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ABSTRACT

The goal of this investigation was to find a method of reducing revision time and improving instruction in some 370 extension courses taken by airmen while on the job to upgrade their training. The goal of the pilot project was to determine which of two systems--TICCIT or PLATO--was sufficiently more attractive than textbooks to justify exploring the purchase of an economical computer based education system for the delivery of the extension courses wherever appropriate. The report describes the history, design, staffing, training, and courseware development processes of both systems as used in the project. (DAG)

A COMPARISON OF THE TICCIT AND PLATO IV SYSTEMS IN A MILITARY SETTING

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TABLE OF CONTENTS

I. INTRODUCTION

In March, 1974, the commander of the Air University (AU) of the Air Force ordered an investigation in the uses of advanced technology in extension education. The goal was to find a method of reducing revision time and improving the instruction of some 370 extension courses with an annual enrollment of 310,000 students. An appointed interdisciplinary committee of specialists in education, psychology, and computer science decided upon a pilot project which would investigate the use of computer-based education (CBE) in Career Development Courses (CDCs). CDCs are extension courses taken by airmen while on the job to upgrade their training. Since CDCs were written by authors from the Air Training Command (ATC), a cooperative AU/ATC project was proposed. In August, 1974, the commanding general of ATC was briefed on the project and gave it his approval.

The CDCs were prime candidates for a project which was to show improvement from the application of modern technology. Once written, the CDC manuals were published and distributed to the field by the AU. Because the medium of paper is used and because the manuals were distributed throughout the Air Force, revisions in texts are costly and slow, taking about six months to reach the field. The use of an extensive computer-based network could reduce the turnaround time in revision and distribution to the length of time it took to make the revision. In the case of the simplest sorts of revisions, a change could be available to CDC users in less than a minute.

The following three CBE systems were selected for the project:

1) Time-Shared Interactive Computer-Controlled Information Television (TICCIT), a television based system developed by Brigham Young University and the Mitre Corporation.
2) Programmed Logic for Automatic Teaching Operations (PLATO), a large CBE system servicing about 1000 terminals located throughout the United States with a large computer at the University of Illinois.
3) Lincoln Terminal System (LTS), a microfiche based teaching machine system developed by Lincoln Laboratories at the Massachusetts Institute of Technology.

The goal of the project was to determine whether one of these systems was sufficiently more attractive than textbooks to justify exploring the purchase of an economical CBE system for delivery of the CDC wherever appropriate.

Before the project got underway the use of LTS was dropped because of high costs. Thus, in addition to the objective of investigating the possibility of using CBE in CDCs, the project became a comparison between the PLATO and TICCIT systems. So far as is known, the project at AU is the only one in which the two systems were compared side-by-side, teaching to the same objectives, and being staffed by comparably qualified staffs. This report focuses on comparing the two systems based on the experience gained at AU.

The information for this report comes from three major sources:

1. The final evaluation report of the project by the director (Hines, 1976),
2. An extensive interview with the project officer of the AU project,

3. The personal experiences of personnel from the Computer-based Education Research Laboratory who conducted the initial PLATO training at AU and acted as programming and instructional design consultants for the duration of the project.

Additional information has been obtained in a telephone interview with an employee of Courseware, Inc. which was the agency responsible for the initial training of the members of the project using the TICCIT system.

II. THE TICCIT AND PLATO SYSTEMS

A brief description of a few relevant characteristics of both CBE systems will suffice to give a background for a discussion of the Maxwell project. The most basic of these are the factors motivating the design of each system. These factors along with pedagogical prejudices built into the systems determined the type, as well as the manner of development, of CBE materials on each system.

A good comparision of the two systems may be found in Bunderson and Faust (1976). Readers wishing a more extensive description of the PLATO system should refer to the article by Sherwood and Smith (1976) and the bibliography of Lyman (1977). The MITRE Corporation (1974) provides a detailed overview of the TICCIT system.

The TICCIT system. The TICCIT system was designed with the intent of becoming the first of a new generation of cost-effective CBE systems (MITRE, 1974, p. 4). With this intent the system was tailored from the start to cut the costs associated with CBE systems. One way in which this was done was to base the system on off-the-shelf hardware components. These components were selected for their low cost in 1971 and their costs have diminished since then (Bunderson and Faust, 1976, p. 72).

Also, at the outset it was recognized that CBE courseware is very expensive. In an attempt to minimize this cost as well as to provide a good environment for CBE authoring, the delivery and authoring components of the TICCIT system were separated. While it is possible to author on-line, the TICCIT system is optimized towards instructional delivery. The authoring is carried out by filling out paper forms. At a later time, the information contained on these forms may be entered onto the TICCIT system by packagers using similar formats on-line. In this way, authors, who are not likely to come to the task of CBE lesson writing with programming skills, are spared from the complexities of programming. Moreover, even the packagers are spared of this task.

Finally, the TICCIT system uses a system-implemented learning strategy. This strategy provides that the "students must be given a chance to use learning strategies that they develop themselves and must be free to accept or reject any strategy advice" (Faust, 1974, p. 95). This "learner control" strategy is incorporated into the forms that the authors and packagers use. Thus, the authors are further relieved of the responsibility of deciding what learning strategy is most appropriate to their subject matter.

An early goal of the designers of the TICCIT system was to develop a way to author CBE materials that would result in uniformly high quality lessons in an efficient manner. The fact that the TICCIT lessons would all use the learner control format would at least give the lessons a uniform quality. (Steinberg (1977) gives a summary of the research to date on the effectiveness of the learner control strategy.) The adoption of a single lesson strategy also promotes efficient lesson production since the authors do not need to invest an effort in designing for each lesson the strategy that is most appropriate to the the subject matter and intended audience. The liberation of those directly associated with the lesson production from the complexities of programming also contributes to efficient lesson production.

For the task of courseware production, the TICCIT system planners provided a blueprint of production team that could best carry out the activities associated with this task (Bunderson, 1974). The team consisted of an instructional psychologist, an instructional design technician, an evaluation technician, one or more packaging specialists, and two to four subject matter experts. The responsibilities, and hence the requisite qualifications, for each position on the development team are precisely defined. With the exception of the subject matter specialists and the packaging specialist, the team is composed of personnel trained in various aspects of instructional psychology. Bunderson (1974) posits five week cycles for the production of all lesson components and graphic displays. Of this time, 2 to 3 weeks are for the preparation of the main content, and 1 to 2 weeks for the packaging with the final two weeks being used for review and revision.

The PLATO system. Although the PLATO IV system was also designed with cost considerations in mind, it bears very little resemblance the TICCIT system. Instead of basing the PLATO system on off-the-shelf hardware components, the PLATO system's design was based on the premise that "the technology of the 1960s was not capable of making a significant and economically practical contribution to the nation's educational program" (Alpert and Bitzer, 1970, p. 1583). Instead it was proposed to make use of recent developments in large, high-speed computing machines and novel, high performance graphics terminals which would be relatively inexpensive when mass-produced to construct a large-scale system of as many as 4000 terminals (Ibid., p. 1587). It was hoped that by creating a facility capable of delivering CBE materials to a large audience the high cost of lesson development could be shared by enough users to make such development cost-effective.

A goal of the system designers was to provide the educational community with a CBE software system "for organizing various teaching, testing, or research strategies" (Ibid., p. 1587). Thus, the TUTOR language was developed for the PLATO system which enabled CBE lesson writers to design their instruction to suit virtually any instructional approach. Because TUTOR provides so many capabilities for CBE lesson writers, it is a complex language. As a result, learning to program TUTOR and actually programming a satisfactory PLATO lesson has become in some environments the most labor intensive aspect of PLATO lesson development. This has been observed particularly in courseware development projects which did not have access to previously trained programming talent (Himwich, 1977).

In summary, the emphasis in designing the PLATO system was to provide a highly versatile facility capable of supporting a variety of instructional strategies and courseware production efforts. For this reason, PLATO users may choose the manner in which they produce their CBE lessons. In fact, a wide variety of CBE lesson production methods have been used with success on the PLATO system. The spectrum of these methods of production has the single author doing the instructional design, programming and formative evaluation to teams of several people dividing the tasks of lesson development among themselves according to some plan.

III. PROJECT DESIGN

Structure

The major goal of the AU/ATC CBE project was to evaluate the use of CBE for the CDCs. A secondary objective, however, was to determine which of the three media was the most effective in delivering the CDCs. Consequently, it was decided to implement the same two CDCs in each medium. The Food Service Specialist Course (62250) and the Materiel Facilities Specialist Course (64730) were selected for this purpose. These courses were to be redesigned and implemented separately in three different media --programmed texts, TICCIT lessons, and PLATO lessons.

The lessons for each medium were to be written by three separate teams sharing a group of subject matter specialists. Each team included its own authors and programmers who were responsible for casting the subject matter into forms suited to the delivery media. To insure a valid comparison among the three media, the qualifications of the three staffs were approximately equal. For the same reason, the levels of funding for each medium were equivalent wherever possible.

In addition to the three different media being considered and the two courses, the variable of student aptitudes was to be observed. For the purposes of the project, students were to be divided into thirds based on the Air Force Qualifications Tests (AFQT).

Objectives

The specific objectives of the project are given in Hines (1976) as follows:

> To determine the relative performance on VREs [Volume Review Examinations], CEs [Course Examinations], and SKTs [Specialty Knowledge Tests] of students who have taken the conventional hard copy,

TICCIT and PLATO versions of the two selected courses.

To determine whether the updating of the CDCs (in two selected courses) can be accomplished more effectively and efficiently with a CAI approach than with conventional approaches.

To determine whether the material in two selected courses can be effectively and efficiently presented without the use of hard copy text.

To determine whether student attitudes toward CAI .ill remain positive during the courses of instruction.

To determine whether selected individual differences are more or less adequately accommodated when a CAI approach is used as opposed to a conventional approach.

To determine whether curriculum development, programming, etc., can be effectively accomplished by ATC/ECI [Extension Course Institute] personnel.

To determine whether CAI courseware will demand more or less manpower and time to prepare and maintain and administer than will conventional extension courseware (Hines, 1976, pp. 7-8).

IV. HISTORICAL SUMMARY

The authors and programmers arrived at Maxwell AFB in late April, 1975. A delay of more than two months in the arrival of the subject matter experts (SMEs) was caused by a less-than-enthusiastic effort by ATC in assigning personnel. In addition to personnel who were at the project site on temporary duty assignments to familiarize themselves with the CBE systems, the authoring and programming personnel included six authors, four programmers, and one editor. Thirteen SMEs joined the project at various times after the arrival of the other project personnel.

The project got underway on April 28, 1975, with a workshop on the writing of objectives. During this two-week workshop, a first version of the objectives for one of the project's courses was produced.

The next six weeks of the project were devoted to familiarizing the TICCIT and PLATO teams with their respective media. This training is discussed in more detail in the section entitled "CBE Training". By June 20, 1975, both teams had received enough formal training to begin authoring CBE lessons.

While actual authoring did begin after the formal training, progress in lesson production was slowed by the late arrival of the SMEs assigned to the project. The first of the SMEs did not begin to arrive until July, 1975, more than two months after the project began. It was not until seven months after the project's start that all the ATC subject matter experts were available to the project.

The remainder of the project, until February, 1976, was spent in implementing the two chosen courses on the three separate media. In January, 1976, when about 80% of the CBE courseware development had been completed, the project's funding was cut. Consequently, the intended field test and comparison of the PLATO and TICCIT systems' instructional performance and cost effectiveness was not made. However, the fact that the project's courseware development phase was almost complete does allow for a comparison of the costs of courseware development for the two CBE systems.

V. PROJECT STAFFING

With the exception of the project administrators and certain technicians, each project member was placed in one of three groups depending upon the medium he or she was preparing instructional material for. In order to provide a basis for comparison of the three media, each group was given approximately the same number of members. For the same reason, the aggregate qualifications of each group were kept as as similar as possible. Deviations from these intentions were caused by different requirements in the preparation of courseware and limitations in the entire project's staffing.

TICCIT team. The TICCIT team was composed of nine full-time members. Two members of the team were educational experts from ECI. They were college graduates selected for the project partially because they already possessed experience in the preparation of military training materials. It was the responsibility of the authors to cast the subject matter into a textual form compatible with the TICCIT lesson structure. In addition to their authoring function, they also reviewed the lessons with the SMEs for accuracy and educational soundness. Each one of these author-reviewers was responsible for one of the two courses. One of the TICCIT author-reviewers had three SMEs working with him; the other, 2 SMEs. The SMEs were enlisted personnel who had extensive experience in the field and, in some cases, instructional experience in their specialty. In addition to providing subject matter expertise, the SMEs offered suggestions on the best methods of fitting the subject matter to the TICCIT instructional strategy.

The final members of the TICCIT team were the two members who converted the text produced by authors and SMEs into TICCIT lessons. These were the only members who worked directly with the TICCIT hardware system. These entry specialists were young officers with little experience with the subject matter or instructional design.

PLATO team. The structure of the PLATO team was very similar to that of the TICCIT team. The PLATO team had two members from ECI who were primarily text authors and lesson reviewers; each of these was responsible for one of the two courses being implemented on the PLATO system. Each author had two SMEs to help him or her organize the CBE lessons and maintain technical accuracy. The lessons in preliminary form produced by each of these authoring were translated into a PLATO lesson by two PLATO programmers. Unlike the authors and the SMEs, the programmers prepared PLATO lessons for either one of the two courses.

Although the structure of the PLATO team was the same as that of the TICCIT team, roles became somewhat more blurred on the PLATO team. During the initial PLATO training the ECI authors for the PLATO team were given the same programming training as the team's programmers. This training was thought to be important so that the authors would be aware of the varied instructional capabilities of the PLATO system. Thus, as designers of the PLATO lessons, they would know that they had considerable flexibility in selecting an instructional approach was appropriate to their subject matter. The PLATO programming training did make the authors aware of many of the PLATO system's instructional capabilities while simultaneously making them modestly competent PLATO programmers. Thus, though the more sophisticated programming was done by the team's designated programmers, the authors themselves were able to program some of the easier parts of their lessons by themselves.

The case was similar for the SMEs of the PLATO team. Although they arrived after the formal PLATO training had been completed, they received an informal on-the-job introduction to the PLATO system and the rudiments of the TUTOR language from other members of the PLATO team. As a result, they were also able to perform easy programming tasks. These tasks were seldom more complex than the arrangement of a PLATO display. Nevertheless, through the programming efforts of the SMEs and the authors, the PLATO programmers were able to devote themselves to the more challenging programming.

VI: CBE TRAINING

TICCIT training. Early in 1975, the two project personnel who were to handle the answer-processing, debugging, and production for the TICCIT team were given temporary duty assignments for seven weeks to familiarize themselves with the TICCIT system. This was carried out at North Island NAS, California. Their training included TICCIT software characteristics and their implications for instructional materials, terminal data entry techniques, and the development of some TICCIT instructional materials as a training exercise.

In May, 1975, two representatives from Courseware, Inc. began a training session at the project site. This training focused on structuring instructional materials for the TICCIT system. Before the end of the first week of this session, the trainees were writing instructional segments that were incorporated without change in TICCIT lessons.

After the first week, the TICCIT hardware was installed. To train the project personnel to use it, Courseware, Inc. sent a representative skilled in this area as a replacement for one of the original representatives and a graphics specialist. During the next two weeks, the training consisted creation and processing, TICCIT familiarization, and data entry. Simultaneously, the original training in courseware development and answer processing was continued.

An additional week of training was given to the TICCIT team about six months later. At that time, most of the tra struction dealt with the refinement of instructional development techniques and assistance with individual problems.

The training of the TICCIT team, then, consisted of seven weeks of familiarization with the system for two members of the TICCIT team and three weeks of training by

Courseware, Inc. personnel at the project site. The project officer was not well pleased with Courseware's training and expressed the opinion that the training materials seemed to be in the developmental stages. He partially attributed the slow development times of the TICCIT courseware to poor training from Courseware (Hines, 1976, p. 41). The employee of Courseware who was interviewed agreed that the training offered to the project personnel was not well organized.

PLATO training. The bulk of PLATO training was carried out in a two week session in June, 1975. This initial training and the follow-on training was conducted by members of the Military Training Centers (MTC) group at CERL. The training and instructional materials that were presented to the Maxwell PLATO team had already been extensively refined by use in training over 250 PLATO authors. In addition, on-line PLATO materials written by the MTC group to accompany its hardcopy training materials had been used by over 10,000 users. This experience had enabled the MTC group to develop a well polished training program that taught the essentials of PLATO authoring and programming (Francis, 1976).

During the first week of the Maxwell PLATO team's training, a member of the MTC group introduced the team to the PLATO system and to a basic subset of the TUTOR language, the programming language used on the PLATO system. The 30 TUTOR commands that were presented were chosen with the aim of introducing the trainees to the capabilities of the TUTOR language. Once these had been mastered, the trainees could use an array of on-line reference materials to supplement their basic knowledge as the need arose. At the end of the first week of PLATO training both members of the PLATO team who had been designated as programmers had completed the TUTOR portion of the PLATO training. Also, one of the two members who were to become instructional designers or authors has completed the training; the other, being available for training only half-time, was somewhat behind the others.

The second week of training emphasized instructional design techniques appropriate to PLATO instructional. This training included PLATO lesson planning and design, techniques of computer-student interaction, and computer-based testing. During this week, the PLATO instructor supervised the planning, design and beginning writing of the first PLATO lessons of the trainees.

About two months after the initial PLATO training two CERL staff members returned to offer some additional consultation. One of these staff members taught the programmers some needed sophisticated programming techniques. Since at that time initial versions of the project's first PLATO lessons were ready, the other trainer introduced the PLATO team to lesson review methods and other techniques used in the formative development of CBE lessons. This last follow-on training period lasted three days.

In addition to the training given the Maxwell PLATO team at the project site, MTC personnel could always be consulted via the PLATO system on programming and instructional design problems. PLATO communication features enabled MTC staff members to assist the Maxwell project quickly with problems as they arose. The reader may obtain a more detailed description of both the type of training and sort of services offered the Maxwell project by the MTC group by reading the sections entitled "CBE Author Training" and "MTC Liaison" in Himwich (1977).

VII. CBE COURSEWARE DEVELOPMENT

In order to maintain comparability between the TICCIT and PLATO systems, the CBE lesson development procedures employed by each group were, within the constraints imposed by systems' differences, the same. Figure 1, which is an adaptation of a graphic representation of the CBE lesson development procedures from Hines (1976), outlines the parallel lesson development procedures employed by the two CBE teams as well as their similar structures. This section discusses the procedures indicated in Figure 1 and the differences in these procedures which were due to intrinsic differences in the CBE systems.

Basic development procedures. Lesson development began with the authors and their SMEs. Figure 1 shows four author-SME groups, two PLATO and two TICCIT groups. For either the TICCIT or the PLATO team, each of the author-SME groups was responsible for writing the instruction for one of either the Food Specialist or the Materiel Facilities Course. (The objectives for both courses were drawn up prior to the authoring stage so that each team was writing instructional materials for the same objectives.)

Following the writing of a segment of instruction, the authors and one SME reviewed the material for instructional soundness and subject matter accuracy. Depending upon the outcome of this review, the segment was either passed on to the programmers for implementation on the CBE systems or was returned to the appropriate author-SME group for rewriting. Generally, at this stage, rewriting only involved small editorial changes.

Two programmmers in each team were responsible for converting the text to CBE lessons. Once the lessons were in a usable form on the TICCIT or PLATO system, they were reviewed once again this time by the author and the two programmers.

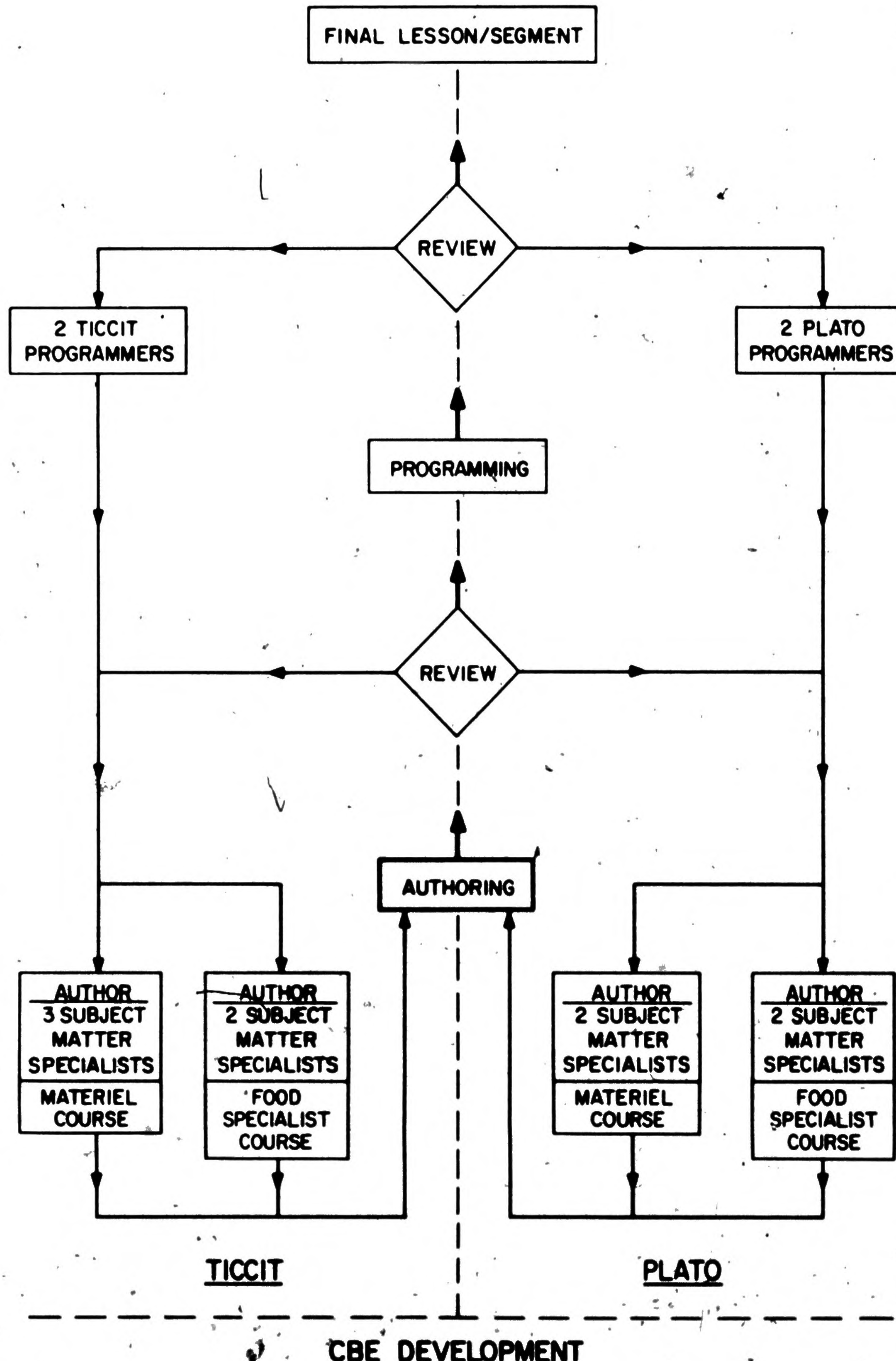
FINAL LESSON/SEGMENT
REVIEW
2 TICCIT PROGRAMMERS
2 PLATO PROGRAMMERS
PROGRAMMING
REVIEW
AUTHORING
AUTHOR
3 SUBJECT MATTER SPECIALISTS
MATERIEL COURSE
AUTHOR
2 SUBJECT MATTER SPECIALISTS
FOOD SPECIALIST COURSE
AUTHOR
2 SUBJECT MATTER SPECIALISTS
MATERIEL COURSE
AUTHOR
2 SUBJECT MATTER SPECIALISTS
FOOD SPECIALIST COURSE
TICCIT
PLATO
CBE DEVELOPMENT

FIGURE 1

Depending on the results of the review, either portions of the lesson were rewritten or reprogrammed or were declared to be finished. If the lesson was not considered to be finished the process of authoring and/or programming and reviewing continued until reviews indicated no changes were necessary. Most of the lessons or segments of lessons were reviewed only twice.

The basic lesson development procedure that was selected for use by the project loosely resembles one that the MITRE Corporation recommends for TICCIT courseware (MITRE, 1974, p. 41). However, it was adopted for the PLATO lessons in order to obtain a better comparision between the two systems. Nevertheless, despite differences in the systems themselves and the consequent differences between the requirements for personnel using them, the procedures for developing lessons on the two systems were formally identical with some variation in their implementation for each system.

Differences in authoring. As discussed in the section entitled "The TICCIT and PLATO Systems", the TICCIT system used the instructional strategy of learner control as the single strategy available to authors. Thus, TICCIT authors have only to mold their subject matter to this strategy. Once this has been done, authors are provided with forms on which they may format the text for later entry on the TICCIT system. For this purpose, the authors were provided with paper forms for later use by data entry specialists (MITRE, 1974, p.42). On the other hand, the PLATO system was designed so that an instructional designer must choose the learning strategy that seems best suited to the subject matter and students. Not only must the author select a general strategy, he or she must decide upon the specifics of adapting the strategy to a given subject matter. Thus, the authoring of PLATO lessons requires some expertise in instructional design to obtain satisfactory results whereas

TICCIT authors need very little design experience. Again, the quality of a PLATO lesson may vary widely depending, among other things, upon the author's lesson design, while TICCIT lessons are more uniform in format and quality independent of the lesson's author or subject matter.

Although the PLATO system presents an instructional designer with great freedom, the Maxwell PLATO lessons do not display much diversity in instructional approaches. Most of the PLATO lessons are straight-forward tutorials. Still, there is some variation in the text-question-text-question pacing and in the presention of end-of-lesson criterion test in the lessons. These superficial differences are due to differences in subject matter and individual styles of the authors. Whether conscious or not, the adoption of a single instructional strategy prevented the project from demonstrating the full instructional capabilities of the PLATO system. However, such a demonstration was not appropriate to the subject matter of the courses and would have needlessly increased courseware development times.

Differences in programming. The term "programming" is a misnomer in the case of TICCIT. In fact, the form-oriented authoring approach is intended to keep authors separated from programming (MITRE, 1974, p. 5). The forms that TICCIT authors fill out are transferred to similar forms displayed at the TICCIT terminal. This can either be done by the author or an entry clerk. In neither case is any programming skill needed. The data that is entered in this way automatically completes an already written skeletal program to make a TICCIT program for a lesson. At some time after data entry, an instructional segment consisting of the manually entered data, text and the pre-programmed package may be viewed as a lesson.

The programming needed for a PLATO lesson is frequently as complex as the "programming" needed for a TICCIT lesson is simple. The language used on the PLATO system, TUTOR, is a rich language containing over 250 commands. These commands fall into five large groups: display, calculation, branching, answer judging, and data collecting. Generally, a PLATO programmer is familiar with only the most basic commands in each of these groups. Usually, however, the task of programming a lesson will require several commands with which the programmer does not possess a working knowledge of.[1] Thus the PLATO programmer must also be familiar with the capabilities of TUTOR in each group so he will have some idea of what options he has in programming a lesson and how easily these options may be realized.

The Maxwell PLATO programmers were able to avoid the cost of using several new TUTOR commands each time they began a new PLATO lesson. The use of a similar instructional strategy in each lesson not only reduced the time needed for instructional design, it also minimized the new programming skills needed for each new lesson.

Comparative development costs. Despite the fact that the tasks of authoring and programming are less complex on the TICCIT system than on the PLATO system, the costs of developing comparable segments of instruction were practically the same for each system. Table 1 gives a breakdown of these costs. These data reflect the manpower that was needed to produce about 80% of the CBE lessons for each of the two courses and includes the training times on each system (Hines, 1976, p.39). Also, the figure for PLATO programming

[1]A PLATO lesson may be written using only a handful of commands. However, economy in the use of TUTOR is generally reflected in lower lesson quality.

Table 1

Comparision of manpower costs for producing CBE lesson material on the PLATO and TICCIT systems based on the production of 32 student contact hours for each system.

Activity	CBE System PLATO (mh/sch)[a]	CBE System TICCIT (mh/sch)[a]
Authoring & Reviewing	141	150
Graphics Production	--[b]	36
Programming	81	60
Total manhours/student contact hour	222	246

[a]Man Hours/Student Contact Hour

[b]The time spent in producing graphics was not separated from the programming costs.

time includes the time needed to produce graphics.[1] After the two courses had been reorganized for the purposes of the project, the Food Specialist Course would required 24 student contact hours; the Materiel Facilities Course, 15 hours (<u>Ibid</u>., p.40). Thus, about 32 student contact hours of CBE lessons had been produced for each of the two systems.

[1]One of the PLATO author aids allows the programmer to design and adjust a display at the terminal. Once the display is considered satisfactory, the PLATO system automatically generates the programming needed to reproduce the display.

Hines (1976) explains the major variations in production times as follows:

> TICCIT required more time for authoring and reviewing due to personnel qualifications and poor quality training by the civilian contractor. The extra time spent in designing TICCIT graphics arose from the fact that the drawings had to be done on paper, entered into the system by means of a digitalization process, and then edited on-line (Hines, 1976, p. 41).

In other military PLATO sites, the greatest manpower costs for lesson production have come from programming and activities associated with programming. At the United States Army Ordnance Center and School (USAOC&S) PLATO project, for example, these activities took about 71% of the total lesson development time (Himwich, 1977). That the Maxwell PLATO lessons were programmed at half the relative cost of the USAOC&S lessons is striking and may be due to the high competence of the Maxwell programmers. Of more interest, however, is the fact that the Maxwell PLATO and TICCIT lessons took about the same amount of time to program. That the programming costs of one system that had reduced programming to form-filling should be comparable with another system which required bona fide programming of a frequently complex nature is surprising.

The same surprise is attached to the generally comparable development times of lessons for each system. With its built-in instructional strategy, simplified authoring, and its design intent to provide cost-effective delivery of CBE materials, one might have expected that cost of lesson development, one of the biggest obstacles to this intention, would be less than those for comparable lessons developed for the PLATO system.

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