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ABSTRACT

The large-scale development of Time-Shared, Interactive, Computer-Controlled, Information Television (TICCIT) at Brigham Young University is described in this paper. The TICCIT project was designed to provide a market success example for computer-assisted instruction, particularly for junior or community colleges. The project incorporated a combination of computer terminals and television consoles that were able to provide the learner with a complete instructional system. This paper discusses the relationships between the general elements of the system: design, training, courseware, and management. The system is unique because it incorporates industrial techniques to a large instructional system. (MC)

THE INSTRUCTIONAL DEVELOPMENT FACTORY

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INTRODUCTION

The avowed purpose of the TICCIT* project is to provide a market success for CAI. The target population is junior or community college. Courses are being developed in freshman English composition, remedial English, algebra, and pre-calculus mathematics. Hopefully, the CAI materials and the system will be vastly improved over other CAI capabilities at a reasonable cost to educational institutions.

The impact at Brigham Young University is one of a large-scale development project profoundly affecting the theory, management, and applications of basic factors of both instructional development and related research. Structuring instructional material for use in a computer medium has generated some serious considerations of the "building blocks" of instruction. Since computers are not intelligent, and are quite arbitrary, new ways have had to be devised to show just what subject matter consists of and how it might properly be manipulated. These efforts have resulted in theory universally applicable to instructional design.

Because the project is large-scale, methods have had to be devised for generating products according to schedule. The synthesis of management procedures thus derived have shown great promise for other development projects, large or small. For this reason, the TICCIT project should be of interest to instructional psychologists everywhere.

This paper attempts to give the flavor of the TICCIT Courseware project (as opposed to hardware and software), not so much in terms of the mechanics and curriculum, but as an example of a development project from which many things may be learned. The project is big enough and long enough (until 1976) that the experience is bound to cause waves throughout the discipline.

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*Time-Shared, Interactive, Computer-Controlled, Information Television

IMPACT OF TIME ON DEVELOPMENT

Time is an important enemy in instructional development. Even if all involved--instructional psychologists, subject matter experts, or production people, are all fully qualified with a complete sense of purpose and direction--time seems to be a critical factor. Abedor (1972) reported a serious reluctance by developers to adhere to disciplined formative evaluation procedures, partly because of the time involved. Diamond, p. 76 (1971) in the report of a large development project for a music course showed time to be critical in several dimensions. This development project encompassed over three semesters of time, with 18 listed participants using a systems model. Experience has shown that even small projects, involving an instructional developer as project coordinator, perhaps one or two subject matter experts, and only three or four hours of instruction, will take two semesters.

The problem is compounded in an unusual, but not unexpected way. Instructional development is a relatively new discipline (Lee, 1972), which means that most involved are in an accelerated learning process. There appear to be as many models as there are project coordinators. In most instances, then, the project coordinators are learning in part by doing. Graduate students, at least, may be required to develop one instructionally designed and validated product as part of their masters or doctoral programs, and then delve into research. The overall effect is that given organizational and individual change, personnel turnover, and the long time it takes to put a product together, few qualified people stay in one place long enough to go through a second development project, let alone a series of them.

Another major factor is the seemingly inseparable relationship between instructional development and research. As one moves through a development project, even though well modeled and scheduled, questions continually arise for which there are no ready answers. For example, would it be advantageous given the target population to include audio? Or which test mode would be best? Or what sequence should be used? These illustrations, of course, are oversimplifications of the real problems. However, each time such a question comes up, there is an agony of time involved in either reviewing the literature, generating a research project, or forging ahead on a "gut" feeling with the expectation that mistakes in judgment will be corrected during formative evaluation. Obviously, all of these take time.

INTRODUCTION TO THE TICCIT* COURSEWARE PROJECT

Three factors at Brigham Young University have changed drastically some previously held concepts about instructional development, and research as well. These are: (1) a synthesis of ideas about a basic theory of instruction which allows developers to approach content and learning strategies as individual entities (Merrill and Boutwell, 1972), (2) development of basic notions about learner-control oriented towards allowing students to decide in large measure both content and mode of presentation (i.e., whether the student will be given statements of fact, practice, definitions, rules, or other available options at the easy or hard level, and in what sequence (Blake, 1972; Bunderson, 1972; and Fine, 1972)), and (3) the impact of the TICCIT* project, which, if it did not catalyze the other two factors, at least benefited immeasurably from them in the same time period.

Team approaches, or syst[illegible] approaches, are not new in instructional development or research. The project by Diamond (1971) and his associates

*Time-Shared, Interactive, Computer-Controlled, Information Television is a good example of the use of many people in a significant development project. Lee (1972) in his field study cites many more. Both stress the importance of teamwork and a systematic approach rather than just getting a group together. The TICCIT Courseware project at BYU, however, is a very large project from which many lessons in teamwork, applications of theory, and production accountability have been learned. This paper attempts to describe some of them, not as a matter of research, but rather as a result of experience. The observations, of necessity, are quite subjective.

The genesis of the TICCIT Courseware project is described to some degree by Bunderson (1972). There has been too little published on the TICCIT project, so that information about it has spread quite largely by word of mouth. The first national article was written by Thomas D. Proffitt (1972) a subject matter expert assigned to the project. Later, an article appeared in Science magazine[1] (Vol. 176, June 9, 1972) which described both the TICCIT project and the Plato IV project at the University of Illinois. Both of these projects are funded by National Science Foundation. A basic difference is that the TICCIT project relies on mini-computers, or a decentralized approach, while the Plato IV system uses a large central computer. Courseware in each instance is quite different.

Courseware

An explanation of use of the term "courseware" should be helpful. In computer parlance the terms hardware and software are quite well known. However, in discussions concerning media, many of the products are called

[1]There appears to be one glaring error in the article regarding displacement of teachers. The intent of TICCIT Courseware is to change the role of the teacher to be more interactive, perhaps with the ability to handle more students in a better way, rather than to replace them.

"software." To avoid this confusion, and, as a matter of fact, as a quite precise term for educational material apart from media, the term "courseware" has proved to be very viable.

One important aspect of courseware is that it is basically universal. Good courseware is needed in any medium, and good courseware by adaptation can be used in any medium. For example, the material being generated for the TICCIT project could be adapted for use with the Plato IV system, textbook applications, movies, videotapes, tape-slide, lecture, or any other media mode. One of the expectations of the TICCIT Courseware project is that by the use of good courseware, as well as an efficient and economical system, many of the earlier deficiencies of CAI with dependence on programmed instruction can be overcome. Earlier failures in educational TV, CAI, and other innovative techniques, including media applications, may very well have been founded in the use of incorrectly designed courseware.

TICCIT at BYU

Brigham Young University is a subcontractor to the MITRE Corporation of McLean, Virginia, who, in turn, has contracted with National Science Foundation for the TICCIT system, at an overall cost exceeding $4 million. MITRE is providing the hardware and software, BYU the courseware. The latter contract extends into 1976 at a cost of over $1.2 million. The system basically consists of two Data General NOVA 800s, with specialized peripheral equipment, driving up to 128 student terminals simultaneously. These terminals consist of a specially modified Sony Trinitron color TV set with a special keyboard. There are seven colors used on the displays. The center of the keyboard is an IBM-Selectric type, adaptable for mathematics and other special uses. There are fifteen keys to the right, twelve to the left for learner control (Blake, 1972).

The courseware consists of two complete instructional systems in English composition and mathematics. The material involved is equivalent to approximately six semester hours of instruction in algebra and pre-calculus mathematics and a similar number of credit hours in remedial English and freshman composition. The target population is that of Junior Colleges or Community Colleges having an open-door admissions policy. It is estimated that the courseware would cover about 20% of the average Community College curricula.

A remarkable aspect of the project is that the elements of hardware, software, and courseware are all being developed simultaneously. The effects of this are a healthy reluctance by anyone to "freeze" the design prematurely, a need for full understanding of the total system by key personnel in every area, and an even more critical than usual requirement for adherence to industry-like management procedures.

A one-terminal system was established at BYU in December, 1972. This is being expanded in March, 1973 to a five-terminal system. By September, 1973 there will be approximately 30 terminals in use for computer entry of courseware materials, compiling, debugging, and formative evaluation. In the summer of 1974, the BYU system will be moved to Phoenix Junior College and expanded to the full 128 terminals. At the same time, a complete system will be established at Northern Virginia Community College in Alexandria, Virginia. At these sites, courses will be conducted for a year or more, after which time final clean-up and analyses of the project will be accomplished. Educational Testing Service has a contract to conduct the summative evaluation of the project.

COST ANALYSIS

Obviously, there are numerous functions which make up a large-scale development project. Identification of these functions and their relationship and order of magnitude is vital to an assessment of the amount of time involved, the skills which are needed, the dollar costs per category, and the phasing relationships among identifiable tasks. There seems to be no great question that the functions identified as being important to the TICCIT Courseware project are generalizable to other development projects, regardless of magnitude. Conversely, key functions for other development projects are appropriate for conduct of the large-scale TICCIT project. These are listed in Figure I.

Project Management

Project Initiation
- Instructional Analysis

Design
- Systems Design
- Evaluation Design
- Implementation Design

Training Development

Training
- Formal
- OJT

Production
- Content Specification
- Instructional Specification
- Packaging

Evaluation

Retrofit

Re-evaluation

Implementation

Validation

Figure I

A compounding difficulty in managing these functions is that any one of them may be active at any given time. However, there are two major lessons learned thus far from TICCIT project experience. These are: (I) The almost vital necessity for completing essentially the design elements before major production phases begin. This includes all the design with as much emphasis placed on formative evaluation design as any other element. (2) The need for training--from instructional psychologists on down. Each function has its unique facets which require a disciplined approach, with a large measure of homogeneity.

The cost data for the TICCIT Courseware project will be provided to Educational Testing Service for the summative evaluation.

TRAINING - PART OF THE SYNTHESIS OF PRODUCTION

The classic approach to instructional development has been for a project coordinator, either a faculty member as subject matter expert or an instructional technologist (a graduate student or instructional psychologist), to work with others, quite often in small numbers, to produce instructionally designed material.[1] This is generally accomplished in linear fashion. That is, certain individuals perform several of the functions previously listed, such as design, authoring, evaluation, and production.

One of the early steps has been to identify the objectives to be reached by the student in behavioral terms. From the vast literature on writing behavioral objectives, it is apparent that these are not easy for even the professional to define, let alone a layman. And yet, at the very least, there may be an expectation that subject matter experts will somehow provide a viable list of behavioral objectives. If this is the case, there is obviously a training problem just in beginning production of courseware materials.

An alternative is for one skilled in describing behavioral objectives to elicit from the subject matter expert enough information regarding the

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[1]Dr. M. David Merrill, Director, Instructional Research and Development, Brigham Young University, calls this the "artisan or shoe-shop approach."

topics to be covered that he can then state them in useful terms. The impact of this would be that a qualified instructional design person could deal with any subject matter expert to arrive at the behavioral objectives for a course. This would alleviate a serious training problem.

Unfortunately, experience on the TICCIT Courseware project thus far has tended toward a much more serious problem than training in behavioral objectives, although problems in writing them have been minimized in a way which will become clear. It is generally accepted that prior to addressing behavioral objectives, larger goals must be identified. It may be helpful to cite a process which has proved viable for the TICCIT Courseware project, and which shows promise of generalizability to any other project.[1] The training implications of this approach are quite apparent.

Logical Sequence of Course Organization and Courseware Parts Generation --An Authoring Problem

To stimulate and discipline the thinking of those involved in an instructional development project, documents relating to the needs, goals, and justification should be produced. The individual who should be most qualified to perform this task is a subject matter expert with considerable experience in his field. He may be assisted by an instructional psychologist, who would provide insight into possible general instructional strategies.

Then, it is possible to state a set of mastery models, which relate to the type of life condition to be achieved by the student of a given target population. There may be several mastery models. These might be terminal objectives, but tend to be difficult to measure in a formative evaluation sense because of the length of time generally needed for their achievement. For

[1] I am indebted to Dr. C. Victor Bunderson, Director, Institute for Computer Uses in Education, for his synthesis of this model, especially that pertaining to needs, goals, justification, and mastery.

example, a student may learn mathematics to enable him to be a good automobile mechanic, but will not adopt that mode of life until he finishes his schooling. Mastery models are the primary responsibility of the subject matter expert.

The author is also primarily responsible for drawing up a list of topics to be covered in the course. Note that from this list, terminal objectives could be written, as well as sample test items. Other items may also be defined, such as "so what"[1] approaches, and statements of definition, rules, memory items, or problem-solving tasks (generalities). Experience has shown that subject matter may be approached from any of these five directions, rather than from merely the behavioral objectives. Moreover, there is a hierarchy involved in that all five items relate to each other at a specified level of lesson content, and that there are successive levels, e.g. course, unit, lesson, and segment. Regardless of from which direction approached, the five items and the hierarchies must be furnished. In addition, prerequisites must be identified (a matter of insight by a teacher or faculty member into the nature of the target population, the skills involved, the probabilities of error and the reasons for error, and the proper hierarchy).[2]

With the many levels involved, all the foregoing is a repetitious task. In addition, it is much more complicated and difficult than merely training personnel in stating correct behavioral objectives according to Mager

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[1]"So what" is a term to describe material oriented toward helping a student understand why he must grasp the concept. It is based largely on the rationale emanating from the needs, goals, and justification and flowing through the mastery model(s).

[2]Note that the content oriented materials, such as the needs, goals, and justification document; the mastery models; the list of topics; terminal objectives; practice test items; etc. are very valuable for content validation, i.e., submission to a panel of subject matter experts for a subjective determination of tentative suitability. Objective determinations should be made during formative and summative evaluation.

(1962), in spite of the fact that it has been found to be less productive to state the objecti jargon under these circumstances than to describe them in ... udent finds palatable and can unc... stand.

One other important ingredient must be added in which most textbooks and classroom instruction are poor. These are the files of instances (examples and matched non-examples) which go with the generalities (concepts and rules). The instances files must be plentiful enough and divergent enough to allow precise learning to occur, and to allow for sufficient practice using previously unencountered instances (to avoid a mere memory process).

There are additional factors, as well, to consider, such as the type of grade contract, diversionary material with high affect (which may or may not be relevant), or alternate media modes.

Training is required for all of these tasks.

Courseware is Theory Based

There is one other element of authoring worthy of consideration in context with the training problem. Stress has been placed on the idea of authoring and content, less on notions of strategy, which may be more properly the domain of the instructional psychologist or technician. The theoretical structure of instructional materials are described by Merrill and Boutwell (1972) in a taxonomy of instructional variables which was summarized by Bunderson (1972) in the following way:

"Merrill's taxonomy involves three classes of variables:

1. Presentation form

	Expository	Inquisitory
Generalities		
Instances		

The system deals primarily with concept learning and rule using, so a generality is a definition of a concept, or a rule. An instance is an example or non-example of a concept or a rule in use.

Expository means to tell, inquisitory to ask. Inquisitory generalities (e.g., "define a concept") are rarely used.

2. Inter-display relationships

   This category involves the matching and pairing of examples and non-examples, the difficulty levels of instances, the scope of the generalities and instances, and their abstractness - concreteness.

3. Mathemagenic Information*

   This category involves prompting and cuing and other attention-focussing techniques. Specific techniques include attribute isolation, search strategies, mnemonic aids, and production strategies."

It is possible, and it is felt desirable, to approach the synthesis of courseware from the two directions of content and instructional strategy, with the author primarily responsible for content, but the instructional designer primarily responsible for strategy. This presupposes an intimacy by the designer with the media to be used. There are disciplined procedures and a good rationale for this approach covering a thorough content analysis and an instructional analysis which help to structure courseware regardless of media (Merrill, 1972). The interactions between a content specialist and an instructional specialist in this model may be minimal. However, the point at which student learning is really focused, if not where it actually occurs, is in the domain of mathemagenic information. This is where content and strategy mesh by way of the contextual relevancy of mnemonic aids (for memory items), attribute isolation (for concept recognition or classification), algorithms (principle or rule using), or heuristics (for problem solving). Merrill (1971) has described the psychological conditions used here. The mathemagenic information also plays a large part in the affective domain.

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*Information which gives birth (gen-) to learning (amthema).

Need for Warmth

In spite of the logic of the foregoing approach, there is a concern that the essence of pleasure and warmth in learning may be lost if content and strategy are not approached with an undefinable sense of empathy and humanity. Authoring of courseware for the TICCIT system, and any other courseware, is a disciplined art. Experience until now has shown that, contrary to an earlier belief, just any subject matter expert cannot be exposed to the wiles of an instructional design specialist and be manipulated into producing good stuff in spite of himself. As is true in many instances, good courseware authors may be born rather than made, even though training is required in any event. This phenomenon may account for the fact that there are few really good teachers in spite of training, or few really good textbook writers.[1]

Other Team Members

Much has now been said about the problems of training subject matter experts (authors). There are others on the team, such as instructional psychologists, instructional design technicians, empirical design technicians, and packaging specialists who need training not only in their own discipline, but in the vagaries of courseware unique to the target population, the curriculum, and the medium being used. Training needs for these categories of personnel will become clearer as their positions are described.

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[1]The production of good courseware, however, is antithetical to the usual textbook authoring approach, although good courseware could be adapted readily to the textbook medium.

THE FACTORY

The instructional development factory as exemplified by the TICCIT Courseware project incorporates industry techniques in a way readily gen-[illegible] to other development projects, large or small. Variations in the model have already been applied to projects at Brigham Young University and will continue to be used. One of the apparent major benefits is that larger numbers of people, once having been trained, can accomplish several projects while the personnel are available rather than having to rely on fewer people over a longer period of time. Other expectations are that individual skills may be better identified. Economics of manpower loading may be realized through use of mass-production techniques. Training may be simplified and standardized, with a large reliance on functional on-the-job techniques rather than massive classroom training sessions, although these are not eliminated.

Personnel

The TICCIT Courseware project expects a peak of approximately 32 full-time and 45 half-time personnel to be assigned at any one time. These individuals are in various states of training as the many functions are conducted, including design, production, and operations and maintenance. Since this is a development project, a major objective besides a market success for an improved CAI system is to learn how to do this kind of development. An overall organizational chart is shown in Figure 2.

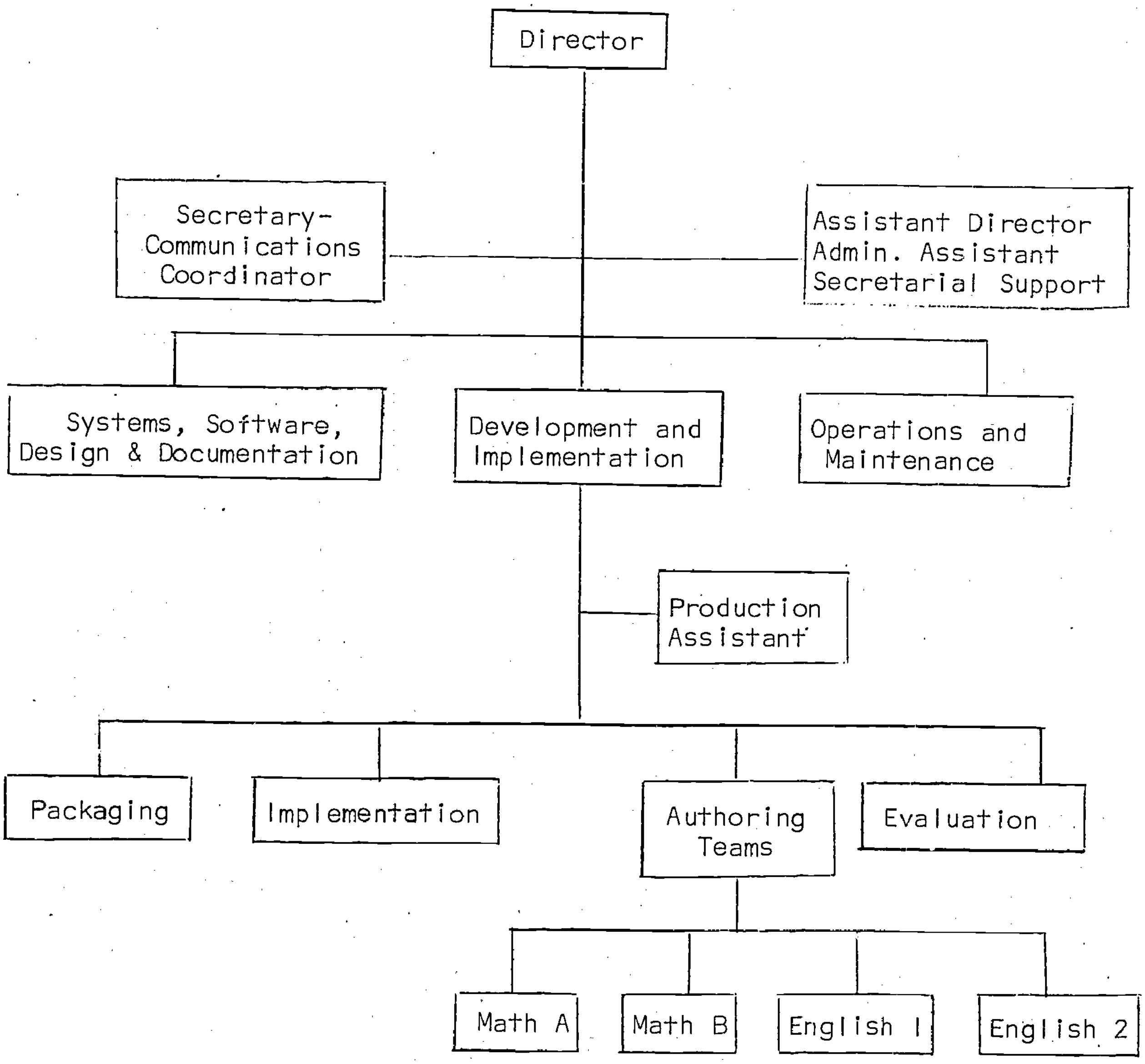
Director
Secretary-Communications Coordinator
Assistant Director
Admin. Assistant
Secretarial Support
Systems, Software, Design & Documentation
Development and Implementation
Operations and Maintenance
Production Assistant
Packaging
Implementation
Authoring Teams
Evaluation
Math A
Math B
English I
English 2

Figure 2

In addition to the management assignments, TICCIT courseware production teams use the following functionaries:

a. Instructional Psychologist (IP). Rule of thumb is that one IP is assigned half-time for each course. His role is to provide advice, assistance, coordination, and review of the course material. He bears the burden of training, and for some period is involved in some way in the design effort. He furnishes the subjective evaluation described by Abedor (1972) as the initial professional level screening of finished material. The interaction between training and quality control appears to be direct. That is, the better the training, and thus the qualifications, of those individuals providing inputs, the less likely will be the difficulty in quality control review. At least two other aspects of instructional psychology as a discipline seem to be highlighted by the experience with the TICCIT project. These are: (1) Whereas usually we speak of instructional psychology as having general branches of development and research, the management requirements seem to be equally important to any others. With the accountability needed to meet industry-like deadlines, it may be that only those instructional psychologists who are willing to accept good management roles, and adopt the necessary practices, will succeed in what may be a vast area of endeavor in the discipline. (2) There is almost a complete lack of homogeneity in the thinking of credentialed instructional psychologists. The reasons for this may be apparent. As stated earlier, instructional development is a relatively new discipline, still groping in many ways for "best" approaches to the science of instructional design. However, to be a productive member of an instructional development team, much harmonization will be needed. It may be necessary for instructional psychologists in a teamwork approach to undergo further training in areas not heretofore studied during a previous career. There is also the problem of the type of contribution to be made by an IP. Management is certainly an important factor. There are questions concerning the artistic input in creating displays and other content structuring which may be in an entirely creative realm rather than in a scientific discipline. Many of the final decisions regarding these questions may only [illegible] through formative evaluation and empirical validation.

b. Author (Subject Matter Expert-SME). One or more authors are assigned to each authoring team. These individuals are expected to be well-versed in the course subject and are primarily responsible for course content. They do influence other elements of the course, however, by providing advice and coordination at selected phase points during production. SME's are generally at various levels of capability as shown in Figure 3, which depicts an ideal organization for one team assigned to one course.

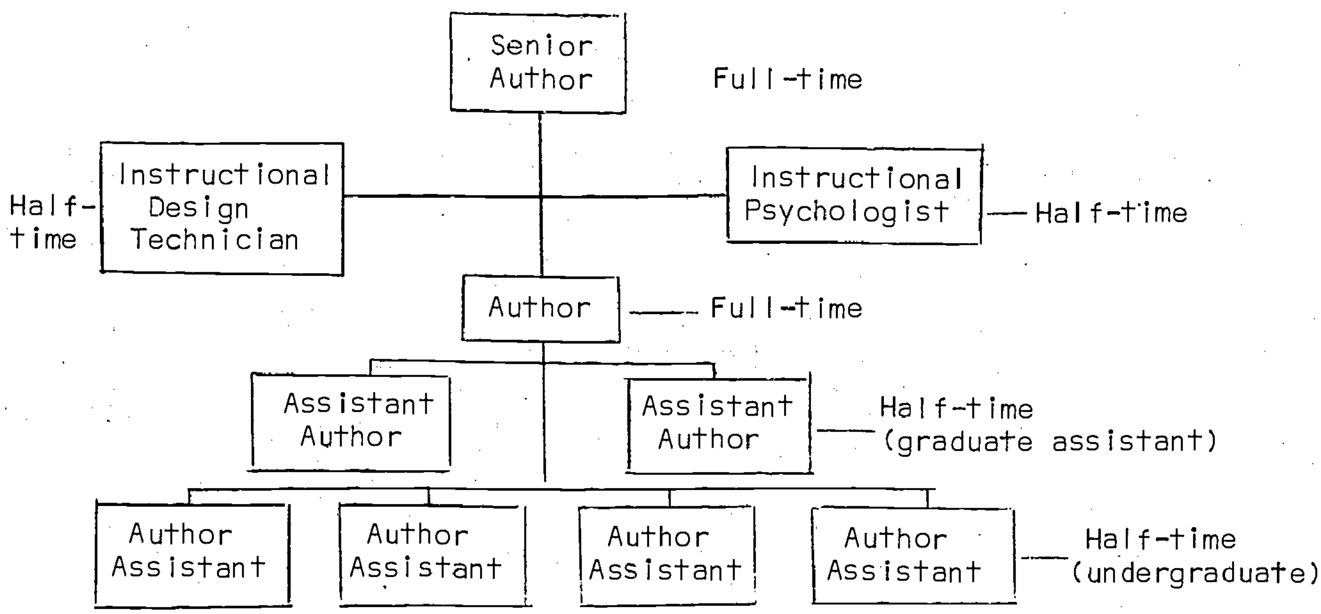

Figure 3

Average annual personnel costs for such a team approximate $45,000 not counting overhead (fringe benefits and facilities costs). The team can produce approximately forty-five one-hour l[illegible]ns in a year. The products include structured content not yet adapted to the medium, but in an adaptable format.

The actual products for which SMEs are primarily responsible are these (Low, 1972); keeping in mind that interaction with an IP or an instructional design technician may be required: Hierarchies, topics, objectives, generalities, instances (matched examples and non-examples) in divergent order, "so whats" ("Why is this material important?"), prerequisites, helps (mathemagenic treatment) and easy and hard versions of the generalities.

c. Instructional Design Technician (IDT). Normally one intern is assigned half-time to each team. These are Ph.D. candidates in educational psychology who are working as graduate assistants in instructional psychology. Each technician is primarily responsible for converting content materials received from the authoring teams into a structure compatible with packaging needs. The objective is to provide the best instructional design for student use considering the media and strategy options. Products for which the IDT is primarily responsible are: assistance in providing objectives, prerequisites, hierarchies and display conventions; response conventions and answer processing; display formats; and helps (mathemagenic treatment) of instances.

d. Empirical Design Technician (EDT). As with the IDT, one intern from the Ph.D. program in instructional psychology is usually assigned half-time to each team. These individuals are responsible for planning and performing several types of formative evaluation of the courseware, depending on its stage of development. The objective is to assure that the material is suitable for use with the target population. The products are generally written summaries of findings of experimental and validation activities.

e. Packaging Specialist (PS). These individuals convert authored material into a form suitable for use in the medium, in this case a computer system. They may do this by filling out data forms, or by entering the material directly into the system on-line at a student terminal. Other tasks include editing the material, acting as proctors for students on the system, performing graphics entry functions, acting as liaison between packaging and authoring efforts and acting as a "sounding board" for the courseware.

Production Model and Schedule

As stated by Lee (1972) there is no single production model. Any one proposed must be flexible enough to accommodate the biases of key individuals who are independent and creative, yet rigid enough to allow generation of a production schedule. The author (Low, 1972) defined a production model which accounted for all of the end products to be formulated at that time (Appendix). The modes at which major end products were to have been completed were called "stations," so that lesson materials could be followed through from beginning to end in a controlled way by referring to station output. The model did not include internal arrangements for authoring teams, which were expected to devise their own. These have since been formulated for each of the four teams, and as might be expected, no two are precisely alike.

The overall model allowed eight weeks for completion of a lesson from start to finish. The master schedule called for beginning a lesson each week, so that there was considerable built-in vertical manpower loading. Of the eight weeks, two were allocated to empirical validation at two separate stations. One was at a midpoint (Station 10) and the other toward the end (Station 19).

These stations are not in the current model. Also not included are many of the outputs of Station 13, such as videotape scripts (which are being handled separately), mini-lessons, "So What" fun options, grade contracts, and complete instance files. These were estimated to require a week. Much of the material in Stations 4 and 6 has been combined into Station 1. But as Bunderson (1972) points out, the basic cycle has been cut to about five weeks. The schedule now broadly looks like Figure 4 for each lesson.

Through Station 5 (less graphics and tests, and not correlated)	two weeks
IP review and recycle	1-1/2 weeks
Team review, correlation, and retrofit	one-half week
Packaging teams (coding and graphics)	one week
TOTAL:	Five Weeks

Figure 4

As more and more material is produced, other cycles of effort will have to be generated. There is still a composite manpower loading to consider, since more than one lesson is being worked on at a time, as well as different elements or stages of a lesson, unit, or course.

CONCLUSIONS

There are some significant conclusions which may be drawn from the experience of the TICCIT Courseware project at Brigham Young University thus far. These are categorized as follows:

Identification of Functions. Figure 1 contains a list of functions identified as being important to the analysis of a development project. These same functions need to be identified, with applicable variations, at the outset of any project. One major use is that of budgeting and time-phasing. Without this information, too little may be known about a project to define accurately its management parameters, or the tasks to be performed.

Design. This is a critical item. The design elements should be completed as early in a project as possible. Indeed, the other functions, with the possible exception of management and initiation, should not even be started until the design is well on its way. As in statistics, time spent in establishing viable designs will be amortized later on, and help to avoid agonies during the production phases.

Training. Another critical item. The disciplined thinking inherent in structuring the training necessary in a project will have wide-spread effects. The training establishes a sound basis for quality control. It is also a reflection of the design. If at all possible, training packages should be prepared as soon as possible as progress in design will allow. There very well may be areas of training which are skill oriented rather than project taks oriented which could be covered even before or during design.

Courseware. A theory based approach to content and instruction allows for the generalizability of the course material across media. This has to be considered a breakthrough which could reduce re-inventions of course material everywhere, as well as to tend to standardize curricula.

Learner Control. It may be as important for students to learn how to learn as it is for them to gain content proficiency. All the familiar terms in instructional development, such as "self-paced," "individualized," "non-lock-stepped," "teaching toward mastery," "criterion referenced," etc. are embodied in the TICCIT Courseware project. Students will have control over both content and the way it's presented within medium limitations. The principles learned in how to structure material for learner control will have a beneficial impact on other instructional development efforts.

Efficiency. Even though the TICCIT Courseware project is large and expensive, much of the effort and money thus far has gone into design and procedural matters. Pushing the edge of theory and technique has cost something which should not have to be repeated. Teams can get projects, or parts of projects, completed with greater dispatch and less total manhours than small groups of individuals working alone. This is an expectation which is expected to be borne out by the summative evaluation. Unfortunately, there may be a tendency to compare the costs and efficiency of producing good courseware with those of a historical textbook approach, an ever present danger. Instructionally designed materials do cost time and money, so that high-payoff courses should be first priority.

Authoring. There is a new brand of authoring required for projects like TICCIT. As a discipline, it may be impossible for instructional psychologists to train enough faculty members, teachers, or even other members, to be able to unilaterally redesign or invent good courseware throughout education. It will all take time and a vast amount of individual training. More likely, groups of authors and other skilled persons with a great deal of aptitude for participation in courseware design will carry the brunt of activity in this important area. Just any subject matter expert, or even any instructional psychologist, will not do.

<u>Logical Approach to Development Products</u>. A major disciplining factor in generating the many development products is the overall approach to content and instruction. A pattern which starts at a broad, general area, and goes by successive logical steps to specific items has been determined to be very effective. Work done to describe needs, goals, justification, strategies, and resulting mastery models will have a direct application at the basic segment level, such as "so what" material, or relevant examples, definitions and practice items. The general series of documents, falling under Project Initiation in Figure I, should be completed very early in the process. To assure widespread acceptability of the material, these early documents should be validated for content by subject matter expert peer groups before actual development begins.

<u>Management</u>. Greater insights into the need for good management in instructional development efforts are required. One of the failings in educational environments, sometimes under the guise of academic freedom, is the lack of accountability on the part of many. One of the reasons for this is undoubtedly the creative nature of the individuals involved--there is always a better way to do whatever is being done. Industry-like practices legislate against this phenomenon. Many academicians may have to discipline themselves as students who have deadlines for turning in assignments which are going to be graded without the potential for amendment.

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APPENDIX

The attached flowchart has been extracted from Low, et. al, August 1, 1972, revised September 5, 1972. The basic document contains several pages of narrative to explain for local use clarifying information about each station and the flowchart in general. A glossary of terms is also included. The model is valid as an example of the way in which lesson components can be followed through a multiple production cycle. In this sense, it is generalizable to any instructional development project. However, experience has shown that models are subject to constant revision and violation, and that a viable approach is to formulate a trial model, then solicit maximum participation by those who are going to have to live with it. In other words, it should be <u>their</u> model rather than <u>your</u> model. Compromises can be made if the schedule is viewed as broad enough to accept internal aberrations as long as major deadlines are met.

TICCIT Courseware Project

Production Model

The production cycle flowchart to follow contains a graphic presentation of the material previously given in narrative form. There are several features which should be noted.

a. The three general phases of activity are shown.

b. Each station is numbered in parentheses.

c. The major category of team member is shown within each block, e.g., SME.

d. More detailed team composition is shown to the side of each station and correlated by station number. The team leader in each instance is underlined unless it is a one function team.

e. The products in succinct terms are specified in each box.

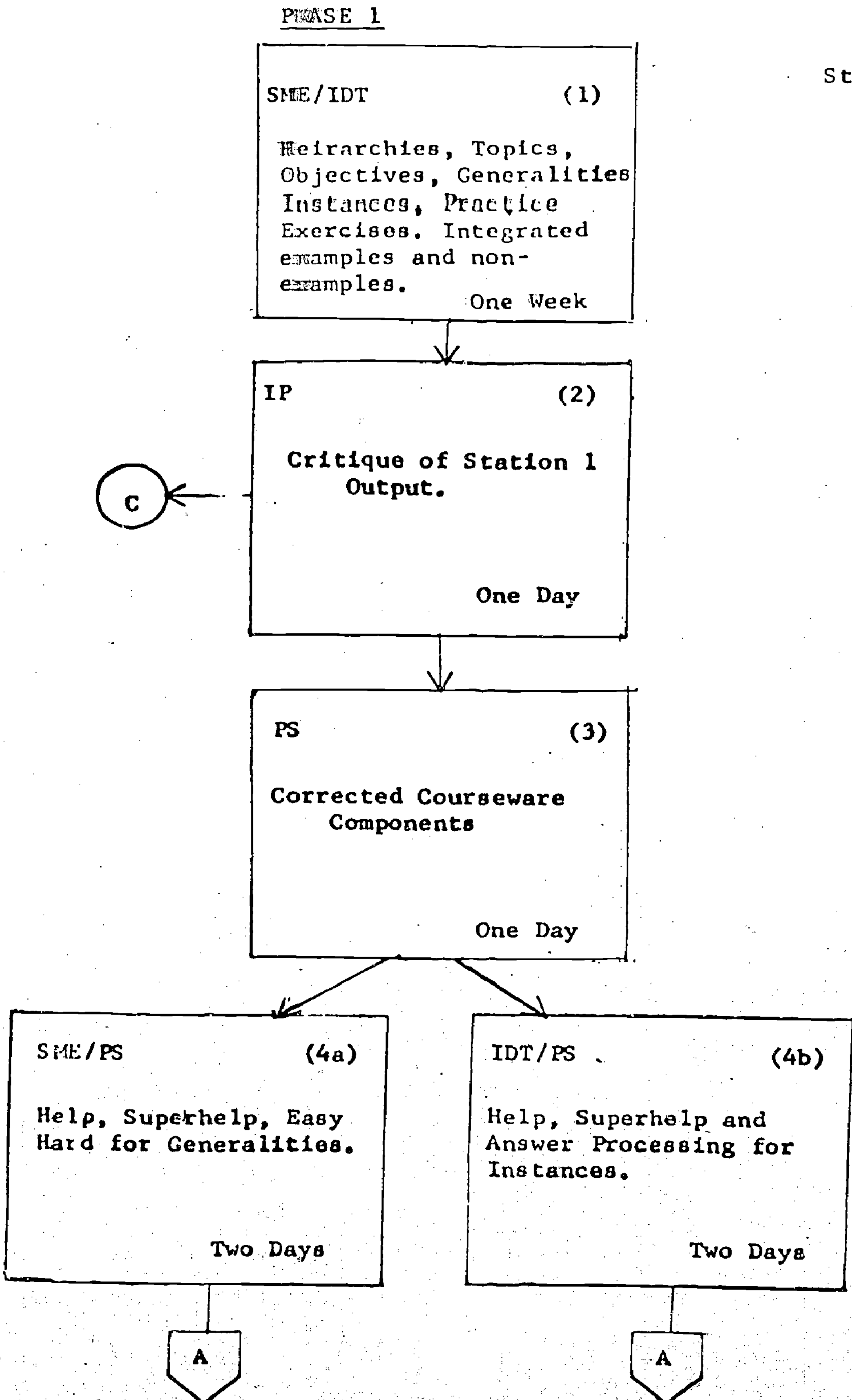
f. The expected time at each station is shown in the lower right-hand corner of each box.

g. Continuations of the flowchart are shown by a ▽ with a letter of the alphabet entered for correlation.

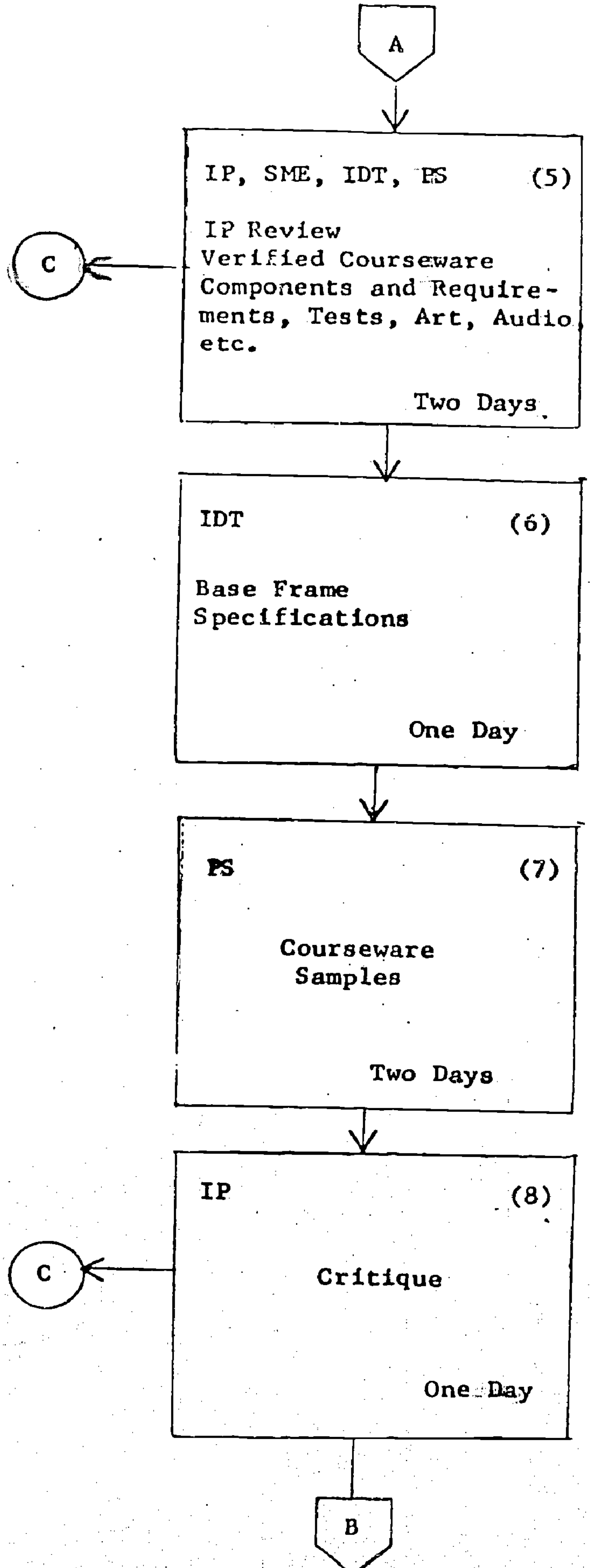
h. A ◯ is shown by each station at which an IP participates. This designates a correction loop which may be specified by the IP to any previous station as well as the coordination which may then be required.

i. Blocks shown with a dotted line are optional at the discretion of the IP.

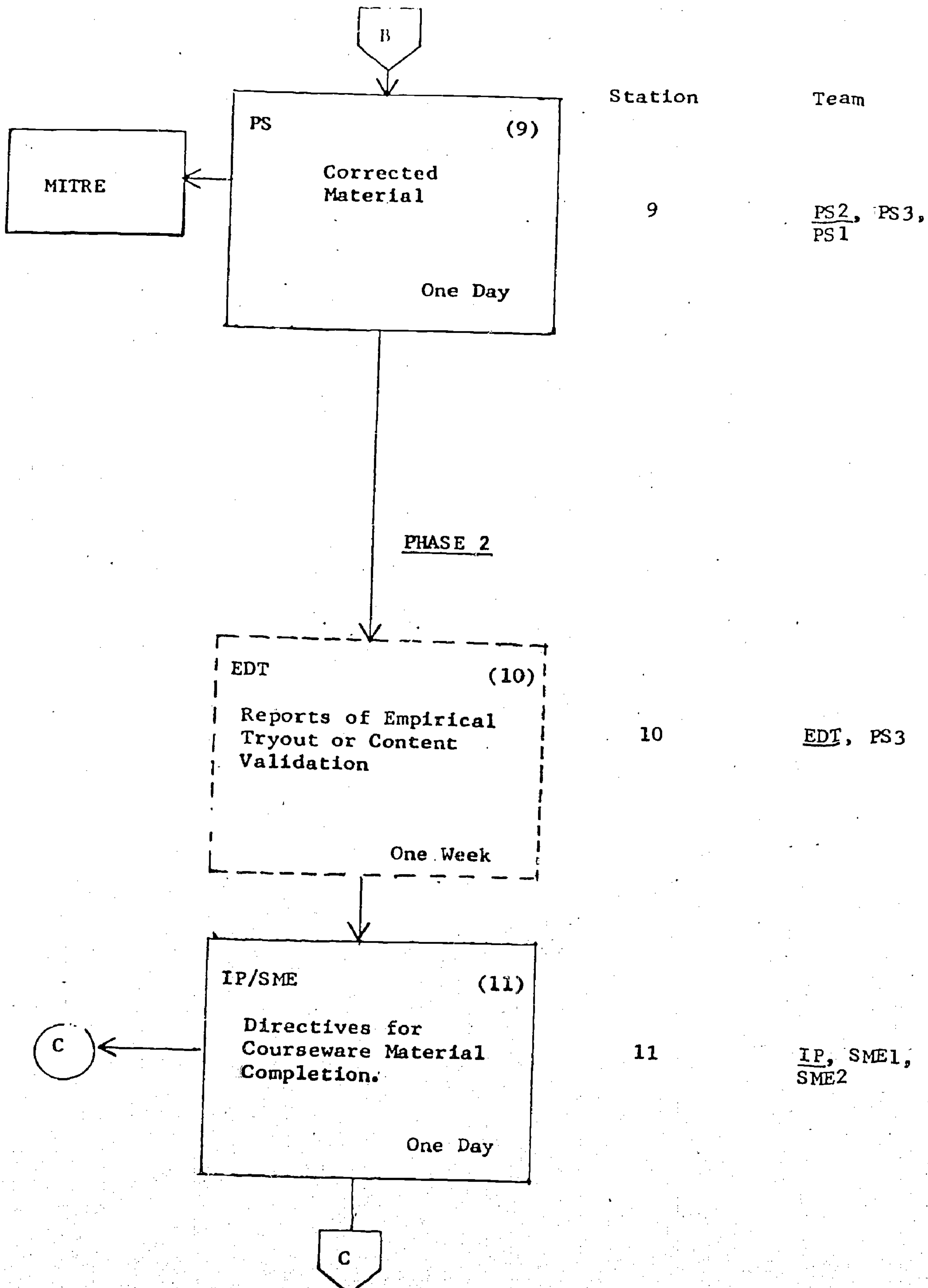
PRODUCTION CYCLE FLOWCHART

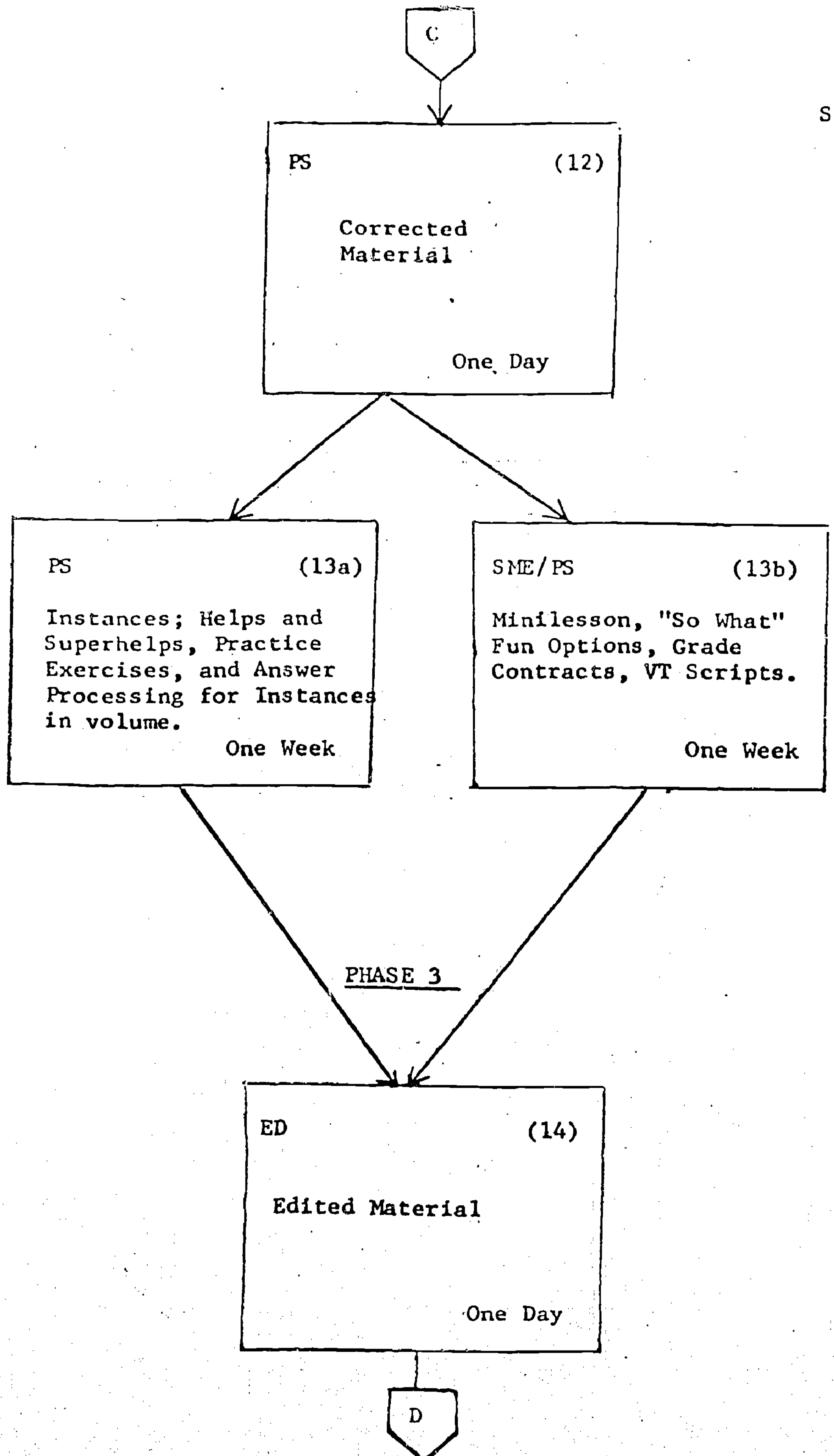


Station	Team
1	SME1, SME2, SME3, IDT, ED, PS3, SME4
2	IP
3	PS3
4a	SME1, SME2, PS2, SME3, SME4
4b	IDT, PS3, PS2

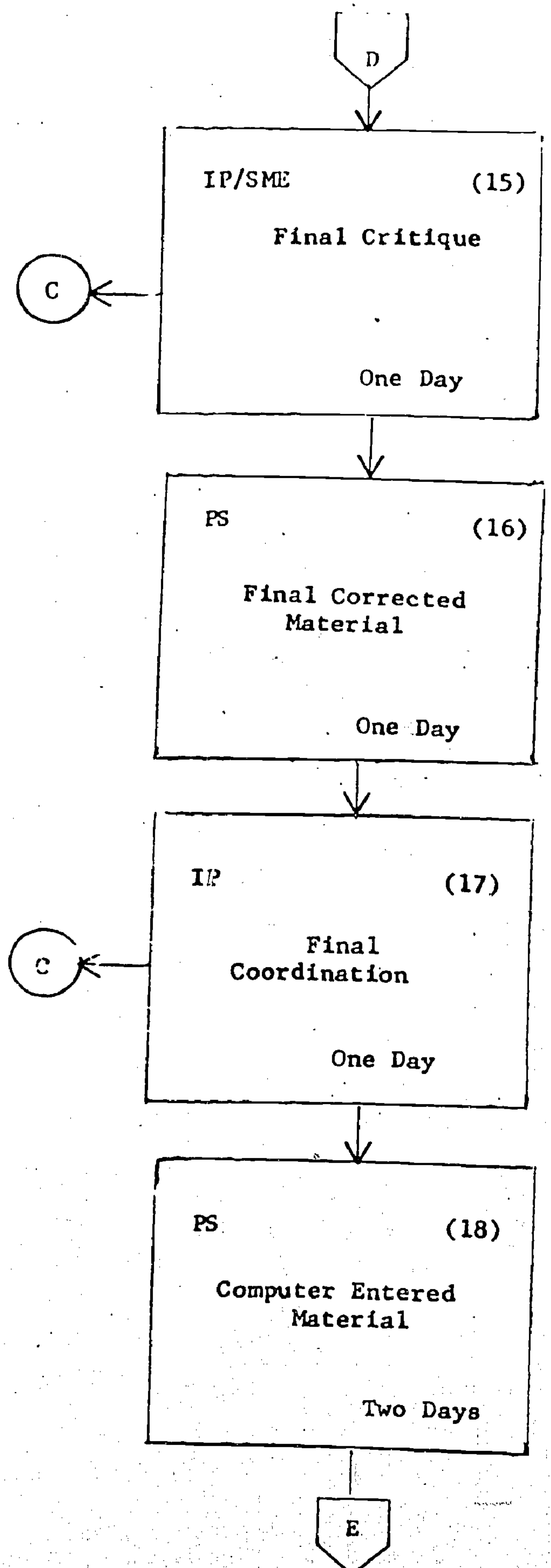


Station	Team
5	IDT, SME1, SME2, PS1, PS2, PS3, PS4, IP
6	IDT
7	PS2, PS3, PS1
8	IP

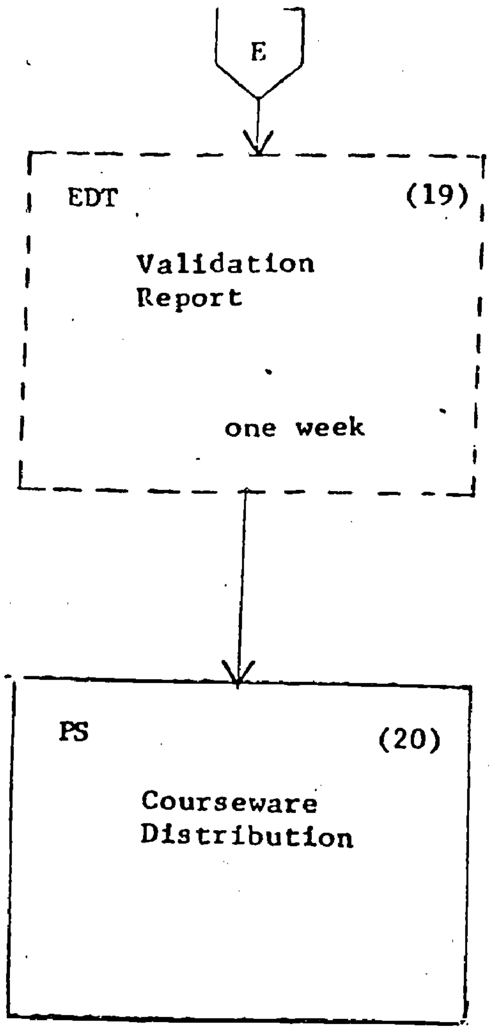

B
Station
Team
MITRE
PS
(9)
Corrected Material
One Day
9
PS2, PS3, PS1
PHASE 2
EDT
(10)
Reports of Empirical Tryout or Content Validation
One Week
10
EDT, PS3
IP/SME
(11)
Directives for Courseware Material Completion.
One Day
11
IP, SME1, SME2
C
C



Station	Team
12	PS2, PS3, PS1
13a	PS2, PS3, PS4, PS1
13b	SME2, SME3, PS3, PS4, SME1
14	ED



Station	Team
15	IP, SME1
16	PS1, PS2, PS3
17	IP
18	PS2, PS3



Station	Team
19	EDT, PS3
20	PS1, PS2, PS3

GLOSSARY

GLOSSARY

Algorithm: A rule or procedure for solving a mathematical problem; in a broad sense, an iterative rule.

Answer processing: Analyzing student inputs to determine the correctness or incorrectness of the response.

Assistant author: Graduate level subject matter expert assigned to authoring.

AI: Attribute isolation.

Attribute isolation: Process used to illustrate relevant attributes of a generality or instance.

Author: Subject matter expert who writes lesson components and who determines content.

Author assistant: Packaging specialist temporarily assigned authoring duties.

Backward book: Material in sequence from back to front.

Base frame: Specific data which controls the use of computer subroutine.

Base frame content file: Wrap-around, question message, instance messages, and response instructions.

Content file: Authored material, graphics, and audio content.

Correlation committee: IDT, SME, and PS; meet at various times during the production cycle to iron out problems in the lesson and to generate MI and answer processing display routines.

COSD: See OSD.

Courseware: Instructional material.

Difficulty level: Ascending/descending level of difficulty in a content file.

E: English.

ED. Editor.

EDT: Empirical Design Technician; person responsible for validation of instructional materials; a graduate student in the instructional psychology program.

Expository: Description of an example or generality requiring no response from the student.

File reference genulator: Generative strategy for computer generated instance and AI files.

Frame: Forms on which a TV screen is outlined, used to simulate the appearance of the material on the TV.

Generality: Definition, rule or memory task.

Grid: Graphic representation of the character spaces existent on a TICCIT display.

Help: A form of mathemagenic information.

HE.N: Help for non-example.

Heuristic: Serving to guide, discover, or reveal further information.

HE.X: Help for example.

Hierarchy: Suggested sequence of minor objectives to reach major objectives.

ICUE: Institute for Computer Uses in Education (BYU).

IDT: Instructional Design Technician; advisor for base frame specifications, objectives, hierarchies, and other instructional design considerations; a graduate student in the Instructional Psychology program.

Inquisitory: Description of an example that calls for a response from the student.

Instance: A single example or non-example.

IP: Instructional Psychologist.

IR and D: Instructional Research and Development.

IX: Inquisitory example base frame; also known as practice mode.

LOSD: See OSD.

M: Pre-calculus course.

Mathemagenic information: A class of responses which give birth to learning, includes heuristic information, algorithms, attribute isolation, and mnemonics.

Mini-lesson: A shortened version of the regular lesson, giving the students an overview of the generalities and some examples.

MITRE: The MITRE Corporation. A not-for-profit systems engineering company. Subcontractor to NSF on the TICCIT Project. BYU is subcontractor to MITRE on the project.

Mnemonics: Techniques of improving the memory.

NM: Non-example message.

NSF: National Science Foundation

OSD: Objective Status Display; the display of the objectives on the screen for a lesson, course or unit; designated respectively LOSD, COSD, and UOSD. Used as an option to preview specific objectives.

Overlay: A frame with windows that is laid over another frame to help illustrate the point and to save having to rewrite the entire screen.

POHE.N: Post help for non-example.

POHE.X: Post help for example.

POSHE.N: Post-super-help for non-example.

POSHE.X: Post-super-help for example.

PREHE.N: Prehelp for non-example.

PREHE.X: Prehelp for example.

PRESHE.N: Pre-super-help for non-example

PRESHE.X: Pre-super-help for example.

Packagers: Packaging specialists.

Production cycle: System through which instructional materials are produced from author to packaging and empirical validation prior to its submission to MITRE.

PS: Packaging Specialist.

QM: Question Message.

RE: Requisite English.

Relevant attributes: Qualitative characteristics which are pertinent to the generality.

RM: Requisite math.

Senior author: Author who is responsible for the authoring team for that course.

SME: Subject Matter Expert; author.

So What?: Tells the student why he is learning what he is learning.

Super-help: Step-by-step presentation of the help.

Terminal: Place where the student sits: carrel with keyboard, TV screen, headphones set included (end of system).

TICCIT: Time-shared Interactive Computer-Controlled Information Television.

UOSD: See OSD.

XM: Example message.