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Issues in Developing and Implementing Computer–Based Instruction for Military Training

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This report discusses the issues involved in fielding a computer-based instruction (CBI) program for military training. This report is based on a series of CBI projects sponsored by the Training Technology Field Activity (TTFA) at Fort Knox, KY. Based on the lessons learned from TTFA's experiences, 25 recommendations are made. These recommendations stress careful planning at the different developmental stages, coordinating the work of many people, having all participants co-locate at the instructional site, following the SAT (Systems Approach to Training) method of courseware development, meeting the instructor's needs, and conducting careful evaluations. Actively involving school management personnel in the CBI project is also stressed.

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Computer-based instruction (CBI) is being touted as a significant instructional technology for the United States Armed Services. CBI's potential as a training medium is dependent on instructional design and implementation that meets the needs of the end user--the military instructor. Training developers without previous CBI experience may have trouble developing a useful CBI product, however, because they do not know the pitfalls. This research report discusses the issues and lessons learned by the Fort Knox Training Technology Field Activity (TTFA) in fielding CBI training programs at the U.S. Army Armor School, Fort Knox, KY. Twenty-five recommendations on managing, developing, implementing, and evaluating a CBI project are made in the report.

The work described in this research report was part of the Fort Knox Field Unit's research program to apply new training technology to armor skills training. A Memorandum of Agreement covering the application of training technology to armor skill training was signed by the U.S. Army Armor School, the U.S. Army Training and Doctrine Command (TRADOC), and the U.S. Army Research Institute (ARI) on 4 November 1983. This agreement was renewed on 28 March 1987. The Technical Director of the U.S. Army Armor School has been briefed on the recommendations cited in this report, and these recommendations are being applied to additional CBI projects being developed and implemented at Fort Knox.
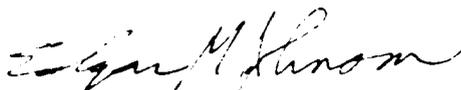
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ISSUES IN DEVELOPING AND IMPLEMENTING COMPUTER-BASED INSTRUCTION FOR MILITARY TRAINING

EXECUTIVE SUMMARY

Requirement:

Computer-based instruction (CBI) is being touted as a significant instructional technology for the United States Armed Forces. CBI's potential as a training medium is dependent on quality instructional design and planning. However, training developers without previous CBI experience may have trouble developing a quality CBI product because they do not know the potential problems they could face.

Procedure:

Based on a series of ongoing CBI projects managed by the Training Technology Field Activity (TTFA) at Fort Knox, KY, this report discusses issues in managing, developing, and implementing CBI programs. This discussion focuses on problems that the TTFA had with management, development, implementation, and evaluation issues. Recommendations for future CBI training projects are made.

Findings:

Based on the lessons learned from TTFA's experiences, 25 recommendations are made. These recommendations stress careful planning at the different developmental stages, coordinating the work of many people, having all participants co-locate at the instructional site, following the SAT (Systems Approach to Training) method of courseware development, meeting the instructors' needs, and conducting careful evaluations. Actively involving school management personnel in the CBI project is also stressed.

Utilization of Findings:

The recommendations made in this report are currently being applied and refined at Fort Knox in the development and implementation of new CBI programs to support the training of Armor noncommissioned and commissioned officers.

ISSUES IN DEVELOPING AND IMPLEMENTING COMPUTER-BASED INSTRUCTION FOR MILITARY
TRAINING

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ISSUES IN DEVELOPING AND IMPLEMENTING
COMPUTER-BASED INSTRUCTION FOR MILITARY TRAINING

INTRODUCTION

Computer-based instruction (CBI) is being touted as a significant instructional technology for the United States' Armed Forces. Orlansky (1985) has noted that CBI is particularly applicable to training military personnel in a significant number of the over 10,000 armed services skill training courses offered in such areas as electronics, maintenance, and communications. Many reports on CBI (e.g., Gray, 1986; Montague, Wulfeck, & Ellis, 1983; Shlechter, in press) have noted that CBI's potential as a training medium is dependent upon quality instructional design and quality implementation.

Training developers without previous experience with CBI training programs may have trouble developing a quality CBI product because they do not know the potential pitfalls facing them. Very few reports exist which would help them by documenting specific problems with fielding this training medium in a military setting. This report then discusses the lessons learned by the Training Technology Field Activity (TTFA) at Fort Knox, KY in fielding CBI programs.

TTFA is a cooperative effort of the US Army Training and Doctrine Command (TRADOC), the US Army Armor School (USAARMS), and the US Army Research Institute (ARI). The TTFA mission is to systematically identify, introduce, and evaluate technology to improve the efficiency and effectiveness of Army Training. TTFA developed CBI training for the MOS 19K BNCOC program (Basic Non-Commissioned Officer Course for M1 Tank Commanders). Courseware was written for the following lessons; Land Navigation, Diagnostic Test and Remedial Training, Military Communications, Call for and Adjust Indirect Fire, NBC Defense, Mine Warfare, and Tank Fire Commands. Voice recognition systems, videodisc systems, and a MicroTICCIT System II (Microcomputer Time-Shared Interactive Computer-Controlled Television) were used as the training media. These programs were TTFA's initial efforts with CBI training.

TTFA personnel have found that fielding a CBI training program involves dealing with issues found in the development of any other training program. These issues were managing, developing, implementing, and evaluating the instructional program. However, TTFA has found that these issues are more complex for fielding a CBI training program than for most other instructional systems. For instance, the courseware must fit the unique constraints associated with a particular hardware system, software system, and authoring language. The complexities and approaches involved in dealing with these issues in the TTFA context will be explored in this report.

It must be noted that some of the TTFA's approaches and difficulties which were experienced might not generalize to other CBI implementations. First, TTFA was not an operational activity of the Armor School. It was an ad hoc group pulled together for the specific TTFA mission. As such, it was

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outside the Armor School and subject to all the problems of an outside agency trying to develop and implement training in the School. Second, very few CBI projects will involve as many different programs and instructional devices as did the TTFA project. Third, these CBI projects had to deal with some unique constraints. For instance, because of limited in-house personnel resources, TTFA had to rely on contract personnel for training design and development.

MANAGING THE CBI PROJECT

The previously mentioned complexities inherent in TTFA's CBI projects required that the utmost care be taken in managing these CBI projects. Managing these training projects included coordinating the efforts of many people from different organizations and monitoring contractual efforts, courseware production, and the instructional delivery site.

TTFA's Team Approach

These CBI projects required a sizeable team effort involving ARI, TRADOC, and Armor School TTFA representatives, BNCOC instructors, subject matter experts (SMEs) from the Armor School, contractual courseware developers, and the hardware developer.

Each of these groups had a different role in the courseware's development and implementation. ARI representatives monitored the different contractual efforts and conducted the preliminary trials of the courseware. TRADOC representatives monitored the implementation of the courseware in the BNCOC classroom and conducted the in-course validation checks (see the evaluation section for a description of these evaluational approaches). The instructors provided information on specific course content. The SMEs provided answers on correct military doctrine and reviewed the interim courseware products to insure that proper military doctrine was used. Contractual courseware developers then designed and developed the courseware for these tasks. All the courseware, except the Land Navigation and Diagnostic/Remediation lessons, were developed by one firm. Project managers (TTFA) made decisions about developmental and implementation issues based upon advice from members of various steering committees. Steering committees included personnel from ARI, TRADOC, and the Armor School.

Problems with TTFA's Team Approach

Unfortunately, there were some problems with this team approach. Because they were located at different sites, these professionals seldom directly interacted with each other. The prime courseware developer, for instance, directly interacted with the BNCOC instructors on only two occasions. Information about the instructors' desires were provided to this firm by the personnel monitoring the contract. Such triangular communication frequently occurred during the course of the supporting contract, a situation which resulted in frequent miscommunications among the participants.

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Correspondingly, the different participants did not understand the constraints faced by the other participants. The prime courseware developer never realized the SMEs' time constraints nor did the SMEs understand this courseware developer's time constraints. Needing a quick review on an interim product, the courseware developer requested that these products be examined immediately. However, the SMEs, having other military duties, needed more time to properly review these products. The courseware developer thus experienced unexpected delays in completing the final product.

TTFA also experienced some difficulties in achieving a consensus among the team members. The SMEs and the BNCOC instructors frequently provided different training content information. For instance, the BNCOC instructors and the SMEs provided quite different information for the "coding numbers' task in the Military Communications lesson. After considerable discussion with the different team members, the TTFA decided to accept the SME's views. Again, the time table for developing and implementing this courseware was delayed.

Rapid turnover among the SMEs also caused problems. A new SME often had different notions about the subject matter from those expressed by his predecessors. TTFA received, for instance, several different opinions on completing an NBC-1 report from different SMEs.

Some other problems were found in these projects due to the team approach employed. First, the military instructors tended to regard these projects as imposed solutions because decisions about their course were not being made by them. An early effort to forestall this problem by co-locating TTFA with the BNCOC instructors was defeated when TTFA was removed from the BNCOC site. Secondly, those individuals who monitored the courseware development were not the people who were responsible for implementing these projects. The Armor School, for instance, had to change some of the completed courseware to meet specific implementation needs.

Recommendations: Some of these problems can be eliminated in future CBI ojects by: a) having more direct meetings between participants and insisting that all agencies attend all meetings; b) surfacing all constraints to development and implementation; c) having a flexible time table for completing the project; d) involving instructional personnel more directly in the courseware development process; e) having a trained permanent support staff to help develop the courseware; and f) having the same personnel who are responsible for implementing the products monitor the different contractual efforts. Other recommendations about methods for (and problems with) coordinating the team effort needed for fielding a CBI project will be discussed throughout this report.

The Roles of the Project Manager

TTFA has found that the project manager's role is vital in developing and implementing a CBI training package. This person must coordinate the team's efforts, devise a realistic time table, and understand the different issues involved in the project.

ARI's representative was the manager for developing the projects while the TRADOC representative was the manager for implementing the training programs. These people and their staffs were quite knowledgeable about military training procedures; however, they had little expertise in computer systems and courseware production methods. More knowledge of CBI systems and the courseware production methods would have helped them to better understand the constraints faced by the instructional delivery system operator, courseware contractor, and the hardware developer. With more expertise they would have realized that the voice recognition system could only be used for very limited purposes, e.g., simple words and sentences. Time and money were spent trying to make the voice recognition system understand complex military communications sequences, when it was really only adequate for training fire commands.

Also, one person should have been the project manager. Sometimes these two project managers had trouble coordinating their activities. The implementation manager, because of other commitments, did not participate in some developmental decisions. These two groups also rarely reviewed the courseware together and had different issues to examine when reviewing the courseware. For example, the implementation team was more interested in the length of the "Call for Fire" program than was the developmental team. The implementation manager should have been responsible for the entire project as this person was responsible to the Armor School for fielding this project.

Recommendation: Managers need some knowledge of CBI systems and courseware production methods. A single project manager is better than several sharing responsibility.

The Terminal Site Manager

TTFA also discovered the importance of the delivery system site manager. This person had the following functions to perform: 1) installing the developed courseware into the system; 2) making sure that the system had enough disc space for the different courseware; 3) making copies of the different courseware; 4) changing the courseware after the contract had expired; 5) scheduling use of the system; 6) troubleshooting problems with the systems, and 7) training other people (e.g., proctors and helpers) to use the system. Most of these functions were quite involved. For example, changing the courseware required expert knowledge of a special authoring language. These changes also had to be made rapidly to meet implementation deadlines. Scheduling the use of the system required coordinating regular "shut-down" periods with the facility's maintenance personnel and coordinating activities with the evaluators and BNCOC instructors. Such personnel could not use the system at will.

The TTFA project managers did not initially appreciate the importance of the site manager. The site manager was given a three-week block of instruction on the basics of using the MicroTICCIT (Microcomputer Time-Shared Interactive Computer-Controlled Information Television) System II. This

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instructional program was found to be insufficient for teaching the special authoring language to the level of proficiency required.

Recommendations: The site manager must have previous CBI experience. Site managers should also be thoroughly trained in operating and programming the CBI system before the project is started.

The Terminal Site

TTFA also found out the importance of securing an appropriate site for the computer terminals. They had problems with acquiring a terminal site which did not need many alterations. The space provided was not already configured for the delivery system. The chosen terminal site thus had to be re-configured and extensive architectural changes had to be made in the new facility. The site's ventilation had to be redone in order to accommodate the computer hardware. Some additional furnishings (e.g., dividers between terminals) were also needed. Additional expenditures were incurred by TRADOC to make this room suitable for TTFA's use.

Another problem with preparing this terminal site for CBI use was that the TTFA could not find any written guidance governing such alterations. TTFA did not know the items to consider and the people to contact in making these alterations. The TTFA team started with the post engineers, since these alterations included additional outlets, electrical buffered power, and additional air conditioning. The post engineers led the team to the following people: the Provost Marshal for site security, the Director of Automated Information Management for information security, and the Fire Marshal for removal of the automatic sprinkler system and installation of a Halon system.

This new site was also problematic because it was not located in or next to the BNCOC "school-house". The evaluation team for the Military Communications courseware, for example, noticed that approximately fifteen minutes were wasted at the beginning of each instructional period waiting for students to find the room and then to settle down. This placement of the terminals also caused the instructors problems when they forgot to bring some instructional aids, e.g., an Army Field Manual. They either had to leave the classroom to get the materials or do without. Hence, a poorly located terminal site can cause instructional problems.

Recommendations: Great care should be given to selecting an appropriate CBI terminal site. This site should need few alterations to accommodate CBI training. This site also must be: 1) located in or near the "school-house"; 2) kept at a temperature suitable for operating the terminals; and 3) secured easily. The issues involved in selecting and preparing the site must be resolved before the hardware is purchased.

Co-Location of All Parties to a CBI Project

Because the courseware development contracts did not specify on-site production, the courseware contractors were located away from the SMEs, BNCOC

instructional personnel, BNCOC students and the TTFA staff. Serious problems resulted from the courseware contractors' absence from the instructional site.

One problem was the previously discussed triangular communications among the different participants. Correspondingly, problematic communications arose when the SMEs and the courseware developers had to communicate directly over the phone. Few people, for instance, have the skill to articulate over a phone the procedures involved in a tank commander's call for artillery fire.

Another problem with the courseware developers' location was that the courseware project manager could not directly supervise the final products. Despite daily phone calls and In Process Reviews (IPRs) approximately every six weeks, the finished products were usually a surprise to the TTFA staff. What they received seldom appeared to incorporate changes that they requested.

Thirdly, the BNCOC instructional personnel only saw the final products, a situation which could have only increased their perceptions that the TTFA programs were imposed solutions. Daily contacts with the instructional personnel by the contractors would have eased these fears and would have allowed the contractors to have a better understanding of some of the problems faced by the BNCOC instructors. For example, these contractors could have limited the length of the courseware because they would have realized the scheduling constraints faced by the BNCOC instructors.

Having the courseware developers at a remote sites also caused problems with processing the courseware into the MicroTICCIT. For one thing, courseware and software bugs existed in the TTFA hardware system which were not present in the hardware system used by the courseware developers. The site manager experienced problems with having the courseware developers explain by telephone how to fix these bugs. An on-site representative who was familiar with the courseware's program could have quickly fixed most courseware problems. The on-site representative, who would have been familiar with the MicroTICCIT System's software, could have helped the site manager correct software bugs. Such software bugs are hard to fix with telephoned instructions.

Recommendations: A courseware development contract should specify that the courseware developer be located or have a representative at the instructional site. This person should remain at this site until the courseware is fully implemented.

Summary

This section has described some of the problems encountered by TTFA in managing CBI projects. As discussed, the following lessons were learned from TTFA's experiences regarding managing the CBI program: 1) a single project manager must be employed; 2) each participant must understand the constraints faced by the other participants; 3) all key participants must be located at

the instructional site; 4) the CBI site manager must be thoroughly trained before the project starts; and 5) the project manager must choose a site which needs few alterations.

DEVELOPMENTAL ISSUES

The development of any Army training program should follow the Systems Approach to Training (SAT--TRADOC Reg 350-7). This SAT process dictates that the training program's development follow a specific developmental sequence. TTFA has encountered problems when the SAT sequence is not followed.

Task Selection and Training Design

Three different selection techniques were used to identify 19K BNCOC tasks for conversion to CBI. Each of these techniques is discussed in turn.

Land Navigation: Land Navigation was identified very early in this project as a training problem area. Representatives of the TTFA decided that the first effort to convert traditional instruction to CBI would come in the land navigation area because of existing problems with the traditional instructional approach. A Land Navigation Steering Committee was empanelled to supervise the work. This committee included representatives from the Fort Knox NCO Academy, the Directorate of Training and Doctrine, Training Group, TRADOC, ARI, and instructors from the 19K BNCOC course. Since none of these agencies had the appropriate resources at Fort Knox to author the courseware, a contractor was let for this purpose. Task selection was based on current training and performance deficiencies and a feasibility analysis of using CBI for training and performing each task based on procedures in Knerr, Sticha, Ramsberger, Harris & Tkacz (1984).

Five tasks were selected for development:

Identify natural terrain features and determine elevation.

Orient a map to the ground by map-terrain association.

Determine location on the ground by terrain association.

Locate an unknown point on a map or on the ground by intersection or resection.

Analyze terrain using the five military aspects of terrain.

Courseware was designed to solve terrain visualization and contour problems. A landform model was developed for the courseware that included various terrain features. The three-dimensional terrain model was then marked with contour patterns. Video sequences of the model were developed that shifted from an overhead two-dimensional view (map portrayal) to a horizontal perspective (heads-up view of the terrain). A special effort was taken to

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provide students with a dynamic view of real world terrain. Terrain photographs were taken that allowed students to pan 360° and to zoom in and out for close-up views (Lickteig & Burnside, 1986).

Training courseware for two of the land navigation tasks—Determine a Location and Orient a Map by Terrain Association—were not formally evaluated due to inadequate courseware design. The design problem unique to both of these tasks was how to best display a 360-degree horizontal view of the terrain on a single workstation monitor, a TV screen. The solution attempted in the courseware design was to simulate a visual pan across the terrain by rapidly accessing from the videodisc 120 sequentially stored video frames with each frame incrementing the pan by 3 degrees. While the pan simulation appeared realistic, soldiers were unable to integrate this linear set of frames into a circular (360-degree), composite view of the surrounding terrain. Soldiers were especially distressed by their inability to infer the angular displacement between terrain features that could not be simultaneously viewed on the monitor.

The design problem unique to both of these tasks was the requirement to maintain orientation of a 360-degree horizontal pan of the terrain when presented on a single monitor with its limited field-of-view. The requirement was analogous to a tank commander's task of viewing the terrain while looking through an isolated vision block as the tank's turret is rotated. This formidable requirement in the tank environment was compounded in the courseware design by the absence of correlated vestibular cues, since the viewer remained stationary and the terrain rotated. Each of the courseware's 360-degree pans of the terrain were based on 120 video frames that incremented the soldier's field of view by 3 degrees as he "rotated" to view the surrounding landscape. Even when soldiers were able to identify, or associate, two or more terrain features with those depicted on the topographic map, they had great difficulty inferring the angular displacement between these features.

In anticipation of this problem, courseware design included an icon of a moving arrow on the display that continually updated the angular distance the soldier had rotated from the initial frame. At the termination of each pan (from 0 degrees to 360 degrees) initiated by the student, the arrow rotated and depicted the angular displacement between the student's current view and his initial view of the terrain. This solution was inadequate (Lickteig & Burnside, 1986).

Skill Level 1 Remedial Training: A second problem identified early on was the need to convert as much of the pre-course diagnostic test as possible to CBI and to provide remedial training on the selected tasks. Tasks in the diagnostic test had been selected as representing skills/knowledge needed in the course but not taught because they were at Skill Level 1. The POI for

19K BNCOC did not include time for remediation. Remediation was the responsibility of the student. Since several of the diagnostic tasks were primarily cognitive, they seemed to be natural selections for CBI. Twenty-one tasks were selected as candidates. From this list, five were selected for CBI treatment based on testability and trainability with the CBI delivery system. These tasks were:

Determine grid coordinates of a point on a military map using the military grid reference system.

Communicate using visual signaling techniques.

Recognize and identify friendly and threat armored vehicles.

Establish tank firing positions.

Operate radio set.

Training design for these tasks followed the Training Effectiveness and Cost Effectiveness Prediction (TECEP) model (Knerr, Nadler, & Dowell, 1984). TECEP translates task descriptions and learning principles into prescriptions for training. TECEP specified, for each type of task, design considerations, including practice, feedback and reinforcement, guidance and prompts, learning strategies, and changes in the training design to enhance stages of learning (Knerr et al, 1986).

TECEP is one model which could be used to provide a better basis for task selection (and design) than the much more informal steering committee approach. All five of these tasks translated well to CBI and were subsequently shown to provide adequate student learning.

Communications-Electronics Operating Instructions, Call For/Adjust Indirect Fire, NBC Defense, and Mine Warfare: Normally, media are selected by identifying the instructional requirement of a task and then matching the identified characteristics to the characteristics of the available media. Factors such as the instructional characteristics of the learner, and instructional strategies are included (Reiser & Gagne, 1983).

In this project, the medium had already been selected -- a CBI delivery system with videodisc capability. The task here, then, was to identify the characteristics of the medium and select the objectives that could best be presented using this system, i.e., apply the media selection process backwards (Jay, 1986).

The media selection process was broken down into three major steps.

Step 1. Determine objective performance level. Objectives, enabling objectives, testing conditions, and criteria were used to determine the performance level of each objective as currently taught.

Step 2. Apply media selection model. Reiser and Gagne's (1983) model was selected. Since the model narrowly defines CBI, some portions of

it were not applicable. Prior to application of the model, information was collected about each objective in the course. Each objective was analyzed for information required by the selection model; performance level (crawl, walk, run) of each objective was determined, preliminary designs of CBI lessons were sketched out, and instructional requirements were specified. This information was put through the media selection flowchart. Finally, possible instructional design strategies were laid out.

Step 3. Apply the final selection process. Final recommendations were based on a mix of objectives which could be completed in the time and budget allotted, priority, and student GO rates. Three factors were considered when determining the time/cost to convert to CBI; performance level of each objective, instructional design/features, and whether the instructional model had to be custom-designed and coded or an existing model could be adapted. Performance levels and preliminary instructional design sketches were compared with the relative cost of the required instructional features and whether a new instructional model would be required (Jay, 1986). This process resulted in the selection of the following tasks.

Communications-Electronics Operating Instructions

Call For/Adjust Indirect Fire

NBC Defense

Mine Warfare

Recommendations: Task selection for CBI treatment must be done either by instructional developers thoroughly versed in this process and experienced in CBI development or by the careful application of a CBI task selection model. Careful task selection can be undone by poor CBI design, hence CBI design must be developed by personnel with experience. Since CBI courseware design appears to be a much more exact process than the design of traditional instruction, considerable time and resources must be allotted. Problematic tasks that require complicated cognitive functions should be avoided unless the literature can show previous successful application.

Selection of a Training Medium

Fort Knox's TTFA was in an early developmental box because of an early decision to use CBI as the training medium. This medium seemed to be appropriate to this project's training needs. As previously indicated, the first phase of the SAT sequence—job and task analyses—determined that new instructional programs were needed in the 19K BNCOC program of instruction (POI) on: a) Call for Indirect Fire; b) Land-Navigation; c) Military Communications; d) Mine Warfare; e) NBC Defense; f) Remediation Training (for BNCOC students who had problems with prerequisite skills); and g) Tank Fire Commands. CBI seemed to be especially appropriate for training soldiers in these different lessons. CBI could provide standardized training which was missing in many BNCOC-level training programs. CBI could also allow military students to have the needed practice when instructor resources were low.

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After completing the courseware, TTFA discovered that some aspects of these tasks were not good candidates for CBI training (see the section on Task Selection and Training Design). TTFA personnel have also observed that procedural skill tasks which involve relatively stable instructional procedures seem to be the most suitable for CBI training. For example, training students to determine grid coordinates is especially suited for CBI training. The instructional procedures for training this particular skill have not markedly changed in a number of years and this task is not likely to change in the future. Conversely, TTFA has discovered that tasks (e.g., tactics) subject to change because of continually changing equipment or doctrine are not good candidates for CBI training.

Unfortunately, a large number of tasks selected for CBI conversion changed during the time period between selection and implementation. It was never perfectly clear whether these tasks had been incorrectly defined in the beginning or had actually changed during program development. Some task procedures also changed because a new SME determined that the old SMEs opinions were inaccurate. The management team was perhaps naive to have assumed that two or more SMEs would agree in all particulars about the performance of a task. These problems with task stability thus underscore the need for a stable team when producing CBI courseware.

Selecting an inappropriate task for CBI use has more dire consequences than selecting an inappropriate task for other delivery systems. For one thing, it is more labor intensive and difficult to change a CBI course than to change a platform instruction course. TTFA has found that a platform lecture can be changed in matter of minutes or days if it proves ineffective. A similar change in a CBI lesson may take weeks or months. For example, TTFA discovered that changing one question on a computer-embedded practical exercise involved several modifications in the courseware program. The operator had to change several things--the question, answer key, correct answer feedback, and wrong answer feedback--which were programmed as separate bits of information. The operator also had to make sure that the proper procedures for making changes were followed otherwise the students might not receive the question or corresponding feedback. Selecting an inappropriate task for CBI use also jeopardizes future CBI funding. Funding agencies would be reluctant to invest the large sums needed in CBI training projects without being assured of positive results for their investments.

TTFA, however, was forced to add instructional objectives after the courseware was nearly developed. Such changes were made to correspond to changes made to the BNCOC training program. Since our courseware was viewed as an exploratory project by the Armor School, the new BNCOC objectives did not necessarily correspond to the developed courseware. These changes were made to tasks with traditionally stable subject matter. For example, encrypting grid coordinates was a new objective for the Military Communications tasks which was not included in the developed courseware. Major modifications then had to be made to this courseware.

Recommendations: The decision to use a particular training medium is best made in the third SAT phase--the developmental phase. The instructional

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medium must be appropriate for training the instructional objectives which were developed in the second SAT phase—the design phase. Finally, the data from the CBI literature should be considered in determining the probability of success in using CBI for the selected objectives. Correspondingly, decisions made during the design phase must remain stable throughout the developmental process.

Selection of the Hardware System

Fort Knox's TTFA program was also in a developmental box because of an early selection of an instructional delivery system. The particular hardware system selected seemed to be an excellent choice for the 19K BNCOC training. This hardware system had an excellent graphics capability, was videodisc based, allowed full student interaction through a keyboard or a light pen, and each host station could operate up to forty student terminals. Also, previous research found th! system to be cost-efficient for military training purposes (Graham, Shlechter, & Goldberg, 1986).

TTFA then found that the capabilities of the delivery system drove the instructional design. Tasks were selected for conversion, and the corresponding instructional design was determined based upon beliefs about what the CBI system could deliver. Because the system appeared to be enormously capable, risky tasks were selected (e.g., the Land Navigation tasks) and problematic training procedures were designed, such as those used in the map orienting tasks.

Another risky training procedure involved the use of the voice recognition system to train Tank Fire Commands and some aspects of Military Communications. All the expert judgment that was solicited concerning device capabilities assured the TTFA team that the hardware could handle it. Unfortunately, several problems surfaced with the interface between the voice recognition system and the MicroTICCIT System II. For one thing, this voice system added peripherals to the MicroTICCIT that stretched the system beyond its designed capabilities. Also the courseware developer had problems because the length of the string of utterances for Military Communications lessons were much longer than anticipated. A misrecognition anywhere in the string resulted in a misrecognition for the entire string. Consequently, the Military Communications program was beset by delays and other problems. It was ultimately decided to complete the Military Communications program without using the voice recognition system.

Recommendations: The decision to use a particular CBI system should be made after the instructional objectives have been determined. Otherwise, hardware limitations rather than the instructional objectives, determine courseware development. The Army should be aware of this problem when it selects and mandates a standard instructional system for all users.

Courseware Production Methods

The method of producing the courseware also effected the instructional program. One courseware contractor was concerned with production efficiency. This firm thus took steps to produce the required courseware within the contractual time frame. This contractor designated a production control monitor who tried to make sure that the courseware was developed on time and within budget. Different people worked on different aspects of the same courseware. And a "template" method was used to produce the courseware. This method involved using the same instructional design for similar courseware. The template method also involved creating a standard page design which could be used for any number of CBI programs. For example, each TTFA lesson contained the same "help" page for using the system. These approaches, especially the template method, were used to reduce the costs and time involved in creating the CBI courseware.

These approaches caused a number of problems for TTFA. First of all, TTFA personnel and the military SMEs were asked to review the interim products--courseware scripts--as rapidly as possible. Sometimes these scripts were as long as fifty pages per segment. They also received a script for each completed segment rather than receiving an entire package of scripts for a particular piece of courseware. As indicated in the team approach section, the SMEs could not review the courseware in the contractors' time frame. The pressure placed upon them by the contractor to review the scripts made the SMEs more reluctant to thoroughly review the different scripts. Also, these SMEs had trouble visualizing the CBI courseware from the "hard-copy" scripts. The SMEs continually complained that the on-line courseware did not look like the previously reviewed scripts. TTFA's project manager and his staff for developing the courseware also experienced similar problems with reviewing the "hard-copy" scripts. The developed courseware thus contained content errors. For instance, erroneous coding procedures were discovered on the developed Military Communications courseware.

The template method also caused problems in presenting some of the instructional materials. The "help" pages explained the mechanisms for going to different pages within this courseware instead of providing any help with the instructional content. Soldiers completing the Military Communications courseware, for example, were upset that these help pages did not provide any additional information about the procedures for encoding messages. The template method also limited the amount of screen space available for presenting the instructional information. Multiple-choice items, for example, were limited to a few briefly stated alternatives. Changing the developed multiple-choice items was possible only after considerable time and effort was spent by the terminal site manager in changing these pages. The template method also forced a non-optimal instructional design upon some courseware. For example, the same instructional design was used for two similar appearing tasks--using the Radiacmeter and Dosimeter--even though these two BNCOC courses contained different subject matter and testing methods.

Time delays caused by the need to mail scripts back and forth produced a need to rapidly produce the courseware. Computer screens were designed with too much haste as was the editing of textual materials and graphics. It was

also obvious that different people produced different aspects of the same program. Different styles of presenting materials were found within a particular courseware. For example, different feedback procedures for similar types of items were found throughout the Call for Fire program.

Despite everyone's efforts, the development of the CBI programs did not proceed on a time scale parallel to previous training developments. CBI development took much longer. The TTFA personnel were unprepared for this. Pressures for more rapid courseware mounted from both the contractor and the funding agency. The contractor, of course, was worried about arriving at the end of the contract without having satisfied all contractual requirements. The funding agency was concerned with a steady outpouring of funds without any implemented programs to show for it. As previously indicated, all the CBI programs suffered because of these pressures.

Recommendation: Training effectiveness must be the bottom line for courseware production. SMEs and the courseware reviewers must be given interim products, including scripts, learning maps, and test plans, which are easy to follow. These people must be allowed an adequate amount of time to review these products. In fact, all parties to the CBI development and implementation process must appreciate that fielding these programs is a slower process than traditional training program.

We also recommend that the courseware developer employ a quality control person. This individual must check and re-check each on-line item for content and typographical errors and must make sure that a consistent style is maintained for each course. This individual must be independent of the designing and programming process because individuals responsible for developing any textual product have trouble with proofreading the materials. And the courseware monitoring team and the SMEs must review the on-line courseware for content and design errors before it is released. TTFA found that controlling such content errors, including typographical errors, was very important because military instructors were hesitant to implement courseware with even the slightest content errors.

Summary

Quality CBI development thus requires that the utmost care be given to each developmental sequence. Choosing a training medium, a particular system, and a particular instructional design should be based upon instructional objectives. Quality control is also required for producing a quality courseware.

IMPLEMENTATION ISSUES

A successful CBI implementation demands that the training program become a standard piece of the program of instruction (POI) or curriculum. A CBI program, regardless of its training effectiveness, will not reach this instructional status if the program does not satisfy the users.

Needs of the Instructors

The TTFA project experienced implementation problems because the BNCOC instructors were reluctant to implement courseware which did not fully meet their immediate needs. For example, the BNCOC instructors felt that some portions of the Call for Fire program would be rarely used as some of these materials were too advanced for BNCOC students. On the other hand, TTFA has found that instructions are eager to implement any CBI programs which will meet an instructional need. For example, an instructor from a more advanced Armor School course was eager to use the Call for Fire program as his students needed all the practice possible on this task.

TTFA also failed to calm the instructors' fears about being replaced by the CBI system. At an Armor School meeting, for example, the representative for the BNCOC instructors complained that CBI training was not needed as his instructors were better prepared to teach the different materials. His comments seemed to be based on the need to save his instructors' jobs. The BNCOC instructors' fears were thus a barrier to implementing the TTFA program.

Recommendation: Instructional personnel must have an active role in CBI development. They must assume "ownership" of the programs developed.

Implementation and Instructional Management Problems

Instructional management was a continual problem. For one thing, instructors did not want any program which they felt was too difficult for their students to complete. A concern was expressed that these programs contained too much reading material for their students. Another concern was that difficult courseware would affect the students' desire to complete the program. The Military Communications courseware, for example, contained some items which frustrated the students because they could not be answered. TTFA personnel noticed that the classroom scene became quite tense when the students attempted to complete these items. Some students even exhibited some verbal hostility toward the program. Fortunately, the classroom proctor was able to help the students complete these items without too much time being wasted. The proctor was able to provide this help because of his familiarity with this particular courseware.

Monitoring the students' time at a CBI terminal was another instructional management problem. TTFA did not initially realize the students' limited capacity for continually viewing a CBI program. Students were initially given breaks as given in traditional platform instruction courses--after each fifty minutes of instruction. TTFA personnel found that the evaluation subjects and BNCOC students would start yawning and losing their concentration after thirty minutes of continuous CBI training. To maintain the instructional flow, instructors should allow their students to have breaks more often than the breaks provided in traditional platform learning.

Scheduling was also effected by the number of terminals available for student use. For example, the current 19K BNCOC class offered at Fort Knox ranges in size from eight to sixteen students per cycle. Because of constraints beyond TTFA's control, this project had only four student terminals. The BNCOC instructors, operating under tight scheduling constraints, were not able to schedule all students to receive CBI training. Such limited terminal availability also presents problems for instructors without any scheduling constraints. These trainers must find activities for students who are not using the terminals while other students are engaged in CBI training.

If an inadequate number of terminals are available, then small group (two or more at a terminal) training is possible option. Shlechter (1987a) found that students who received group CBI training completed the lesson quicker than did the student who received individual CBI training. He did not find any differences in the subjects' learning of the materials. Group training would thus allow more students to receive CBI training with the same among of hardware. Of course, group presentation of CBI materials may not be appropriate for certain types of courseware, e.g., a remediation program.

Recommendations: The implementation team must devise a plan for dealing with potential course management problems. Instructors need to know that more frequent breaks should be scheduled. Enough terminals are needed to obviate scheduling problems. If it is not possible to acquire an adequate number of terminals then group presentation of CBI materials is recommended.

Implementation Plans and Maintaining the System

TTFA has also discovered that any system failure can greatly disrupt the instructional process. For example, a faulty light-pen, the MicroTICCIT system's responding mechanism, impeded students' ability to complete a lesson. Such minor system problems were not uncommon. The system's reliability also effected the developmental and implementation process. Our videodisc-based system--as do all systems--had some hardware and software bugs. For example, TTFA personnel experienced problems with frozen computer frames, (i.e., the terminal getting stuck on one page). Developmental and implementation delays were then caused when the system was down for an extended period of time.

Such reliability problems have also been shown by the research literature to be an important factor in instructors' decisions to continue or discontinue using the system (Shlechter, in press). For one thing, a relationship has been shown to exist between educational productivity and a medium's downtime during the instructional process (Shlechter, 1987). Also, instructors must re-schedule, if possible, their program to meet the changes necessitated by the problems with the system.

Recommendations: Implementation plans should include procedures for maintaining the system. A maintenance contract with the hardware developer is an absolute necessity. The site manager is also important for maintaining the system. Many systems problems are resolvable through "quick-fix" procedures (e.g., activating certain programming codes to unlock a frozen frame).

A successful implementation requires thoroughly training the system operator in troubleshooting the CBI system.

A successful implementation also requires choosing a CBI hardware configuration, including its peripherals, with a proven track record. TTFA's system was problematic because many new features were added to the MicroTICCIT System II.

Training the Instructors

TTFA's implementation plans should have also included an instructional program for the BNCOC instructors. These instructors were given some preliminary training on the courseware and MicroTICCIT system by the implementation team. However, this training was not sufficient for them to resolve many problems without a civilian proctor's being present.

A trained instructor would be able to resolve quickly any minor system problems before any serious instructional problems (e.g., bored students bothering other students) could occur. Secondly, the instructor needs to be familiar with the instructional program to maintain the instructional flow. As stated, the trained TTFA proctor was able to help students complete the Military Communications lesson. The BNCOC instructors should then have been "computer literate" with regards to the different courseware and the Micro-TICCIT System II.

This training for instructors should also prepare them for a new instructional role. Instructors, especially military instructors, are quite familiar with the lecture mode associated with conventional platform training. As discussed, however, the instructor's role in CBI training changes to that of an instructional facilitator with the main responsibility of ensuring the courseware's proper instructional flow. Instructors with such computer literacy would thus not harbor as many anxieties about using this training medium because they would know that they still had a viable instructional role. Instructors who are expecting too much from CBI may become disillusioned after using this training medium.

Recommendations: A successful implementation requires training the instructors to use the computer courseware and system and adopt a new instructional role. However, the personnel--implementation team members and the terminal site manager--who are responsible for this training should refrain from overselling the product to the instructional personnel

Commitment from the School's Management

Many of the Armor School's management personnel were not actively involved with this project. These department heads had been told that TTFA was an experimental project whose products would probably never be permanently implemented at Fort Knox. These department heads, including the BNCOC Division Chief--were thus not totally committed to implementing this project's products.

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Another related implementation problem was that the school's management redesigned the 19K BNCOC course midway through the TTFA project. The TTFA staff was not notified of this action. This problem underscores the continuing communication problem.

This lack of committment from the school's departmental heads was manifested in several other ways. Several departments were hesitant to approve aspects of the courseware as part of the regular BNCOC program of instruction. For example, the Department of Evaluation and Standardization (DOES) did not see a need to expedite their approval of the computer-embedded tests. At a military training site, tests used to evaluate students must be approved by DOES. The BNCOC instructors could not use these computer-embedded tests as evaluation instruments. Also, the military SMEs viewed their job with TTFA as tangential to their other military duties. Even though these personnel were extremely cooperative, their TTFA duties were always secondary to other duties--e.g., creating their own courses. Implementation delays thus resulted in waiting for these SMEs' reviews of the on-line courseware.

Recommendations: The TTFA personnel should have spent more time at the project's beginning with these department heads without overselling the new training products. The department heads may have then been convinced of TTFA's viability. Consequently, the management personnel would have made sure that the TTFA training programs were put on their project list. This step is important because such projects get a permanent action officer. This action officer would want to develop a quality product in a timely fashion. The action officer would make sure that his or her personnel were committed to implementing TTFA's products. He or she would make sure that the departmental heads were regularly briefed about the project's progress.

Summary

TTFA has found that an effective CBI implementation program must include procedures for (1) meeting the needs of the instructors; (2) training the instructors to use the medium; (3) choosing a proven hardware configuration; and (4) maintaining the instructional flow. The classroom instructor and on-site support staff also have important roles in successfully implementing this medium. Finally, implementation planning should have the full "blessings" of the school's management and instructional personnel.

EVALUATION OF THE CBI PROGRAM

CBI's potential as a training medium is also dependent upon quality evaluation checks. These evaluation checks must be done at each stage of the program's life cycle.

TTFA's "One-on-One" Testing Procedure

TTFA's preliminary evaluation of the developed courseware involved a "one-on-one" testing procedure with one subject being closely observed by an evaluator. The subjects were the course instructors and six BNCOC-like soldiers who came from an operational armor unit. The evaluation team's previous experience with soldiers from these units suggested that their performance would be similar to the performance of BNCOC students. Problems encountered by a subject were recorded by the observer. The subject and observer also discussed each problem as it was encountered. Each subject was encouraged to "think aloud" when completing this courseware. In the "thinking aloud" methodology subjects provide a running verbal account of their ability to complete the courseware (for a further description of this methodology see Ericsson and Simon, 1984). The "one-on-one" testing approach provided TTFA with insights into subjects' performance which were hard to obtain through traditional evaluation procedures. For example, TTFA realized after examining data for the Land Navigation courseware that students would have trouble completing the map orienting task. Data also provided insights into the reasons for the subjects' problems with this task.

Recommendations: Thorough content reviews, including "one-on-one" testing, should be conducted on the interim products. The results of these tests should be known to the courseware developer so that they can correct any problem areas before delivery for in-course evaluation.

Developmental Trials

TTFA's subsequent and more formal evaluation of the CBI courseware will be referred to as the developmental trials. Determining the quality of any instructional program is difficult. TTFA employed developmental trials to determine the quality of their CBI programs. These developmental trials involved a pretest-posttest design to measure changes in subjects' performance on representative achievement measure(s). Data were also obtained on the subjects' time for completing the lessons and their attitudes toward the program. The subjects for these studies were the BNCOC-like soldiers from the operational armor unit.

The developmental trials were conducted under experimental conditions. the evaluation team controlled the instructional environment. Members of the evaluation team observed and monitored the subjects' behavior while they completed the CBI lessons and tests. For example, a member of this team also served as a proctor who assisted the students with their problems. This proctor also administered any off-line instruments (e.g., demographic and attitudinal questionnaires) to the subjects. These developmental trials did indicate that the developed programs were suitable for inclusion in the BNCOC POI.

There were several potential problems with these developmental trials. A problem with these developmental trials was that the experimental scene may have produced artificial results. Students have been known to perform differently under experimental training conditions than under regular training

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conditions. Secondly, these students' favorable comments about the course-
ware could have been geared to please the evaluation team (see Shlechter,
1986 for a further discussion of this latter possibility). A third problem
was that the BNCOC-like subjects' were not comparable to the BNCOC students.
Shlechter (1987b) noted that the BNCOC-like students differed with regards to
demographic composition (such as they had less previous experience with using
the military communications materials) from normal BNCOC students. This prob-
lem could have also been an issue in the "one-on-one" testing. Finally,
doubts about the different programs' value remain because the developmental
trials data were not directly compared with baseline measures of a system's
effectiveness—such as the subjects' learning for the already established
instructional program. Even though our data compared favorably to those
provided for the established program from previous classes, a baseline meas-
ure was still needed to determine the relative effectiveness of the CBI
courseware.

Recommendations: We recommend that the developed courseware be evaluated
by an agency independent of the development and implementation process.
Courseware should be evaluated under actual learning conditions and with the
students who are going to be using the courseware. Baseline measures of a
system's effectiveness should also be obtained.

Validation Check

TTFA finally conducted a validation check on the developed courseware
before implementing it. Data were collected when the BNCOC students were
using the program as part of their regular training. The BNCOC instructors
controlled this instructional environment with only minimal concessions to
data collection, i.e., allowing only one observer to watch the entire class.
For the most part, these data were similar to the developmental trial re-
sults. For example, the data for the Military Communications' validation
check paralleled those obtained in the developmental trials. However, the
validation checks data did show that some courseware and implementation modi-
fications were still needed. For example, the instructors were still depend-
ent on TTFA personnel to fix minor system problems.

The validation trials' (and developmental trials') data were reported
back to TTFA management. The question was whether to proceed directly with
the implementation, make the appropriate changes, or discontinue the program.
With the sizeable investment in developing the CBI program, the third option
was unlikely. Of course, negative evaluation data about a system's instruc-
tional effectiveness would have made management reconsider any future CBI
program development.

Also, very little is known about CBI's worth for advancing the military
training process. This is because implemented CBI training programs have
rarely been compared to other implemented instructional programs for that
courseware. Training developers and instructional personnel thus do not know
if the implemented CBI program is better than other training programs for
their intended purposes. The evaluation team should compare the implemented
CBI program with the already established program.

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Recommendations: Questions will remain about a program's effectiveness until the implemented program either fails or becomes obsolete. The evaluation team should collect data for an extended period on a system fully implemented. If possible, data should be collected to compare CBI to any other operational training methods to determine the cost-effectiveness of this solution. Such data will show the system's long-term success or failure for training BNCOC students. Data from a fully implemented system will also provide information about a hardware system's reliability for normal training conditions, about the relationship between projected and actual life cycle costs, and about instructors' and students' actual attitudes toward using the system. Such data are needed as very little is know about the long-term worth of CBI systems in military training programs. Since the primary function of any training program is to insure that students transfer the information to the appropriate situations and retain the information, transfer studies are also needed.

Summary

Evaluating a CBI program has thus been shown to be a vital part of a program's development and implementation process. "One-on-one" testing, developmental trials, and validation checks are also recommended as procedures for evaluating CBI courseware. Suggested improvements in TTFA's method of employing these evaluation procedures are also made.

SUMMARY OF RECOMMENDATIONS

TTFA did have some success in implementing these programs. However, the developmental program could have been smoother if it had been able to anticipate the problems discussed in this paper. In summary, the following recommendations have been made based upon TTFA's experiences:

Managing the CBI Project

1. All agencies involved in CBI development, directly or tangentially, must meet regularly to share concerns and input to the process.

2. All constraints to development and implementation must be surfaced as early as possible.

3. The time table for development must be more flexible than for traditional instruction.

4. Managers of the CBI development process must be knowledgeable of CBI systems and courseware production methods.

5. A single project manager will expedite development and evaluation. This person must be the agent responsible for implementation.

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6. The CBI site manager must have previous CBI experience. He/she should be thoroughly trained on the CBI delivery system before system acquisition.

7. The CBI site should require few alterations to accept the hardware and should be located close to or in the "school-house".

8. The CBI development manager, courseware designers, courseware developers, instructors, and SMEs should be co-located during development.

Developmental

1. Task selection must be done either by instructional developers thoroughly versed in this process or by careful application of a CBI task selection model.

2. Problematic tasks that require complicated cognitive functions should be avoided unless the literature can show previous success.

3. The selection of training media must follow the guidance in the systems approach to training.

4. Data from the CBI literature should be considered in determining the probability of success in using CBI for selected objectives.

5. Decisions made during the design phase must remain stable throughout the development process.

6. The decisions to use a particular CBI system should be made after the instructional objectives have been determined.

7. Training effectiveness must be the bottom line for courseware production.

8. A separate, independent, person/agency must be employed for quality control.

Implementation

1. Instructional personnel must have an active role in CBI development. They must assume "ownership" of the programs developed.

2. Managers must be prepared for instructional management problems, unique to CBI.

3. Implementation plans must include procedures for maintaining hardware and software.

4. Instructors must be trained to use the hardware early in the development phase.

5. An action officer from the school's Directorate of Training and Doctrine is essential for smooth coordination of courseware development.

6. Choosing a CBI system including its peripherals with a proven track record is recommended.

Evaluation

1. Thorough content reviews should be performed on interim products.

2. Courseware evaluation should be performed by an independent agency.

3. Both formative and summative evaluations should be performed. Data must be collected on a fully implemented system.

Conclusion

This report has also indicated that the CBI development and implementation team include personnel from all the directorates and departments in the school. This should be done even if these departments and directorates appear to be marginally involved in the effort. Problems with acquiring a terminal site and with choosing stable instructional materials were caused by neglecting some of the Armor School's management personnel. Since CBI development is a very costly venture, it is not worth risking unuseable courseware because some agencies have been excluded from a meeting now and then. It is also imperative that agency representatives to the steering committee be empowered to speak for the agency's head.

TTFA has thus found the development and implementation of a CBI program to be more complex and intricate than other previously developed training programs. Quality CBI programs are still worth the efforts and problems described in this report. This medium can be useful to the military as an instructional tool and can make the already established program more effective. This medium can also alleviate some problems faced by the military training community, e.g., a need for training basic skills with dwindling instructional resources. Finally, CBI can provide the military with standardization of instruction and provide the reserve components with needed sustainment training.

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