ARI Research Note 86-85

THE TRAINING INFORMATION MANAGEMENT SYSTEM: Phase II Final Report Technical and Management Overview

Perceptronics

for

ARI Field Unit at Presidio of Monterey, California

TRAINING RESEARCH LABORATORY
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Research Institute for the Behavioral and Social Sciences

July 1986

U. S. ARMY RESEARCH INSTITUTE

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Note 86-85	2. GOVT ACCESSION NO. AD-A172 099	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE TRAINING INFORMATION MANAGEMENT SYSTEM: Phase II Final Report Technical and Management Overview		5. TYPE OF REPORT & PERIOD COVERED Final Report, Vol. 1 April 84 - January 86 6. PERFORMING ORG. REPORT NUMBER - -
7. AUTHOR(s) Perceptronics		8. CONTRACT OR GRANT NUMBER(s) NAS 7-918, Task Order No. RE-182/183
9. PERFORMING ORGANIZATION NAME AND ADDRESS Perceptronics, Inc. 6271 Variel Avenue Woodland Hills, CA 91367		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		12. REPORT DATE July 1986 13. NUMBER OF PAGES 15
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) ARI Field Unit at Presidio of Monterey California, P.O. Box 5787, Presidio of Monterey, CA 93944-5011		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE - -

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

- -

18. SUPPLEMENTARY NOTES

This contract was managed for ARI by Jet Propulsion Laboratory, Pasadena, California

Jack H. Hiller, contracting officer's representative

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Keywords:
Training Management
Soldier Performance
Unit Evaluation
Field-Portable Computer Unit

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Training Information Management System (TIMS) is a computer-based system which can be used by Army personnel to collect and display training evaluation data during field training exercises, and to generate summary evaluation reports following the exercises. The TIMS has two major subsystems: the Electronic Clipboard System (ECS), and the Training Base Station (TBS). The ECS is a hand-held electronic field training and performance evaluation aid, which contains

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ARI Research Note 86-85

20.Abstract (continued)

and displays performance evaluation checklists and other associated information to allow a training evaluator to record the success or failure of a soldier in meeting the standards of performance for selected tasks. The TBS is a computer-based subsystem that maintains multiple checklist databases, transfers data to and from the ECS, and generates printed and displayed summaries of training performance. It is not field-portable, but resides at a fixed location (e.g., the unit headquarters). → FLD 19

This research note provides a technical and management overview of the development and evaluation of the Technical Management Information System.

The complete list of reports, of which this is volume 1, is as follows:

RN 86-85 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
Phase II Final Report
Technical and Management Overview

RN 86-78 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
Phase II Evaluation Report

RN 86-79 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
Phase II Functional Specifications

RN 86-76 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
User's Manual for the Training Base Station

RN 86-81 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
Software Design Documentation for the
Training Base Station

RN 86-77 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
User's Manual for the Electronic Clipboard System

RN 86-82 THE TRAINING INFORMATION MANAGEMENT SYSTEM:
Software/Firmware Design Documentation for the
Electronic Clipboard System

ABSTRACT

The purpose of the TIMS program (Phases I and II) was to design, develop, and evaluate a prototype Training Information Management System (TIMS) containing two major subsystems: (1) the Electronic Clipboard Subsystem (ECS), a hand-held device which contains and displays performance evaluation checklists and other associated information to allow training evaluators to record the success or failure of soldiers in meeting the standards of performance for selected tasks; (2) the Training Base Station (TBS), which maintains multiple checklist databases, transfers data to/from the ECS, and generates summaries of training performance.

The goal of both program phases was to rapidly produce prototype systems that could be "touched, handled, and kicked" so that early and efficient hands-on evaluation of the device by the user community would be possible.

The result of Phase I was a Brassboard ECS and prototype (VAX 11/70-based) TBS. During Phase II, twenty ECS field units and an updated (IBM PC-based) TBS were produced and field tested at Fort Knox, Kentucky.

Resulting from the successful field test were a set of user recommendations for improvements that should be included in the next version of TIMS.

NEW TECHNOLOGY

No reportable new technology items were developed on this contract.

1.0 PURPOSE AND SCOPE

The purpose of this report is to provide a technical and management overview of the Phase I and Phase II Technical Information Management System (TIMS) program. This report contains the following six sections:

1. Purpose and scope
2. TIMS background
3. Overview of technical approach and "lessons learned" on Phase I program
4. Overview of technical approach and "lessons learned" on Phase II program
5. Management retrospective
6. Recommendations for future TIMS improvements

2.0 TIMS BACKGROUND

The Training Information Management System (TIMS) is a computer-based system that can be used by Army personnel to collect and display training evaluation data during field training exercises, and to generate summary evaluation reports following the training exercises. The TIMS has two major subsystems. The first, called the Electronic Clipboard Subsystem (ECS), is a hand-held electronic field training and performance evaluation aid. The ECS contains and displays performance evaluation checklists and other associated information to allow a training evaluator to record the success or failure of a soldier in meeting the standards of performance for selected tasks.

The second subsystem is called the Training Base Station (TBS). The TBS is a computer-based subsystem that maintains multiple checklist databases, transfers data to/from the ECS, and generates printed and displayed summaries of training performance. The TBS is not a field-portable subsystem, but rather resides at a fixed location (e.g., the unit headquarters).

The purpose of the TIMS Phase I effort was to develop and demonstrate a preliminary TIMS, comprised of an ECS Brassboard (ECSB) and a prototype Training Base Station Emulator (TBSE). The purpose of the Phase II effort was to build upon the technical information and expertise gained during the Phase I effort to develop, produce, and validate an Electronic Clipboard Subsystem Prototype (ECSP), and then fabricate, field test, and deliver a TIMS comprised of twenty (20) ECS field units and one TBS.

3.0 OVERVIEW OF TECHNICAL APPROACH AND "LESSONS LEARNED" ON PHASE I PROGRAM

3.1 Phase I Technical Approach

The Phase I effort began with the development of two primary documents, namely (1) the Detailed System and Subsystem Requirements document, and (2) the TIMS Functional Specification. These two documents taken together described to the hardware and software engineers the devices that were to be produced. The TIMS Requirements Document focused on (1) the assumptions about the use of TIMS, (2) the hardware and software requirements, (3) the operational requirements, and (4) the environmental requirements for the overall system and the two major subsystems: the Electronic Clipboard Subsystem (ECS) and the Training Base Station Subsystem (TBS).

The TIMS Functional Specification was based on an analysis of (1) the training checklists that were to be displayed on the ECS and (2) the training data that would be collected on the ECS and analyzed at the TBS. Whereas the TIMS Requirements Document gave consideration to fabrication concerns, such as size, weight, power consumption, etc., the primary focus of the TIMS Functional Specification was on the functional characteristics to be included in the system. Thus a major section defined the functional requirements for the overall Training Information Management System (TIMS), and specifically the functional characteristics that were to be included in the ECS and the TBS. These functional characteristics were described in terms of the display screens that were to be presented to the ECS and TBS users, and the controls that they would have available to operate these subsystems.

Concurrent with the development of the TIMS Requirements Document and the TIMS Functional Specification, the hardware engineers began a preliminary analysis of the components that would meet the overall needs of the various subsystems. It was recognized immediately that the design of the ECS would be subject to severe limitations in (1) size and weight imposed by the need for portability, (2) numbers of displayed characters imposed by the need for large amounts of data to be presented at any one time, and (3) power consumption imposed by the need for extended operations between recharging. Thus the hardware engineers focused immediately on the appropriate display technologies, including Liquid Crystal Displays (LCDs), and Electroluminescent (EL) panels. They also gave immediate attention to various battery alternatives, and the available low power memory technologies.

As soon as the TIMS Requirements Document was approved, and the basic hardware technologies (i.e., display, battery, and memory) had been selected, the hardware and software engineers began development of the ECSB and TBSE. The focus of the Phase I effort was to develop a Brassboard ECS, which could be used to present a concept demonstration of the Electronic Clipboard. Thus the focus of the hardware and software development was to produce a device that could be "touched, handled, and kicked," as soon as possible in the program. Therefore, the effort was not focused on creating a fully finished, field-ready device that contained all of the possible optimization in terms of hardware design (e.g., minimum number of ICs, lowest power consumption, etc.) or software design (e.g., modular device drivers, etc.).

The final product of the Phase I effort was an ECS Brassboard, which consisted of a hand-held portion that contained the Liquid Crystal display, attached by cord to a box that contained the wire-wrapped PC boards. The hand-held portion of the ECSB was built to the same dimensions (i.e., size and conformation) as the planned ECS Prototype, and weight to simulate the ECS Prototype. The Training Base Station Emulator software operated on a DEC VAX 11/70, and was connected by a serial interface to the TBSE for uploading and downloading ECS data and programs.

3.2 Phase I Technical Lessons Learned

The primary technical lesson to be learned, based on the changes that occurred in the design of the ECS from Phase I to Phase II, is to be sensitive to, and accommodate, the rapid changes that are occurring in electronics technology. For example, in the short time (6 months) between selecting the LCD for the Phase I ECS Brassboard and the Phase II Prototype, massive and significant improvements occurred in LCD technology. These advances impacted not only the choice of display, but also the display drivers and the case size. Similar advances can be expected in the development of any ECS and TBS that will be developed following Phase II. The conclusion to be drawn is (1) to expect that any design, be it mechanical, electrical, or software, will be subject to significant changes, based on advances in technology, and (2) to allow for such advances by (a) designing sufficient flexibility into the initial design to accomodate anticipated advances [note that such flexibility may be inordinately expensive in terms of schedule and/or budget], or (b) being ready to make changes as they are needed or possible.

Another important lesson concerns the amount of user input solicited at the end of Phase I. It would have been appropriate to invite potential end users to participate in the Phase I Final Review and to "try out" the ECS Brassboard. Given the users' comments from this initial "try out," the configuration of the ECS that would have been developed during Phase II would have fit more closely to the actual field users' expectations, and the field evaluation conducted at the end of Phase II could have focused more extensively on validation of the users' requirements.

4.0 OVERVIEW OF TECHNICAL APPROACH AND "LESSONS LEARNED" ON PHASE II PROGRAM

4.1 Phase II Technical Approach

The Phase II effort began with a revision of the TIMS Functional Specification developed on the Phase I program. The purpose of this specification revision was twofold: (1) to update the system requirements in light of the technical lessons learned during the Phase I effort, and (2) to incorporate new requirements stated by the Fort Knox Armor School representatives during a meeting on 11 July 1985. (Note: the major new requirement was for a capability for "three-pass evaluation," whereby students are given up to three opportunities to "pass" a given checklist evalution item). A new requirements document was published, entitled the "Functional Specifications for the Training Information Management System (TIMS): Phase II".

Development of an ECS Prototype (ECSP) began in earnest after the publication of the new requirements document. The ECSP hardware and software design efforts were accompanied by the development of initial design documentation, and by a parallel effort for revision of the TBSE design.

As the designs progressed, work began on the development of a test plan for validation of the functionality of the ECSP and TBS. More specifically, both a Phase II TIMS Validation Test Plan and an Electronic Clipboard System Prototype (ECSP) Validation Test Plan were developed. Both contained actual evaluation checklists to be used to validate the conformance of the TIMS and ECSP with the physical, functional, environmental, and interface requirements stated in the Phase II TIMS requirements document.

Also prepared during the design phase was a Phase II TIMS Utilization Plan document which defined the requirements for the Ft. Knox field test of the prototype TIMS. This document contained two major parts. Part I was the Phase II TIMS Familiarization and Training Plan, which outlined the approach for familiarizing and training U.S. Army personnel at Fort Knox, Kentucky, in the use of the Phase II TIMS. The plan outlined the requirements for both classroom and "hands on" training. Part II was the Phase II TIMS Field Operation Plan, which specified the approach for generating, collecting, verifying, storing, and disseminating appropriate U.S. Army evaluator, personel, and checklist data required for evaluation of the Phase II TIMS.

Prototype development of both the Phase II ECSP and the TBS was completed at approximately the same time, and functional testing of both units was conducted according to the pre-prepared plans. A critical finding of the validation testing was that the power requirements of certain major ECSP components was far greater than anticipated, thereby causing an unacceptable decrease in score memory retention time and necessitating a redesign. By far the greatest part of the problem was caused by the liquid crystal display, which was a recently released state-of-the-art product for which only preliminary technical data was available. The technical data provided by the vendor proved to be inaccurate with respect to the power requirements of the display. This led to the power problem observed during the validation testing. Redesigned circuitry, allowing for a complete shut-down of the display during the ECSP power-down mode, was developed for inclusion in the 20 field units. (Note: a more comprehensive display power-down capabilitiy had not been included in the original design due to the cost and space requirements associated with the circuitry.)

Subsequent to the validation tests, and during the time that development of the twenty ECS Field Units (incorporating the redesigned circuitry) was underway, documentation was prepared for the Field Test. Specifically, the following documents were developed:

- Phase II TIMS Utilization Documentation - which presented a detailed description of the training activities to be conducted at Fort Knox, and contained the actual training materials to be presented

- Phase II TIMS Evaluation Plan - which provided a description of the evaluation and data analysis methods to be employed during the field test, and included the actual "structured questionnaire" form which was to be used during the evaluation

- Electronic Clipboard Subsystem (ECS) User's Manual

- Training Base Station (TBS) User's Manual

As the 20 ECS Field Units were constructed, the functionality of these units was tested in accordance with the requirements of a pre-prepared ECS Field Unit Acceptance Test Requirements Document.

The results of all functional tests (i.e., for the ECSP, TIMS, and Field Units) was documented in deliverable reports (ECSP Validation Test Documentation; Phase II TIMS Validation Test Documentation; ECS Field Units Acceptance Test Results).

The Fort Knox field test was conducted during the month of November 1985. The TIMS evaluated at Fort Knox consisted of one TBS and 20 ECS Field Units. At the completion of the field test, results were analyzed and then summarized in a Phase II TIMS Evaluation Report. A set of recommendations for future TIMS improvements, based upon results obtained from the field test (and documented in the Evaluation Report), was developed and is included in the present document in section 6.0.

Final hardware and software documentation were prepared (i.e., Final ECSP Layout and Packaging Drawings; Final Phase II ECSP Software/Firmware Design Documentation; Final TBS Software Design Documentation) to provide a permanent record of the final design configuration.

4.2 Phase II Technical Lessons Learned

User inputs regarding the TIMS current hardware and software capabilities and recommendations for both immediate and long-term product improvement were obtained during the Fort Knox field test. These data constitute perhaps the best summary of "lessons learned"and is summarized in a document entitled Phase II TIMS Evaluation Report.

5.0 MANAGEMENT RETROSPECTIVE

As during any program there were lessons to be learned from a management perspective. In this section four specific "lessons" will be discussed in the hopes that they may benefit future programs.

5.1 LESSON 1: Requirements Are Bound To Change So BE FLEXIBLE

This lesson was brought home in three separate ways during the program.

(1) An early design decision to use flexible word processing and data post-processing programs to input evaluation checklist databases proved critical in allowing for easy adaptation to an unanticipated change in the format of the databases required to be used for the Phase II evaluation.

(2) It was determined during the conduct of the program that additional flexibility in hardware and software design , over and above that incorporated in the current design, is desirable to accommodate changes in requirements, (e.g., those changes that occured as a result of a meeting with the Armor community at the beginning of Phase II, where a requirement for "three pass scoring" was first raised). A desirable step in this direction could be made in future versions of TIMS by incorporating a capability for downloading not only databases, but also applications programs into RAM thereby allowing easy adaptation of the system for multiple environments (without the necessity of burning new PROMS).

(3) Preparations for the Fort Knox Field test were extensive and included the development of structured questionnares to be used for the assessment of users' opinions. These questionnaires were, in fact, used during the field evaluation to obtain feedback from 30 respondents. However, due to the tight time schedules of the BNCOC evaluators, it was found more expedient to extract evaluation data from them in a more free-form format, by the use of verbal questions (modeled after questions on the questionnaire) and "role playing", whereby the evaluators ran through scenarios for using the Clipboard under operational conditions and reported their thoughts and impressions as to the strengths and weaknesses of the current design. The lesson here is simple - know exactly what information you have to obtain, but be flexible enough to obtain that information in various formats.

5.2 LESSON 2: Active Participation in the Program by the Technical and Contractual sponsors (in this case ARI and JPL) is a positive factor in program success.

Both ARI and JPL participated actively on the program, especially during the critical parts of Phase II, the TIMS validation testing and the Fort Knox field evaluation. Such participation allows for not only an efficient development and review process, but also a superior product.

5.3 LESSON 3: It is not always cost effective to make all interim hardware and software products deliverable under the contract.

A prime example of this principle concerns the development of the ECSP in Phase II. The prototype was developed for purposes of assessing the functionality of the design in meeting the requirements as specified in the Phase II requirements document. During the validation testing, design changes were determined to be necessary (for example, to accommodate the power-saver circuit). However, it was determined to be neither efficient nor cost-effective to try to retrofit the existing unit with the new circuitry. The practical approach was to insure that all required changes were incorporated in the subsequent 20 field units. It appears that in cases such as this it is not cost-effective to require delivery of development models, as they are suboptimal in comparison to the final units and contain expensive parts which can be re-used in the building of the final production models.

5.4 LESSON 4: Two phases of field testing are optimal.

The philosophy used during the current contract was that of "rapid prototyping", whereby a preliminary product is produced in a relatively short period of time so that a product, rather than a paper specification, can be evaluated early by the customer community. Maximum exploitation of such an approach requires that the results of the user evaluation be analysed and the critical recommendations be implemented in a second prototype, which is then returned to the field for a final evaluation. Unfortunately, only a single evaluation phase was provided for in the current contract.

6.0 RECOMMENDATIONS FOR FUTURE SYSTEM IMPROVEMENTS

As a result of the analysis of the field evaluation data, a set of recommendations was developed for future TIMS improvements. These recommendations are documented in the Phase II TIMS Evaluation Report and are also included herein for the reader's convenience.

The system features recommended for inclusion in future TIMS designs were divided into two categories:

- Those considered to be very important to include in a new design
- Those important for future consideration but optional for the next generation design (i.e., not absolutely essential)

6.1 Essential Features to Include In Future Designs

- High contrast display
- Positive feedback on touch panel (so user can tell when keys have been pressed)
- Addition of a Keyboard Enable button that tells the system when to accept keyboard inputs (prevents accidental keypresses).
- Increased ruggedization
- Faster scroll

- Link "Train on Drill" and "Evaluate a Drill" modes in such a way that user can go rapidly back and forth between them without losing his place.

- Do not automatically route user into next unscored pass each time "Train On Drill" mode is requested. Make the solider indicate that he has completed a pass before he can access the next pass.

- Improve the means of indicating when a given key selection has been made (e.g., use flashing of entire key selected, or inverse video)

- Show student name and pass number at all times in the "Evaluate a Drill" mode

- Add an "OFF" switch capability for the backlight and power (e.g., toggle the light and power switches).

6.2 Optional Features for Next Generation Design

- Increase Clipboard memory retention time from five days to over one month

- Provide intensity control for electroluminescent backlight

- Make batteries field replaceable

- Increase Clipboard memory so Clipboard can store multiple training guides simultaneously

- Provide a capability to charge Clipboard from a DC power source

- Add a numeric keyboard (software keys)

- Make displayed error messages more obvious

- Add a "set marker" function that will allow users to define their own places in the database to which they can rapidly jump

In addition to the above, the following recommendations for improvements were made by the developers (Perceptronics):

- **Consider adding a capability to download not only databases but also applications programs to the Clipboard. This will allow the Clipboard to be easily configured to support multiple requirements.**

- **Consider rehosting the Training Base Station onto other computers currently in use by major user communities.**