study based on available literature, conversations with and interviews of researchers in the field, military and civilian personnel currently involved in computer-based instruction development and implementation. Most of the people I talked to were in the Navy or work for the Navy (Naval Postgraduate School (NPS), Chief of Naval Education and Training (CNET) and Naval Personnel Research and Development Center (NPRDC)) others work for other defense related institutions (Defense Logistics Agency (DLA) and Institute for Defense Analysis (IDA)).

The thesis consists of seven chapters. Chapter I is the introduction. Chapter II contains background information on computer-based instruction. Also included are some definitions relating to computer-based instruction or training as used in this thesis. Chapter III contains a short history of computers in Naval education including some of the milestones and accomplishments. Chapter IV concerns cost-effectiveness of the various types of computer-based training. Chapter V deals with the implementation of the various types of computer-based instruction. There have been some problems trying to get computer-based training implemented on ships and in schools. Chapter VI covers the effectiveness of computer-based training. The question arises: do we really have a good way to measure effectiveness of computer-based training or any other training? The chapter also deals with how we have measured effectiveness and why they are not necessarily the best methods. Chapter VII presents the summary and conclusions.

The question of whether computers will be and should be used in the Navy is not addressed in this thesis.

If the computer were to disappear from classrooms today their use would still have been a very worthwhile investment of time and money. They have focused attention on how little we really know about learning styles and writing good lessons.

II. BACKGROUND INFORMATION

Instruction using computers is referred to by a variety of acronyms: CAI, CAT, CBE, CBI, and CBT are used interchangeably and many people aren't aware that CMI is different.

A. DEFINITIONS

Computer-Assisted Instruction (sometimes called Computer-Aided Instruction or CAI) seems to be the most widely recognized term for training or education with computers. Computer-aided instruction was the first type of computer training to be used extensively in public schools.

> In computer-assisted instruction (CAI), lessons are stored in the computer; each student interacts with the lessons at his own pace by means of a terminal (or light pen, "mouse" or touch-sensitive screen). The computer responds by providing new material based on whether the student has answered an item correctly or incorrectly; the computer also maintains records of student progress, attendance and various administrative details. (Orlansky, J., 1985, p.16)

CAI is usually defined narrowly as a way to present material, but most systems also take care of some of the record keeping. Drill and practice, self-paced instruction or programmed instruction (PI) are the most widely known and recognized forms of CAI.

Another type of instruction which can be self-paced is Computer-Managed Instruction (CMI).

> In computer-managed instruction (CMI), instruction takes place away from the computer. The student uses a lesson book and perhaps an audio-visual projector. After completing a lesson, the student takes a test that is scored by an optical reader attached to a computer. The results appear on a printer that interprets the score and tells the student what lesson to take next, e.g., proceed, try again, or report to the instructor. (Orlansky, J., 1985, p. 16)

CMI has been used more recently with courses that are not self-paced. The primary difference between CAI and CMI is that with CMI all instruction takes place off-line, away from the computer. Many courses now use traditional classroom instruction, using the computer to score the tests and record the results.

The Navy CMI center has recently changed its name and is now referred to as the Instructional Support System (ISS). The emphasis has changed from self-paced instruction to scoring tests. ISS is still a CMI system managed by Chief of Naval Technical Training (CNTECHTRA) in Memphis, Tennessee.

Surveys of training commands indicate that the computer is looked upon primarily as a device to be used to aid instruction and for managerial support. When the computer was first used in training it was primarily used for instruction. Computers can easily automate the management processes of keeping records and tracking student progress. (Wetzel, C.D., Van Kekerix, D.L. and Wulfeck, W.H. II, May 1987, p. 18-19)

Computer-generated Imagery (CGI) on a CRT has replaced the television as the dominant visual system for computer education in the 1970's.

> By using a computer program to draw lines on a cathode-ray tube (CRT), CGI offers a greater display flexibility, modifiability, interactiveness, economy, and reliability than other methods of display...Video discs contribute greater realism to visual displays, although they lag behind CGI in other respects. Researchers are developing capabilities for overlapping computer graphics onto video disc images, thereby combining the benefits of CGI with the photographic realism of video discs. (Blaiwes, A.S. and Regan, J.J., 1986, p. 97)

Interactive Video Instruction (IVI) also called Interactive Videodisc (IVD) is one of the latest methods of instruction using a computer. It may also be the most expensive. Interactive Video Instruction, as it is used now, usually consists of a computer and a five inch CD-ROM reader (Compact Disc Read Only Memory) or a twelve inch laser disc player.

With IVI the lessons are stored in the computer and on the compact disc (CD). Each student interacts with the lessons, as in CAI, at his own pace by means of a terminal (or light pen, mouse or touch screen). Each side of a videodisc may contain up to 54,000 frames of information which can be seen as single-frame images, text pages or linear sequences. (DeBloois, M. and others, 1984, p. 19)

The student can stop the movie or any part of the lesson and run it over again. IVI is generally self-paced. If the student is interested in details it is possible to explore every answer and question in the course work. It is also possible to move through the program, learning the course without getting into great detail. Unlike other training on a computer, the graphics with IVI can be the actual picture or a movie rather than a drawing or digitized picture of the subject. This method can have some great advantages, the student in a maintenance course can see actual repairs done on the equipment and go over it again and again. IVI is usually used by one person at a time, but has been used in classroom situations.

I will use computer-based training (CBT) and computer-based instruction (CBI) synonymously. In this thesis CBI will be an all inclusive term for any computer system used to aid teaching, this includes both CAI and CMI as well as simulators. IVI has not been used in the military to any great extent but will probably be used more in the future. Most of the following discussion will be referring to CBI exclusive of IVI. These are the only acronyms I will refer to in this thesis and are the terms generally referred to by military training commands.

B. ADVANTAGES AND DISADVANTAGES

Each of the different types of CBI have advantages and disadvantages that are important to note.

It is necessary to understand Conventional Instruction's (CI) advantages and disadvantages in order to clearly understand the differences between it and CBI. Conventional Instruction permits flexibility in the presentation of material to suit the needs of individual classes. An obvious advantage of CI is that human contact can serve to motivate some students, but how much do the students really get?

> ...work sampling data on education productivity in the public schools have shown that, in a six-hour elementary school day, the average teacher spends only about 126 minutes on instruction. Of that amount, less than one minute a day is occupied in providing interactive trials and feedback with individual students. (Bunderson, V.C. A., 1982)

Most studies have dealt with elementary education. Adult or Navy classes would have a higher percentage of instruction. I suspect the interaction, with students, would be little different than the elementary level.

The costs to implement a conventional class are low. On the other hand, individual attention is impossible for all. In a large lecture situation very few individuals get personal attention. The good learners get bored, the slow learners get lost. Table 2-1 summarizes the advantages and disadvantages of conventional classroom instruction.

TABLE 2-1 ADVANTAGES AND DISADVANTAGES OF CI

Advantages

Low delivery cost for large class sizes.

Flexible in mode of instruction, use of media, course content, and emphasis.

CI has direct human contact.

Simplifies planning because all students must progress at the same rate and complete the course at the same time.

Instructors prepare instructional material

Grades at end of course define how much each student has learned in relation to a normative sample.

Disadvantages

Not all students are able to progress at the same rate with equal mastery.

Low student:instructor ratios increases costs.

Individual attention to students is more difficult as class size increases.

Differences between instructors may lead to non-uniform achievement.

Fast learners may lose interest in course.

Slow learners become increasingly penalized.

Load on instructor for scoring test and managing students' progress increases markedly with class size.

Difficult to insure student mastery of training objectives since norm-referenced rather than objective-referenced testing procedures are used.

Difficult to insure that instructors present the relevant instructional information

(Orlansky, J. and String, J., 1979, p. A-13)

Prior to the advent of CBI, it was realized that there was a need to give more individual attention to some students. Computers can be a good way to give individual instruction. Individualized Instruction (II), whether delivered by programmed texts, multi-media approaches, or by computers has the advantage of being able to deal with the slow, as well as the fast, learner on an individual basis. II can also take prior knowledge of the student into account by pretesting. Individualized instruction makes better use of the student's time than does conventional classroom instruction.

All of this individualized attention is not without its price. A lot of work goes into determining specific course objectives. It is difficult to develop course materials that have all of the required learning objectives. It is very exacting and painstaking work to develop tests which correctly diagnose student problem areas. To make a program to correct these problems is also difficult. Table 2-2 summarizes the advantages and disadvantages of individualized instruction.

TABLE 2-2 ADVANTAGES AND DISADVANTAGES OF II

Advantages

Explicit course and lesson objectives.

Standardized instruction.

All students progress at their own rate.

Students can skip course material they already know, as shown by preassessment tests.

Lessons are generally one track.

All graduates are warranted to know the required information.

Instructors can concentrate on those students who need assistance at both ends of the distribution.

Permits greater use of instructor's aides, thereby reducing the average level of qualification required of instructors.

Permits wide use of different instructional media.

Instructors relieved from rote repetition of basic materials.

Instructors can have time to address concepts as well as students evaluation, motivation and enrichment.

Disadvantages

High initial costs for development of course materials, carrels, audio-visual equipment, etc.

Increases demand for qualified personnel to prepare instructional materials.

Requires changes in the instructor's role in conventional instruction.

Load on instructor for scoring tests and managing students' progress increases markedly with class size.

(Orlansky, J. and String, J., 1979, p. A-13)

CMI (or ISS) is a good tool to help manage the administrative burden imposed by individualized instruction or conventional instruction. Conventionally taught courses are using ISS for grading tests and for keeping track of registration and other student records. The Navy has cited the following advantages for the distributed concept in training:

-increased reliability and availability

-increased modularity

-increased flexibility

-increased resource sharing

-increased responsiveness.

(Capehart, B.L. and Morris, C.L., 1983)

CMI systems can be readily linked to personnel and manpower systems used by all military services. A problem with CMI or any other computer graded test is the lack of flexibility in the test format. A more detailed summary of the advantages and disadvantages of CMI are included in Table 2-3.

TABLE 2-3 ADVANTAGES AND DISADVANTAGES OF CMI

Advantages

All of those for individualized instruction plus:

Reduces demand for number of instructors.

Presentation of lessons and taking of tests not dependent on computer .

Automated test scoring, evaluation, prescription.

Multi-track lessons readily handled.

Automated student management, record-keeping and scheduling.

Detailed information routinely available for evaluating and modifying lessons and tests.

Manual scoring possible if computer and/or communication fails.

Predict graduation date, based on rate of student progress in course and personal date in student's file.

Provides data base for research, course development, and management decisions.

A wide array of courses can be offered with few instructors (or at remote facilities).

Disadvantages

All of those of individualized instruction plus:

High initial costs for courseware, CPU, terminals.

High operating costs for communications, where needed.

Instructional material poorly matched to students' abilities and expectations may discourage students and reduce effectiveness.

Scoring and student management inoperative if computer and/or communications fail.
(Orlansky, J. and String, J., 1979, pp. A-13,A-14)

As mentioned earlier CAI and CMI can have much in common. CAI can have all the advantages of CMI with a few additional ones like the tremendous flexibility that a well written CAI course gives the student. The biggest problem is the difficulty in writing good programmed instruction for CAI.

> The following major problems were identified with PI: (1) difficulties in procuring suitable programs, (2) high costs of program development, (3) limited application of programs, (4) long development time, and (5) unstable or unsuitable subject matter...it appears that the drawbacks to PI ultimately outweighed the advantages. (Kearsley, G. 1984, pp. 73-74)

The writing of good software is by far the greatest difficulty with any CBI course whether it is IVI, CAI or CMI. Another disadvantage of CAI is that when the computer is down the entire course comes to a stand still. CMI courses can continue until it is time to enter the test scores if the computer is down. Table 2-4 summarizes the advantages and disadvantages of CAI.

TABLE 2-4 ADVANTAGES AND DISADVANTAGES OF CAI

Advantages

All of those for CMI--except the ability to operate when the computer is inoperative is extremely limited plus:

Very flexible means for presenting material and taking tests via computer.

Interactive tutorial modes are feasible.

Simulation of processes and equipment is feasible.

Computational aids are readily available.

Can provide detailed information needed to improve specific lessons and tests. e.g.,student success with various subjects, method of presentation.

Can provide instructors with data bases, formats, guidelines for developing improved course materials.

Facilitates maintaining the security of tests.

It probably has the greatest degree of individualized instruction currently available, except where very low student:instructor ratios are acceptable.

Disadvantages

All of those for CMI, plus:

Instruction becomes difficult when computer responses are delayed.

No instruction possible when computer and/or communications fail.

(Orlansky, J. and String, J., 1979, p. A-14)

Interactive video instruction has all of the advantages of CAI and CMI. The tremendous amount of data that can be put on the videodisc is a big plus for IVI. It is now possible to store 1.25 billion bytes of read-only-memory per disc side. It is much more flexible than either of the others and it is also more difficult to program. One of the biggest disadvantages, besides programming, is the expense and difficulty of making the laser disc. CNET does not have the capability to either master or copy the discs. At present mastering is accomplished by a few companies. Compact and laser disc technology for computers is still in its infancy but has tremendous potential. As with CAI, making a good IVI lesson is very difficult and time consuming.

C. DIFFERENCES BETWEEN TRAINING AND EDUCATION

This thesis is primarily concerned with Navy computer education and training. As a general rule technology is used differently in training than in education.

One major difference is that training materials are usually developed by the people who are going to use them. Training materials meet specific needs of the organization while educational materials can be "off the shelf" because they are more generic. Off the shelf educational CBI materials that the Navy uses are math and literacy programs for "A" Schools, and the Navy Campus program on ships. Training programs usually have specific goals related to job skills and competencies. (Kearsley, G., 1984, pp. 14-15)

The military is more concerned with training than education. A notable difference between civilian education and military education is the time factor. Public and private schools are not concerned with the time it takes to present a lesson. In civilian education, if the course is done earlier than planned, there may be nothing left to do for the rest of the quarter, the instructor has to think of something. In the military, the time saved can be translated into a faster return to the fleet. Time can be especially critical for military training commands particularly during time of war when a lot of people need to be trained as quickly as possible.

Practice is something the military does all the time and is more common in a training program than an educational one. We practice any time we do an exercise in the fleet or ashore. Many training systems are basically environments for practice. "Part of the commitment to practice is dictated by the demand that students being trained actually become proficient at some skill." (Halff, H.M., Hollan J.D., Hutchins, E.L., 1986, p. 1138)

Organic (also called embedded) training has no counterpart in education. Operational equipment can have training built; i.e., embedded, into it. All that is needed is for someone to show the trainee how to get started. The equipment itself teaches the trainee how it is used. Computers make this possible. This was done with the early NTDS system for training in Anti-Air Warfare (AAW). (Fletcher, J.D. and Rockway, M.R., 1986, p. 178). It is an attempt at making the equipment sailor proof.

III. THE HISTORY OF NAVAL CBI

Computer-based instruction or training in the Navy has had a diverse history. Research and development for computers in naval training began in the late 1950s. The research progressed into the implementation of training systems on large mainframe systems at various sites. With the success of these first systems the Navy expanded the systems and added more systems rapidly.

Today we are still using many large systems. In addition we are using a growing number of micro-computers. This chapter will trace some of this evolution. Some of the developments that precipitated change in the way we do computer-based instruction will be pointed out.

Perhaps the most well known of all the CBI projects initiated by the military is PLATO (Programmed Logic for Automatic Teaching Operations). It has attracted the most attention and support. PLATO was supported solely by the military from 1959 to 1965, the first six years of its development. It was begun in the Coordinated Sciences Laboratory (CSL) at the University of Illinois in Urbana-Champaign using the ILLIAC computer. Since 1965 Control Data Corporation (CDC) has been the primary sponsor of the work. By this time PLATO III was in use on a CDC 1604. (Fletcher, J.D. and Rockway, M.R., 1986, pp. 208, 209)

One of the early goals of PLATO was to support more than two students. When PLATO changed to the CDC 1604 this goal became possible. In 1966 the PLATO project left CSL to form the Computer-Based Education Research Laboratory (CERL). Work began on a large 4,096-student station PLATO IV system. The 4,096-terminal station never materialized. (Fletcher, J.D. and Rockway, M.R., 1986, p. 210) PLATO IV used a large central computer (CDC CYBER 74) at CERL which supported 950 terminals, 400 simultaneously, at about 150 locations in the United States and one in Sweden. In 1976 about 80 organizations (12 military) had dedicated communications lines to PLATO IV. (Orlansky, J. and String, J., 1979, pp. B-5, B-6)

The terminal was, for the user, the best part of PLATO IV. It "featured a plasma screen, or panel, the development of which had been supported entirely by the military." (Fletcher, J.D. and Rockway, M.R., 1986, p. 211) Defense Advanced Research Projects Agency (DARPA) provided hardware and communications support for about 100 terminals at military and civilian test sites. Organizations at the test sites provided support for evaluation of the equipment. PLATO's influence over CBI and especially micro-computer instruction currently under development may be its most important contribution. Four assumptions are currently made in CBI development as a result of PLATO.

> 1. The incorporation of graphics, especially interactive graphics, is not seen as a frill but as an integral and uniquely powerful component of instruction delivered by computers.
> 2. Sophisticated answer judging including spelling checkers, alternate forms of correct and incorrect answers, student-expression evaluation...are included...as essential components.
> 3. Touch-screen input is seen as important and desirable.
> 4. Computer-based instruction itself is seen as a major and desirable use of computer.
> (Fletcher, J.D. and Rockway, M.R., 1986, p. 212)

The Navy began its use of computers for training and instruction in the mid 1960s with three projects. Two IBM 1500 instructional systems were installed. One was used for training at Basic Electricity and Electronics (BE/E) school in San Diego. The other was used for officer education at the Naval Academy in Annapolis. The third project was a set of time-shared teletypewriter terminals also at the Academy. (Fletcher, J.D. and Rockway, M.R., 1986, pp. 183-184)

The U.S. Naval Academy at Annapolis was one of the first four colleges to offer any courses by computer. It was the first to offer college level courses. Many computer-based techniques were tested with groups of midshipman from 12 courses using them. Techniques included, straight drill, tutorial presentation with diagnostic remedial routines, remedial problem solving and laboratory simulations (Fletcher, J.D. and Rockway, M.R., 1986, p. 185).

At the same time another project sponsored by the Office of Education was studying multimedia presentations. Included in this study was anything that could be considered multimedia including the IBM 1500 and teletypewriters.

> The projects represented the first systems approach to multimedia instruction in which computer presentations were included as one of the media...This study was one of the first to record students' attitudes toward instruction using computers.(Fletcher, J.D. and Rockway, M.R., 1986, p. 185)

While these projects were underway at the Naval Academy and Basic Electricity and Electronics (BE/E) school, the first of the Navy CMI programs was also getting underway. In 1966 the Assistant Secretary of Defense for Manpower and Reserve allocated $70,000 to begin a CMI project (Fletcher, J.D. and Rockway, M.R., 1986, p. 188). The CMI project was started at NAS Millington, Tennessee in the Aviation Mechanical Fundamentals School. The project was to determine if CMI was less expensive than CAI and less computer dependent than CAI. In addition some clerical and administrative functions could be accomplished by computer, saving the teaching and administrative staff a great deal of work often associated with Computer-Aided Instruction.

After the initial period, the CMI project was expanded to include the Aviation Familiarization School. This new course was used for all sailors ordered to the Naval Air Technical Training Center, Memphis after they finish Recruit Training. With about 500 students per week going through the school they had a large enough number of students to record some good, valid statistics. The statistics they developed supported a shortened version of the course using CMI. "The present course was two weeks in length (originally six weeks) yielding an average time reduction under conditions of CMI of 2/3 or 67 per cent." (Hansen and others, 1975, p. 10). This project did not attempt advances in the state of the art. In 1974, the Chief of Naval Education and Training (CNET) adopted CMI as a formal part of the Navy training program. In 1975 a contract was let for the hardware and software for the next system. (Van Matre, N., 1980. p. 1).

Group-paced instruction in Navy technical training is conducted across the country using the CMI computer out of Millington. Each school may have classes in several buildings that will vary in size from 20 to 500 students. The instructional method within a class may vary from group-paced to fully individualized self-paced instruction. Because of widely varying methods of instruction, CMI software and hardware must be very sophisticated and extremely flexible.

Other CMI courses were started at Naval Air Station, Lemoore, California (VA-122) and Naval Air Station, Miramar, California (VF-124) because of the positive experience at Millington, Tennessee. The Marine Corps developed an installation at Twenty-Nine Palms, California. (Orlansky, J. and String, J., 1979, pp. B-12, 13)

The original CMI project is still active today but greatly modified. It was expected to handle from 16,000 to 18,000 students in 24 separate schools at six Navy Training Centers by the mid 80s. It was intended that all of the schools be linked to a central processor at the Management Information and Instructional Systems Activity (MIISA), Millington Tennessee, but the Navy CMI system never grew to the predicted size. It was, however, one of the largest in the world with six schools and over 9,000 students in 1981.

A study of the Navy's CMI system by Nick Van Matre and Kirk Johnson from the Navy Personnel Research and Development Center (NPRDC) was performed in 1981. The study was done because "...the CMI schoolhouses have experienced problems with deteriorated system response time (RT) and excessive downtime (DT)." (Van Matre, N. and Johnson, K., 1981, p. 1) This was making it difficult for the students to do their work and to take their tests when they were ready for them. If a school can not complete one of its courses on time and has to have the students stay longer, the whole training system slows down.

The study showed that part of the reason for this RT and DT problem was that the system was doing a lot of things it was never designed to do. It was originally designed to support only CMI but by 1981 it was supporting a number of additional information systems. Numerous upgrade recommendations were made to alleviate the DT and RT problem. (Van Matre, N. and Johnson, K., 1981, p. 1) Today the system has been altered to reflect present needs.

> The CMI system has changed its name to ISS (Instructional Support System) and will be primarily a records keeper, and data storage system for the schools. Support for individualizing instruction is de-emphasized. (Montague, W.E., 12 January 1988).

Dr. William Montague (NPRDC) and Dr. Nancy Perry (CNET) both agree that CMI is not gone but is definitely changing. The schools seem to be quite content in many cases not to use ISS. There is no CNET policy to force them to use it. Therefore, if they find it easier to use a local system they do. One of the local alternatives that is being used is called COGENT a micro-computer based CMI program. Used on the Zenith Z-248, COGENT will not only keep track of the administrative paperwork and the tests, it will also help prepare the test (Montague, W.E., 14 Jan 1988). Preparing tests is not a function of ISS. The fact that COGENT is locally controlled and helps in the preparation of tests is a big plus to schools that have the people to use it effectively.

Computer-managed instruction is still the single largest component of CBI in the Navy. Computer Technology and CMI systems are constantly changing and as we learn more about them the systems we design are improving.

I include simulators in this discussion of computer-based training because in almost all cases simulators use computers or the simulation equipment is enhanced with a computer. Simulation of actual equipment for training abounds, the variety is tremendous. Simulators can be used for both training and help on the job. Computers have added a new dimension to simulation. The most well known are those aircraft simulators used by the military as well as the airlines to train pilots. Aircraft simulators have done so well that the FAA allows commercial pilots to take all of their transition training from another aircraft to the 727 in a simulator (Blaiwes, A.S. and Regan, J.J., 1986, p. 134). Besides aircraft and equipment simulators, there are medical simulators for training cardiopulmonary resuscitation, childbirth assistance, and anesthetics. Other simulators train Anti-Submarine Warfare, navigation and piloting, radar and sonar, engineering drills and many maintenance functions.

Simulators have played an important role in the Navy. In reference to simulators, "The Navy did most of the early research and development in this area." (Fletcher, J.D. and Rockway, M.R., 1986, p. 190). Joseph Rigney and his colleagues in the Behavioral Technology Laboratories at the University of Southern California began work in the late 1960s on the Taskteach tutorial system. The Navy's Generalized Maintenance Trainer/Simulator (GMTS) and Modular Integration of Training Information by a Performance Aiding Computer (MITIPAC) evolved from their work.

> The intent of all this work was to use computer-based techniques to provide hands-on training for operator and maintenance personnel by using adaptive, computer-based systems to simulate equipment...it was to develop a true job-site training capability. (Fletcher, J.D. and Rockway, M.R., 1986, pp. 192-193)

Another area of simulator research which has been supported almost exclusively by the military is the intelligent training system. Intelligent training systems are a logical follow on to MITIPAC and are an attempt to use some artificial intelligence (AI) techniques with computer-based training. A good intelligent training system would be able to lead a student through the training and answer all the questions the student has along the way. The Sophisticated Instructional Environment (SOPHIE) was the first major system. SOPHIE was:

> designed to teach basic information on electronic circuitry through laboratory like exercises with a simulated power supply, SOPHIE contains an English language processor, a semantic interpreter, an electronic-circuit simulator, and a semantic-network knowledge representation. (Fletcher, J.D. and Rockway, M.R., 1986, p. 195)

SOPHIE generates random faults in the simulated power supply. Students may ask it, in English, to test certain points in the circuit. SOPHIE would provide the test information. Then SOPHIE could ask the student why he chose the tests he did and see if it matched what he had been taught. (Fletcher, J.D. and Rockway, M.R., 1986, p. 196)

Following the successful development of SOPHIE came Steamer in 1984, a system developed by NPRDC to teach the principles of steam plant operation and maintenance. Steamer was written in LISP on a LISP machine in an attempt to use artificial intelligence. "What makes Steamer unique in instructional philosophy is that students and teachers can also interact with abstract views of the plant." (Halff, H.M., Hollan, J.D. and Hutchins, E.L., 1986, p. 1134). It allows the students to look inside a ships propulsion plant and see relationships that are not intuitively obvious and will not show up by simply reading the gauges of a real propulsion plant. It teaches the theory of how the plant reacts to specific stimuli by giving a pictorial representation of the engineering plants response.

Simulators could easily be the subject of another thesis. Simulators have a long history prior to the advent of computers, but a more varied and realistic one since the introduction of the computer.

By 1984 on an average day about 209,000 active duty personnel, 44,000 National Guard and Reservists and 12,000 foreign Military students were undergoing some type of formal training (Fletcher, J.D. and Rockway, M.R., 1986, p. 173). A large part of this training was with the help of computers. What these numbers do not show is the informal training which was also going on the same day. It has been estimated that two to three times as much training is occurring on in an informal basis. If the training of civil servants working for the military is added, the numbers grow even more. What must be kept in mind about the role of military training is that unless there is an actual war the military's primary job is training for battle. Anything that can facilitate that job will have many applications.

Micro-computers have become common place in the last few years. It is estimated, in many contemporary computer publications dealing with the business community, that businesses use over ten million personal computers, with more being bought every day. In the education field the latest estimate I have seen was over one million micro-computers in public schools by the end of the 1986-1987 school year. Over 98% of all public schools use computers. (Eckhouse, 1988, p.1)

In the early 1980s the Navy began looking at the possibility of using these micro-computers for training. NPRDC developed an interactive air defense game on a micro-computer in 1981 that was used by researchers to develop human performance parameters in AAW threat analysis. The study showed the flexibility and portability that micro-computers offered the Navy. (Crawford, A.M. and Hollan, J.D., 1983, p. 1)

The Tactical Action Officer (TAO) course, taught at Fleet Combat Training Centers, Pacific and Atlantic (FCTCP and FCTCA) and the Department Head Course at the Surface Warfare Officer School (SWOS) in Newport, Rhode Island, was chosen for further study regarding the use of micro-computers. The large body of facts which must be memorized by students and the constant need for a TAO to relearn the old and new facts helped to make it a good choice. The possibility of being able to use micro-computers at the school, pierside as well as onboard ships gave additional reasons for using this course. Refresher training could use the same software in other environments. A TERAK micro-computer with two floppy disk drives and 32K of memory was used for the study. (Crawford, A.M. and Hollan, J.D., 1983, p. 2)

The micro-computer was very effective. The results of this TAO study and others led to more general uses of micro-computers in Navy CBI. Today, the micro-computer is much improved over the TERAK, allowing a great deal more to be done.

Many of the developments of CBI in the military are meant to be used with a micro-computer as a stand alone or to facilitate/coordinate the use of other equipment.

Currently there are several courses either developed or under development for use on micro-computers. At least two are in the fleet being tested on Zenith Z-248s onboard ships. A package for learning the use of a maneuvering board is one and another is for rules of the road. A program for engineering administration and Electronic Warfare (EW) should be in use soon. Three more courses, relating to damage control are also under development.

The Naval Academy at Annapolis received Z-248s for all of its new students. Some of the Academy's professors have written software for the students. Currently there is a signal flag recognition program that is being evaluated for use elsewhere in the Navy. (Hayes, W., 1987)

The latest CBI mode is Interactive Video Instruction (IVI). According to Frank Savely of the Computer Based Training Division at the Defense Logistics Agency (DLA), they are trying to implement IVI but it is still very expensive to master a CD-ROM to use for the programs.(Savely, F., 17 Nov 1988)

Nancy Perry of CNET is also very positive about IVI and its potential. She said the Navy is currently implementing an IVI system at ASWTRASUBPAC in San Diego. It is estimated to be about one-half implemented. One of the medical commands in Great Lakes is also implementing an IVI system. Dr. Perry says it is very expensive to get discs made and CNET has no capability to make them. (Perry, N., 1988) The Army has a few programs they have used with laser video discs as well. At least one interactive maintenance program in the Navy, that I have seen, uses pictures of the aircraft on laser disc to facilitate the simulation.

In early 1987 Philips and Sony, companies who have pioneered with CD-ROM, announced a new standard called compact disc interactive (CD-I), for use with IVI. At present there are no standards for IVI CDs so there are several competing systems. In addition, it is very memory intensive to put pictures on a CD (also called laser disc) so pictures drastically cut down the amount of memory remaining to store a program.

General Electric (GE) has been showing a newer technology than CD-I called Digital Video Interactive (DVI). It uses custom chips to compress high quality video and sound images so that more than one hour can go on a CD-ROM disc. In either case it will probably be two years before either of these technologies is readily available in the marketplace. (McGinty, T., 1987, p. 29)

Either of these technologies could improve what is already an impressive form of CBI.

There is a project just beginning at NPRDC to make a distributed online CBI system for the Reserves. It is envisioned as a system where the Reservist can ask questions via his terminal. A human "expert" will get an answer if it is not covered in the training materials. This is proposed to connect all 235 Reserve Centers to a distributed network. It is currently in the feasibility study phase. The potential to keep our Reserve Forces up to date on the latest equipment and doctrinal changes is tremendous. (Van Matre, N., 28 Jan 1988)

This short history has shown how far CBI has come in just the last 20 years. It also gives an indication that there is a lot more to come and it is still a rapidly changing and improving technology. Peter Drucker made the comment when speaking of the relationship between making knowledge into an accepted product that "the lead time for knowledge to become applicable technology and begin to be accepted on the market is between twenty-five and thirty-five years." (Drucker, P.F., 1985, p. 110)

For technologies like IVI and compact discs there is still a lot that can be done, and will be done, to make them a more viable and affordable alternative in computer-based instruction.

IV. COST EFFECTIVENESS OF CBI

From a budgeting viewpoint cost minimization makes a lot of sense. It doesn't always make sense from a practical or tactical view point. A system that is cheap and does the job better is ideal, but not always possible. Proving that a system or method is both less expensive and more effective is often very difficult.

There are a lot of intangibles that must be taken into account with computer-based training in the military. Some of the intangibles have nothing to do with computers but with effectiveness of the education and training. Educators still don't know the most effective way to teach students. They don't know how people learn well enough to say "this is the best way so lets do it." If we don't know these basic principles it makes it much more difficult to involve the computer.

Recently educational innovations have had three phases. In phase one, the advocates of the innovation tell of its usefulness and success. In phase two, the innovation is being used and many people like it. The last phase consists of skepticism and criticism of the innovations usefulness. Since the criticism is late in the process, it doesn't help improve the technique but, rather, speeds its demise in favor of the next innovation. The process then starts again. Some believe the main causes of this cycle are political and social. (Montague, W.E., 28 Jan 1988)

One well known example within the last 20 years is the 'New Math' which isn't around any more. Another is the look-say method to teach reading by ignoring phonics and relying on the memorization of words. It is still around but losing favor as our national illiteracy rate continues to grow. If teaching were an exact science, then books like "Why Johnny Can't Read" by Rudolf Flesch in 1966, and its sequel, "Why Johnny Still Can't read" 15 years later, would never have been written. Teaching reading is one of the bigger uses of CBI in the military and in industry. (Montague, W.E., 30 Sep 1987; Wetzel, C.D., 20 Jan 1988; Perry, N., 15 Jan 1988)

A. CBI COSTS

When CBI was first introduced it was hailed as a great cost saver. Most of the first studies, however didn't take many things into account that have an effect on the cost. The costs which can be attributed to CBI that are different from any other instruction method have to be determined. There are a great many areas where all instruction can be improved.

Training is the mainstay of our armed forces. With the all volunteer force, we get a high turn over of people. Unless we are in actual combat the primary mission of a combat unit is to train. "Initial individual training for recruits, officers, specialized technicians and pilots cost 17.9 billion dollars in Fiscal year 1985". (Orlansky, J., 1985, p. 3) This indicates that 12 per cent of all military personnel are assigned to schools either as an instructor or student. When the support personnel for these schools are considered it is much more, perhaps as high as 20 percent. Considering that formal schools are only a small part of the total training that goes on, the total dollar amount spent by the military for training is tremendous. A more cost efficient method of training would save the military and the taxpayers a lot of money.

Cost effectiveness assessments are required by DOD for all first time funded projects, and periodically for on-going activities. Because of this, cost effectiveness studies were done on CBI before all the costs were really known. It can probably be argued that total costs of any system can never be known. When doing cost effectiveness studies there are two ways of evaluating cost effectiveness. Either you select the system (of two equal systems) which costs less, or if they both cost the same the one with the greater effectiveness is preferred.

Computer-based systems have been designed to provide the same level of effectiveness as conventional instruction. Therefore, the issue of which system costs less is used to evaluate CBI systems. (Orlansky, J. and String, J., 1979, pp. 25-26)

According to Orlansky and String most of the early studies were really studying effectiveness or operational feasibility with costs or cost effectiveness thrown in as a secondary consideration.

When cost effectiveness was considered it was usually from a very limited perspective. As noted in earlier chapters CBI courses generally take less time, approximately 30 per cent less, than their conventional counterparts. Most studies looked almost exclusively at the direct costs of the software and hardware compared to the time saved by the students. Unfortunately there is a great deal more to be taken into account. Hardware costs were the easiest to find.

> The real problem is to estimate the costs of program development (e.g., instructional materials and programming) and program delivery (e.g., instructors, support, management, student pay and allowances) for particular applications, primarily because a data bank on these cost factors does not exist at present. (Orlansky, J., 1985, p. 22)

There were no separate records for many of the things that needed to be considered for an accurate estimation of cost effectiveness. Table 4-1 taken from Orlansky and

TABLE 4-1 DATA NEEDED ON COSTS OF INSTRUCTION

<u>Program Development</u>

Program Design

Instructional materials

Conventional Instruction
Individualized Instruction

Programming
First-Unit Production

Computer-Based Instruction

Programming
Coding

<u>Program Delivery</u>

Instruction

Instructors
Instructional Support Personnel

Equipment and Services

Laboratory (including simulators)
Media Devices
Computer Systems
Communications

Materials (including Consumable)

Facilities

<u>Program Management and Administration</u>

<u>Student Personnel</u>

Pay and Allowances

Other (Permanent Change of Station, Temporary Duty)

(Orlansky, J. and String, J., 1979, pp. 64-81)

Strings 1979 paper is one of the first attempts to list the things that needed to be considered. This table relates to any type of instruction, not just computer-based instruction. Orlansky and String noted that limited cost data were found for some areas and none for others. A more extensive list of costs can be found on pg. 50 of "A Cost Element Structure for Defense Training" by Orlansky and Knapp written in 1983.

The reason cost data was hard to find is that many of the costs were buried in other accounts, not separated to show the part used in instruction. With conventional instruction, a lot of things have been taken for granted that have to be accounted for, if a true picture of the costs and effectiveness of CBI are to be made. Conventional instruction can not be truly evaluated for comparison without this information. A few years ago Admiral Watkins, then CNO, said that the Navy would not start any more individualized instruction (II) with out clear proof that it is better. At the same meeting it was pointed out that there is no clear proof that conventional classroom instruction is any better than II. Clear proof is very difficult to provide.

Another problem when comparing effectiveness data came about while developing the CAI or CMI course materials. In most cases, the instructional material had to be broken up into computer lessons. In the process some material was left out and other material added. The combination of these changes meant that the CAI course, was in reality, a different course than the one conventionally taught in the past. The conventional course it was being compared with was possibly not as good before the revision. Even though the results did show better test scores, it could not be proven whether it was the computer or if the improvement was because of the course revision. This can be a factor any time a course is changed from a conventional method to a computerized one.

CBI consistently took less time to deliver course material than the same course taught conventionally, generally 30 per cent less time. In addition the longer a CBI course is used the better the time savings. Student time is not relevant to effectiveness of training, but it is to cost. In military training environments the student is finished when he gets a satisfactory score on the test, no matter how long it takes. Therefore, since the standard for passing the test didn't change, just the time it took to reach the standard, the cost is less for CBI. The only measure we have for the effectiveness of instruction is the final test. CBI courses do as well or better than conventional instruction on these tests.

B. FACTORS IN CBI COST-EFFECTIVENESS

Certain types of courses lend themselves to CBI. Many courses use more than one method of instruction such as independent study, lecture, discussion and tutoring. Recently CBI has been included in this list. All methods of instruction can be integrated into one course or used separately.

> Computer-based instruction is a new technology that is proposed often for use in military training. It would be particularly applicable to specialized skill training; the services offer about 10,000 skill training courses to about 1.4 million students at a cost of 4.4 billion dollars in fiscal year 1985. (Orlansky, J., 1985, p. 15)

Another factor that can have a mitigating effect toward computerization is the number of students that take the course. The costs of computerization can be spread out over a larger number of students making computerization more cost efficient.

Studies have shown that individualized instruction, when compared to CAI and CMI, produces the same achievement level on tests. Time savings is also the same for all three methods. The major difference is that administrative and instructor time involved is much greater for the non-computer course.

The time saved by finishing a course early is not cost savings unless there is something for the student to do while waiting for his next school. Individualized study, whether with a computer or conventional methods, has this same possibility of wasted time.

Most Navy courses are only offered at certain times. If the student is taking a series of courses he will often be ordered to a school prior to its beginning, and wait for the next class. Courses with the longest waiting time are usually long courses themselves. Courses with a long waiting time before starting are a good candidate for CBI. CBI could be put to good use with the students who are waiting. Remedial, enhancement or background courses could be given to students who might need them prior to beginning the course. This would give them a better chance of successful course completion. Studies have shown that CBI works better with slower students. One area in public education where CBI has shown surprising success is with special education students. The above average student also gets more out of CBI than the average. (Niemiec, R. and Walberg, H.J., 1987, p. 32) A computer based language course was given to OS 'A' school students who tested poorly in language skills. These students historically had a very high attrition rate. After completing the language course their attrition rate was normal. (Wetzel, C.D., 28 January 1988) The result is fewer students fail to make it through a course, saving TAD and PCS funding.

The development of CBI is the most time consuming and costly part of its life cycle cost. When a course is being updated or revised it should be considered for conversion to CBI, if it hadn't been considered before. Since program development for CBI involves a rewrite of a curriculum to begin with, when a rewrite is planned the cost to change to CBI is not that much greater. (Montague, W.E., 28 Jan 1988)

Some of the more demanding courses should be considered for CBI.

> Courses in which a substantial number of students are set back or do not reach criterion on the first attempt complicate student management. Students in these courses may require additional instructional delivery and more individual attention. Therefore these courses are good candidates for both CMI and CAI, particularly for individualized remediation programs. (Wetzel, C.D., Van Kekerix, D.L. and Wulfeck, W.H. II, May 1987, p. 8)

The longer courses usually have a larger time difference for completion by the students. The longer the course, in general, the larger the disparity between the fast and slow students. These courses are ideal candidates for CBI. Over half of current CBI use is in courses of at least 40 days length. (Wetzel, C.D., Van Kekerix, D.L. and Wulfeck, W.H. II, May 1987, p. 4)

C. SIMULATORS AND COMPUTERS

Training effectiveness evaluations (TEE) show that certain skills can be learned with less expense in simulators. There are many reasons for this. Simulators allow students to practice skills that would not be done on actual equipment. One of the more important skills simulators allow is emergency training.

Much training, in aircraft, for example, that is dangerous or life threatening can be practiced in a simulator with no danger. Many aircraft emergency manuevers can't be done in actual aircraft. Another example would be working on power supplies or other equipment that may be too expensive or dangerous to use with beginners training. The cost savings from these types of training aren't reflected in flight training or lives saved in any cost effectiveness table. Though intangible benefits in most cases they are, nevertheless, very real.

Simulators for maintenance are available for sonar, avionics, radar, propellers, flight control, navigation, aircraft power plants, communication and ship boiler control systems to name a few. The cost to develop a simulator for maintenance is much less than the cost of the actual equipment it simulates, for most training programs simulated. Student achievement with simulators is at least as good as with actual equipment, and simulators generally cost less. The conclusion: maintenance simulators are cost effective for the military. (Orlansky, J. and String, J., 1981)

The majority of the equipment is used for operational rather than maintenance training. The use of more simulators could save the military money in equipment costs alone. Blaiwes and Regan stated that:

> "...85 per cent of the Navy's $8 billion stock of training equipment is unmodified, operational equipment. The Navy currently spends three times more for operational training equipment than for equipment specially designed for training, but the trend is toward reducing this ratio. (Blaiwes, A.S. and Regan, J.J., 1986, p. 105)

Simulators can be used to fill in when there is not enough operational equipment to go around. While students are waiting there could be low cost simulators for them to practice certain skills. In one aircraft maintenance school the students were divided into two groups, one worked on the actual equipment and the other read technical manuals about the equipment while waiting their turn to work on the equipment. A simulator, of the systems to be worked on, was added to the school. The waiting students used the simulator instead of reading technical manuals, resulting in increased learning (Malec, V., 29 January 1988). A large task can be split into smaller components that can be taught with a simulator. This is true whether the student is learning to fly or fix a piece of equipment. A simulator which is an exact reproduction of the equipment is called a high fidelity simulator. Low fidelity simulators do less then the high fidelity simulator. The smaller tasks can use a low fidelity simulator, therefore saving equipment costs.

Training effectiveness evaluations show which skills and tasks can be taught with less expense in simulators. Such information has allowed program developers to cut down the flight time and train certain skills with simulators. This allows the flight time to be more productively used for skills that are not as easily taught in a simulator.

Cost savings can be estimated by looking at the costs for operating the trainer as compared to the actual equipment. The best and most obvious data at present is for flight simulators. Orlansky, Knapp and String (1984) concluded that training is about five times more cost-effective with simulators than with aircraft.

A U. S. Naval Institute Proceedings report states that 40 additional flights would be required to replace the 52.9 hours of simulation given to each student in the F/A-18 program. This translates into a one-month increase in training time per student and a requirement for more than ten additional aircraft. (Rondestvedt, C.R., 1984, p. 27)

One reason for the high acceptance and use of flight simulators over maintenance simulators is the length of time flight simulators have been around. Flight simulators in one form or another have been in use for 60 years. The move to the computer to get higher fidelity has occurred relatively recently. Maintenance trainers do not have such a long history of acceptance. The computer has generated many attempts to use maintenance simulators. Maintenance simulators may become more widely used than flight simulators as CBI and IVI technology improve.

D. ON SITE TRAINING

One of the areas where CBI can really shine is on site training. What is needed is good software and the management support needed to make it happen. This means doing CBI training on the ships, in the air squadrons and, in general, anywhere there is a computer. AT&T, for example, mailed 1600 training disks to its various sites, vice bringing people to the home office for a one week training program. They saved a lot of money on travel, food and hotel bills as can the Navy. (Hassett, J. and Dukes, S., 1986, p. 33)

This couldn't work for all types of training. Some training equipment, especially that used in technical training, is too big to have everywhere. Some training resources can not be divided up, e.g., the cpu of a mainframe computer. On site training would have some other cost savings that are not as obvious. Some of the more obvious savings are the following: 1) training facilities must have buildings to house the classes, 2) housing for the students, 3) support personnel and 4) equipment. Some new construction could possibly be avoided. Buildings that had been used for training could be used for other things.

We have a long way to go before we can do away with training facilities. The cost of CBI development is high and will remain high for the foreseeable future except in rather pedestrian uses such as page turning. The falling prices of microcomputers will help get CBI to the fleet but software prices are not falling, they are going up. The personnel who write software are more expensive. But no matter how inexpensive the software or hardware, if the instructional material is bad the course is bad.

At present it still takes between 100 and 500 hours to produce one hr of good CBI. The development time has to be reduced before CBI will be economical. The Navy Personnel Research and Development Center (NPRDC) is working on developing several authoring languages to write CBI programs for the Navy. The goal of an authoring language is to allow anyone to write good instructional material without a lot of educational experience. The educational expert is in the authoring tools in the language. Most of the Navy's course material is written by people with only minimal educational and substantial subject matter expertise. An authoring language would allow them to create more effective courses.

The AIM (Authoring Instructional Materials) authoring package is currently under development and testing. It is being used with great success at Great Lakes, San Diego and other training commands. AIM is being used to help write instructional material not necessarily computer-based instruction. It is an example of what is being done with computers to improve Naval training. AIM's computer aided design feature has paid for itself twice in the first year at Great Lakes Naval Training Center making overheads, graphs and pictures. AIM and other authoring packages will make CBI and conventional instruction writing easier and therefore cheaper and more cost-effective.(Montague, W.E., 30 Sep 1987)

Personnel at the Defense Logistics Agency (DLA) have been very enthusiastic about Goal Systems International's Phoenix Authoring and Presentation System that they are using. Course development time is decreasing with its use and quality is increasing. Frank Savely feels it has the potential to cut down the development time for CBI to only ten per cent of what it is today. They are conducting training at various DLA sites to teach people how to use it to cut their CBI development cost. (Savely, F., 1 November 1987)

Interactive Video Instruction (IVI) is another good candidate for on site instruction. It has been used for various training programs successfully but is very costly to develop. "To produce high quality state-of-the-art programs will cost anywhere between $50,000 and $150,000 per video-disc side." (Cohen, S.L., L'Allier, J.J. and Stewart, D., 1987, p. 34). Each side is only 30 minutes of run time but approximately two to three hours of instruction. The wide range of cost is due to the difficulty in creating different types of courses. A program designed to teach a technical skill ($50,000) is easier than trying to teach an interpersonal skill such as decision making ($150,000).

Once a laser disc or CD has been mastered the distribution cost is small. Making the original disc is still done by only a few companies and very expensive. However, each additional CD costs only about seven dollars to produce. The music CD recording business has helped drive down the cost. If an IVI application can be used at many locations to spread out the costs, it is much easier to cost justify.

E. COST-EFFECTIVENESS CONCLUSIONS

Before we can decide if something is cost-effective we must know how much it costs and if it is effective. Currently we can't reliably measure the effectiveness of either CBI or conventional instruction. The increased speed and improved scores achieved with CBI are important measures but not the whole story.

Measures that really count in the Navy are: How much does the student remember once he gets to his job? How well can he do his job because of the training? How well can he apply what he has learned? We don't know how long students retain what they have learned or if CBI achieves higher retention than conventional classroom instruction.

The Navy doesn't have any way to measure the performance of the students training once he is at his gaining command. Evaluations measure a lot of things but they don't measure how well the training stayed with the student.

Neither the Navy nor anyone else has an adequate data bank of information on the costs of education. We haven't separated the various training costs to apply them to the different training programs. We know the start up cost of a training program that is technology based is high, but what are the costs associated with a long term training program? The life cycle costs of training programs need to be studied. What are the cost advantages of having a CBI course that is the same everywhere so that all graduates have been taught exactly the same information?

Recent studies to resolve some of these questions are not apparent. In electronic mail from Jesse Orlansky I received the following answer to my question on recent cost-effectiveness studies: "I know of no new info on cost data, cost factors or instructor attitudes. All of this should strike you as curious. Me too." (Orlansky, J., 13 Nov 1987) Apparently no new studies have been done. If CBI is to be able to prove its cost effectiveness, there must work done to get more meaningful information

V. IMPLEMENTATION AND USAGE

Implementation of CBI, assuming everything else is done well, can still make a good CBI course fail. It is in implementation that the user finds out that the designer forgot to take certain critical factors into account. The Navy has had its share of implementation mistakes. Many of the mistakes are common to CBI.

Problems that have come up when the Navy has tried to implement various CBI programs or systems and some of the things that are being done to improve the situation merit attention.

A. IMPLEMENTATION AND USAGE PROBLEMS

As often happens with a new technology a lot of promises are made about its efficacy, people get excited and immediately start using it. Part of the problem with any new idea or technology is that no amount of experimentation will remove all of the difficulties associated with its implementation and use. This has certainly happened and is still happening with CBI. Some times these problems are referred to as growing pains. Unfortunately these growing pains can, on occasion, be fatal if they are not understood and handled properly.

When CBI was first introduced into education it was advocated for all subjects. It was thought that CBI would be the best solution to all educational problems. This initial enthusiasm has since been tempered with a little reality. Research is still on going to see which areas can best utilize CBI.

Computer-aided instruction was, perhaps, the first type of CBI to be widely used. CAI was basically a computerized page turner for programmed instruction. This led to self-paced instruction where the students were allowed to finish as quickly as they could. This also meant that if a student didn't want to finish quickly he could go slowly and take more time than he really needed. Some students took advantage of the situation and went slowly to stay in the school as long as possible. So long as they were making progress they were allowed to stay. This held true for any self-paced school such as the CMI courses. More careful monitoring of the students has helped this problem.

These self-paced programs clearly brought to light the massive scheduling problems associated with students graduating at various times. Conventional instruction scheduling problems were easier to manage. If a recruit finishes his course early, is he going to be able to immediately go on to a follow on school or to his next assignment? Can he get orders? Is the next phase of the training flexible enough to start when he is finished? Can he start a new course while he is waiting for the course he is scheduled to take? The recruit who is just waiting derives no benefit and neither does the Navy if he can not be productively employed. With students finishing courses at different times, can we get them to a new class? Can the schedule be made more flexible? More simply what do we do with the student who finishes his course early? (Montague, W.E., 30 Sep 1987) This is not a problem if all of the courses are self-paced, since the student can move on to the next course without interruption. Self-paced instruction mixed with conventionally taught courses has exacerbated the problem. CBI can provide a solution. Short, self-paced courses, can be used to fill in the waiting time. At the same time they would allow the student to gain useful knowledge.

With any self-paced learning program student motivation is of primary importance. Some type of incentive is needed to get the student to want to finish the course quickly. Many things have been tried from incentive charts or graphs of student progress to large doses of positive feedback from both the computer and the instructor. (Van Matre, N., 1980, p. 9)

Barbara McDonald is heading a research project at NPRDC to determine what works best to motivate students in a learning environment. The project applies to both conventional and computer-based learning. (McDonald, B., 28 Jan 1988)

A common reason for poor performance by students using CBI is that they have not been taught the correct way to use it. (Dobrovolny, J.L., 1987) This lack of knowledge frustrates the student. Not only don't the students know how to use CBI, in many cases the instructor doesn't know how to teach it. There has been no role model for instructors to follow. The instructors are not given adequate training in the use of CBI in the classroom. Many instructors, having been taught in a regular classroom environment, do not trust the computer and are resistant to the new technology (Korbak, M. Jr., 1984, p. 97). Resistance to change and the need to provide worthwhile incentives for the students to do the course are frequently overlooked areas. When new technology is involved, the resistance to change is often high.

The writing of CBI programs has not had a good start. In several of the Navy's courses the user interface was either poorly designed or so cumbersome that it inhibited some users from using the software (Perry, N., 15 Jan 1988; Montague, W.E,, 14 Jan 1988).

A simple user interface is especially important in CBI where the user may not be sure of himself or the computer. Imagination is a prime prerequisite for any course. With CBI, imagination is especially important. Writing good computer programs is difficult. Writing good educational material is also difficult. It is rare to find both skills in any individual. Only recently has the Navy begun trying to put the two together. Making a good CBT course should be a team effort.

> ...producing a CBT course is no less complex than producing a movie, and it's certainly more complex than producing a book. Yet if we look at the book industry we see that publishers employ designers, illustrators, editors, typesetters, and a variety of other support staff to help authors produce their manuscripts. Anybody can't do CBT working alone; it takes a number of people with a range of skills. (Heines, J., 1985)

The Navy has always let its sailors stationed at schools write the conventional instruction material. In this manner the latest information from the fleet was incorporated into the training programs. Unfortunately, these subject matter experts were rarely educational experts. They were given rudimentary methods for writing instructional material and expected to do well. Some very good courses resulted, but most often it led to very poor courses. (Montague, W.E., 1984, p. 7) Some of these courses were then rewritten into CBI courses with little change. It is easier to use what you have than to do a complete rewrite. A CBI course can't rephrase part of a lesson, until it is understood, as an instructor can when it becomes obvious the student doesn't understand. Some material that became CBI, although good information, was not presented well. In some cases it was not appropriate for computer presentation.

When CBI was first introduced in the Navy there were few good examples of what CBI should look like. This is still true today. Much commercial CBT courseware is developed under proprietary agreements and is generally not available for review. We need to combine programmers with educators to make good programs. Occasionally programmers may lose sight of the basic requirements, "...such as the ability to express ideas clearly and concisely in English," in the attempt to make the program efficient (Hassett, J. and Dukes, S., 1986, p. 36).

A few years ago a program called Passive Acoustics Analysis was used at STG "A" school in San Diego. It was not successful for several reasons. One of the problems was that the program tried to do too many things. It was designed to output graphs on a screen projector. The graphs were not clear enough to be seen well on the screen. The basic graphs or lines on a chart worked OK, but once the graphs became more complex there wasn't enough resolution on the screen to make out detail.

Students quickly required detail to the point where the resolution was not good enough to be useful. In addition the program did not allow the instructors the capability to answer "what if" questions, e.g., What will the graph look like if the ship turns? In addition all of the programs capabilities were not used. The instructors were not well enough versed in the full use of the program. The developers could use them but the regular instructors could not. (Hayes, W., 23 October 1987)

This is a classic example of not training the trainers. Many CBI programs have been poorly received because the instructors were not familiar enough with them to be comfortable using them. The instructors need to be involved in the implementation. When CBI is written, it is done with the student in mind and little or no thought given to the instructors role. This has led to poor acceptance by the students as well, because instructors unfamiliar with the courseware will hesitate to use the CBI.

Instructors should be responsible for the military orientation and discipline no matter what training method is used. Even with CMI the students are not left alone for the entire school day to do as they please.

> There has been a concern that in using CMI students became too independent, and their "military" orientation and discipline suffered. There are no data I know of to substantiate that. (Montague, W.E., 12 Jan 1988)

When micro-computers became available, the Navy began to use them for CBI. The same principles that apply to CBI for a mainframe apply to a micro-computer, the micro-computer is just more portable and costs less. It was thought by a lot of people that micro-computers would make everything easier. Full utilization of micro-computers hasn't occurred and some of the reasons are:

> There are at least three problems with the uncritical use of "modern" microcomputer-based instructional systems: First the computer is often relatively superfluous, i.e., the materials and testing on the computer carry the major instructional function; the computer simply delivers them and keeps records...Second, the computers capability to simulate tasks and problems, and carry on an intelligent interactive dialog with a student is seldom seen. And third, the developers of micro-CBI have about as much training in the proper analysis, design, and development of instruction as other instructional developers today; that is, little or none. Therefore the resulting CBI is not likely to be much better than other versions of the instruction. (Montague, W.E. and Wulfeck, W.H. II, 1983, pp. 8-9)

According to Bill Hayes at Chief of Naval Education and Training (CNET) there have been several problems getting programs to the fleet. He said the initial iteration of one CBI program sent to the fleet wouldn't run on the Zenith Z-150s. The software also needed an enhanced graphics adapter (EGA) card. Most Z-150s did not have EGA, the ships didn't want to pay the additional money for EGA boards. The software was returned to CNET unused. Currently the Navy is buying the Z-248 which has enhanced graphics capabilities. (Hayes, W., 23 October 1987)

Another reason for standardizing on the Z-248 is the complexity and size of many of the new CBI packages. Doug Wetzel of NPRDC is working with CBESS (Computer Based Educational Software System) a set of four CBI packages to be used on the Z-248:

(1) Computer Based Memorization System (CBMS)
(2) General Computer Based Instruction (CBI) Package
(3) Language Skills Computer Aided Instruction (LSCAI)
(4) Equipment Problem Solving Trainer (EPST)

There is a common configuration file for five different graphics cards to alleviate problems in that area. Some of the programs do require an EGA. An XT style machine like the Z-150 leads to student frustration because it is not fast enough to run these programs and takes too long between questions and answers. A floppy disk also takes too long to run the programs because of all of the disc accesses needed. Therefore a hard disk drive is needed for increased speed and to hold the large data base used in some of the programs. The problem solving program requires a specific mouse to run properly. If a video disk is to run with one of these programs a Media Graphics card is also needed. (Wetzel, C.D., 20 Jan 1988)

According to Nancy Perry, of CNET, this standardization problem is being addressed right now. It is much easier to make programs like CBESS for one machine with standard features than for several. CNET has asked LANTFLT and PACFLT to standardize on the Zenith Z-248 with the EGA card to simplify the problem. LANTFLT agreed, but PACFLT is studying the issue. (Perry, N., 15 Jan 1988)

Programs that have gotten to the fleet include a maneuvering board program which Operation Specialists (OS) can use as well as officer bridge watchstanders. The program had been tested and is well done. However, in order to see how well people would do with the program a recordkeeping section was added to the front. Prior to using the program the student was required to enter some information about himself. The record-keeping section is daunting to some of the less computer literate who wanted to use the program. Consequently it was not used as much as it might have been. The record-keeping section is currently being changed to make it simpler. A program which intimidates the people who need to use it is not useful. Another program on Rules of the Road has also been developed without the recordkeeping front end and has been accepted readily. (Perry, N., 15 Jan 1988). Two other packages are nearly ready for the fleet: one on Threat Recognition and another on Engineering Management. What has been learned on the first programs is being taken into account with new programs like the CBESS set.

People trying to use new software, knowing they will use it only occasionally, won't bother to read the documentation. If the program is too difficult to learn they will usually give up. This is part of the reasoning behind many of the game programs used in education. They are simple and keep the user interested. Only if the individual feels they will use the program a great deal, or if it is in their best interest to learn it, will most people bother reading the documentation. Adults are generally motivated to learn something that they feel will help them with their job.

CNET has a lot of experience setting up lecture type classes. Computers and CBI present different problems. CNET is still learning how to set up a CBI training program. It took them a year to set up the maintenance contract for computers used in training courses. For the shipboard environment spare parts should be stocked onboard and supported by the Navy Stock System. Parts, like disk drives and replacement boards, should be available. A preventative maintenance system needs to be set up on board ship to see that the micro-computers are kept in working order. We are not there yet. (Montague, W.E., 30 Sep 1987)

B. IMPROVING IMPLEMENTATION AND USAGE

CBI is not appropriate for all instruction. Some classes are better taught by people. There are specific times, like memory drills, when a computer can be used to great advantage. Rather than computerize an entire curricula only specific modules that are well suited to CBI should be computerized. In those cases the Navy should implement CBI whenever possible.

> Courses with long average holding times for students might use some form of CBI for course-relevant pretraining, remediation, enrichment, or other form of individualization...courses in which a substantial number of students are set back or do not reach criterion on the first attempt complicate student management. Students in these courses may require additional instructional delivery and more individual attention...courses in which there is a disparity between completion times for "fast" and "slow" students are also good candidates for CBI such as management, or remedial or enrichment programs...inadequate terminal and/or enabling objectives indicate that a substantial course revision may be needed...this revision would be a good opportunity for using CBI...a large number of students entering a course without prerequisite skills suggest the need to develop remedial programs to correct the deficiencies. CBI should be considered as a vehicle for diagnosing the need and providing the remedial programs...CBI should be considered as a vehicle for meeting the special needs of students with low reading and math level scores...Courses required to generate many reports should be considered for CMI...In general, CBI is applicable in any situation calling for attention to individuals. (Wetzel, C.D., Kekerix, D.L. and Wulfeck, W.H., May 1987, pp. 4-24)

Courses requiring either a lot of practice or exact responses should be considered for CBI. If a computer is already in use, CBI could be added without any hardware expense. Any course with a lot of procedures to be learned or where time compression allows events to occur quickly would be appropriate for CBI. The student can see the results of his actions without waiting a long time. (Wetzel, C.D., Kekerix, D.L. and Wulfeck, W.H., October 1987, p. 18)

We still need to improve the instructional quality of conventional and computer-based training. The Navy is standardizing CBI programming techniques and incorporating proven techniques in all courseware. CNET is presently working on an instruction to make them the clearing house for all Navy CBI (Hayes, W., 23 Oct 1987). This will help standardize CBI and prevent duplication of effort.

The CBESS series of programs is designed to be reused with other training courses easily. The CBMS memorization program, for example, has been designed to work with other data bases. CBMS works with words and definitions, anything where memorization is the goal. The CBESS General CBI package is designed to be used when a question and answer format is needed to develop programs. The General CBI package has several templates that can be used for interaction between the program and student. (Wetzel, C.D., 20 Jan 1988; 28 Jan 1988)

Currently EM 'A' school in Great Lakes is developing a model classroom. They are trying to incorporate the best practices in training from beginning to end. As they learn more, they will update the program. They will continue to improve the classroom whenever possible. A great deal will be learned about implementing new learning practices and their effectiveness. (Hayes, W., 23 Oct 1987)

Lessons learned about CBI apply equally well to Interactive Video Instruction (IVI). The main difference is that IVI has been used even less than CBI. The video disc or CD-ROM can be used to great advantage as a reference book. The combination of text, pictures or video and sound, accessible from a micro-computer, has great potential. Microsoft has recently released a CD-ROM disc with a great deal of useful information for people who write. Microsoft's disc, Microsoft Bookshelf, a collection of ten useful reference tools all on one disc. It includes the entire American Heritage Dictionary; The World Almanac; U.S. Zip Code Directory; The Chicago Manual of Style; Roget's Thesaurus; Bartlett's Familiar Quotations; Houghtlin Mifflin Usage Alert; Spelling Verifier and Corrector; plus an extensive collection of letters, outlines, forms and business information sources. It isn't a big technological breakthrough just a big time saver. It puts all the information at your fingertips and allows easy access to all ten books. The technology could be used to store bulk reference material at training sites. It allows the storage of up to 250,000 pages of text on one CD-ROM disc. The usage of IVI has great promise and has been used to great advantage. The Navy will need to look at CD-I and DVI, interactive extensions of the CD-ROM technology, and decide how we can best use them.

CNET is investigating the possibility of acquiring two vans, one for each coast, and putting 15-20 CAI stations in each. Two stations are to be reserved for video tape programs and possibly another two for IVI. The vans will be used to try out new CBI packages that are developed for the ships. This will allow some feedback before they are sent out to all the ships in the fleet. The vans will also provide training for ships without compatible hardware to run the programs. Compatible hardware should not be a problem much longer. The use of the vans will ensure that there are some people on board the ship who can run the CBI software. The van can be driven between ports (i.e. from Norfolk to Charleston) to allow more people a chance to use it. (Hayes, W., 23 Oct 1987)

To help shipboard implementation several other things could be done. The first is to be sure that someone on board is trained in the maintenance and repair of the micro-computers. The Electronics Technicians (ET), Aviation Electronics Technicians (AT) and Data Systems Technicians (DS) have the requisite skills.

Secondly, because of the problems many sailors continue to have with CBI, a person needs to be available for assistance. Setting up a micro-computer the first time to run the courseware may also require some special knowledge. A CBI course could be developed to train this individual to assist the students and to setup the computer. The CBI course will eliminate the need for an additional school to train a CBI instructor. As computers become more common in the next few years, it will become easier to find an individual who can help set up the computers properly and assist novice users without a special course.

VI. EFFECTIVENESS AND CBI

The purpose of military training is to provide the student with the skills and knowledge required to do specific tasks. He must be able to do them in a low stress peace time environment and in a high stress combat situation. The effectiveness of different methods of instruction must be evaluated against how well students, trained by any method, perform their duties. In the Navy, the measure of effectiveness must ultimately be related to performance on the job, in an operational billet. How do you objectively measure performance on the job, based on the training received?

At present there are only two measures of effectiveness used for any type of training. They are the speed with which a student goes through his course and the score he achieves on the test he takes at the end. Do these two measures of effectiveness really tell us how well the sailor is going to do on the job? No, but at present they are the best indications of effectiveness that we have.

A. WHAT IS AN EFFECTIVE COURSE

In the last 20 years many evaluations have been done comparing the effectiveness and efficiency of CBI relative to standard, fixed-time lecture courses. Most of the studies compared computerized versions of programmed instruction with content delivered by lectures and texts. Today most CBI is not programmed instruction.

The evaluations make some basic conclusions about CBI effectiveness: 1) some gain in effectiveness using achievement tests as the measure, 2) overwhelming evidence that students completed the material faster, 3) CBI provided better management of the students. Increased their time available to use the equipment and allowed for more access to instructors, 4) CBI provided the chance to practice unusual (in peace time) or dangerous events. (Montague, W.E., 1984, p. 2)

The effectiveness and efficiency gains did not result simply from using CBI. Using a systematic approach for design of the courses and allowing the students to progress at their own learning rates contributed. In the military, where course materials and tests address training objectives derived from job-task analysis, gains in student performance would not be expected. However, time savings compared with conventional courses would be expected.

The initial evaluations were valid for what they tested but they were too limited in scope. An effective Navy training course is one where the students learn what they need to know, to be more effective in their job. There is no method of evaluating training courses that does this. We need to look at job performance to learn what makes effective training?

> Effective instruction depends on determining what is to be learned, not just at some gross "top" level, but in sufficient detail so that intermediate learning requirements for the eventual development of expertise can be identified. Effective instruction also depends on being able to contrive situations and interchanges to promote student learning. (Montague, W.E. and Wulfeck, W.H. II, 1983, p. 2)

It is necessary to identify exactly what it is we want the student to know before we can teach them. Identification can be one of the hardest tasks in development.

In a hypothetical course the student should be able to repair a radio transmitter at the end of the course. It is a difficult and time consuming job to delineate all of the steps necessary to teach someone, who has never seen a radio transmitter, to repair one. After we are satisfied that the course does what it is suppose to do, effectiveness can be discussed.

Course effectiveness depends on the consistency between the training requirements, both terminal and enabling course objectives, and how the instruction is presented. Much of the time, even though we know what knowledge or skill we want the student to have when he is done, we don't teach it.

> Instruction is usually "topic oriented" in that it tells about something (e.g., how a radar operates) rather than being "performance oriented," which tells a student how to operate the radar. The learning is usually evaluated systematically, and training adequacy is judged in terms of what students say about it. (Montague, W.E. and Wulfeck, W.H. II, 1982, p. 2)

Even though the course taught the student how a radar operates the course was in essence ineffective, because what we wanted him to learn was how to operate the equipment.

Another factor that needs to be considered, before a course is developed, is the audience of the course. A novice will require a completely different course, in many cases, from the person who has had experience. A refresher course should be different than a beginners course.

Bill Montague related an analogy to the difference between a course designed for the novice and one for the experienced student. A cookbook designed for chefs had a recipe for mayonnaise six lines long plus the list of ingredients. In another book, intended for less experienced cooks, was another recipe for mayonnaise that was 13 times longer. He said that even this longer recipe might not be adequate for the complete novice. The second book still did not explain certain basic things, like how to separate the yolk from the white without breaking the yolk, even though it was 13 times longer. (Montague, W.E., 28 Jan 1988)

Problem solving is the goal for most teaching and training. The logic of problem solving is what we need to teach, but often do not. We teach knowledge often not related to the real world. To interest the student, and show how things work, lessons need to be put into context.

Bill Montague of NPRDC described tests that were developed for an "A" school. The tests were designed to see if the students could trouble shoot, a goal of the school. They were different than the school's criterion-referenced test (CRT). (A CRT consists of questions that are intended to measure specific skills or knowledge.) The questions asked were comparable to "If you walked into a dark room what would you do to find out why the power is out?" The students, who had already passed the CRT, only scored in the 50-60 percent range. This is compared to the 85 percent required to pass the CRT they had taken earlier. (Montague, W.E., 28-29 Jan 1988)

It was thought the CRT was an accurate measure of ability to trouble shoot and that students would do equally well on the new test. These tests indicate not as much knowledge about trouble shooting as was thought had been learned. The canned problems, they did in the course, were designed more to allow the student to pass the CRT than learn to trouble shoot. A criterion-referenced test depends on content for validity. Each test item is meant to measure whether an individual has the required competency. The canned problems worked well enough to pass the CRT but were not good enough to help the student do more general trouble shooting. (Montague, W.E., 28-29 Jan 1988) An effective course should teach the student to trouble shoot well enough so that the students would have little trouble with a new test.

An effective CBI course should enhance and improve the usage of student/instructor time. The student should be able to use his time to the best advantage to learn the material. The instructor should have more time to spend with individual students, helping them learn higher order skills, like problem solving, which are more difficult to teach using CBI. The instructor should be able to help the students who are having special problems. In most learning situations there are a few who need special attention. CBI should allow the instructor to work with them.

Much work done with various technologies indicates that it is not the media that is most important in learning. Instruction methods are the most important aspect of any training to foster learning. We need to concentrate on methods and learning styles to develop effective instruction. At present, job relevance is often ignored and the instructional methods are selected because they are available, not because they are effective.

B. IMPROVING EFFECTIVENESS

The Navy can't make more effective conventional instruction or CBI without knowing more about learning strategies.

One of the problems of learning-strategy methodologies is that they have not been tested enough in actual training settings with adult learners. The tests are usually done with college students in research studies at universities. This is a much different environment than a Naval training center. This research showed that merely introducing effective learning methods is not sufficient, a great deal of practice is required by the students. Often ineffective learning habits must be replaced. This is especially difficult for adult learners whose learning habits are deeply ingrained. (Kearsley, G., 1984, p. 124)

The Navy has adopted the Instructional Systems Design (ISD) methodology for doing instructional design and development. There are proceduralized guide books that support ISD and its management. They give help analyzing, designing, developing, evaluating and implementing instruction. One of the major problems with ISD is that it depends a great deal on the designers expertise.

> Military-curriculum design efforts are continually handicapped by shortages of experts to conduct training-program design and development, poor analysis of how to match training to jobs, inadequate prescriptions for deciding how to train, inadequate performance measurements, differences in student skills and motivation, problems in managing training courses, and problems in planning the use of computers and simulators in training. It is important to recognize that these problems all stem from fundamental inadequacies in our understanding of how people learn and, therefore, how to teach them. (Montague, W.E. and Wulfeck, W.H, II, 1986, pp. 1-2)

Another problem is that the ISD methodology is long on "what to do" and short on "how to do it" (Montague, W.E., Ellis, J.A. and Wulfeck, W.H. II, 1983, p. 1). ISD's explanations leave something to be desired for the inexperienced curriculum or lesson designer.

The Instructional Quality Inventory (IQI) is designed to supplement the military's ISD method. It focuses on test items, objectives and linking the instruction to the objectives. "IQI uses a scheme that classifies objective, test items, and instructional presentation" (Montague, W.E., Ellis, J.A. and Wulfeck, W.H. II, 1983, p. 2). Objective and test items can be classified according to what the student must do (task) and the instructional content (what must be learned). An automated version of the IQI could speed the internal review process and facilitate improvements and corrections.

Even with ISD and IQI, judgments about adequacy of instruction still rely on the designers knowledge of instructional practice, and of relevant psychological and educational research. There is a lot of educational psychology used to write CBI. Things as simple as using too much color or too much humor can detract from learning. In a CBI lesson humor is not the same as in a conventional classroom course.

Computer-based aids can reduce the apparent complexity of instructional design. They can do the more mundane tasks, allowing designers to pay more attention to the difficult tasks of analysis and design. Automated aids for instructional development and evaluation are currently being developed for CBI and conventional instruction.

An authoring system is a software program written for a non-computer oriented individual, so that he may write instructional lessons using a menu-driven series of commands.

An authoring language is a computer language with the capability to control various devices such as videodisc players. These authoring systems with their authoring languages are not just for writing CBI, but also for writing conventional instruction. Commercial authoring systems have proliferated in the last few years. "We've gone from twelve systems in 1982 to 68 last year--and the 1987 guide lists 93" (Data Training, April 1987, p. 28).

AIM is an authoring system developed at NPRDC and used at various commands in the Navy, however it is not designed to write CBI. The CBESS system of programs are designed to help write better CBI programs.

Many authoring languages for CBI are less capable than needed to write really good CBI. While writing about authoring languages used with IVI, Nat Kannan said that authoring software must have, at a minimum, the following characteristics:

> 1) It should be easy to use and yet allow creative flexibility.
> 2) It must harness the very interactivity of the medium in assisting in the creative process of design.
> 3) It should be infinitely malleable and flexible to permit the creation of the most elementary to the most advanced applications.
> 4) It should not attempt to promote a single theory.
> 5) It must allow access to the riches of outside software designed for microcomputers.
> 6) It should allow the author the freedom to mix and match different hardware components.
> 7) It should allow the creation of embedded expert systems such as the intelligent tutoring system.
> 8) It should be dynamic and accommodate new hardware as the technology evolves.
> 9) It should be useful at all stages of application development.
> 10) The software should evolve constantly in new directions by taking into account the needs of the authors. (Kannan, N., 1986, pp. 18-19)

Using these tools will help the development of better CBI and conventional courses. Once a good CBI course has been developed the Navy needs to collect the software in a library for reuse. CNET is a possible location for a CBI library. The CBI software needs to be written so that it is sufficiently flexible to support development and management to meet many instructional requirements. It should be easily transportable to other programs and machines. The reuse of proven code could speed the development of courses tremendously. This would facilitate making better courses and cut the costs of development, making CBI more cost effective.

Many studies have shown that a great deal of what we learn is forgotten in a relatively short period of time without constant use. Repetition is a key to maintaining a superior level of knowledge and making any instruction more effective. Frequent refreshers are needed. CBI on a micro-computer is good for asking questions that wouldn't normally be asked, enabling identification of weakness in the students knowledge. It is faster than studying by yourself, so more information can be covered in a short amount of time. It has also been shown that spacing out learning over several short time periods is more effective than learning something all in one large time frame. Once a sufficient body of CBI software has been developed to run on the Zenith Z-248, refreshers can be done at frequent intervals onboard ship. This will allow the material to be learned in smaller chunks, thereby facilitating learning.

VII. SUMMARY AND CONCLUSIONS

A. SUMMARY

The purpose of this thesis was to investigate CBI in the Navy and determine what is being done today. Primary areas of concern were cost effectiveness, implementation, usage and the effectiveness of Navy CBI. Primary sources of information were papers written within the last 10 years, personal interviews and phone conversations.

B. CONCLUSIONS

Computer-based instruction is a valuable tool in Navy training. It can be even more valuable in the future. Much of the learning research done to improve CBI and IVI will also make conventional instruction better.

Computer literacy in the Navy is still at a very low level. Despite the growing number of computers in business and in the home there are still relatively few around. A large variety of computer abilities exists. The Navy needs to assure that there is at least one competent, computer literate individual at every command, several would be better. A computer literacy course needs to be developed to teach a command microcomputer manager or CBI manager, if not both. It could be as simple as a CBI course, or school, lasting a few days, to teach how to use the machines. I recommend a CBI course so each ship could have one. The course should be simple enough that no prior experience with micro-computers is needed. A set of standard set up and operating procedures, for CBI courses on micro-computers, should be adopted. The course should, at a minimum, cover basic commands needed to use CBI courses. This course should also include detailed installation instructions for CBI courses, things like how to write batch files and how to install a program on a hard disk. (Many courses require a hard disk in order to run.) Future courses should be written to comply with procedures taught in the course. Courses already written which don't fit the standards should be rewritten, to conform to standard CBI operating procedures.

To facilitate the standardization each test site, and sites where CBI is written, should be using a standard machine and standard operating system. This needs to be done so all programs written will be portable to any location in the Navy.

Automated support for ISD, IQI and other authoring aids need to be developed and used to obtain quality and effectiveness improvements in CBI. More work needs to be done, to discover the best learning strategies, so CBI can be used to its best potential. Instructional technology and learning strategies need to be included, as much as possible, in these instructional aids. Guidelines need to be developed delineating when CBI, IVI, simulators or conventional instruction is most appropriate. More needs to be done with simulators for maintenance and operator training. Simulators need to be thought of as training devices, and included when applying learning strategies to Navy courses. These suggestions should make both conventional and computer-based instruction more efficient, consistent and effective.

Decisions need to be made about the tradeoffs involved in the fidelity of the simulation compared to the effectiveness. When an exact duplication of equipment is needed it should be used, but in many cases lower fidelity simulators (training devices) will be much cheaper and very effective to train certain jobs.

The Navy needs to concentrate on better, rather than more, CBI. Bad programs only turn people against CBI. They make acceptance of the good course harder. When quality is high, then and only then, should quantity become a high priority.

Two of the biggest advantages of CBI on micro-computers are convenience and consistency. If all Navy commands had micro-computers then CBI, initial and refresher training, could be done anywhere there was a machine available. Everyone would be using and learning the same material. This could save a lot of TAD money for special schools. The possibility of remote testing and training would allow more instructors to be at sea. With CBI courses at every command, the number of students able to take a course would increase. With sailors using their free time doing CBI courses, to get ahead, there might be a decrease in social problems encountered at sea. In addition, successful completion of certain CBI courses could be prerequisites to shore command schools, ensuring a higher and more consistent level of training at the school. This would allow the schools to specialize in the areas where an instructor or conventional instruction is the preferred method of instruction. Schools with CBI prerequisites could be shorter, cutting costs.

With programs like COGENT, administrative support could be provided for many schools. They could relieve a great deal of the administrative and clerical functions provided by the school. Schools with high and low student throughput could benefit from computerized record keeping. Commands should ensure that a computer supplied for training does not get preempted by the office staff for paperwork. A training computer should be reserved exclusively for training so that it is available when needed. If that is not possible, a system of timesharing needs to be worked out.

More studies on training effectiveness need to be done. Decreased course length is a good measure of effectiveness but measures related to job performance need to be developed. We can't truly know what is the most effective method unless an objective system is put in place at gaining commands to evaluate the effectiveness of training programs.

One area that needs to be explored more is distributed training systems. Training can be conducted on micro-computers in small commands linked to larger computers elsewhere. This link could be done either through land lines, satellite or both. Many civilian companies are beginning to use satellite hookups to hold seminars and other one time training requirements. Satellite hookups could include ships, overseas bases or small stateside bases. To offset or justify the cost of these technologies, benefits should be quantified and demonstrated if possible.

Technology doesn't, by itself change instruction. It only permits change to take place as it is incorporated into training. Initially many problems are encountered using a new technology like the computer, as happened with the airplane and the car. In time, we learn more about how the technology can be used to help us make life easier or solve problems. As a technology matures many of the original problems disappear. I believe that within ten years, as computers become more integrated into our everyday lives, very few of the problems we have with CBI today will be with us. More capable computers will allow more capable CBI programs to be written. Ten years from now most, if not all, of the Navy's instructors and students will be familiar with computer technology. The resistance to and fear of computers will be gone. Learning strategies for use with computers, and without them, will be better understood. We will know when a computer should be used and when a conventional classroom is better and be using them properly. CBI will be the method of choice for many types of instruction and integrated with classroom teaching where appropriate.

The Navy must take care to see that CBI implementation is germane. With the rapidly changing world around us, and the growing dependence of the military on high technology, we need the most effective training we can get. CBI has the capability to decrease the time needed to learn and at the same time learn as well or better, than conventional classroom instruction. Computer-based training is the best way to meet many of our training needs in the future.

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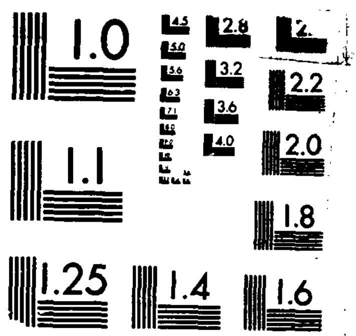

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