ARPA Authoring System

Massachusetts Inst of Tech Lexington Lincoln Lab

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

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SEMIANNUAL TECHNICAL SUMMARY REPORT
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ABSTRACT

The goal of the project is to produce an authoring system to permit local experts to prepare material for delivery by machine at the work site. A system to permit preparation of materials for the Lincoln Terminal System is being deployed to the 5th Combat Communications Group at Robins AFB. A set of authoring procedures is included that enables authors to prepare lessons on the methods and rationale for maintenance of electronic gear, and on various other subject matters. A second revision of these authoring procedures is undergoing test. Facilities are being readied to permit local generation and checkout of materials with a computer assist.

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ARPA AUTHORING SYSTEM

I. INTRODUCTION

A. Problem Statement

The goal of this project is to design, deploy, field test, and evaluate a system to enable locally qualified personnel to prepare individualized instructional material for on-the-job training (OJT) by machine delivery. OJT is the only appropriate type of training for many operational, maintenance, and repair tasks because these tasks are unique to particular pieces of equipment and to the environment in which the equipment is used.

Currently, OJT is conducted by qualified operators and technicians who instruct and supervise novice personnel, most frequently on a one-to-one basis. These same operators and technicians are also responsible for equipment maintenance, repair, readiness, and operations. As a consequence, training is often unavailable and, at best, inefficient. Capturing the expertise of these technicians and operators in suitable form for automated delivery could provide continuous availability of training, decrease the utilization of expert personnel for one-to-one instruction, further standardize training, and increase the overall effectiveness of OJT.

While the feasibility of machine delivery of instruction at the work site has been demonstrated with the Lincoln Terminal System (LTS), the acquisition of appropriate instructional material remains a problem. Professional technical instructors or writers are not suited to the task of generating such material because they do not generally have the extensive local operational experience and up-to-date technical knowledge that are required to design materials with the necessary precision and relevance of content. Operational personnel do not have the requisite authoring skills. The goal of this project is to develop procedures and facilities that will compensate for this lack of authoring experience, and will enable locally qualified operational experts to prepare materials that will meet the needs of OJT.

B. Background

Under the sponsorship of the Air Force Communications Service (AFCS), Lincoln Laboratory has recently carried out feasibility tests of machine-supported OJT at the 5th Combat Communications Group at Robins AFB. The 5th CCG was chosen on the recommendation of AFCS because the training problems at that site are representative of those elsewhere in the command and are particularly acute. These tests demonstrated that novice (3-level) personnel at the 5th CCG were able to execute extensive maintenance procedures with few errors and little outside help when the procedures were presented on the LTS-3S. (This unit is part of the Lincoln Terminal System; it combines audio/visual presentation of information with computerized management of learning in a stand-alone machine.) Although the trainees were not presented with the full rationale behind the procedures, they acquired hands-on experience which was important as a basis for further skill knowledge training and considerably speeded up their readiness for independent line work. These findings have been applied by the 5th CCG in implementing an interim training program using the LTS-3S and supplemental classroom instruction.

Our experience with the 5th CCG has afforded us a realistic appraisal of their OJT requirements and, with the continuing cooperation of AFCS, a suitable environment for the experimental development and evaluation of an authoring system. Accordingly, a substantial amount of time

during the past several months has been devoted to laying groundwork with the 5th CCG, Hqs. AFCS, and TACCOMMAREA (the headquarters to which the 5th CCG reports) for a cooperative program of work directed at the problem of acquiring instructional materials for OJT.

II. AUTHORING PROCEDURES DEVELOPMENT

A. LTS Lesson Authoring Procedures

This project tests the hypothesis that lesson authoring can be reduced to a procedure which operational personnel without prior authoring experience can follow to produce an adequate lesson. The lesson type of present concern is called a Task Procedure and Interpretation (TPI), which is a documented, step-by-step description of how each task of interest is to be performed and why. It provides procedural information and also the rationale for each step in terms of what each step accomplishes in the task. It provides enough detail so that the trainee, with access to the LTS (or other lesson delivery system), can learn to perform the task and understand what he is doing with only minimal supervision.

The techniques of authoring TPIs were derived from those general principles of instructional design that appeared relevant to the specific purposes of TPIs. These techniques are now incorporated in a 30-page how-to-do-it manual with a set of worksheets and an example of a validated TPI. The manual is itself a TPI designed for technical experts who have not previously written teaching materials and for whom writing teaching materials will probably be a secondary and short-lived duty. Rather than present many rules at once for the author to keep in mind while he is writing, he is given only a few rules to incorporate at each stage in the process of lesson development. Each step or rule is explained in detail, and a brief rationale for the rule is given. Illustrations of the implementation of each rule are referenced in a sample TPI that accompanies the manual.

In the first section of Authoring Procedures, the author is asked to divide his task into several major parts, then outline the actions or steps which comprise each part. Next, he is asked to design the logic flow of his TPI and draw a flowchart for it. He begins writing frames by being asked to write several introductory frames following structured directions and models. The purpose of this is to ease him into the writing task painlessly. Then he drafts and refines the contents of his other frames. He is given guidelines to follow regarding the level of explanation, the amount of material in each frame, the types of visuals which should work best for his purposes, the length and content of the audio messages in each frame, and the logic instructions which must be written for the LTS in each frame.

B. Training Coordinator

The process of TPI preparation includes a training coordinator role, which will presumably be instituted at each LTS-supported training site. The training coordinator would have at least three major functions: (1) supporting LTS authors, (2) designing training programs for trainees, and (3) collecting data for long-range project evaluation.

A second manual has been prepared to guide the training coordinator in the first function – that of supporting LTS authors. This manual provides the necessary guidance for selecting TPI authors and tasks, counseling and editing for authors during the actual writing stages of TPI preparation, conducting TPI tryouts and collecting revision data, coordinating the typing and filming of TPI manuscripts, reporting on the successes and failures of the authoring experiment, and suggesting revisions.

C. Test of Authoring Procedures to Date

Two individuals from Lincoln have been involved in producing TPIs as a formative evaluation of the Authoring Procedures under development. The first person is a photographer who operates the LTS fiche production facility. He has completed (ready for final artwork) a TPI for producing a copy from a master fiche. The second person is an Engineering Assistant involved in LTS design and implementation who is preparing a TPI on setup of the LTS-3S Recording Console for production of modulated or unmodulated circles for test fiche. This effort is about 50-percent complete.

Discussion and extensive investigations were conducted with qualified experts and training personnel in the 5th CCG to establish an adequate sample of authoring activity to aid in the testing and revision of authoring materials and facilities. At this point, eight efforts are in various stages of progress:

(1) A TPI on one of the performance checks for the AN/TRC-97A is about 30-percent complete, and two TPIs for bench alignment are in the planning stages.

(2) Three TPIs for setting up conference calls on the TCC-30 telephone switching van have been outlined, and one is about 75-percent complete.

(3) A TPI on camouflage techniques is about 50-percent complete.

(4) Work has begun on lessons on the operation of the Control Head for the TSC-60 HF radio set. The Control Head permits remote operation of the radio set, including such functions as frequency selection and timing.

(5) A TPI is being written for the DAC-8 of the TSC-62 van. The DAC-8 provides checkout and control of TTY circuits in the communications system.

(6) A TPI on the Astreon 409 for the TSC-62 [illegible]ch control van is being planned.

(7) At least one area of teletype operat[illegible]vi[illegible]be chosen for lesson preparation.

(8) Instruction in Systems Interface Management will be outlined, and certain materials will be produced in this area.

Topic (8) goes somewhat beyond the scope of training material addressed by the Authoring Procedures. This effort will provide valuable feedback in helping design author guidance in preparing lesson material of a more conceptual nature than that addressed by our present Authoring Procedures.

The feedback from ongoing authoring activities has been most encouraging. Primarily, there is every indication that the TPI Authoring Procedure is written at an appropriate level and covers most of the questions that occur in the authoring process, and that the example which accompanies the manual has proven to be a valuable guide for novice authors. Several deficiencies have become apparent. In the first edition, we do not give sufficient emphasis to the importance of interaction and monitoring of student behavior – which is a unique capability offered by a computer-augmented delivery medium like LTS. Somewhat related to this is a failure to

clearly emphasize that other modes of interaction than those suggested in the Authoring Procedure are certainly feasible, and may indeed be desirable. Another is the relationship of frames to layout on the actual fiche, and the general idea of access to a single frame from several points within a TPI. These and other issues are certainly being considered in the iterative revision of the Authoring Procedure.

With a moderate amount of human guidance, operational personnel have been able to proceed with little hesitancy. The three partially completed examples indicate that the [illegible] procedures can be laid out in a concise and orderly manner, with a good understanding of where corrective or supporting material ought to be included. The one completed example is quite good and, with minor additions, should make another model example.

III. AUTHOR SUPPORT FACILITIES DEVELOPMENT

A. LTS-5 Simulator

Work has been initiated on the LTS-5 simulator that runs on a PDP-8/Floppy-Disk System which will simulate the operation of the new LTS-5. The purposes of the simulator are to: (1) provide authors with a means of checking modules prior to committing the logic to fiche, and (2) provide students with a virtual LTS-5 to be used in conjunction with lesson material in notebook form. In the simulator, disk files are used to store the frame logic. The projected date of completion of the simulator system and all related documentation is mid-August 1976.

B. LTS-5 Delivery Unit

The hardware portion of the original proposal called for the construction of one LTS-5 and the modification of one LTS-3S to make it a functional equivalent of an LTS-5. It has been determined that it will be possible to construct two LTS-5's within the constraints of available manpower and funds. The LTS-5 model has been developed with support from the Bureau of Mines (BoM) over the last 12 months. Under the provision of the BoM contract, a production prototype of the LTS-5 will be constructed during FY 76T. We propose, therefore, to construct at the same time two additional such units for the DARPA program. Ordering of parts for the two DARPA units is complete, most are now on hand, and construction is under way. The BoM contract also calls for the upgrading of the software package used with the LTS [illegible]. This redesign work is essentially complete and will be available for use with the DARPA equipments.

IV. APPLICATIONS AND PLANS

A. Further Considerations

This project is part of a larger effort to improve the means for obtaining materials for individualized instruction. It is oriented toward the subject matter expert being the author, in contrast to the instructional expert. More specifically, the kind of subject matter expert is one who must, as part of his operational responsibilities, indoctrinate novice personnel in work procedures.

TPIs are a specific type of lesson appropriate to OJT implemented in accordance with general principles of instructional design. Applied to technician training, they are characterized by implicitly stated behavioral objectives, explicit checks on performance, a lesson structure which follows task structure, and reliance on reference documents rather than task memorization. Other types of learning present a different set of requirements. For operator training - such as

piloting, communicating, or air traffic control – a prototypical lesson would place a greater emphasis on memorization. Training materials would therefore support task rehearsal until rapid and accurate performance is achieved. We anticipate defining and developing authoring procedures for a prototypical lesson of this type in addition to the TPI. Support of the TPI sometimes requires a rather elaborate interpretation of procedure in conceptual terms, and task structure is not a valid basis for the design of such material. In that case, selection of behavioral objectives would play a greater part in lesson structuring, and the modes of interaction would differ significantly. The design methods and procedures developed for in-school training would be appropriate.

Current assessments of the cost effectiveness of preparation of individualized, computer-based instruction are generally not encouraging. The difficult part of authoring is to determine behavioral objectives and to design lesson material so that it explains basic concepts. The variety, complexity, and novelty of concepts require a sophisticated approach to lesson design. When there is a requirement to prepare materials for individual delivery [Individually Programmed Instruction (IPI)], with or without diagnostic and remedial aids [Computer-Based Instruction (CBI)], the establishment and maintenance of a team of skilled authors are major and costly undertakings. These conditions prevail in the school environment. The advent of the LTS has made it fruitful for the first time to give serious consideration to applying these new methods to the support of OJT. Somewhat surprisingly, the problems of authoring seem less severe for job-related materials. The prognosis for the success of the TPI approach to development of materials appears to be good.

In OJT, the author's basic rationale is usually the work procedure itself; the primary objectives are already known, and the operational expert as author is intimately familiar with the subject matter. Thus, a procedure can be developed for construction of lessons, and extensive training of authors can be obviated and the work distributed among the experts best suited to each area. Furthermore, the content in the form of work procedures is largely agreed upon, whereas the training needs and requisite concepts underlying technical training in schools are more controversial. These conditions favor more orderly and economic development of materials for the work environment than for the school.

The requirement to try out the authoring procedures in an operational environment in order to establish the validity of the methods appears more important than originally conceived. The authoring of materials is a chore. Dividing up the work is an obvious advantage afforded by the procedural approach. This consideration seems overshadowed, however, by the motivational advantages. In this situation, both the author and his commander perceive the authoring task as part of a solution to an immediate and important problem. Thus, in the 5th CCG, the LTS has been shown to reduce the training load on operational experts, and this is the basis for the widespread interest in trying out the authoring procedures. If the investment in lessons by the expert translates directly into improved work performance, it seems much more likely that the benefits of the technology will be assured in the long run.

B. Test Plan

The present activity supports training operations at the 5th CCG on a small but useful scale. Modules of instructional materials are being prepared by the new authoring procedures, and "formative" evaluation consists of training coordinator and peer review. The materials will be evaluated in terms of their effect on work performance and, in this manner, a rough "summative"

evaluation of each author product will be carried out. Technical services for cutting and testing frame logic and summarizing student data will be installed and tried out in November 1976. This activity will serve as a test bed to further refine and expand the author procedures and the facilities. The process of improvement will continue until approximately 1 January 1977.

There is a proposal to upgrade training in the 5th CCG and other units that would require a very substantial initial investment in manpower to prepare materials. It would have to be followed either by a procurement of computer-supported instructional hardware such as the ITS-5, or by provision of substantial instructional staff. It has been suggested that a pilot project be initiated instead, a precursor that sets the pace in a few critical areas. Either a large- or small-scale effort would afford opportunity for a subsequent full-scale field test of the authoring procedures and facilities. A plan to incorporate the authoring test in the larger training effort is being negotiated at present with the Air Force Communications Service.