AFHRL-TR-90-33(II)

AD-A228 044

AIR FORCE

HUMAN RESOURCES

INSTRUCTIONAL SUPPORT SYSTEM (ISS): AN OVERVIEW FOR MANAGERS

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September 1990

Final Technical Report for Period October 1985 - March 1990

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NOTICE

This report has been reviewed and is approved for publication.

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1990	Final Report - October 1985 - March 1990

4. TITLE AND SUBTITLE
Instructional Support System (ISS): An Overview for Managers

5. FUNDING NUMBERS
C - F33615-85-C-0011
C - F33615-88-C-0003
PE - 62205F
PR - 1121
TA - 10
WU - 34, 43

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Training Systems Division
Air Force Human Resources Laboratory
Brooks Air Force Base, Texas 78235-5601

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFHRL-TR-90-33(II)

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This report describes several efforts that led to the development of the Instructional Support System (ISS) from prototype research and development (R&D) software toward a production computer-based training (CBT) system that supports both computer-assisted instruction (CAI) and computer-managed instruction (CMI). These efforts included the operational test and evaluation of the software, rehosting of the software to a validated Ada compiler, development of MicroCMI and interactive videodisc capabilities, development of critical user and system documentation, and design and development of a micro-based version of the software to run on IBM-compatible hardware. ISS is a Government-owned product written in Ada in a modular format, enabling it to run on machines ranging from micros to mainframes, and is available through the National Technical Information Service (NTIS).

This is the second of three volumes on the Instructional Support System (ISS). Volume II contains an overview of ISS to assist managers in determining if ISS is the best medium for their specific needs.

14. SUBJECT TERMS
Ada
computer-assisted instruction
computer-managed instruction
instructional support system
transportable instructional system

15. NUMBER OF PAGES
24

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

SUMMARY

This document provides training managers and administrators with information on major features of the Instructional Support System (ISS). The overview assumes that the training manager has a general understanding of computer-based training (CBT), but that further information about ISS is needed before intelligent decisions can be made regarding its suitability for a particular application.

Chapter I describes ISS and provides a brief history. Chapter II details the wide range of instructional and management capabilities available with ISS. Chapter III provides technical specifications, including software, hardware configurations, interfaces, and professional staff requirements. Support features available with ISS are addressed in Chapter IV. Chapter V discusses essential factors to be considered by a training manager before selecting a CBT system. A glossary of terms follows the overview.

PREFACE

This is the second of three volumes on the Instructional Support System (ISS). This volume contains an overview designed to assist managers in determining if ISS is the correct medium for a specific training application.

The Overview for Managers provides training managers and administrators with information on major features of the ISS. This document is designed for those training managers with a general understanding of computer-based training (CBT). It provides specific information regarding the suitability of ISS for particular training applications.

TABLE OF CONTENTS

LIST OF TABLES

INSTRUCTIONAL SUPPORT SYSTEM (ISS):
AN OVERVIEW FOR MANAGERS

I. INTRODUCTION TO ISS

The Instructional Support System (ISS) is a computer-based training (CBT) system available to Government agencies. ISS combines both instructional and management capabilities into one system, facilitating the creation, delivery, and management of instruction for students and instructors alike. ISS is Government-owned and is written in Ada, a standard Department of Defense (DoD) programming language. Using Ada enables ISS to be transported to a variety of machines, ranging from mainframes to microcomputers.

The modular construction of ISS makes it possible to load the entire system simultaneously or in portions, depending on the user's need. In addition to simplifying user access, the modular components facilitate software maintenance.

Creating courseware also is facilitated with ISS. Because ISS uses interactive menus and prompts for creating courseware, instructional developers need not know a programming language.

A similar set of menu-driven management editors increases training program control and efficiency. Management capabilities within ISS include creating tests, enrolling students, logging-on students, assigning lessons automatically, tracking resources, monitoring students, evaluating course materials and/or student performance, and generating student performance data.

Furthermore, ISS accommodates a light pen, mouse, and touch panel. ISS also interfaces with videodisc players and graphic overlay devices.

A Brief History

In the early 1970s, the Air Force Human Resources Laboratory (AFHRL) initiated a research and development program to explore CBT. Although a few commercial systems existed at that time, none of them met Air Force needs. The Advanced Instructional System (AIS) was designed to train and manage a large number of students using a mainframe computer. AIS implementation was highly dependent on the hardware and software available at the time.

In the early 1980s, microprocessor technology emerged, along with alternative CBT configurations. To capitalize on the new hardware and software developments, ISS became the successor to AIS. The Air Force accepted ISS as a prototype on the VAX 11/780 minicomputer in October 1985. In 1986, the Strategic Air Command at Dyess AFB, Texas, served as the operational test and evaluation site, using ISS to develop B-1B aircrew training.

ISS was rehosted from an early Ada compiler to a validated Ada compiler in September 1986, making it a more stable and maintainable product. Several management enhancements were added. A training package was developed in-house that provides on-line instruction for developing courseware.

An on-line training package for designing and managing curricula using ISS's management component has been developed. In addition, the application software has been documented to facilitate transitioning the software to a long-term support agency.

An interactiive videodisc capability was integrated into ISS in 1988. In addition, management software has been developed which is compact enough to run on microcomputers, yet powerful enough to track student progress and preserve data required to evaluate instructional effectiveness.

ISS has been rehosted to the Zenith 248 and Micro VAX II. The Zenith 248 version may be networked, allowing several workstations to access the same database residing on an Operating System/2 (OS/2) server. Because the Zenith 248 venture was successful, ISS could provide the basic architecture for a common Air Force-wide CBT system.

II. ISS COMPUTER-BASED TRAINING CAPABILITIES

As a CBT system, ISS is divided into two major functions: computer-assisted instruction (CAI) and computer managed instruction (CMI). In this overview, these two major functions are referred to as instructional and management capabilities, respectively. The instructional capability provides the development and delivery of courseware on-line, while the management capability controls instructional resources and tracks student progress.

Instructional Capabilities

ISS instructional capabilities allow non-programmers to develop exciting and interactive courseware which addresses individual student needs. Five separate capabilities deserve comment: text presentation, graphics, student interaction, individualization, and simulation.

Text Presentation. By using an instructional editor, courseware authors create text by engaging in an on-going dialogue with the system via the use of menus. The text, in turn, is presented to the student in a series of screen displays. The ISS software incorporates many different types of displays; each display represents a single chunk of information or asks a question. Collectively, the different displays broaden instructional options and better serve the needs of individual students. Students initiate the displays at a rate compatible with their own learning styles. Text presentation in ISS, however, consists of more than a one-way, linear delivery of information. Student interest and curiosity are maintained throughout a course of instruction by numerous opportunities for interaction, branching, remediation, feedback, and prompting.

Given that minimum display station requirements (to be discussed in Chapter III) are met, ISS offers the following text characteristics:

- 24 to 32 lines per screen with a minimum of 80 characters per line
- 96 standard ASCII characters
- Varying character sizes
- Different style fonts
- Color text and background
- Blink capability

Graphics. Graphics are used to lessen the explanatory burden of the text as well as to emphasize key points in the lesson. Because much of high quality technical training depends upon clear and unambiguous graphics, ISS users are fortunate to have available a highly diversified capability for creating graphics. An ISS menu-driven graphics editor guides the graphics artist in creating detailed schematics and illustrations. Rapid access to the graphics database and the ability to quickly insert, delete, display, and change graphics results in considerable labor savings for artists and their supervisors. To assist the artist further, ISS supports a variety of input devices, including keyboard, joydisk, light pen, and data (bit) pad.

ISS supports the following graphics display capabilities:

- Any mixture of graphics, text, and background
- Graphics and text displayable in eight basic colors and a variety of color fills
- Screen size 13-inch-diagonal minimum
- Drawing primitives including points, arcs, vectors, circles, and rectangles
- 480 (horizontal) by 360 (vertical) minimum resolution
- Blink capability with background and foreground elements
- Random cursor positioning

Student Interaction. ISS supports student interaction through the creation of interactive text (questions) and branching response. Interactivity transforms students from passive recipients of information to active participants. For example, embedding questions in the lesson materials stimulates student interest, and active involvement reinforces the learning process. Feedback is immediate and tailored to student responses. The student proceeds to another task or problem, based on the correctness of the response. If needed, remediation can be provided by branching techniques. Student input devices such as touch screens and light pens further facilitate interactivity.

Individualization. With ISS, students progress at their own pace. Slower students are not left behind, nor do faster students lose interest. An authoring editor makes it possible to individualize courseware by means of branching logic; students are routed along different paths, based on individual responses. Students can control lesson material by choosing alternative paths from branching displays. By changing the order in which courseware is presented, students adapt the courseware to their own learning styles. Prompts can also be delivered to the student and are provided on the basis of a response, completion of lesson segments, or even the non-completion of lesson segments. Help and elaboration frames are available and make the overall instructional process more personal and responsive. The ISS software incorporates many different types of frames; each frame represents a single chunk of information or asks a question. Collectively, the different frames broaden instructional options and better serve the needs of individual students.

Simulation. As an approximation to a real-life situation or system, a simulation helps replace expensive or impractical equipment use. A computer-based simulation prevents unnecessary wear on operational equipment and reduces possible accidents by novices unfamiliar with the equipment. In ISS, a special simulation editor assists the author or artist via menus in creating high-resolution graphics in real-time or near-real-time animation. Animation, for example, can show process flow or movement, and can represent gauges and meter readouts. With ISS, simulation is an excellent instructional tool for teaching problem-solving and decision-making skills required in a progressively complex technical environment. By using animated graphics, ISS simulation offers the added training benefits of realism and increased student motivation.

Management Capabilities

Anyone who has served as a course administrator or instructor in a Government or military setting knows that the recordkeeping and administrative chores can be overwhelming at times. The highly efficient management capability of ISS manages both student progress and training resources. Because ISS helps perform these management functions, course administrators and instructors can use their skills more productively.

Special ISS management editors assist course administrators in performing numerous student management, resource management, and report generation functions. For discussion purposes, the student management capabilities have been further divided into scheduling, progress management, student monitoring, mastery testing, managing resources, report generation, and additional management functions.

Scheduling. Scheduling and assigning students to instructional activities traditionally has been a time-consuming administrative task in most training organizations. The ISS scheduling capability allows course administrators to set up automatic schedules, including on-line and off-line assignments, tests, and other instructional activities. As a result, false starts are avoided and students are directed into appropriate courses and lesson paths. Furthermore, student records are updated each time a student signs onto the system and works on lesson assignments. Instructors can receive a complete progress report on each student.

Progress Management. Lesson content varies in difficulty. Students may have difficulty with certain portions of the lesson material, but not with other portions. Progress management is a valuable instructor tool which processes student assignments and keeps track of how long students take to complete lessons. For example, if the mean time for completing a particular lesson is significantly greater than the time to complete other lessons for the same students, the instructor may want to supplement the material with off-line instruction or mark it for subsequent courseware revision.

Student Monitoring. The instructor's ability to monitor students from a remote terminal during on-line instruction is another valuable management tool. In a traditional classroom setting, it is often difficult to determine if students are having problems with lesson material in that tests are given infrequently and often too late in the course. With ISS, the instructor can observe whether students are having difficulty while they are learning the material and not several days or weeks later. If the instructor observes that the student is spending an excessive amount of time on a particular lesson, it may be necessary to elaborate on the instruction or schedule additional activities.

Mastery Testing. Mastery tests immediately confirm whether students are performing at the specified level. ISS provides a special test editor used for creating, copying, modifying and defining passing criteria for mastery tests. The editor is designed primarily for criterion-referenced tests, but can also be used to develop norm-referenced tests. Test keys identify test records quickly. Tests may be developed for both on-line and off-line presentation. Alternate forms of the same tests are easy to create with the special editor. In brief, the automatic presentation, scoring, recording, and analysis of mastery tests are highly valued ISS features.

Managing Resources. Training resources, like students, need to be managed if they are to achieve their optimal potential. As with other management functions, ISS employs special menu-driven editors for managing different resources. Resources are classified as portable (i.e., items that can be moved), facility (e.g., simulators and learning centers), or consumable (e.g., pens, pencils, and paper). In each of these categories, the manager can scan the different resources, get a description of each, identify the number in the inventory, and the number currently available. The manager can also change the number of available resources to reflect supply increments or decrements. Another resource editor allows the instructor to reserve resources for students who may be available only on specific dates and times. Resource reservations can be updated daily or weekly.

Report Generation. As an aid in evaluating course material and student performance, ISS prints out several different reports in various formats. Student performance reports can be collected across different instructional levels (i.e., module, block, course), or individually for text and question frames containing branching (decision) logic. One report accumulates and reports student comments. Data can be analyzed by groups, lessons or blocks. A variety of summary statistics are available, including number of students in the sample, mean and standard deviation of time spent on a block of instruction, numbers and percentages of different types of failures (e.g., cognitive and performance), and mean and standard deviation of time to lesson completion. Test item evaluations, as well as correlations of items with objectives and of items with the entire test, are also available.

Additional Management Functions. Two additional management functions are worthy of note: a message function and an off-line interface. The message function permits sending assignments or other communications between instructors or between an instructor and a student. The message function allows busy instructors and students to keep in touch in a manner compatible with their individual schedules. The off-line interface provides data collection through off-line test scoring and attitude tracking in a vari ty of instructional settings by means of an optical mark reader.

III. ISS TECHNICAL SPECIFICATIONS

The Air Force developed a transportable system that can run on a variety of candidate systems. Some basic specifications for candidate systems are discussed below. These have been divided into software specifications, host operating system requirements, hardware requirements, interfaces, hardware configurations, and professional staff requirements.

Software Specifications

Because ISS is implemented in the Ada language, candidate systems must have an Ada compiler. Training managers should be aware, however, that an Ada compiler does not guarantee successful ISS implementation. Some validated compilers place limits on code/data sizes and pragma implementation (i.e., information that is conveyed to the compiler without affecting the correctness of the program). Other compilers may provide only partial implementation of the features needed by ISS.

Certain pragmas are necessary for efficient ISS implementation. For example, pragma PACK compresses data sufficiently to keep records small and ensure data management performance; pragma INTERFACE ensures smooth communication with required virtual machine layer (VML) procedures, and pragma SUPPRESS, or its equivalent, eliminates costly execution time checks which cause performance degradation due to high central processing unit (CPU) utilization. In some cases a system may be implemented without the above pragmas; alternate methods which achieve the same effect should be considered.

Host Operating System Requirements

To provide a variety of ISS capabilities and meet performance needs, the application support layer (ASL) software must utilize VML machine-dependent procedures. The VML procedures must be rewritten and compiled to rehost ISS to a candidate system. The VML procedures can be divided into those that call host operating system software for the needed capability and those that have been created to attain necessary performance. To clearly specify the host operating system software requirements, tables have been prepared which identify the VML entry point names and the capability and performance requirements fulfilled (see AFHRL-TR-85-53, *Instructional Support Software System*, pp. 13-14). Because it may be possible to implement some of the VML procedures in Ada on some systems and still meet capability and performance requirements, alternate yet equivalent implementations should be pursued where appropriate.

Hardware Requirements

Computer hardware varies considerably with respect to capability, capacity, and performance. This can make selecting a system difficult. An essential first step is knowing the basic requirements. The basic hardware requirements for developing and implementing ISS are described next under two categories: processor/peripheral requirements and display station requirements.

Processor/Peripheral Requirements. Although a more restricted version of ISS can be implemented on hardware with less capacity, the minimum processor and peripheral requirements for successfully executing ISS are as follows:

- Processor clock of 8 MHz minimum

- Capability to address a minimum of 1 megabyte (MB) of random access memory (RAM) for software development and ISS execution

- A minimum of 40 MB hard disk storage for operating system, program development, and ISS data applications storage

- A 1 MB floppy disk drive

Display Station Requirements. The following display station requirements are considered the minimum for successfully presenting ISS displays:

- Interactive color graphics monitor with alphanumeric and graphics display; a mixture of text, graphics, and background colors is allowed

- Points, vectors, arcs, circles, and rectangles as drawing primitives

- Clipped picture elements that do not exceed screen boundaries

- Specific monitor requirements:

    13-inch-diagonal screen or larger

    Dot triad spacing of 0.31 mm or better

    Minimum 42 Hz, non-interlaced refresh rate to prevent flicker

    480 (horizontal) by 360 (vertical) minimum resolution

    Blink capability

- 24 to 32 lines with minimum of 80 characters per line
- 480 characters-per-second writing rate minimum
- At least 10 microseconds-per-pixel vector-writing rate

- Keyboard with function keys and numeric pad
- 96 standard ASCII characters plus varying character sizes

Interfaces

ISS supports the following user interfaces:

- A touch screen interface is available which can be connected to almost any display screen. This allows the student to select answers or make choices by touching the corresponding area of the screen.
- Bit and data pads are supported but are display station specific and should be selected when stations are evaluated and purchased.
- A videodisc and graphics overlay capability is available which expands media selection options.
- An optical mark reader interface provides optical scoring of off-line tests for CMI data collection.

Hardware Configurations

ISS is currently implemented on the VAX 8600, VAX 11/785, VAX 11/780, Micro VAX, and Zenith 248 computer systems. The display station types used with ISS include Digital VT100, Digital VT125, Tektronix 4105, Tektronix 4107, and Tektronix 4109.

Tables 1 through 3 that follow list the typical equipment required for VAX installations, including item quantities, mounting hardware, and software requirements using configurations of four, eight, and twenty-four stations.

Professional Staff Requirements

One of the most important components of any CBT system is the people who will manage and develop courseware on the system. Staff selection should focus on the skills needed for ISS implementation. Though the skills needed will vary with the type of CBT involved and the size of the program, most programs require the professional staff members listed in Table 4.

It should be noted that different skills are in greatest demand at different stages in the instructional process. For example, the systems manager will be doing a lot of planning before the system is procured. Designers need to outline the curriculum before developers create lesson materials. Instructors cannot monitor students until students are actually interacting with the courseware, and training managers cannot evaluate the courseware's effectiveness until a certain number of students have completed their courses.

Table 1. **Four-User VAX System**

Hardware	4-User Tempest System	4-User Non-Tempest System
MICROVAX II SYSTEM	1-5 MB	1-9 MB (3-RD53/TD50)
MEMORY-4 MB MOS	1	-
DISK CONTROLLER (RD53)	2	1
EXTENDER FOR RQDX3	1	-
RD53 DISK DRIVE (71 MB)	1	-
TS05 MAG TAPE 1600 BPI	1	1
TABLETOP TERM (CONSOLE)	1	1
TEKTRONIX C/G TERMINALS W/64K	4	4
INFOSCRIBE PRINTER	1	1
RFI SHIELDED RS232 CABLE	4	-
RS232 CABLE	-	4
Mounting Equipment		
5.25" RACK ADAPTOR	1	-
TS05 CABINET KIT	1	1
Software		
MICROVMS LIC. 1-8 USERS	1	1
MICROVMS MEDIA AND DOC	1	1
TXV05 I/O DRIVER	1	1
TSV05 MEDIA AND DOC	1	1

Table 2. **Eight-User VAX System**

Hardware	8-User Tempest System	8-User Non-Tempest System
VAX 8200 4 MB (RACKMOUNT)	1	1
MEMORY 8200/8300, 2 MB	4	4
MEMORY BATTERY BACKUP 8200/8300	1	1
VAXBI TO UNIBUS ADAPTER	1	-
VAXBI RA DISK CONTROLLER	2	1
RA60 205 MB DISK (removable w/o cabinet)		2*
TU80 MAG TAPE 1600 BPI	1**	1
COMMUNICATIONS CONTROLLER	1	1
TABLETOP TERM (CONSOLE)	1	1
TEKTRONIX C/G TERMINALS W/64K	8	8
PRINTRONIX LINE PRINTER, 600 LPM	1	1
FILTER I/O CABLE ASSEMBLY	1	-
RFI SHIELDED RS232 CABLE	8	-
RS232 CABLE	-	8
BULKHEAD I/O PANEL	1	-
UNIBUS EXPANDER BOX	1	-
EXPANSION BACKPLANE	1	-
* - one with cabinet, one without cabinet		
** - requires tempest cabinet		
Mounting Equipment		
TEMPEST CABINET	1	-
CABINET KIT	1	1
Software		
VMS MEDIA AND DOC	1	1

Table 3. **Twenty-Four User VAX System**

Hardware	24-User Non-Tempest System
VAX 11/785 COMPUTER 6 MB	1
MEMORY 2 MB MS780-GA 2ECC MOS	5
FLOATING POINT ACCELERATOR	1
UDA50 DISK CONTROLLER	2
RA60 205 MB DISK (removable w/o cabinet)	3
TU77 MAG TAPE 1600 BPI	1
DMF32 COMMUNICATIONS CONTROLLER	3
LA100 TABLETOP TERM (CONSOLE)	1
TEKTRONIX C/G TERMINALS W/64K	24
PRINTRONIX LINE PRINTER, 600 LPM	1
LQP02 DAISY WHEEL PRINTER	3
RS232 CABLE	24
Mounting Equipment	
None Required	
Software	
VMS MEDIA AND DOC	1

Table 4. **Professional Staff**

Skill Position	Major Responsibility
Systems Manager	Insures software is up and running; minimizes downtime; plans system updates.
Course Administrator	Schedules students, instructors, and resources; evaluates training effectiveness.
Instructional Designers/ Developers/Authors	Design and create on-line and off-line courseware.
Graphics Artist	Creates graphic screen displays to support instructional program.
Instructors	Facilitate the instructional process; monitor students.
Subject-Matter Experts	Work with authors to develop courseware.

For small-scale programs, some of the professional staff may need to serve dual roles. Given the diversity of skills involved and the different stages of courseware development, delivery, and evaluation, the need for effective management of the overall process is apparent.

For additional information on planning a management strategy for CBT development, the reader is directed to Electronic Systems Division (ESD) *Prototype Methodology for Designing and Developing Computer-Assisted Instruction*, 21 August 1986. Contact Lt John Herman, ESD/XRSE, DSN768-2713 or commercial (617) 377-2713.

IV. ISS SUPPORT FEATURES

Newcomers to ISS do not have to fend for themselves when they have questions and need to learn more about the system. Documentation support and self-paced on-line and off-line training materials are available for becoming proficient with ISS in the shortest possible time.

Reference Manuals

Reference manuals have been prepared for each ISS editor module. Each manual contains a brief overview of the capabilities and functions of the editor. ISS terminal hardware specifications include charts to help users determine available hardware features based on their own unique needs. For example, a function chart provides specifications on each terminal's capabilities, and a keystroke detail chart specifies the keys or control commands used on each terminal. Each manual defines ISS terms and specific modules; detailed procedures for using each module also are given. Furthermore, error messages are provided, with a brief explanation of their meanings and a list of corrective actions. The last chapter of each manual provides solutions to problems that are not addressed by error messages.

For individuals that may be interested, programming and development specifications for the support environment are available. There is also documentation for the application software, the data structures and database documentation for the entire system.

A report which describes the development of ISS, entitled *Instructional Support Software System*, AFHRL-TR-85-53, can also be obtained.

Training

A training program on the ISS instructional component is available to the first-time user and combines on-line and off-line instruction. The training package includes descriptions of editor functions and capabilities, as well as practice exercises for each editor.

V. SELECTING COMPUTER-BASED TRAINING: FACTORS TO CONSIDER

Effective and cost-efficient training of personnel represents a continuous challenge to the Air Force training community. It is understandable that many training managers want to develop training programs that reflect state-of-the-art training technology and realize the benefits associated with CBT. Although there is evidence of the expected benefits with the well-planned introduction of CBT in appropriate settings, there also are instances where well-intended efforts have gone awry.

Findings From Previous Feasibility Studies

Previous feasibility studies of CBT implementation have shown some major differences when compared to the conventional classroom approach. Most studies have shown higher start-up costs associated with CBT but lower ongoing costs when compared to instructor-based training. The initial costs of instructor-based training are relatively small, but with each offering of the course, costs associated with salaries and travel can increase considerably. Due to courseware development and hardware acquisition, the initial costs for CBT are going to be higher, but ongoing costs become less as economies of scale are realized with repeated offerings.

Given a training program that is likely to be in demand for a long time and for which student volume is sizable, CBT is likely to be more cost-effective. Conversely, if the course is to be offered only a few times, it is unlikely that CBT implementation costs will be justified.

Because CBT represents a significant undertaking for many organizations, a feasibility study on those factors likely to determine the success or failure of a CBT program is recommended as the first step. Instructional, organizational, economic, and technical factors need to be evaluated.

Instructional Factors

Instructional feasibility raises the question: Does adopting a CBT system make sound instructional sense? Some important instructional questions are listed below that should help a decision maker when examining instructional feasibility:

- Does the total number of students requiring training annually justify CBT?
- Will the training course be in demand for a long time? How many times will the course be repeated?
- Does a need exist for standardized training; that is, should the course always be offered the same way?
- Do differences in student entry levels necessitate self-paced and individualized instruction?
- Would students benefit from instructional concepts and procedures which emphasize participative learning, interactivity, and frequent practice?
- Does training involve the use of scarce subject-matter experts or equipment?
- Is training required on short notice whenever and wherever needed?
- Does management of student records need improvement?
- Is the student likely to use computers or automated systems on the job? If CBT were adopted, would the job environment benefit from exposure to computers during training?
- Can large portions of the training be conducted without an instructor?

Organizational Factors

Due to the fact that the introduction of a CBT system frequently changes individual roles within an organization, it is necessary to evaluate the organizational climate and conditions before introducing and implementing CBT. Without serious organizational support and commitment, successful CBT implementation would indeed be difficult. Candid questions regarding organizational readiness and expectations should be asked.

- What potential organizational problems might jeopardize CBT success?
- Do you have the resources to provide ongoing operational management for the CBT system?
- Are trained personnel available to create and update CBT materials?
- Are administrative personnel available to plan, supervise, and manage CBT activities?
- Are expectations realistic in terms of what CBT can and cannot do?
- Are current program and policy pronouncements compatible with the introduction of CBT?
- Is there a demand for greater sectors within the organization to become more computer-oriented?
- Are the top decision makers in the organization likely to support CBT?
- Can the long-term cost-effectiveness of CBT be demonstrated?

Economic Factors

It is well known that training budgets are fixed and often limit proposed programs in spite of their instructional and organizational feasibility. Someone is sure to ask: "How much is all this going to cost?" Before that question is answered, it is important to know all of the costs associated with the existing program, as the proposed CBT program costs are likely to be compared to current costs. A minimal evaluation of CBT cost feasibility requires answers to these questions:

- What are the total costs for the existing training system (include instructors, administrators, facilities, equipment, materials, preparation time, student/instructor travel)?
- What are the total development costs associated with the proposed CBT system (design, development, testing)?
- What are the total delivery costs of the proposed CBT system (hardware acquisition, software, system operation and maintenance, course management, facilities, documentation, off-line materials)?
- Do amortized CBT costs result in annual or life cycle savings over the existing system?

- What are the added benefits of the proposed system?
- Are assumptions regarding costs and utilization clearly stated and reasonable?
- Is sufficient funding available to cover start-up costs, assuring a reasonable chance of success?

Technical Factors

Technical considerations refer to the hardware and software features of the proposed CBT system and whether the system has the functional capability for meeting the training requirements of the end user. A clear specification of technical considerations will ensure that whatever system is selected, it will satisfy the user's functional requirements. The following basic technical factors require examination:

- Does the proposed system have the input, display, and output capabilities required?
- Does the system come with mature software and courseware development packages?
- Will the system support the required number of simultaneous users during peak load periods?
- What is the system response time under peak load conditions? Is it conducive to real-time interaction and rapid student response?
- Can courseware be downloaded to run on microcomputers?
- Does the system have the required instructor/student communication capability?
- Is the system's storage capacity adequate for present needs? Will it accommodate further expansion of courseware and student records?
- What is the system's record on unscheduled downtime? Have good reliability and service been demonstrated?

Assessing the Results

Only individual organizations can determine how to weigh the above factors when assessing CBT feasibility. To be sure, each organization will need to supplement the above factors with questions that address its own uniaue requirements. Rarely will all the factors be resolved in a way that unequivocally supports or does not support CBT. Given recent advances in state-of-the-art training technologies, technical feasibility factors can usually satisfy most Instructional requirements; however, economic and organizational factors still provide significant obstacles. Many organizations prefer not to implement CBT as a total training system but instead, to try it on a small-scale or pilot project basis.

For a more detailed discussion of the above factors, the reader is directed to an excellent introductory book entitled, *Computer-Based Training: A Guide To Selection and Implementation*, by Greg Kearsley. Another recommended source is AFHRL-TR-84-46, *Computer-Assisted Training: Decision Handbook*, April 1985.

REFERENCES

McDonnel Douglas Astronautics Company. (1986). *Instructional Support Software System* (AFHRL-TR-85-53, AD-166 776). Lowry AFB, CO: Training Systems Division, Air Force Human Resources Laboratory.

Kearsley, Greg. (1983). *Computer-Based Training: A Guide to Selection and Implementation.* Addison-Wesley Publishing Company.

Kemner-Richardson, S., Lamos, J.P., & West, A.S. (1985). *Computer-Assisted Instruction: Decision Handbook* (AFHRL-TR-84-46, AD-A154 646). Lowry AFB, CO: Training Systems Division, Air Force Human Resources Laboratory.

GLOSSARY

The following is a glossary of terms used in this overview and other ISS documentation.

Term	Definition
Ada	The standard Department of Defense (DoD) programming language, developed to enhance DoD software development productivity.
Application Software	Computer programs developed to meet user requirements for a specific purpose or task.
Application Support Layer (ASL)	Part of the ISS application support environment which assists terminal communications, data management, inter-process communication, text handling, program control, and mathematical services.
ASCII	Refers to American Standard Code for Information Interchange, a widely used convention whereby 128 keyboard characters are defined by seven-bit code.
Bit Pad	A graphic art input device used with a mouse or stylus. Also called a data pad.
Block	A unit of instruction within a course, comprised of lessons and modules, covering a specific subject.
Branch	An instructional feature that transfers students from one lesson path to another.
Branching	Instructions that route students to individual paths based on responses or author-defined conditions.
CAI Authoring Support System (CASS)	An ISS application program that allows authors to create lesson materials by combining informational text, graphics, questions, and simulations.
Cognitive Test	A test used to determine student knowledge of lesson material.
Computer-Assisted Instruction (CAI)	Interactive instruction presented to the student on a computer. Also known as courseware.
Computer-Based Training (CBT)	Instruction that is developed, delivered, and managed on computers.
Computer-Managed Instruction (CMI)	The use of computers to provide administrative support for CAI. This includes managing student progress and tests, scheduling students and resources, and generating management reports.

GLOSSARY (Continued)

Term	Definition
Consumable Resources	Expendable resources used by students (e.g., paper).
Courseware	Also known as computer-assisted instruction. Interactive training developed and displayed by computer.
Curriculum	Largest organizational unit within the ISS program of study. Consists of courses, course versions, course blocks, and lessons.
Database	Collection of data in a form capable of being processed by a computer.
Data Pad	An input device used by artists. See Bit Pad.
Display	The visual contents on the video screen, which could be menus, lists, text, and graphics.
Drill and Practice	A basic instructional technique whereby a problem or question is presented, a student's response is accepted, and feedback is provided based on correctness of the response.
Editor	Program that allows the user to develop, implement, and evaluate instructional materials. In ISS, editors allow quick access to the database via menus and prompts. System users need not be programmers.
Error Messages	Instructions that appear on the screen warning users they have made a mistake. Instructions on how to correct the error are provided.
Facility Resources	An immobile instructional environment which includes learning centers, classrooms, and simulators.
Fill	A graphics capability referring to any solid color or combination of colors contained within a polygon.
Flag	A marker which can be attached to frames in order to give special instructions.
Frame	A display screen which presents information or asks questions. Each frame should normally contain only one chunk of information.
Graphics Editor	A special purpose ISS program that enables an author to create illustrations for lessons.
Hardcopy	Information or data output from a computer on printed paper.

GLOSSARY (Continued)

Term	Definition
Hardware	The essential physical components that go into a computer: the CPU, memory, and input/output devices.
High-Order Language	Programming languages that are less dependent on the limitations of a specific computer; in other words, languages common to most computer systems.
Individualization	An Instructional feature that allows students to proceed at their own pace through a variety of paths. In ISS, individualization is achieved through branching and curriculum design.
Instructional Support System (ISS)	A large-scale, computer-based training system providing both instructional and management capabilities. ISS is a software package, written in Ada, designed to be machine-independent, and grouped into functional modules that may be executed individually or combined as needed to support user requirements.
Lesson	Basic unit of instruction in the ISS system.
Mastery Test	Tests designed in the ISS test editor to evaluate a student's comprehension of course material. Scores on master tests may be recorded, evaluated, and reported.
Menu	A list of options presented in a screen display to provide the user with a choice for retrieving information or for performing different functions.
Module	A unit of instruction within ISS containing segments, frames and pages. An alternate method of presenting instruction.
Off-line Instruction	Instructional material delivered independent of a computer system (e.g., lecture, discussion, workbooks).
On-line Instruction	Training delivered via a computer system.
Optical Mark Reader	Device that reads the markings from off-line tests and enters the test data into the computer.
Overlay Function	Allows previewing frames or a series of frames as they will be presented to students.
Part-Task Trainer	A training device which addresses a well-defined subset of tasks to be trained.

GLOSSARY (Concluded)

Term	Definition
Peripherals	Accessories that can be added to a computer system (e.g., printers, disc drives, joy-sticks, videodisc players).
Portable Resources	Training materials that a student can carry from one location to another (e.g., books, handouts, video or audio cassettes).
Progress Management	An ISS management capability which processses student assignments and keeps track of the time students take to complete lessons.
Prompt	A brief message displayed on a computer terminal which instructs the user.
Response Time	Time required for the microprocessor to respond to an input device.
Restricted Access	A condition that can be established within ISS that allows a user access to certain modules but not others.
Simulation	In ISS, an animated, graphic portrayal of a real-life situation.
Student Monitoring	Capability that allows an instructor to view a screen while the student is working on a lesson or taking a test.
Unlimited Access	Access given to the highest level ISS users. Unlimited access allows a user to author, alter, or delete courseware, and to manipulate, delete, or add data to records.
Videodisc	A peripheral device with a large storage capacity. Displays instructional sequences that require high resolution and motion. Videodisc players can be integrated with ISS.
Virtual Machine Layer (VML)	ISS software procedures, written in assembly language, which must be rewritten and compiled on a candidate system to rehost ISS to that system.

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