CONF-8609105-1

MASTER

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36

RECEIVED BY OSTI JUL 07 1986

TITLE: A TRILEVEL INTERACTION DESIGN MODEL FOR PILOT PART-TASK
TRAINING

LA-UR--86-2244

DE86 012428

AUTHOR(S): Jorge H. Roman, Ronald A. Pistone, Mary L. Stoddard

SUBMITTED TO: 1986 Annual Meeting of the Human Factors Society
Dayton, Ohio
September 30-October 3, 1986

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution or to allow others to do so, for U.S. Government purposes.

The Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

Los Alamos Los Alamos National Laboratory
Los Alamos, New Mexico 87545

with

A TRILEVEL INTERACTION DESIGN MODEL FOR PILOT PART-TASK TRAINING*

Jorge H. Roman, Ronald A. Pistone, and Mary L. Stoddard
Training Research Team, Military Systems Group
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

ABSTRACT

Development of effective, scenario-driven training exercises requires both an instructional design and a delivery system that match the subject domain and needs of the students. The Training Research Team at Los Alamos National Laboratory conducts research and development of prototype training systems. One of the Team's efforts is a joint research project, supported with funding and behavioral science guidance from the Army Research Institute, to develop a prototype part-task trainer for student helicopter pilots. The Team designed a "trilevel interaction" model and a Level III interactive videodisc delivery system for this project. The model, founded on instructional and psychological theory, should be transferable to other domains where part-task training is appropriate.

INTRODUCTION

The complexity of today's Army helicopters and limited availability of aircraft for training call for more use of training aids than ever before. Sophisticated simulators exist but are very costly and are oversubscribed by students. The need exists for realistic part-task trainers and presimulator practice opportunities. A part-task trainer is a training system that challenges the user to exercise a subset of the tasks involved in performing a complete operation. Computer-Based Training (CBT), using a Level III interactive videodisc system, is well-suited for a part-task trainer. It offers individualized presimulator and preflight practice. The design model used to build the CBT is, however, the most critical factor in exploiting the technology to help the learner accomplish the objectives.

The Los Alamos National Laboratory Training Research Team (TRT) developed a "trilevel" interaction model specifically for use on Level III interactive video systems. The trilevel interaction model's unique aspects and implications are documented here so that other CBT development teams can benefit from this work. The paper begins with a description of the model. Rationale for the model, with theoretical underpinnings, is provided next. Use of the model is illustrated with the Fort Rucker application. The paper concludes with a discussion of implications for design of similar part-task trainers.

*This project is supported by the Army Research Institute, Training Technology Field Activity, Fort Rucker, Alabama, under Los Alamos Proposal SP-F84-011, Amendment 1.

The authors gratefully acknowledge the assistance of Paul Knudsen of Los Alamos National Laboratory in his insightful review of this paper.

THE TRILEVEL INTERACTION MODEL

The trilevel model is represented on Figure 1. Trilevel refers to three different instructional pathways a student can select to begin his training.

Figure 1

The three pathways are:

1. **Simulation:** This path provides a student with the opportunity to demonstrate skill in applying concepts and procedures in task performance simulations. A student's competitive spirit is excited because the simulations are also game-like. The student receives a score at the end, with an explanation of score derivation. If a student's performance at key points in the simulations is below specified thresholds, he is notified and is directed to the "practice" pathway. He can return to the "simulation" path after more preparation by practice and/or study.

2. **Practice:** This path provides a student with the opportunity to encounter the simulations in a practice mode, without the pressure of being scored. The key difference between simulation and practice is feedback; in practice, feedback is automatic when an error occurs. The student may select the third pathway, "reference" if he feels the need for additional remediation. Also, relevant reference material is automatically presented when the student fails to meet specific thresholds at key points in the practice.
3. **Reference:** This is a pure remediation path that provides the student with the opportunity to refer to and review details of concepts and procedures. This pathway reinforces use of the Operator's Manual, is accessible from any place in "practice," and can be selected directly at sign-on. It is context dependent when accessed from practice but is menu-driven when accessed directly.

An important feature of the trilevel interaction model is "shared control." Control of progress through the training exercises is designed to be the responsibility of both the student and the computer. The student has the initial choice of which pathway to use, but if his performance is below specified thresholds, the computer is programmed to send the student to the next more remedial pathway. To accomplish this, the program collects data on the student's performance (referred to here as the "student model") and compares this dynamically with programmed performance criteria.

RATIONALE FOR DESIGN APPROACH

This model was constructed to satisfy the following design requirements: (1) exploit the capabilities of the Level III interactive video system; (2) be sensitive to individual learning strategies; (3) accommodate variable entry performance levels; (4) allow learner control and, at the same time, satisfy individual trainee needs; and (5) provide a motivating experience. Satisfying such demanding requirements is non-trivial, especially if cost effectiveness is an important factor (as it is in this effort). Each of the design requirements was analyzed, relative to the subject domain, literature, theory, and existing CBT designs. A summary of the analysis for each requirement is given below.

Exploiting Capabilities of Level III System

The Level III interactive videodisc system is so powerful for CBT applications that use of old models for design is not appropriate (Aggen, 1986). The technology makes implementation of the features described above possible.

(Figure 2)

The system configuration used by the TRT (Figure 2) is as follows:

The system features microcomputer-driven interactive video, color graphics, and text; both digitized and analog audio; touch-panel and keyboard input; and large-screen color monitor, system monitor, and optional peripheral devices. As shown in Figure 2, the large monitor is used to display interactive video depicting the views a helicopter pilot sees while flying over battlefield terrain. Graphics over the video duplicates the instruments and canopy structure as seen by a pilot. The smaller monitor, equipped with a touch-panel, displays the pertinent helicopter instrument panel. Here the student pilot can practice "switchology" by interacting with cleverly designed graphics and branching keyed to touch responses. An authoring system is used to construct graphics (using a graphics tablet), to input digitized audio, and to develop the courseware.

The relative uniqueness of this configuration lies in reliance on an alternative input device, use of multiple screens, and support of the trilevel interaction model. Use of motion and still frame video is particularly applicable to part-task training for pilots that includes simulation of in-flight activities. Combined with overlaid text and graphics, high fidelity of pilot views through the canopy and of the instrument panels can be achieved. The use of multiple screens allows simultaneous visual contact with simulated battlefield situations and instrument panel status. Add the touch-panel and the student can realistically simulate interaction with switches and knobs. The third monitor can display help screens, extracts from the operators manual, or system-specific information. Moreover, the response storage and assessment capability supports development of a "student model" and implementation of the unique instruction design described below.

Learning Strategies

Learning strategies are the cognitive activities students use when encountering learning tasks (Dansereau et al., 1979).

Students' learning strategies vary greatly and accommodating these differences is of crucial importance in instruction. The use of an individual's own cognitive strategies improves learning (Garhart, 1985). This model does not focus on diagnosing a student's preferred learning strategy, nor is it designed for teaching students more effective learning strategies. It is, however, designed to enable a student to choose a preferred method of learning. A student may execute the exercises in any order and quickly change from one instructional pathway to another. Figure 3 illustrates three different hypothetical maps of student behavior while using the CBT.

Figure 3

Entry Performance Levels

Accommodating varying entry performance levels is a factor in any CBT development effort, but it is of particular interest here in concepts and procedures reinforcement tasks. Historically, CBT designs deal with this issue by including tests at the beginning of a course and then directing the student to a suitable lesson based on his test results (e.g., Dean and Whitlock, 1983). The trilevel design model accommodates varying entry performance levels through not only the three pathways, but also through developing and using the "student model" (Storward, 1983). The courseware is designed to include dynamic monitoring of student performance in practice and simulation, comparison of student performance with specified criteria at key points, and diplomatic adjustment of the student's path when necessary.

Learner Control

The thrust towards design for total learner control over instructional pathways has prompted research into this area. Although we humans prefer to have a feeling of control (e.g., Shneiderman, 1982), we sometimes misjudge the optimal learning pathway. Atkinson (1972) found that adaptive computer-controlled strategy was better than learner-controlled strategy. Garhart (1985) reports on several research studies which indicate that learner control without some sort of advisement or coaching will result in ineffective learning. The trilevel interaction model responds to this research by accommodating learner preference

and adjusting control only as deemed appropriate by performance. The learner may choose which pathway to enter, but if performance is substandard, a more remedial path is directed.

Motivating Experience

The area of human motivation is one that has been widely studied, but few well-accepted theories have resulted. Odiorne (1980) reviewed motivation theory; a few of his statements relevant to this work are:

- o we seek stimulating activity
- o new things get more attention than old
- o we strive to have our own uniqueness recognized

Relevant to CBT specifically, Swenson and Anderson (1982) consider that the function of reinforcement is motivational in nature. They highlight the importance of the timing of reinforcement, as well as the need for active reinforcement and appropriateness. The trilevel interaction model reflects a recognition of the importance of motivation in four ways: first, through the use of a game-like simulation (Ellington, Addinall, and Percival, 1981); second, through the use of the student's name and the earning of a personal score for the simulation; third, through the use of realistic video images, and fourth, through specific advisory feedback provided only when errors occur in the practice pathway.

IMPLEMENTATION OF THE MODEL

In implementation of the trilevel model, a human factors approach was taken. A very rapid prototype was developed and tested, early user involvement occurred, and subsequent prototypes were designed on the basis of feedback from user testing (Gould and Lewis, 1983).

The target population for this experimental CBT is qualified aviators taking the Attack Helicopter Qualification Course at Fort Rucker. The CBT prototype implementing the model is designed to be used as a part-task trainer covering the Heads-Up Display System (HUDS), a visual instrument used by the pilot of an attack helicopter. The CBT has the following goal:

- To improve a student pilot's ability to locate and use HUDS controls and symbology, as measured in written exams, simulator exercises, and evaluations in flight with an instructor pilot.

The simulation and practice are composed of exercises centered around two levels of learning: factual and procedural. The factual level includes learning characteristics about HUDS controls, symbology, and components. At a

higher level of cognitive difficulty are procedures. In procedures exercises, the student is presented with realistic scenarios where he should perform the correct procedures as described in the Operator's Manual. A sample procedure exercise is as follows:

- o Digitized audio output
(Simulated radio communication)

Scout helicopter:

"COBRA Team, Target 3000 meters, light-armored vehicle, your two o'clock."

COBRA Team Leader:

"Roger. COBRA Team, let's go! Use rockets."

- o Video Monitor 1

On the large screen appears a presentation of running videodisc images photographed from a helicopter in flight over a simulated battlefield. Computer-generated graphics overlay the image to present an outline of the canopy including the HUDS, appropriate symbology, and targets.

- o Video Monitor 2

On the small screen with touch-panel appears a presentation of the pilot's instrument panel.

The student interfaces with the exercise through the touch-panel. When an area on the instrument panel displayed on the small screen is touched, the display changes to an exploded view of the designated area. At this time the individual switches can be manipulated by touch response to achieve the desired setting. If the correct setting is not achieved in the time allotted, the student will fail to successfully engage the target.

What follows depends on the student's performance. If a mistake was made, the next exercise will be in the same area, covering engagement with rockets. If the results of both exercises are not satisfactory, the student is placed in the practice path where he will be presented additional exercises and pertinent feedback. If his performance in practice doesn't meet prescribed thresholds, he will be presented with information from the reference path about the correct procedures. If performance is satisfactory in practice, he will be allowed to return to the simulation path. Many different scenarios are available so that the same ones need not be repeated.

The HUDS prototype CBT is being tested in the field at Fort Rucker. The hypothesis for the test is:

The tri-level interaction design model will improve proficiency of student pilots who have various learning strategies and different entry performance levels.

Preliminary results of the testing will be included in the conference presentation.

SUMMARY AND IMPLICATIONS

Design of exciting computer-based training that responds to different performance levels and different learning strategies is a big challenge. To meet this challenge, the Los Alamos Training Research Team developed the "trilevel interaction model." This model is characterized by shared control between the learner and the computer and by three different instructional pathways. It has been implemented, and is being tested, in a helicopter pilot part-task, CBT exercise. Central to the implementation of the model is the use of a state-of-the-art Level III interactive videodisc delivery system.

The uniqueness of the model stems from its responsiveness to cognitive psychology and human factors principles, its exploitation of the now interactive videodisc technology, and its foundation in user requirements. Implementation of the model does require more resources than implementation of conventional models, such as those that use templates for authoring CBT. This research and development effort serves not only to illustrate an alternative design model, but also as an attempt to more fully use the power of Level III interactive video for the sake of the learner.

REFERENCES

- Aggen, W., Held, T., and Reeves, T. (1986). "Designing and Producing Computer-Based Interactive Video Courseware." A workshop conducted at the ADCIS Conference, New Orleans.
- Atkinson, R. (1972). "Optimizing the Learning of a Second-Language Vocabulary." Journal of Experimental Psychology, 96, 124-29.
- Dansereau, D., McDonald, B., Collins, K., Garland, J., Holley, C., Diekhoff, G., and Evans, S. (1979). "Evaluation of a Learning Strategy System," H. O'Neil and C. Spielberger, eds., Cognitive and Affective Learning Strategies, Academic Press, New York.
- Dean, C. and Whitlock, D. (1983). A Handbook of Computer-Based Training. Nichols Publishing Co., New York.
- Ellington, H., Addinall, E., and Percival, F. (1981). Games and Simulations in Science Education. Nichols Publishing Company, New York.

Garhart, C. (1985). "Interactive Video as an Instructional Medium; A Look at Related Research," paper presented at the 26th ADCIS Conference, Philadelphia.

Gould, J. and Lewis, C. (1983). "Designing for Usability--Key Principles and What Designers Think." Proceedings from the Computer-Human Interaction Conference, Boston, 50-53.

Odiorne, G. (1980). "An Uneasy Look at Motivation Theory." Training and Development Journal, June, 106-112.

Shneiderman, B. (1982). "Adopt Computer Game Principles?" Excerpt from a workshop, University of Maryland, College Park.

Stoddard, M. (1983). "Modeling the behavior of the Computer-Assisted Instruction User." Journal of Computer-Based Instruction, May 9, 211-216.

Swenson, R. and Anderson, C. (1982). "The Role of Motivation in Computer-Assisted Instruction." Creative Computing, October, 134-139.