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ABSTRACT

The outline, steps, prodecures, methods, and format of a planned evaluation of the United States Army's Computerized Training System (CTS) are given. The evaluation is built into the CTS project and will have both summative and formative aspects. The three main areas to which the evaluation is directed and for which specific evaluation plans are outlined in this document are technical effectiveness, cost effectiveness, and training effectiveness. (WH)

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Report CTS-TR-74-1

PRELIMINARY EVALUATION PLAN FOR US. ARMY COMPUTERIZED TRAINING SYSTEM

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NOTICES

This report has been reviewed and is approved.

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Disclaimer

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Foreword

The US Army Computerized Training System (CTS) represents the resultant of a multidisciplinary effort combining the latest advances in mini-computer hardware and software, learning theory and instructional strategies. Accordingly, it is appropriate that an evaluation of such a system itself be highly multifaceted. In this respect, three major evolutionary stages of the CTS are addressed: developmental, operational and projectional. Further, within each of these stages, three major dimensions of effectiveness are considered: technical, cost and training. Again, by the same token, each of these dimensions will be assayed on three major levels of analysis: microscopic (subsystems evaluation), macroscopic (systems evaluation), and telescopic (follow-on evaluation). Likewise, each of these levels will subsume their own manifold perspectives. The end product of the evaluation, however, will not be merely an expanding diffuse analysis of the multiplex aspects of CTS, but a synthesis of the findings toward meaningful operational decisions concerning its overall feasibility and effectiveness.

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Introduction

1. Etiology of CTS Evaluation. The mission of the CTS Evaluation Division is to conduct Phase V of the general development plan as provided for in the Product Manager Charter and CTS Management Plan (cf. Appendices A, B). As indicated in the general development plan, "This phase will be conducted by the Product Manager concurrently with Phase IV (CTS Operation) and is concerned with the feasibility and effectiveness of the entire system". This evaluation phase, similar to the other four phases, has been charted along a time phase schedule (cf. Appendix C). The key activities identified in the Time Phase Plan as essential to the evaluation of the CTS are: (1) form preliminary evaluation plan; (2) identify necessary evaluation data; (3) finalize evaluation plan; (4) program evaluation requirements; (5) conduct test on evaluation data; (6) conduct formal evaluation of CTS; and (7) analyze data and draft final evaluation report. The information contained in this report relates to items one and two, and will be considered preliminary till item three is completed.

2. Orientation of CTS Evaluation. The CTS will be evaluated from a multidimensional point of view. First, from its inception it was decided that CTS would be tested and evaluated in an operational Army training milieu. In consonance with the rationale underlying the design, development, and operation of CTS, the keynotes to the evaluation as well will be "pragmatic" and "functional". Thus, emphasis will be placed on operational reliability and utility. This approach will insure that the evaluation will not be misdirected in deriving many "nice" answers to a lot of oblique questions. Rather, it will insure that the ultimate evaluation product will represent a realistic "in vivo" appraisal of CTS with immediate practical results and implications.

Secondly, within the pragmatic-functional context, the evaluation will be generally conceived to be both expository and demonstrative. An expository view will include a thorough description of operational events and problems which occur within the Course Development/Operation and the System Operation/Programming Divisions. The use of accepted procedures of qualitative naturalistic observation and quantitative statistical descriptive measures will be applicable here. The demonstrative aspects of the evaluation of CTS will include comparative analyses employing both internal and external criteria. The use of systematic assessment and evaluation control procedures employing classical inferential statistical procedures will be utilized as appropriate.

Thirdly, within the expository-demonstrative context the evaluation will be conducted on two contrasting levels: macro and micro. The macro level will address the global "Gestalt" aspects of CTS; whereas, the micro level view will address its more elemental subsystem facets.

Lastly, for the enhancement of thoroughness and objectivity, the entire evaluation will be oriented toward an adversarial assessment to include both the pro and con aspects of the primary components of CTS (instructional model, courseware programs, software programs, CTS language, etc.) and any unanticipated by-products and unforeseen side effects. The net effect of this approach will contribute to a goal-free (serendipitous) as well as a goal-based (preplanned) evaluation, which will insure against a narrow tunnel vision syndrome.

3. Perspective of CTS Evaluation. For the sake of adequate perspective, a description of how the CTS evaluation relates to the entire project is presented in Figure 1. An overview of the evaluation areas and their relationship to the CTS Organization (Figures 2, 3) will be discussed in sections 4 and 5 below. As indicated in Figure 1, the orientation of the evaluation design, similar to the course and system design, is contingent upon the general requirements defined for CTS in its Management Plan (cf. Appendix B). Subsequent to the design and development of the CTS courseware, system hardware/software and evaluation plan, the prototype system run will be conducted. The system run will be subdivided into two stages: trial and operational. In the trial stage (also called the formative period), the courseware and computer software will be evaluated for their internal consistency and interactive integrity; and, during the operational phase (also called summative period), the integral CTS package will be evaluated for its operational reliability and external validity against existing baseline control information. The resultant of the multidimensional analyses of CTS are projected to define three courses of action: full acceptance and implementation of the final courseware and software products, minor or major redesign of the same with subsequent implementation, or suspend judgement till the state of the art demonstrates a proper course of action. It should be noted that contemporaneous with the formative and summative evaluation, other essential aspects of CTS will be assessed. These include course development/operation, system hardware/software, and costing of the entire CTS.

4. Scope of CTS Evaluation. Operating within the scope of the CTS Charter and Management Plan the evaluation of CTS is intended to be both intensive and comprehensive. In this context, the depth and breadth of the CTS evaluation will be directed toward, and limited by, the US Army's stated evaluation objectives of testing the feasibility and effectiveness of CTS (cf. CTS Management Plan: Appendix B). On the basis of these two global objectives, five basic subareas have been identified for evaluation: hardware, software, cost, courseware and student. For the sake of expediency, and by the logic of their relationships, these five subareas will be consolidated into three broad evaluation areas which are: System Effectiveness, Training Effectiveness and Cost Effectiveness (cf. Figure 2).

The thrust of the three pronged evaluation plan will be based on the assessment dimensions, outlined in section 2 above, as appropriate: pragmatic-functional, expository-demonstrative, and micro-macro. For example, the technical effectiveness of the CTS will address the reliability and utility of the hardware and

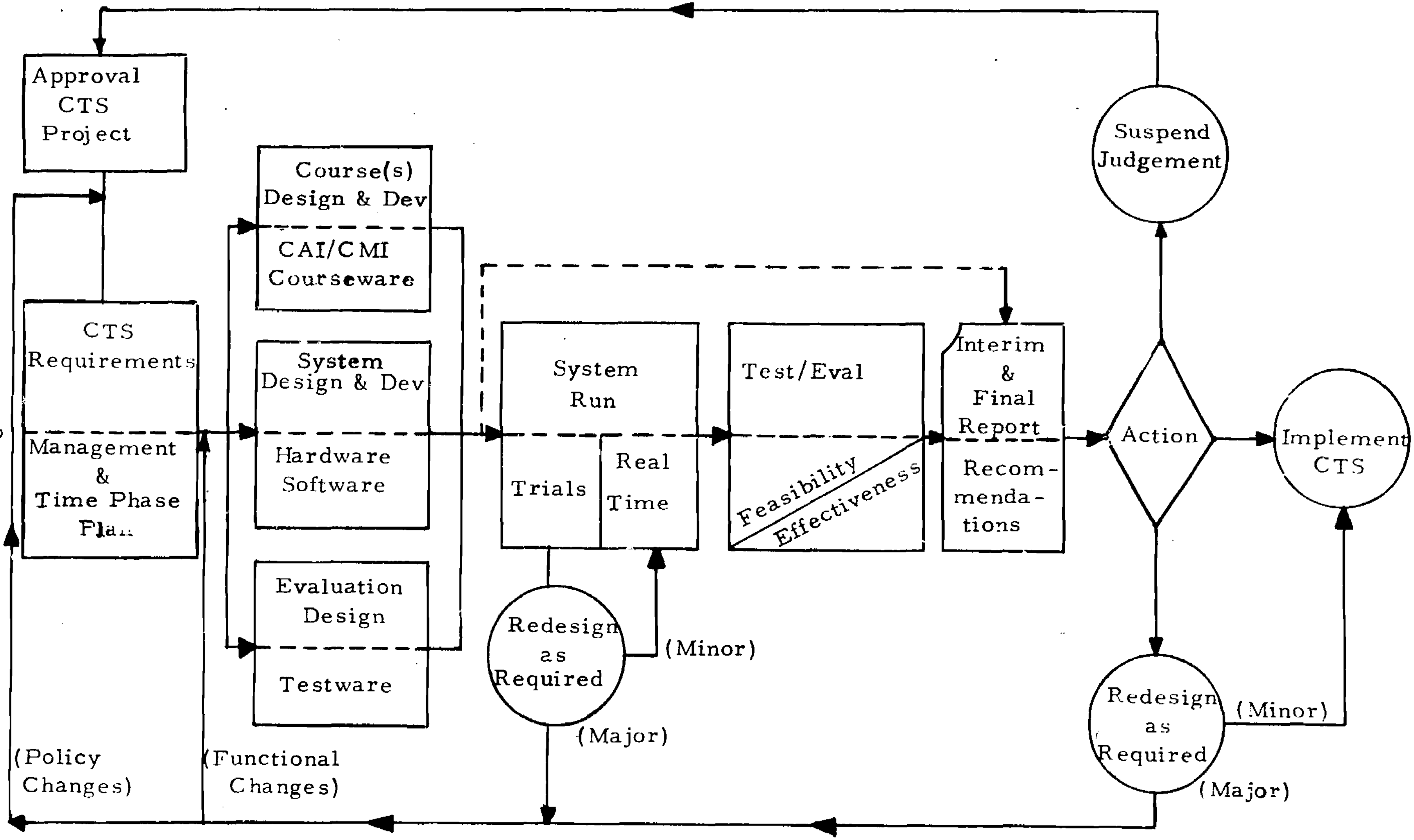

Figure 1 Overall CTS Organization Flowchart

software subsystems and system as a whole (micro and macro views). The strengths and weaknesses of the system components will include an assessment of their follow-on operational system implications (pragmatic view). Performance characteristics will include flexibility and extendability of the hardware/software and operating/maintenance characteristics of the component subsystems (expository view). As appropriate, input to these performance characteristics will be drawn from the full range of potential consumers: systems operation and course development personnel, instructors, and students via their respective perceptions of the system's components (demonstrative view).

In regards to training effectiveness, the operational reliability and validity of both student performance and course efficiency will be examined. Student performance broadly includes course achievement as measured by means of written and performance tests specifically designed to measure the skills and knowledges attained (pragmatic view) in each of three Army technical training courses assigned for CTS study purposes. Also included will be measures of student attrition, time to complete training and attitudes toward CTS (expository view). Course efficiency willbe assayed on 2 levels: formative evaluation (micro-view) utilizing preestablished criteria of course excellence; and; summative evaluation (macro-view) via empirical testing of CTS courseware against courseware utilizing the same objectives but developed along a different instructional method (demonstrative view). These two assessments constitute the internal and external quality control procedures for supporting the optimum development of CTS, and will further provide prototype benchmark norms for future CTS development.

Thirdly, the cost analyses will attend to cost budgeting, effectiveness and benefits that accrue to the CTS. A multidimensional assessment of CTS costing will include type of cost (capital/developmental/operating); purpose of cost (direct/indirect/noninstructional) and area of cost (subsystems and areas). The scope of this cost assessment will range from item costs (micro) to total system cost (macro). It is anticipated that the derived cost model will enable acquisition of the following required cost information amenable for management information and decision making purposes: descriptive costs (budget/cost accounting); predictive costs (cost analyses/forecasting); and, comparative costs (cost effectiveness/benefits). Here, the assessment encompasses both expository and demonstrative costs. Finally, it is to be noted that the underlying theme of the cost analysis will be the educational benefits accrued by the costing levels (pragmatic-functional).

The joint findings of the above three evaluation areas will contribute to the determination of the overall feasibility and effectiveness of the CTS. This objective will also be viewed from three separate aspects: developmental, operational and projectional. An outline of the specific objectives apropos to the three evaluation areas and a detailed description of each of the areas is contained in the succeeding section below and chapters to follow.

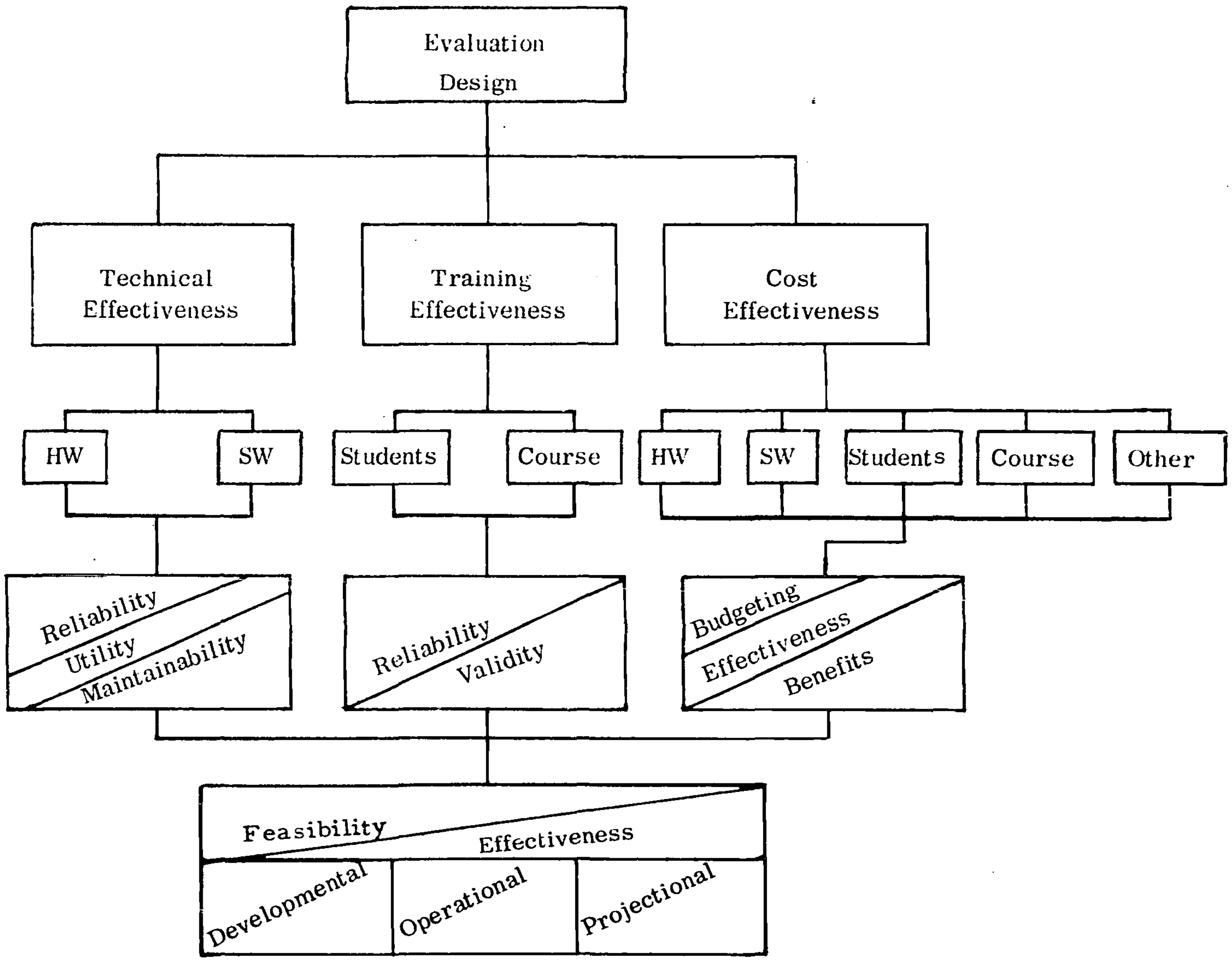

Figure 2 Overall CTS Evaluation Flowchart

5. Objectives of CTS Evaluation. In keeping with the scope of the CTS Project outlined above, the specific objectives of the CTS evaluation can be classified into the three broad areas of technical, cost and training effectiveness. The relationships of these areas to the overall CTS organization network is presented in Figure 3. The underlying intention of the evaluation objectives is to provide, with demonstration when appropriate, a panoramic "snapshot" of the findings relating to the development and operational implementation of CTS for each of three Army technical courses. As indicated in Figure 3, this "snapshot" will be pragmatically based upon the processes and products of the Course Development/Operation and the System Operation/Programming Divisions. Thus, the evaluation domain will encompass the gamut of the organizational and functional aspects of these two CTS component divisions as considered from a technical, cost and training effectiveness point of view. An outline of the evaluation objectives are presented below.

Outline of CTS Evaluation Objectives

I Technical Effectiveness of CTS

- Required technical expertise/training of personnel
- System architecture characteristics/problems (hardware)
- System programming characteristics/problems (software)
- CAI/CMI processing requirements/problems (interactive/batch)
- System operation/maintenance (procedures/problems)
- Support of course development/evaluation requirements
- System operator perceptions of system/subsystems

II Cost Effectiveness of CTS

- Descriptive costs (budget/accounting data)
- Comparative costs (cost effectiveness/benefits)
- Predictive costs (cost analysis/forecasting)

Within these broad areas the following costs will be identified:

- Type of cost (capital/developmental/operating)
- Purpose of cost (direct/indirect/noninstructional)
- Area of cost (subsystems/components)

III Training Effectiveness of CTS

A. Course Development and Operation

- Required technical expertise/training of personnel
- Course development (time/support/problems)

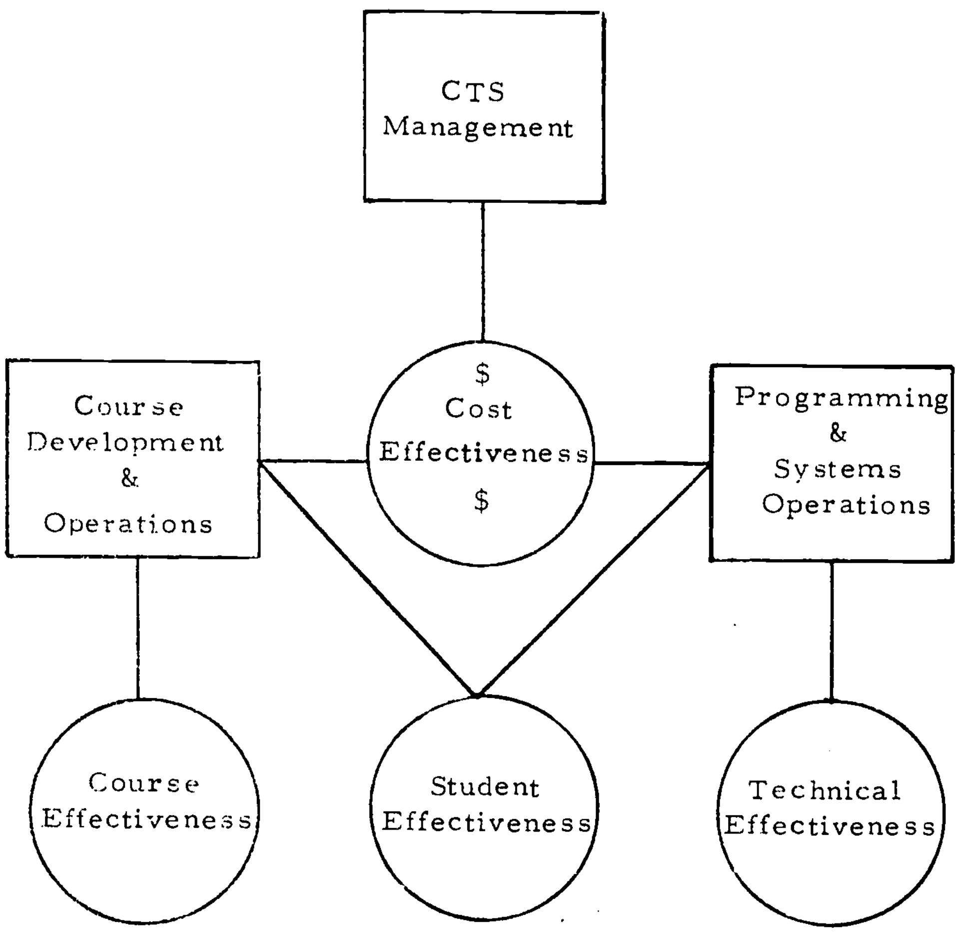

Figure 3

Relationship of Evaluation Areas to CTS Organization

- Course operation (procedures/processing requirements/problems)
- Role of personnel (instructors/IP/IPES) *
- Attitudes toward system (instructors/IP/IPES) *

B. Formative Evaluation

- Author feedback requirements (procedures/reports/problems)
- Data processing support (procedures/problems)

C. Summative Evaluation

- Benchmark appraisal of CTS/baseline data:
  - Completion time
  - Course achievement
  - Course attrition
  - Student attitudes

IV By-Products/Side Effects

A. Technical Effectiveness

- Human factors (radiation/eye fatigue/ambience)
- Other

B. Cost Effectiveness

- Cost benefits
- Other

C. Training Effectiveness

- Course development/operation
- Other

V Heuristic Aspects of CTS Evaluation

A. Technical Considerations

- CPU/media/language
- Interactive/batch processing (CAI/CMI)
- System operation
- Other

*Cf. Glossary: Appendix E.

B. Course Development/Operation Considerations

- Strategies
- Operation
- Contingency management
- Other

VI Summary/Conclusions/Recommendations

6. Schedule of Evaluation Events. The following schedule contains the projected completion dates for the major evaluation events.

Schedule of CTS Evaluation Events

Evaluation Events	Projected Completion Date
o Preliminary Evaluation Plan Submission	9/15/73
. Technical Effectiveness Plan	8/15/73
. Cost Effectiveness Plan	8/15/73
. Training Effectiveness Plan	8/01/73
. Course Development/Operation*	8/01/73
. Formative Evaluation Plan*	1/01/73
. Summative Evaluation Plan*	3/01/73
o External Consultant Group	
. Selection of Consultants	10/15/73
. Contracting of Consultants	2/15/74
. Initial Meeting (Full Board)	3/15/74
. Follow-up Meetings (Team/Individual)	(Variable)
. Final Meeting (Full Board)	8/15/76
o Identify Necessary Evaluation Data*	12/15/73
o Develop Measurement Techniques (questionnaires/procedures)	8/01/74
o Program Evaluation Requirements*	3/01/75
o Baseline Data Collection	5/01/75

*Generalized for 3 Courses.

Evaluation Events	Projected Completion Date
o Conduct Interim Evaluation	1/01/76
o Analyze Data/Draft Final Evaluation Report	8/30/76

The above completion date schedule is necessarily tentative, contingent upon developments within the Course Development/Operation and System Operation/Programming Divisions.

Prior to the final evaluation report, it is anticipated that a series of interim reports will be produced not only by the Evaluation Division but the other CTS divisions as well. Furthermore, administrative and historical events of interest occurring at the management level during the span of the CTS Project will be reported via periodic progress reports and other publications. In this perspective, the CTS evaluation is viewed as only one of several reporting functions of the CTS Product Manager's Office.

7. Consultant Team. In order to obtain added professional expertise an external consultant board will be established. This board will be comprised of 3 teams representing the major evaluation areas of technical, cost and training effectiveness, consisting of eminently qualified individuals drawn from both the civilian and military community. Each team will consist of a chairman and approximately four panel members all of whom will exercise a consultant capacity albeit on different levels.

A tentative selection of the consultant members was accomplished on 15 October 1973. The administrative details of contracting for the consultants is expected to take several months. For this, and other management reasons, the initial meeting with the consultants is planned for approximately March 1974. It is anticipated that both the initial and final meeting will be an appropriate time to have all the consulants rendezvous together at CTS, Fort Monmouth, N. J. At the initial meeting relevant methodological matters will be addressed. These will include: the introduction of consultants and review of their roles and functions; an orientation of CTS describing its nature and status; a tour of the CTS facilities including a demonstration of the CTS hardware/software system; and a review of the preliminary evaluation plan. The final meeting, of course, will consist of a wrap up of the substantive evaluation events.

The frequency and mode of interim interactions with the consultants will be left variable, to be determined by significant developments and the nature of events occurring within the CTS Evaluation Division. Thus, as a minimum average, it is expected that the respective consultants will be engaged on 2 to 4 other occasions during the span of the evaluation depending on the exigencies of the situation. Likewise, the quorum (by board, team, individual) and manner of engagement (at CTS, by proxy) of consultants will be ascertained by the logic of the given circumstances. It is anticipated that the consultants will be employed on a team and individual basis by proxy the major proportion of the time. Full board and individual level consultant meetings will be held on site as the situation warrants. They will provide auxiliary support as needed during the evaluation of CTS.

Technical Effectiveness

In evaluating the technical aspects of the CTS prototype, it is necessary to develop data concerning the technical operation of the prototype hardware, software and their interaction as a system.* The data thus developed will provide a sound basis for recommendations by the Product Manager (PM) to the Department of the Army concerning the adequacy of the prototype technical system, operational configurations, and areas requiring further research and development.

1. Methodology. The technical evaluation will be based on the 128 terminal prototype from which estimates for the mean system (ie., 500 terminals) will be calculated. The technical evaluation will consist of a descriptive summation of hardware/software characteristics, and then a detailed evaluation of the CTS prototype technical system and its individual components as they affect the author/student/instructor relationship. Due to the emphasis on user/system interaction, there are several performance criteria usually examined in a system evaluation which may not be addressed in this report. The prototype system will be examined, from a technical viewpoint, by mode of operation (Interactive Processing/Batch Processing) and area of operation (CAI, CDI, CMI), where possible, rather than technical elements (hardware/software/system). **

Due to the uniqueness of the CTS prototype, no standard benchmark programs exist which can be utilized to evaluate the overall system. For this reason, one objective of this evaluation, if feasible and practical, is to establish such a benchmark program which can be utilized for the operational system. If any Army Standard Programming Languages (ASPL) are utilized, then existing benchmark programs can be used to check out the efficiency of the CTS prototype in these areas.

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*U. S. Army Signal Center and School, "Multi-Mini Computer Training System." Computerized Training System Specification Number S-125-72 which initiated a Request for Proposal (RFP) by the Product Manager, April 1972.

** Cf. Glossary: Appendix E.

The evaluation will focus, primarily, upon the functions of the student, the system and their interaction. The evaluation will include the functions of the instructor, instructional programmer, administration and required batch processing. Where possible, technical data will be identified as occurring during periods of predominately CAI, CDI, or CMI operation.

2. Instruments for Data Collection. Data collection methods to be used are:

a. Observations. This will include, primarily, personal experiences, opinions, and observations by the PM, his staff, the evaluation team, their consultants, and the system/courseware designers. This data will be subjective and may lead to further quantitative data collection.

b. Questionnaires. These will be answered by all operational users of the CTS system (student/instructor/instructional programmer/entry specialist/systems programmer/administrator) on a periodic basis. A typical period might be at the beginning and end of a course for students and every three months for permanent party. The questionnaires will be directed at collecting data on human factors, how the user feels the system is reacting to his needs, and suggested improvements.

c. Internal System Routines (On-Line). This will constitute the benchmark program to determine actual system and individual component efficiency, utilization, adequacy and functional reliability. This program will be developed, if feasible, by the evaluation team in conjunction with the Systems Programming and Operation Division, CTS.

d. Interviews. Key personnel will be interviewed on a periodic basis to solicit opinions, answers to questions, clarifications, and any other data concerning technical performance. Personnel to be interviewed are the PM, his staff, the system/courseware designers, and selected authors/students/instructors/instructional programmers/entry specialists/ system programmers/administrators.

e. Student Performance. Data will be maintained on student performance as this remains the ultimate test of technical adequacy. This data will be examined to determine areas where the technical capabilities or capacity of the system caused identifiable variances in student performance.

3. Data Items and Collection Methodology.

I Interactive Mode:

A. User:

(a) <u>Human Factors</u>:

(1) Does reading of the terminal screen cause eyestrain?

o Method: The data for this point will be collected mainly by questionnaires from the users. It will allow the PM to determine whether the CTS terminal is the one which should be recommended.

(2) Forgetting unfamiliarity with the keyboard, is the terminal comfortable to use?

o Method: (Same as 1).

(3) Are images on the primary and secondary device clear?

o Method: (Same as 1).

(4) Is the carrel design durable and conducive to learning?

o Method: (Same as 1). The student's opinion of this data item is very important. He must remain in this area for approximately six hours per day as long as it takes him to complete the course. Therefore, if the carrel arrangement is not comfortable, it should be designed or reconfigured. This will probably be a continual item of concern, not only for the prototype, but for each operational system. It is yet to be determined whether one configuration would be acceptable for all courses, however, it is felt that each course will require its own configuration.

(5) Do the carrel and terminal designs satisfy existing safety standards concerning radiation, electrical and mechanical hazards?

o Method: This data will be collected by technical inspection and measurement of radiation levels, etc., by knowledgeable personnel qualified in these areas. Their reports will be included in the evaluation.

(b) Primary Device:

(6) What is the time (avg, high, low) to fill the screen with pure textual material?

o Method: The data for this item will be mainly gathered by on-line programs; however, it will also be a question posed on questionnaires to ascertain how people believe the system is operating. The data for this item will be gathered on a sampling basis and stored in matrix form. The timing for this item will begin when the textual material is pulled out of queue and sent down the communication channel and end when the last element of the chain has been reproduced on the screen. This will provide data as to whether the system is fulfilling the performance requirements desired, and also provide data for use in simulations of larger systems.

(7) What is the time (avg, high, low) to fill the screen with pure graphical display?

o Method: (Same as 6)

(8) What is the time (avg, high, low) to fill the screen with a combination of text and graphics?

o Method: (Same as 6)

(c) Secondary Device:

(9) What capabilities and features are included in the secondary device such as audio/visual tape, microfiche, etc.?

o Method: This will be by observation and is for general purpose use.

(10) Is the secondary device convenient, i.e., does the user have to load tapes, etc.?

o Method: (Same as 9)

(11) Is the secondary device computer controlled?

o Method: (Same as 9)

(d) Utilization:

(12) What is the percentage of utilization of the terminal subsystem in CAI mode? In CDI mode? In CMI mode?

o Method: An on-line clock routine will be utilized for this item. Each terminal will be timed for the period that it is active, and the mode designated. This information will provide guidance for operational systems on just how many terminals they need per shift and mode of operation.

(e) Special Training and Documentation;

(13) What individual training is required by the user prior to utilizing the terminal subsystem?

o Method: In order for the system to be effective, the user should not have to spend considerable time learning how he is to interact with the system. This should take very little time and become somewhat second nature to him. Therefore, data for this item will be gathered mainly through the use of questionnaires.

(14) Do adequate training programs and documentation exist for daily operation of the terminal subsystem?

a. Author Training Package

b. Proctor Training Package

c. Systems Programmer Training Package

d. IPES Training Package

e. Administrative Training Package

f. Student Orientation Training Package

g. CTS Demonstration Package

o Method: This will be by observation and is for general purpose use.

(15) What technical expertise is required for instructors, instructional and system programmers and entry specialists prior to training?

o Method: This data will be collected by questionnaire from managerial personnel in their respective areas.

(f) System Response:

(16) What is the time (avg, high, low) required for the CPU to respond to a user query?

o Method: The data for this item will be obtained purely through on-line programs. The timing will begin when the CPU starts to process a query from a user and end when the CPU has fully responded to the query and released it for transmission to the user. This will be accomplished on a sampled basis and will be the cumulative average of the data from number 17 below.

(17) How many of sampled CPU response times fall into the following time slices?

a. 0.0 - 0.5 milliseconds

b. 0.51 - 1.0 milliseconds

c. 1.01 - 1.5 milliseconds

d. 1.51 - 2.0 milliseconds

e. 2.01 - 2.5 milliseconds

f. 2.51 - 3.0 milliseconds

g. 3.01 - 3.5 milliseconds

h. 3.51 - 4.0 milliseconds

i. above 4.01 milliseconds

o Method: The data here, gained by on-line programs, will provide a distribution for CPU response times per user query. This will provide some insight into the percentage of CPU usage by students, and provide data for future simulations. It will also provide the instructional programmer with information as to whether the responses they desire are too long, or too short.

(18) What is the time (avg, high, low) from when a user initiates a query until the system has completely displayed an answer?

o Method: Both on-line program and student questionnaires will be utilized to gain data for this item. This will aid the PM to insure that the system is meeting its performance requirements, and provide authors with information as to whether they are tying the system up too much with the average display, or whether they can enlarge their average displays and expected responses.

B. System:

(a) Response:

(19) How large do queues build in the system in CAI mode? In CDI mode? In CMI mode?

o Method: The data for this item will be obtained by on-line programs. The information will provide insight as to why system response times are anything other than expected values. It will also provide an indication as to whether the system is I/O bound.

(20) Where do queues build in the system in CAI mode? In CDI mode? In CMI mode?

o Method: This will also be obtained by on-line programs. In order to reduce queue length and improve system response time, the system programmer must know where the queues are building.

(21) How long does it take to reduce queues in the system in CAI mode? In CDI mode? In CMI mode?

o Method: On-line programs will provide this information. This item, along with items 19 and 20, will give the system programmers the information they need relative to queuing problems to enable them to take corrective action, if and when queues become a problem.

(b) Utilization:

(22) What is the percentage load on each job processor for purely course work in CAI mode? In CDI mode? In CMI mode?

o Method: This data will be obtained strictly by on-line programs. To obtain this data, it is planned to sample time slices to see what the load on each processor is at that time. This will provide information as to just when additional job processors will have to be added to the system as the number of terminals is increased and the number of courses on line increase.

(23) What is the percentage load on each job processor when both students and authors are on-line in CAI mode? In CDI mode? In CMI mode?

o Method: (Same as 22)

(24) What is the percentage load on each job processor when just authors are on-line in CAI mode? In CDI mode? In CMI mode?

o Method: (Same as 22). The purpose is to see just what actual load the authors place on the system. Here data will be obtained during periods when just authors are on-line.

(25) What is the percentage load on each job processor when students, authors and batch processing is taking place in CAI mode? In CDI mode? In CMI mode?

o Method: (Same as 22)

(26) What is the percentage load on the master processor for the above four items?

o Method: The data for this item will also be obtained by on-line programs, by sampling time slices. The data from this will be utilized to determine just when in the expansion of the system a new master processor will have to be added to the system.

(c) Storage:

(27) How much disc storage does each course occupy?

o Method: This item will also be obtained by on-line programs. The data from this item will provide a good indication as to just how much disc storage a course requires. This will allow the PM to make recommendations as to the number of disc drives needed per course.

(28) How much core does the operating system utilize?

o Method: The data for this item will be provided by an on-line program. This will indicate how much core storage is available for processing.

(29) How much core is available for single user programs?

o Method: The data for this item will be obtained from an on-line program. The core available will be the core that is not required for all other uses. This will allow the programmer of single use programs to know just how much core he has available for use.

(30) How much core does each software system utilize?

o Method: This will be done by on-line routines and will be utilized as information needed before adding to any software system.

(d) Maintenance:

(31) What is the time (avg, high, low) between failures for each hardware piece?

o Method: The data for this item will be maintained on each piece of equipment, and will be gathered by observation and on-line programs. The information from this item will be utilized in determining the reliability of each piece, and the system as a whole.

(32) What is the time (avg, high, low) for repair of each hardware piece?

o Method: Observation will be utilized in gathering this data. It will be utilized to determine reliability of service, and the overall system reliability.

(33) What effect does downtime on each hardware piece have on the overall system capability?

o Method: Observation and questionnaires will be utilized to provide data input for this item. The data obtained here will be utilized to assess the criticality of each piece of hardware on the overall system. It will also provide information as to whether the system can operate, and how efficiently, when a particular piece is down.

(34) What effect does power fluctuation have on the overall system?

o Method: Observations will be used to gather this data and will determine just how stable the system power source must be.

(e) Software:

(35) Is the authoring language capable of handling all course presentation requirements?

a. Does the software support a single track, linear, with branching instructional model?

b. Is branching available and based on the student's prior experience in the field of study and performance in the course?

c. Is remedial branching available and based on the student's performance record?

d. Is recycling under computer control provided at skill, training objective and lesson level?

e. Does the student have the option to recall previous material?

f. Are performance records dynamic and changed under computer control based on the student's responses?

g. Does the system permit a multimedia approach to instruction?

h. Does the system analyze student performance data under computer control and provide feedback to the author for course updating?

o Method: These items will be obtained by questionnaire. This will be a continuous operation to insure that all authoring requirements in course presentation are being met.

(36) Can the courseware be easily updated?

o Method: This will be accomplished by questionnaire. It is useful in determining time and cost required to make additions to the courseware.

(37) Can the authoring language be easily updated?

o Method: Same as number 36 except for CAI language.

(f) Records:

(38) What are the features of the student users, performance and history records and how frequently are they updated?

o Method: This data will be collected by observation and an on-line program to measure frequency of update.

(39) Is there a graduation date and final grade predictor and what is its reliability and validity?

o Method: This data will be collected by observation. Data concerning predicted graduation date and final grade will be documented periodically throughout the course and correlated with the actual graduation date and final grade.

(g) Capability of Expansion:

(40) Can the capacity and capability of the system be expanded or upgraded by additional hardware utilizing the modular concept?

o Method: The data for this item will be obtained from many other data items. This will provide the PM with information as to just how many terminals can be active before additional components must be added to the other subsystems, and the associated time and cost of such expansion.

(41) Can the system software be easily upgraded?

o Method: This will be accomplished by observation and questionnaires. It is useful in determining time and cost required to make software additions.

(h) Efficiency:

(42) What is the number (avg, high, low) of machine instructions generated per line of coding for each software system?

o Method: This will be obtained by observation based on the efficiency of individual compilers and the system's assembler. This is a measure of software efficiency.

(43) How much thrashing is done by the operating system during periods of heavy load?

o Method: This will be accomplished by the use of on-line programs, and will be utilized by system operations personnel. This will indicate just how effective the system resource monitor is for the prototype, and how it should be changed to increase efficiency.

(44) Does the system become input/output bound?

o Method: The data for this item will be obtained from several other data items. It will provide an indication as to where improvements need to be made in the operating system.

(i) Special Training and Documentation:

(45) Do adequate training programs and documentation exist for daily operations of the computer system?

o Method: This will be gathered by observation and questionnaires.

(46) Do adequate training programs and documentation exist for on-site maintenance of the computer system?

o Method: (Same as 45)

(47) Is complete documentation available for all hardware systems?

o Method: (Same as 45)

(48) Is complete documentation available for all software systems?

o Method: (Same as 45)

(j) Environment:

(49) Does the system require unusual amounts, types, and reliability of power?

o Method: (Same as 45)

(50) Does the system require unusual amounts and location restriction of equipment space?

o Method: (Same as 45)

(51) Does the system require unusual amounts and types of environmental control?

o Method: (Same as 45)

II Batch Processing:

A. Utility Programs:

(52) What utility programs are available?

o Method: (Same as 45)

(53) What are their features?

o Method: (Same as 45)

B. Special Programs:

(54) What special programs are required?

o Method: (Same as 45)

(55) What are their purposes?

o Method: (Same as 45)

(56) What are their features?

o Method: (Same as 45)

(57) When and in what quantity are administrative reports processed?

o Method: (Same as 45)

C. Special Features:

(58) Are memory and file protect options available?

o Method: (Same as 45)

(59) What levels of priority are permitted?

o Method: (Same as 45)

(60) What provision is made for a lesson material security access code?

o Method: (Same as 45)

(61) What debugging facilities are available for each language?

o Method: (Same as 45)

(62) Are automatic restart (recovery) procedures available?

o Method: (Same as 45)

(63) What capability exists for the system to continue processing when system components fail?

o Method: (Same as 45)

The above list is not all inclusive, but rather represents a foundation for further evaluation planning. Details as to how each item will be utilized, or where a certain timing operation will begin and end, has not been resolved at this time. The final technical evaluation will ultimately depend upon the prototype system adopted for use with the CTS project.

The main thrust of the technical evaluation will be to determine whether the CTS prototype satisfies, in an efficient manner, the technical requirements of the author, the managerial needs of the instructor and instructional effectiveness for the student. Data items will be collected to indicate how the system actually operates and the impressions of the users (the above and the system programmers) as to how they think it operates. Together, these approaches will provide a broader picture as to the technical suitability of the CTS prototype to the military instructional environment.

Cost Effectiveness

In evaluating the CTS Prototype in the area of cost, it is necessary to develop a cost model which will provide costing information for management and decision making purposes. The cost model must provide data for the preparation of descriptive costs (budget reports/cost accounting), predictive costs (cost analysis/ forecasting), and comparative costs (cost effectiveness/benefits).* The cost evaluation will be primarily summative in nature although several comparative cost measures will be provided to give a broad relationship between CTS cost effectiveness and other instructional methods. Finally, the process will be repeated for each course of instruction adopted for use with the CTS prototype to provide a range of costs for CTS courses with varying modes of lesson presentation.

The modes of presentation referred to in this report are Computer Assisted Instruction (CAI), Computer Directed Instruction (CDI), and Computer Managed Instruction (CMI). Several definitions of these terms exist with many overlapping interpretations; therefore, the following definitions and guidelines will be used in relating costs to a particular mode of presentation.

- <u>CAI mode</u>: is storage of instructional material on-line within the computer system and the computer serves as the instructional medium.

- <u>CDI mode</u>: is a combination of CAI instruction and off-line instruction under the direct and immediate control of the computer. In this mode the student does not sign off the computer.

- <u>CMI mode</u>: is the presentation of lesson material via off-line media under computer management. In this mode the student signs off the computer and leaves the terminal area to receive instruction.

- <u>CMI overhead</u>: consists of those administrative functions such as lesson assignments, test scoring, resource allocation, remedial work and monitoring of student progress which occurs during all three of the above modes of presentation. Accordingly, costs related to CMI overhead will be included in the cost of the above modes of presentation with which they are associated.

It should be noted at this point that the identification of costs by mode of presentation is solely for the purpose of accurately predicting future CTS course costs and not

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*Wilkinson, Gene L. "Needed: Information For Cost Analysis", <u>Educational Technology</u>, July 1972.

for cost comparison of CAI vs CDI vs CMI. Conclusions concerning such a comparison should be avoided due to the fact that such costs are identified only as they can be measured within the CTS environment. No attempt has been made to identify the cost of CAI vs CDI vs CMI as stand alone systems, and it is not the intention of this evaluation to do so.

1. Descriptive Costs. Descriptive costs will categorize cost items for several different areas providing a complete view of the CTS prototype cost. The CTS prototype will be examined in terms of type of cost (capital/developmental/operating), purpose of cost (direct/indirect/non-instructional), and area of cost (CAI/CDI/CMI). The CTS prototype life-cycle cost will be displayed in a manner similar to figure 4.

2. Predictive Costs. Predictive costs will include estimates of a complete CTS system, i.e., a mean terminal number of 500 vs 128 for the prototype; yearly operational cost for follow-on systems; effect on cost of equipment down time; and associated cost for system expansion in upgrading. These costs will be obtained using simulation, regression, and other analytical techniques.

The primary objective for calculating predictive costs is to provide planning data concerning implementation of a fully operational CTS at major TRADOC training centers. Based upon predictive costs provided by the prototype, an estimate for life-cycle costs, figure 5, for each system can be made.

At this time, the extent of an operational CTS as to which training centers, which courses, and desired timing is unknown. Accordingly, it is the intention of this evaluation to develop a model for determination of CTS cost effectiveness at individual TRADOC schools based upon their particular requirements and conditions. The methodology and cost model to be utilized for predicting cost effectiveness is based upon the model developed and reported in CONARC Task Group Report, Computer Assisted Instruction, Vol I, April 1972. This model has been updated and revised to accommodate the data associated with the CTS prototype. (Cf. Appendix D).

3. Comparative Costs. Comparative costs will be identified and calculated to provide a basis for a broad, general comparison of CTS to Conventional Instruction (CI) as will be further discussed in paragraph 6. Several measures of cost effectiveness will be included for future use in comparing CTS to specific instructional systems. Inherent to the calculation and use of the cost effective measures are the following necessary assumptions:

a. Any Instructional Program used in a comparison with CTS must use courses of instruction with similar objectives, content and testing criteria. Calculations made for such a comparison must agree in methods of depreciation, system utilization, etc.

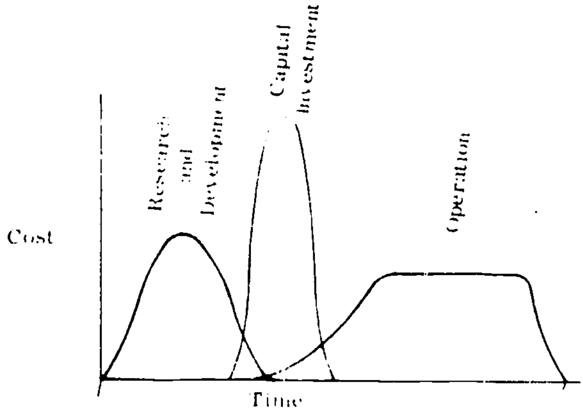


Figure 4
CTS Prototype Life-Cycle Cost

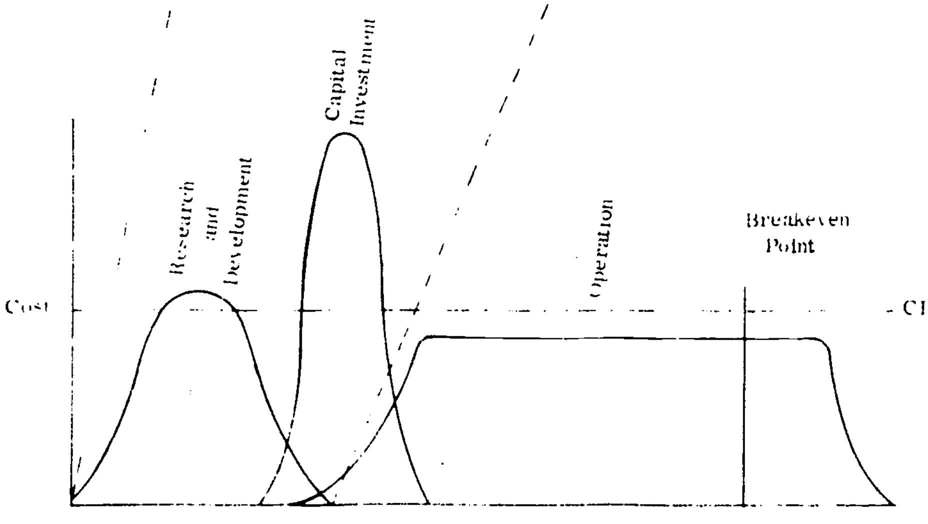


Figure 5
CTS Operational Life-Cycle Cost

b. Time savings cost can be made use of by timely reassignment of the student once he completes a self-paced course. If the student is not reassigned upon completion of the course, this savings cost will be of no value and may actually be a detriment.

c. The life of an instructional program is 3-5 years.

d. Equipment life is 5-10 years.

The measures of cost effectiveness to be used for each course considered may include, but are not restricted to, the following:

o Cost of instruction: The unit of measure is the hourly cost of instruction per student or

(1) $$\frac{\text{monthly cost}}{\text{student contact hours per month}}$$

The monthly cost includes costs relating to hardware, software, course development and administration. Each of these items will include amortized costs, as applicable, pertaining to capital investment, physical plant, training, operation, maintenance, personnel, etc.

o Graduation cost: The unit of measure is the cost to graduate a student calculated on a monthly basis or

(2) (hourly cost of instruction) X (course duration (avg) of graduate)

o Attrition cost: The unit of measure is the cost of instruction expended on a failing student calculated on a monthly basis or

(3) (hourly cost of instruction) X (course duration (avg) of failures)

o Course cost: The unit of measure is the total cost associated with student course termination (graduation and attrition) per month or

(4) (Graduation cost X # Graduates) + (Attrition cost X # failures)

o Time savings cost: The unit of measure is the difference between graduation cost with varied course duration (early or late completion for self-paced) and graduation cost with fixed course duration or

(5) (Graduation cost (lockstep)) - (graduation cost (self-paced))

4. Cost Model. The model to collect and document the cost items to be used in preparation of descriptive, predictive and comparative costs is represented by a three dimensional matrix. In this manner, each cost item may be identified immediately as either a Capital, Developmental, or Operating expenditure in the areas of Direct, Indirect, or Noninstruction, and whether the cost is related to CAI, CDI or CMI, as applicable. The best representation of this matrix would appear as shown in figure 6. In this approach, cumulative cost in any one direction can be easily calculated.

5. Data Items. The general headings for the individual cost items to be documented are shown below.

I Acquisition (Nonrecurring):

A. Hardware Cost:

(a) Master Processor Subsystem:

(1) Equipment List

(2) Site Preparation

(3) Delivery

(4) Installation

(5) Acceptance Testing

(6) Maintenance (Principle Period)

(7) Documentation

(8) Training

(b) Job Processor Subsystem:

(Same)

(c) Terminal Subsystem:

(Same)

(d) Administrative:

(1) Personnel

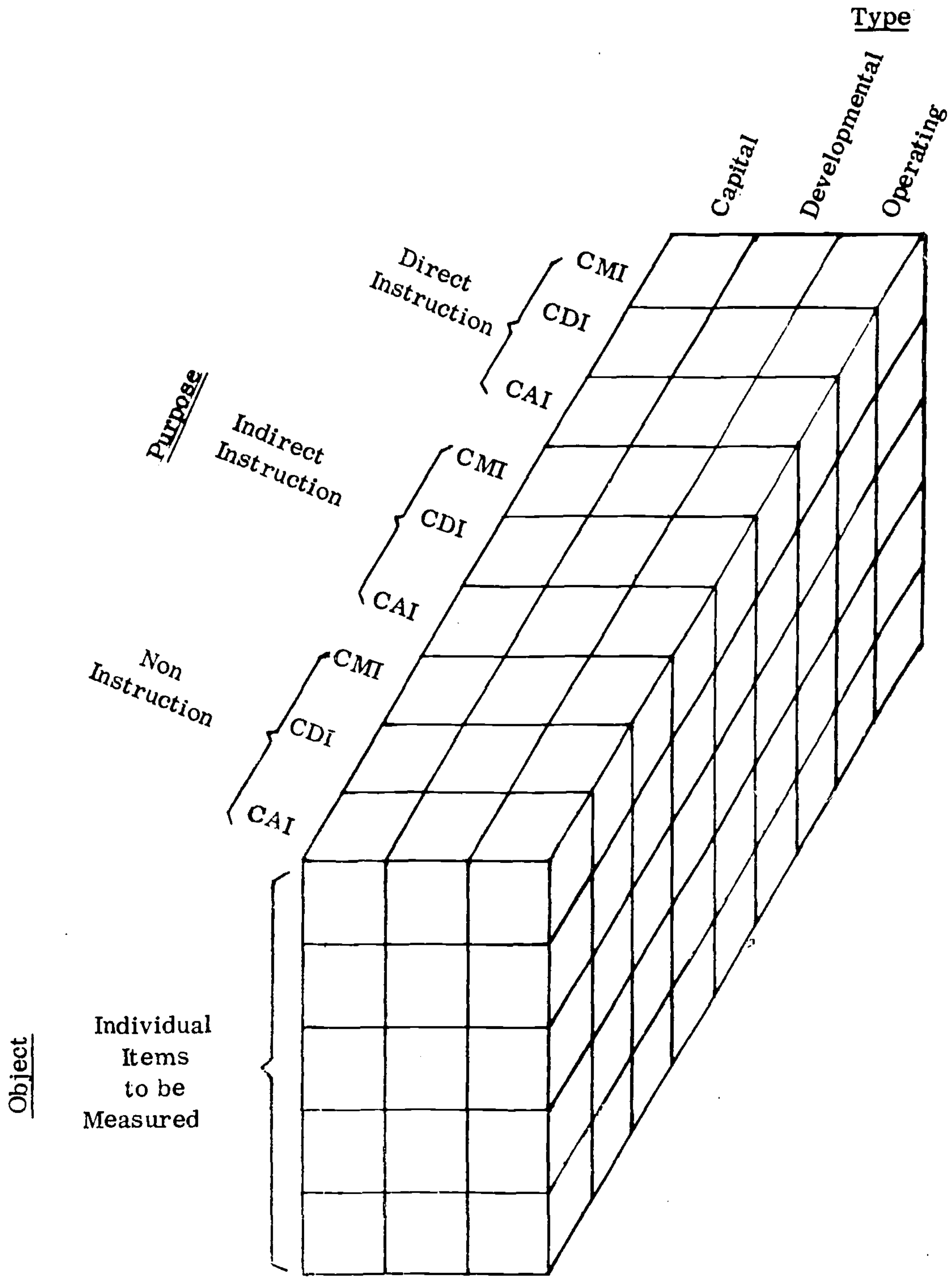


Figure 6

Cost Model For Data Collection

a. Salary

b. Travel

c. Post Support Activities

(2) Operating

(3) Maintenance

(4) Contractuals

(5) Facilities

(6) Miscellaneous

B. Software Cost:

(a) <u>Operating Subsystem</u>:

(1) Development

(2) Delivery

(3) Installation

(4) Acceptance Testing

(5) Maintenance (Principle Period)

(6) Documentation

(7) Training

(b) <u>CMI Subsystem:</u>

(Same)

(c) <u>Courseware Subsystem:</u>

(Same)

(d) Evaluation Subsystem:

(Same)

(e) Other Required Compilers:

(Same)

(f) Administrative:

(1) Personnel

a. Salary

b. Travel

c. Post Support Activities

(2) Operating

(3) Maintenance

(4) Contractuals

(5) Facilities

(6) Miscellaneous

C. Courseware Cost:

(a) Author:

(1) Salary

(2) Additional Training

(3) Operating

(b) IPES:

(Same)

(c) Support:

(1) Training Aids

(Same)

(2) ETV

(Same)

(3) Typing

(Same)

(4) Other

(Same)

(d) Administrative:

(1) Personnel

a. Salary

b. Travel

c. Post Support Activities

(2) Operating

(3) Maintenance

(4) Contractuals

(5) Facilities

(6) Miscellaneous

II Operating and Maintenance (Recurring):

A. Hardware:

(a) Personnel (Supervisors, Operators, Repairmen, etc.):

(1) Salary

(2) Additional Training

(3) Post Support Activities

(4) Travel

(b) Operating

(c) Maintenance

B. Software:

(Same)

C. System:

(Same)

III Other:

A. Upgrading Cost:

(a) Hardware:

(b) Software:

(c) System:

The above list at this time is representative of categories of individual cost items that must be collected. Further detail of cost items is largely dependent upon the system (hardware, software and manner of operation), currently being developed as the CTS prototype. These and other items will be added and further detailed as the system definition becomes finer.

6. Methodology. The cost attributable to CTS will be provided bythe Comptroller on a monthly basis. Individual expenditure documents, to include operating, contractual and other costs, will be maintained at the CTS administrative offices. These costs must then be broken down into the areas mentioned above, by type. For purposes of determining monthly cost, developmental cost will be considered a one-time cost and not part of the operating system. Capital cost and courseware cost will be amortized using the straight-line method of depreciation on a monthly basis and included in monthly cost. Sensitivity of the system to amortization and utilization, figure 7, will be included in the evaluation by providing calculations for equipment amortization of 5 and 10 years, courseware amortization of 3 and 5 years and utilization factors of 6, 12, and 18 hours use per school day.

Inherent to any comparative evaluation is the establishment of a baseline cost to be utilized in the comparison. Two options are available at this time: first, collect cost for each course (CI) which will be tested under the CTS prototype and

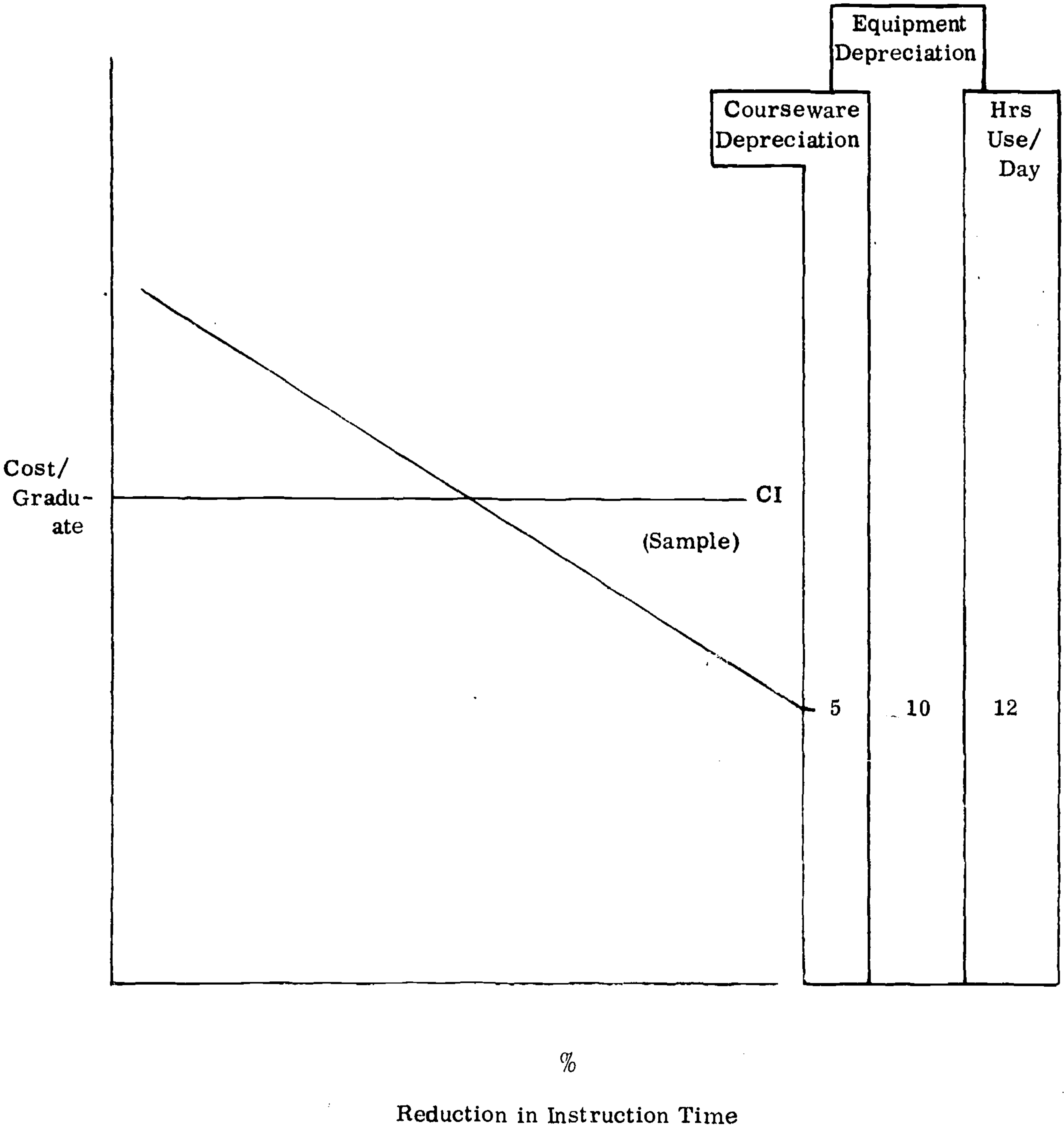


Figure 7

Sensitivity Analysis of Comparative Costs make a one-to-one comparison; or second, obtain a broad, general cost for Conventional Instruction and use this as a baseline cost for showing a general, comparative relationship between CTS and CI. The former is dependent upon what course is used with the CTS prototype and whether sufficient data exists from the CI course for a meaningful one-to-one comparison. If this option is used, baseline data for each course will be collected during a comparable period prior to the CTS operation period. The latter is general in nature and provides a broad feeling for CTS vs CI cost effectiveness. The general approach for comparative evaluation is currently planned anticipating the nonavailability of required data from CI courses for a meaningful test.

This is a preliminary approach to a cost evaluation of the CTS prototype. It will be updated and refined as the plans for the CTS Prototype development, test ana evaluation become more crystallized.

An initial bibliography is provided in a later section of this report as a general overview of the recent literature in the economics of CAI and previous effort by the Army leading to the CTS project.

7. References. (Cf. Bibliography Section: pages 65-66).

Training Effectiveness

The training effectiveness of the CTS Prototype will be evaluated on three separate levels: administrative, formative and summative. The administrative aspect of training effectiveness pertains to the procedures relating to course development and operation. The formative aspect of training effectiveness pertains to the appraisal-debugging-revision phase of course development where course content is honed to meet certain predetermined quality specifications. The summative level of evaluation pertains to the cumulative effectiveness of a given segment or total block/module of course material. The general rationale, procedures and data requirements for these three evaluation levels are outlined below.

A. Administrative Evaluation: Course Development/Operation

1. Course Development. The process of developing lesson material has evolved through a pragmatic trial-error approach to Computer Assisted Instruction (CAI) lesson preparation.

The combination of subject matter expert, instructor, author and some functions of a computer programmer has led to the "one-man" instructional programmer concept. This individual is an expert in his technical training field as well as being an experienced instructor and knowledgeable of some basic language commands in programming instructional material. The "one-man" concept of CAI lesson development procedures has evolved from several years of user development environment rather than a research atmosphere. The pragmatic approach to lesson preparation has delineated a number of skills, knowledges, and responsibilities for individuals tasked to prepare lesson material.

The content of a lesson is determined by the terminal behavior desired in the student. This terminal behavior is guided by the terminal performance objectives derived through systems engineering of training.

The following paragraphs delineate the sequence of steps required to prepare lesson material for computerized presentation. The evaluation will address these topics quantitatively, qualitatively or both, as the event dictates. The aim of the course development evaluation will be to present both a structural and functional description of the CTS course development process. Further, both positive and negative aspects of the entire course development process will be addressed. This inclusive and candid approach will insure adequate and reliable final products (3 courses) for immediate operational use and provide guidelines for developing additional Army technical courses.

I The Instructional Programmer:

A. Instructional Programmer (IP) Resources:

(a) System Engineered Training Objectives:

(1) Terminal Performance Objectives

(2) Enabling Objectives

(3) Skills and Knowledges

(b) Instructional Model

(c) Authoring Language with Macros or Subroutines

B. Preliminary Planning by IP:

(a) Research

(b) Determine Teaching Points

(c) Outline Lesson Sequence

(d) Determine Method, Media and Strategy

C. Lesson Module Development Done Concurrently:

(a) Textual Development and Formatting

(b) Slides and Graphics

(c) Audio

(d) Practical Exercises

(e) Supplemental Material

(1) Information Sheets

(2) Operation Sheets

(3) Equipment Manuals

(4) Programmed Text Booklets

(f) Coding

(g) Training Devices

D. Coordination Time with:

(a) Other Instructional Programmers

(b) Training Aids

(c) Instructional Programmer Entry Specialists (IPES)

(d) Common Basic Electronics Training (COBET) or Other Subject Matter Specialists

(e) System Programmers

E. Review and Revision Time:

(a) Editing and Debugging(On and Off-Line)

(b) Lesson Review at Lesson by IP

(c) Supervisor and Peer Review

(d) Student Trials

(e) Modification and Revision after Student Trials and Implementation

F. Time Spent on Record Maintenance and Updating Documentation

G. Miscellaneous Time:

(a) Meetings and Conferences

(b) Additional Training

(c) Training Other Personnel

(d) Leave Time

H. Miscellaneous Information:

(a) Diary of Significant Events

(b) Instructional Model

(c) Programming Course (POI)

(d) Follow-on Projections

II In-House Support:

A. Instructional Programmer Entry Specialists (IPES):

(a) On-Line Entry

(b) Minor Debugging

B. Typing Support:

(a) Supplement Material

(b) Work Requests

C. Special ADP Support:

(a) Special Coding of Course Material

(b) Student Performance Data for Revision

III External Support:

A. Training Aids:

(a) Training Devices

(b) Illustration

(c) Photography

B. Logistics:

Supplemental Material Reproduction

C. WFM-TV:

Short Video Tapes

D. Subject Matter Specialist (Other)

E. Miscellaneous:

(a) Private Contractors

(b) Consultants

(c) USASCS Staff

2. Data Collection:Procedures/Instruments (Course Development). The following data collection procedures/instruments will be utilized in the evaluation of CTS course development.

a. Off-Line. In order to expedite the collection of both quantitative and qualitative information regarding the basic processes (and problems encountered) of course development a two page form was devised. This form pertains to Instructional Programmer Time (Figure 8) and In-House/External Support Time and Cost (Figure 9). The agent responsible for logging the necessary information will be the instructional programmer. The frequency of his entries as an instructional programmer will be daily; however, entries for in-house/external support time/costs will be periodic according to the circumstances relating to each lesson.

b. On-Line. Besides off-line data collection, real-time data will also be collected on-line pertaining to the instructional programmer and entry specialist. It should be noted that while the instructional programmer focuses his attention to authoring (primarily off-line), testing, editing, and debugging (on-line), the entry specialist is concerned with entering the instructional programmer's work interactively on-line. Data collection procedures for obtaining information on off-line course development were indicated above. Information concerning the on-line aspects of course development regarding both the instructional programmer and the entry specialist will be collected on-line in real time through special software programming. The following information will be collected:

(1) Interactive Instructional Programming:

- Mean #/variability of terminals available for interactive authoring, testing, editing and debugging of interactive displays;

- Mean #/variability of terminals used for authoring, testing, editing, debugging of interactive displays;

INSTRUCTIONAL PROGRAMMER TIME

Page

Name: Date Started:

Date Completed:

Lesson Title:

TASK	Time spent on lesson (Daily/Minutes)						COMMENTS (Pro/Con)
	Mon	Tue	Wed	Thur	Fri	Total	
Preliminary Planning							
Lesson Development							
Record Maintenance							
Document Updating							
Debugging							
Evaluation & Review							
Coordination							
Miscellaneous							
This Wk's Total							
Pre-Sheet Total							
Cum Wk's Total							

Figure 8
Instructional Programmer Time

IN—HOUSE SUPPORT TIME

Name | Lesson Title:
Segment:

TASK	Time spent on lesson (Daily/Minutes)						COMMENTS (Pro/Con)
	Mon	Tue	Wed	Thu	Fri	Total	
IPES							
Typing							
Special ADP							
Miscellaneous							
Total							

EXTERNAL SUPPORT TIME/COST

Facility	Job Number	Date Submit'd	Date Return'd	Charge Time	Cost of Job	COMMENTS (Pro/Con)
Training Aids						
Logistics						
WFM-TV						
Miscellaneous						
Total						

Figure 9
In-house Support Time

- Type of interactive processing performed on interactive displays (initial composition, editing, etc.);

- Mean time/variability to prepare information for input (finalize) during interactive authoring, testing, editing, debugging of instructional material;

- Mean #/variability of terminals used for developing instructional logic;

- Type of interactive processing performed on instructional logic (initial composition, editing, etc.);

- Mean time/variability to prepare for input (finalize) during interactive authoring, testing, editing, debugging of instructional logic.

(2) Interactive Entry Specialist:

- Mean #/variability of terminals available for interactive entry at any given time.

3. Course Operation. Besides course development a second important evaluation aspect from an administrative point of view is course operation. The areas addressed in this section include: (a) a definition of the technical expertise and amount of in-house training required of the various personnel engaged in the operation of the CTS classroom; (b) a thorough scenario of the procedures utilized in the actual operation of the CTS classroom with sample printouts/documentation; (c) an accounting of the problems encountered in the formal operation of the CTS classroom with recommended solutions; and, (d) a parametric assessment of the course operation functions to be supported by CTS. The first three areas will represent a generalized qualitative view of course operation; the last area, a micro-quantitative view. These four perspectives will provide a comprehensive description of the operational aspects of CTS.

The approach to areas "a-c" above will be toward factual description of the personnel status and operational events as they occurred within the conduct of the CTS Prototype. As necessary, appropriate logging forms and procedures will be developed to obtain an accurate account of each of these areas. The approach to area "d" above will consist of a detailed assessment of the instructional processing requirements of CTS. Operationally, the functional areas to be addressed herein are as follows:

I. Interactive Processing

o Student Mode

- o Instructor Mode
- o Administrative Mode

II. Batch Processing

- o Instructor Processing
- o Administrative Processing

Each of these functional areas have a number of parameters of vital interest to those engaged in course development and operation which will be outlined in a succeeding section below. In order to render these functions more operationally meaningful, they will be examined within a tri-dimensional framework encompassing the following independent variables:

I. Lesson Type

- o Conceptual Context
- o Functional Context

II. Mode of Presentation

- o CAI
- o CDI
- o CMI

III. Instructional Method

- o Tutorial
- o Drill and Practice
- o Problem Solving

This interpretative structure of independent variables may be graphically represented as in Figure 10:

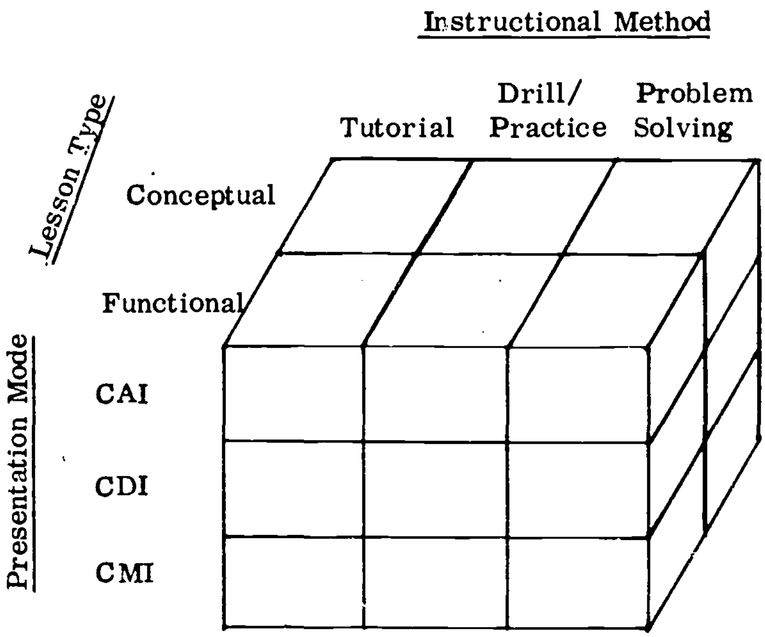


Figure 10
Interpretative Structure for CTS Instructional Processing Requirements

4. Data Collection: Procedures/Instruments (Course Operation). The dependent variables are the lesson parameters to be investigated (cf. below). These are graphically represented as cell data in the above three-dimensional figure. Therefore, data summations within each cell (mean's, variabilities, etc.) will be directly comparable between/among all levels of representation: (a) between lesson types, (b) among presentation modes, and (c) among instructional methods (by collapsing any two dimensions); and, overall, comparisons can be made among lessons themselves (by collapsing all three dimensions).

The lesson parameters of interest are given below:

I. Interactive Processing:

A. Lesson Description:

(a) Lesson Presentation Mode (Designation)

(b) # of Students Concurrently Using Lesson On-Line

(c) # of Interactive Displays Required per Lesson

(d) Type of Questions to be Asked (Multiple Choice/Numeric Constructed/ Alpha-Numeric Constructed)

(e) Mean #/Variability of Alpha-Numeric Characters per Interactive Display

(f) % of Interactive Displays (Graphic)

(g) # of Static (Film) Displays Required

(h) Amount of Audio Required (Minutes): (If Available)

The above parameters will serve to describe the general character of the lesson of instruction across all dimensional perspectives described earlier. The summation of this information across all lessons will describe the general character of the course of instruction. Disproportionate parameters will be identified for follow-on recommendations.

B. Student - Lesson Interaction:

(a) # of Interactive Displays Required per Hour of Instruction (by Aptitude Level)

(b) # of Static (Film) Displays Required per Hour (by Aptitude Level)

(c) Amount of Audio (Minutes) Required per Hour of Instruction

(d) Mean #/Variability of Student Responses per Hour of Instruction

(e) Max. # of Dynamic (Animated) Displays per Hour of Instruction

(f) Max. # of Static Displays per Hour of Instruction

(g) Max. # of Audio Messages per Hour of Instruction (If Available)

(h) Mean Length/Variability (Minutes) of an Audio Message (If Available)

The above parameters will serve to describe how each lesson was utilized by the student across all functional dimensions described earlier. Disproportionate parameters will be identified for follow-on recommendations.

C. Testing and Inquiry:

(a) # of Tests Administered On-Line (Pretest, Posttests, Lesson Tests)

(b) Mean #/Variability of Test Items (by Test Type)

(c) Mean #/Variability of Questions Per On-Line Test

(d) Mean #/Variability of Inquiry Requests Made per Student per Hour of Instruction

The above parameters will serve to define the instructional scenario in quantitative terms. Disproportionate parameters will be identified for follow-on recommendations. Besides the above, a thorough description of the instructional environment will be given which will incl de: course description; types of questions used; manner in which student performance was managed; how tests were administered, etc. Examples of materials, questions, tests, branch procedures, etc., will be given also.

D. Interactive Instructor Mode:

(a) What Instructor Functions will be Performed Interactively (Monitoring of Students as Group/Individually, etc.)?

(b) Will Instructors Interact Directly with Students Through the System? To What End? How Often? For How Long on Average?

(c) Mean #/Variability of Instructor Calls per Lesson, by Student, etc.

The above parameters will also be moderated along the tri-dimensional structure described earlier. The results may serve to assist the formative evaluation during the course development stage; they will serve to define the instructor's operational role.

E. Administrative Inquiry Mode:

(a) Description of the Administrative Function to be Performed Interactively

(b) Description of Administrative/Operational Reports to be Obtained Interactively

(c) Mean #/Variability of CTS Terminals Used for Administrative Purposes

(d) Mean #/Variability of Administrative Inquiries per Lesson

As in previous sections the above parameters/queries will be fractionated along the tri-dimensional structure outlined earlier. This information will serve to describe the general administrative role in the varied categories of computer assisted, computer directed, and computer managed instruction functions of the CTS.

II. Batch Processing: Instructor/Administrative Modes:

A. Description of Types of Jobs Processed:

(a) Instructor Reports (Attendance Rosters/Class Profiles, etc.)

(b) Administrative Reports (Attrition Rate/Graduation Prediction, etc.)

B. Input Files Used:

(a) Type (Card/Disk/Tape)

(b) Contents (Student History, etc.)

(c) Size (# of Records/Record Sizes, etc.)

(d) Output Files Used:

(1) Type

(2) Contents

(3) Size

(e) Job Frequency (Daily/Weekly/etc.)

(f) How Run? (Concurrently with Interactive Processing/Background Job, etc.)

B. Formative Evaluation

The formative evaluation of course material is the internal quality control phase of course development. At some point in course development, each course instructional programmer is faced with the problem of whether his programmed instructional material is suitable for operational use. The use of the reporting capability of the computer is intended to facilitate the instructional programmer's decision making problem regarding the suitability of his product. A paradigm for formative evaluation is as follows:

1. Scenario. Subsequent to the development of an integral segment of CAI material (element/module) to the instructional programmer's preliminary satisfaction, and

its approbation by his peers and supervisor, a live trial run of that material will be conducted to determine its adequacy on a small representative sample of students. Through its reporting capability, the computer will provide a statistical summation of predetermined performance indices (by individual by group by aptitude level, etc.) on the representative sample. These summary reports will be obtained as a batch job on demand and provided to the instructional programmer. The instructional programmer will review the diagnostic information, which will include student comments as well, and make such course revisions as are indicated. This formative process normally occurs prior to course implementation, but does not preclude subsequent periodic course revision during operational conditions.

2. Data Processing/Instructional Programming Requirements. In order to accomplish the formative evaluation, two data processing steps having two corresponding instructional programmer activities are envisioned: The interface and sequence of data processing/course authoring procedures are as follows:

a. Initial Data Processing: During the student trial run, a student performance record is obtained on predetermined parameters (cf. section 3 below). This performance record is extracted and placed on a master tape. These performance records are addressable by means of an ep (enter/process) identifier which again, by predetermined convention, provides an index to any number of crucial variables (e.g. course name, student #, module #, element #, type of response, etc.). Thus, every student response of interest (e.g., prover frame/lesson test responses) will be recorded and stored; and, upon demand request, will be retrieved and sorted. Initially, the following data items are processed and provided to the respective instructional programmers:

(1) All student comments (extract/print).

(2) All unanticipated responses (extract/print).

b. Initial Instructional Programmer Analysis: The instructional programmer will initially review the student comments and make instructional revisions as necessary. Further, he will review the unanticipated answer list marking them correct/wrong as appropriate. If other answers are afforded by this review, he will check (X) those responses to be added to the response repertoire as alternate right/wrong answers. The instructional programmer will then update the course master tape in accordance with the indicated course revisions and the unanticipated responses. This initial data processing/authoring analysis is conducted either prior to (i.e. on short instructional segments) or in conjunction with the advanced course revision cycle (i.e. on relatively large and complete instructional segments), as discussed below, contingent on what the instructional programmer considers to be the most expedient for his given material.

c. Secondary Data Processing: In accordance with established minimum authoring needs and the constraints of time available for course revision, the following data processing reports will be made available to the instructional programmers and course instructors respectively:

(1) Item Aptitude (I-A) response matrix.

(2) Item Student (I-S) response matrix.

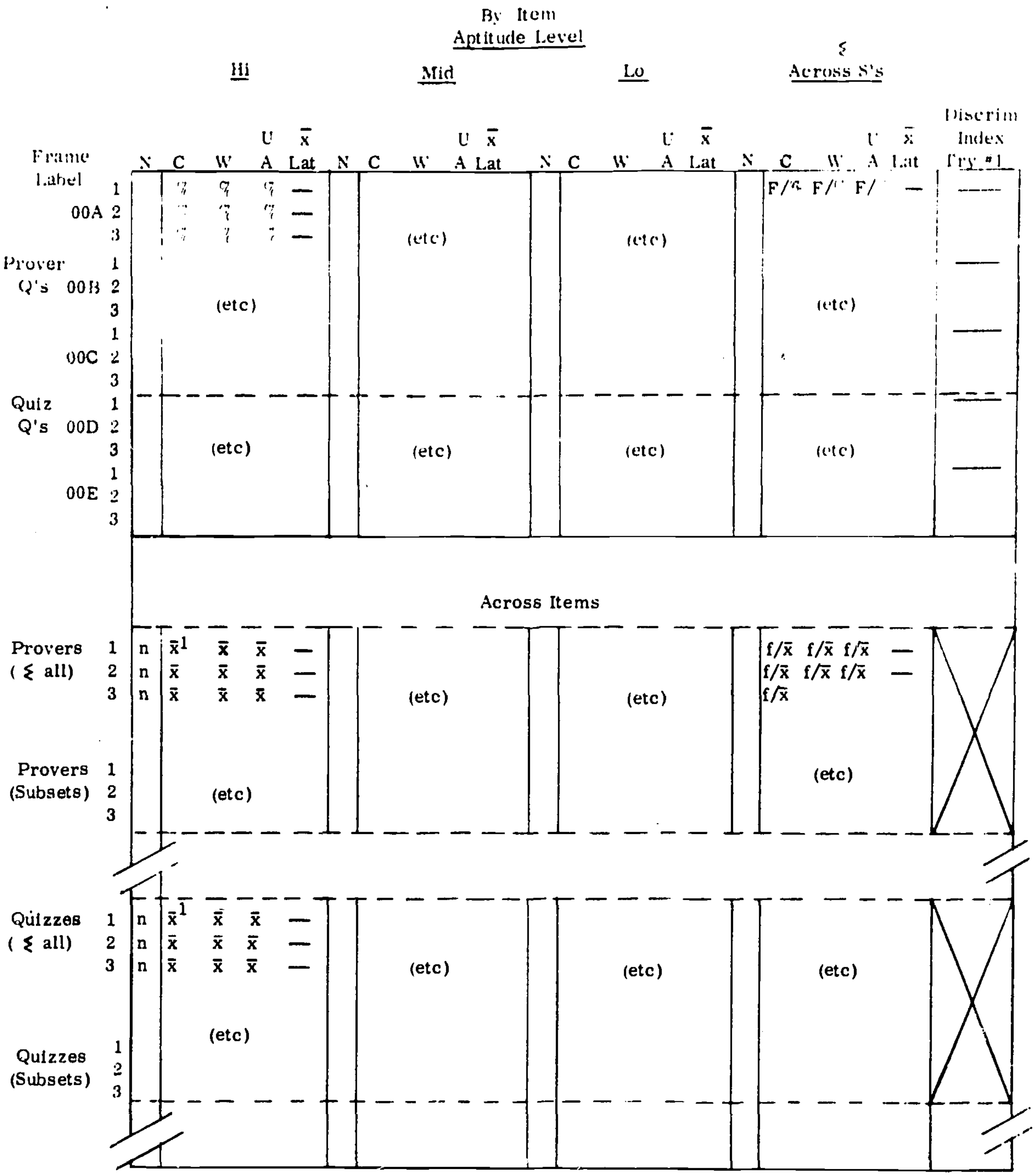
A sample of each report is illustrated in Figures 11/12.

The I-A response matrix is intended primarily for the instructional programmer whose main concern is with group performance (during course development) on the instructional material. In contrast, the I-S response matrix is more appropriate for the CTS course instructor whose main interest will be with individual performance under operational conditions. During the instructional development phase, however, both documents can be generated. Their value for purposes of course revision is considered to be complementary by describing the effectiveness of course material in terms of group (general) as well as individual (specific) performance.

By means of the ep identifier, the instructional programmer can define which block(s) of instructional material he wishes to assess. This can range from a subelement to the entire course of material. However, expediency suggests that an intermediate complete segment of material (module/several elements) will provide the best basis for student trials and diagnostic author appraisal. At any rate, it is understood that if more than one perspective of instructional material is desired (e.g., course, phase, module, element, subelement), a separate printout of Figs. 11/12 for each level is required. From a diagnostician's point of view, this would be prohibitive. Figures 11/12 are designed, therefore, to provide the most desired information with the least number of reports.

d. Secondary Instructional Programmer Analysis: Upon review of the I-A (and I-S if desired) response report, the instructional programmer will ascertain which frames and/or areas of the instructional material need revision. By design the I-A reports will provide select information on student responses which will be organized as follows:

- By aptitude level (hi/mid/lo)
- Across aptitude levels (cumulative)
- By type of frame (prover/quiz)
- Across frames (cumulative)
- By try (1st/2nd/3rd)
- By instructional segment (subelement/element/module/phase)



F = Frequency of S's
f = Frequency of items
N = # of S's who attempted item

n = # of items attempted
UA = Unanticipated
$^1\bar{x}$ = Mean % = $\frac{\Sigma \%}{n}$

1, 2, 3 → Try #

Figure 11

Item - Aptitude (I-A) Response Matrix
(For Instructional Programmer)

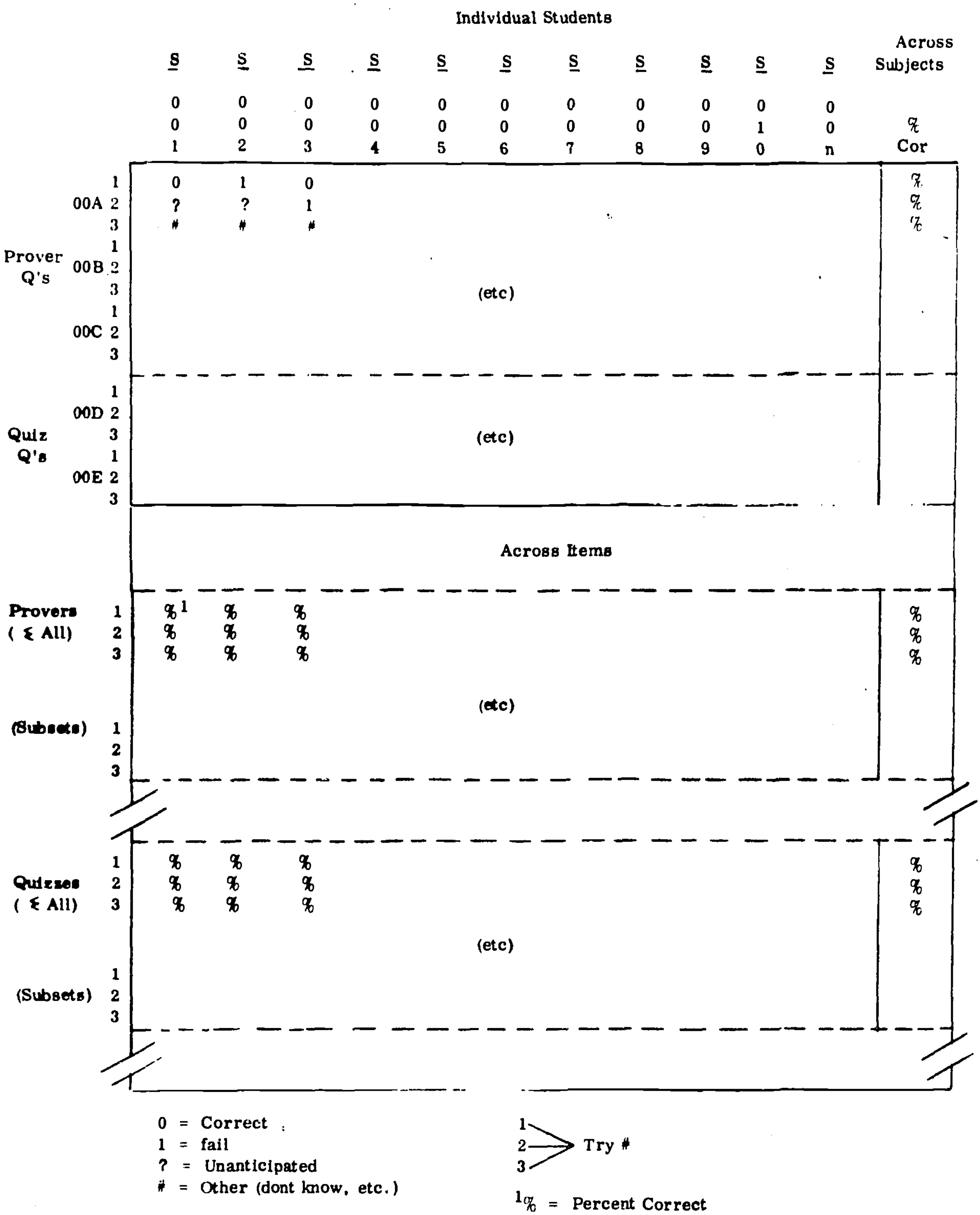


Figure 12

Item-Student (I-S) Response Matrix
(For Instructor)

The select information will include:

- Percentage of correct/wrong/unanticipated responses
- Frequencies of correct/wrong/unanticipated responses
- Mean ($\bar{X}$) response latency
- N's for number of S's responding
- n's for number of frames responded to
- Item discrimination indices (biserial coefficients)

Many intuitive and inferential conclusions can be drawn directly from the I-A response matrix, such as:

- Which terminal performance objectives are not attained
- Which aptitude level needs more attention
- Which prover frames are too: difficult/easy/invalid
- Which elements/subelements need revision
- Which quiz items are too: difficult/easy/invalid
- Which lessons are not yielding sufficient mastery
- Etc.

Each instructional programmer's personal acquaintance with his own instructional material will dictate the appropriate prescription for those weak/problem areas exposed by the I-A matrix.

3. Basic Data Requirements. The data requirements are as follows:

a. Background data (to be defined).

b. Course data:

- Course name
- Date
- Time of day
- Student #
- EP identifier (part of course/type of item/etc.)
- R identifier (correct/wrong/unanticipated)
- Latency time
- Self report ($<$30 words)
- Counters (all contents)
- Switches (all contents)

C. Summative Evaluation

In consonance with the CTS Management Plan, the CTS Evaluation Division will conduct Phase V of the general development plan (Appendix A). As indicated in the plan, "This phase will be conducted by the Product Manager concurrently with Phase IV (CTS operation) and is concerned with the feasibility and effectiveness of the entire system". With respect to training effectiveness, this requires that the evaluation be summative (in-breadth), as well as formative (in-depth).

The summative evaluation is concerned with the overall effectiveness of an integral block of course material relative to several independent criteria. In contrast with the formative evaluation, which represents a process evaluation directed toward insuring the internal reliability/validity of course material, the summative evaluation is a product evaluation oriented towards demonstrating external reliability/validity of course material in relation to other presentations of the same course material. For decision-making purposes, the formative evaluation results will be primarily most useful to the in-house cadre of instructional programmers for course quality control purposes; whereas, the summative evaluation results will be primarily most useful to higher management personnel interested in the global aspects of training effectiveness for follow-on implications. The capability of the computer for statistical analyses will assist the evaluation division in deriving the necessary descriptive and inferential statistics to assess the summative adequacy of the CTS. Such analyses will be conducted on a background batch job basis. A paradigm for the summative evaluation is given below.

1. Scenario. Three representative Army electronics courses are being considered for the CTS prototype evaluation. The CTS Course Development Division will program these three courses for CTS presentation, utilizing both CAI and CMI techniques. During the interval designated on the CTS Time Phase Plan, the CTS Evaluation Division will conduct a formal summative evaluation of the programmed material. In accordance with standard evaluation procedure, random representative samples of students will be selected from each of the three prototype courses to take the CTS and non-CTS instructional material. The performance of the two counterpart student samples will be compared on several accepted measures of achievement including: written and performance scores, academic setback/failure rates, and time to complete training. Attitudes toward CTS will be obtained from a variety of subgroup consumers.

From a summative training perspective, the crucial hypothesis to be assessed concerns the basic reliability and validity of the CTS to do what is expected of it: train Army technicians to a degree equal to or better than on-going operational instruction, and in less time. In order to perform this assessment, the evaluation will specifically inquire to what extent the above dependent measures vary as a function of differences in two basic independent variables: training method and aptitude level. As a by-product of the statistical design, the interaction effects of these variables will be examined as well. Baseline statistics (means, variances, etc) will provide the necessary parameteric and descriptive information regarding the performance of the two study groups; and, inferential statistics (F, t, X^2, etc) will provide the necessary information concerning the reliability of any differences obtained between the respective training methods and aptitude levels. These findings will provide higher management with additional information regarding the effectiveness level of CTS and the directional emphasis to be taken to insure optimum follow-on implementation.

2. Summative Evaluation Requirements. In order to perform the summative training evaluation, a standard evaluation format will be employed. The format specifications may be summarized under the following categories:

- o Objectives
- o Variables/Measures
- o Subjects
- o Instruments
- o Procedures
- o Evaluation Design
- o Decision-Making Process

A description of each category is given below:

A. Objectives: The basic objectives of the summative training evaluation (for each of the 3 CTS Prototype courses respectively are as follows:

(a) Determine baseline parameters for CTS for each of the three CTS prototype courses on select training effectiveness criteria;

(b) Compare student achievement as taught by CTS/non-CTS modes of instruction on select training effectiveness criteria;

(c) Compare student achievement among 3 aptitude levels on select training criteria;

(d) Assess the extent of interaction between instructional methods and aptitude levels;

(e) Survey student attitudes toward CTS and relate student attitudes to achievement;

(f) Determine relationship between student entry characteristics (aptitude/skills) and in-training achievement with final training performance;

(g) Survey administrative personnel (instructor/staff-faculty) attitudes toward CTS.

B. Variables/Measures: The basic training variables to be investigated (in each of the 3 CTS Prototype courses respectively) are sub-divided into two classes, independent and dependent, as follows:

(a) Independent Variables:

(1) Instructional Methods (Systems)

- CTS
- Non-CTS

(2) Aptitude Level:

- High
- Middle
- Low

(b) Dependent Variables:

(1) Achievement Measures:	Type Criteria Continuous	Categorical
. Module Scores	Writ/Perf	Acad Failures
. Phase Scores	Writ/Perf	Acad Failures
. Course Scores	Writ/Perf	Acad Failures

(2) Completion Time Measures:	CI	CTS
. Course #1:	Self-Paced	Self-Paced
. Course #2:	Self-Paced	Self-Paced
. Course #3:	Self- Paced	Self-Paced

(3) Attitude/Opinion Measures:

- Student Attitudes/Opinions
  - Course Content
  - Instructional Methods/Modes
  - Instructional Media
  - Individualization
  - Training Conditions
  - Other
- Instructor Attitudes/Opinions
  - All of above
  - Acceptance of CTS/Non-CTS
  - Instructor Role (Problems)
  - Instructor-Student Relationship
  - Other
- Staff-Faculty Attitude/Opinions
  - Acceptance of CTS/Non-CTS
  - Faculty Role (Problems)
  - Faculty-Instructor-Student Relationships
  - Required Staff-Faculty Changes
  - Other

(c) Matching Variable:

It is tentatively planned that a separate regression equation (Pearson Product Moment) be derived for the following courses for group matching purposes:

(1) Course #1

(2) Course #2

(3) Course #3

The equation variables, and their raw score "b" coefficients, will be derived from a correlation matrix of the Army Classification Battery subtests and the respective course criterion measures. A modified solution to the correlation matrix (Wherry-Doolittle/F-max test) will be used to select the minimum number of variables to yield the maximum multiple R^2 (variance explained). The criterion variable will be final course achievement.

C. Subjects: The student samples for the summative evaluation will be selected at random from the normal inputs of draftees and Regular Army students to the three respective study courses. A minimum N of 100 per instructional method will be targeted. Similarly, a representative sample of instructors and other administrative support will be selected from the pool of available personnel to assess their attitudes toward CTS course development/operation/administration.

D. Instruments: The following instruments will be employed:

(a) Achievement Tests: In order to obtain the desired specificity in the assessment of student achievement, in-house designed tests relating to the assigned instructional material will be employed. This includes tests addressing both the written and performance aspects of training. Emphasis will be put on the use of parallel forms of all tests in both the study and control groups within each course to safeguard the integrity of the instruments.

(b) Completion Time: Measures of time to complete training will be made available for the CTS subjects via the computer time clocking system and bookkeeping procedures as necessary; and, for the non-CTS subjects via summation of assigned POI hours of training plus bookkeeping of all other relevant training time (setback time, etc).

(c) Attitude Questionnaires: Attitudes toward CTS will be solicited from three sources (students, instructors and other staff administrators). The attitudes of these subgroups will be measured, as appropriate, via specially prepared data gathering instruments and techniques. These will primarily involve the direct questionnaire approach. The attitude questionnaires will consist of both Likert type items as well as open ended items which elicit free expression of opinion and are amenable to content analysis.

(d) Attrition Incidence: Incidence of academic pass/fail will be obtained via administrative records. Separate accounting of administrative types of attrition will be made as well.

(e) Achievement Prediction: An expectancy of student achievement will be obtained by means of empirically derived equations based on the least squares principle of regression.

(f) Graduation Prediction: Both least squares regression and actuarial prediction of student success/failure and time to complete the training will be derived.

E. General Procedures: The required statistical information on the summative study variables cited above will be collected in two stages: (1) baseline and (2) operational. It is anticipated that baseline data will be collected during a period preceding the operational use of CTS. This set of data will represent the basic control information for the summative evaluation of CTS. The baseline group will represent a much larger pool of non-CTS subjects relative to the CTS subject pool to be obtained during the operational phase of the CTS Project. This will insure maximum representation of student participation in the two methods of instruction. As a minimum, it is expected that the training conditions for the baseline control group for each course of instruction will be kept free of major administrative-instructional modifications to insure the integrity of the normative baseline data. By the same token, intrusions into the control group training atmosphere by the evaluation personnel will be avoided as much as possible. The basic source of control group data will be the administrative records maintained by the respective study courses.

The operational CTS data will be collected in three separate courses. It is anticipated that these three courses will be phased in sequentially for summative evaluation as they are programmed and subjected to an iterative formative evaluation process. In keeping with the effort to automate the CTS as much as possible, the summative achievement testing for the courses will be administered and scored on line. On the other hand, because many items will be open-ended and for other administrative reasons, attitude measures of students, instructors and faculty will be obtained off-line. As indicated for the control group, an overriding consideration during the operational phase of the CTS will be to insure, as much as possible, that the training milieu is truly representative of a real-time operational situation, unimpeded by experimental or administrative intrusions and manipulations. This will minimize such artifacts as the Hawthorne/novelty/social approval effects, and enhance the generality of the results for follow-on implications.

F. Evaluation Design: The paradigm for the summative training evaluation will basically consist of two independent variables and four dependent variables for each of the respective courses under study. The independent variables will be: training method (CTS vs non-CTS) and aptitude level (hi/mid/lo). The dependent variables will be: achievement (written/performance), time to complete instruction, attrition rate and attitude toward CAI. While the formal evaluation will operate essentially within a quasi-experimental framework, utilizing both controlled assessment and independent-dependent variable procedures, naturalistic observation techniques will also be employed where appropriate.

Except for attrition and attitude measures, which reflect an ordinal level of scaling, all the achievement and time measures will be assumed to have attained the interval scaling level. In order to test the reliability of the obtained differences between the various treatment statistics (means, variances, percentages, etc.), classical tests of statistical significance will be employed. Variations in design and scaling assumptions will dictate the use of either a parametric or non-parametric test of significance. Three separate types of statistical tests will be utilized relative to the scaling nature of the dependent variable in question and the purpose of the test: analysis of variance (ANOVA), t test and chi square (X^2). It is anticipated that the ANOVA design will consist of a fixed effects model employing a two way treatment by levels paradigm (for achievement/time to complete measures); the t tests will be based on two equivalent group models, matching by pairs or group means as appropriate (again, for achievement/time to complete measures); and the chi square test for proportions (for correlated/uncorrelated samples) will be used on the attrition and attitude measures.

As the logic of the circumstances dictate, the CTS and non-CTS groups will be matched either pairwise on the basis of the derived matching variable (optimized predicted achievement) or as equivalent groups on the basis of their obtained means/ variabilities. Further, in keeping with the emphasis noted above to maintain a realistic operational milieu, group matching will be accomplished "after the fact" by statistical (analysis of convariance) or random sample selection techniques as the logic of the situation dictates. Both of these classical matching techniques provide the most efficient administrative approaches to the conduct of matched group designs in an operational training milieu (i.e. maximum matched groups with minimum/no interference in the on-going training process). These procedures are consistent with the basic emphasis of the evaluation as indicated above, to maintain the operational realism of all variables during the formal study period.

G. Decision-Making Process: A statistical analysis and interpretation of the summative training data will be conducted upon their acquisition. The usual level of statistical significance (.01/.05) will be established as decision criteria with the former level offering more conclusive evidence in rejecting the null hypotheses. The statistical tests of significance, of course, will provide valuable information to the decision-making process regarding the summative training merits per se of CTS.

From a larger perspective, however, the merit of the CTS as a viable training system will be contingent upon a multidimensional (triangular) decision-making process which will concurrently take under advisement technical and cost considerations as well as its training aspects. How these three dimensions are to be weighed will depend on what apriori value system (assumptions) and personal probabilities are adopted. On the one hand, from a student end-product point of view, the tridimensional construct may best be represented by an isosceles triangle: assign more concern to the training aspect (long baseline) relative to the cost and technical aspects (short sides). However, in the "long run", the reliability and validity of the CTS as a viable training system will be limited both by the effectiveness of its technical components (hardware and software) and its cost effectiveness (i.e. approximates an equilateral construct). Thus, ultimately, the final value judgement of the CTS will be a convergent process representing an integration of divergent sources of information relating to its cost, technical and training effectiveness. The evaluation effort will endeavor to provide a fortiori empirical evidence (both pro and con) to assist in this decision-making process. The evaluation information of itself will not represent the total basis for judgement but will contribute substantially to arriving at a realistic minimax appraisal (expected gain-loss) of CTS.

By-Products - Side Effects

The CTS evaluation will endavor to be oriented not only toward predetermined objectives (i.e. goal-based) but attentive to significant by-products and side effects (goal-free) as well. These will include unanticipated aspects of CTS (both positive and negative) resulting from direct experience with the Prototype course development/ operation and system development/operation. The analysis of these operational by-products/side effects will be structured along the same dimensions as the basic evaluation plan itself: technical, cost and training effectiveness. Feedback of the necessary information will be accomplished by a variety of administrative instruments and procedures, including: CTS periodic fact sheets, logging forms (as discussed in the Technical and Training Effectiveness sections above), and questionnaires. The findings of this section will enhance the thoroughness of the evaluation and contribute substantially to the practicality of the CTS Prototype effort for potential follow-through implementation.

Heuristic Implications

Besides yielding answers and solutions to given questions, it is anticipated that the CTS evaluation will discover, a posteriori, other critical matters relating to the development and operation of the Computerized Training System which will require further consideration and resolution. The nature and criticality of these new problems can, of course, only be determined through an operational run of CTS itself since it has no existing replicate as yet. While the CTS evaluation will endeavor to identify the major problems to be encountered in the real-time operation of a completely self-paced computerized training system, it would be presumptious to suggest that it will experimentally investigate and resolve all such problems in the same time frame (one year) as the operational run of CTS itself. Therefore, it will encumbent on the second generation of CTS to investigate the identified problem areas through manipulation and control of the appropriate independent variables and other standard evaluation procedures. The problem areas encountered will bc classified and discussed in accordance with the technical and course development/operation aspects of CTS. Besides identification of potential problem areas for future investigation, the final report will endeavor to provide a generalized evaluation plan for their investigation and resolution.

Summary/Conclusions/Recommendations

The evaluation findings will be summarized in this section and will emphasize specific conclusions and recommendations. This will include a synthesis of the technical, cost and training results as they impact on the development and operation of a computerized training system and its follow-on implementation in the U. S. Army.

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In preparation of the preliminary evaluation plan, a number of professional research and evaluation writings were reviewed. A select sampling of these writings is presented below. This literature is subdivided into six broad evaluation categories: Technical, Cost, Course Development/Operation, Formative, Summative, and Educational Evaluation/Issues. This listing reflects the complexity and manifold ramifications of the CTS evaluation effort.

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Appendices A - D

APPENDIX A

PRODUCT MANAGER CHARTER

(REVISED)

PROTOTYPE COMPUTERIZED TRAINING SYSTEM

US ARMY TRAINING AND DOCTRINE COMMAND

1. DESIGNATION OF PRODUCT MANAGER

Colonel G. B. Howard is designated US Army Training and Doctrine Command (TRADOC) Product Manager for the Prototype Computerized Training System effective 1 July 1973. The Product Manager reports to the Commander, US Army Training and Doctrine Command. This charter will be reviewed annually on its anniversary date by the Product Manager to insure currency and adequacy.

II. MISSION

Colonel G. B. Howard is responsible for the program management of the Prototype Computerized Training System in accordance with DOD Directive 5000.1, AR70-17, AMCR 11-16, and other pertinent regulations.

III. AUTHORITY

The Product Manager is delegated full line authority by the Commander, US Army Training and Doctrine Command and is responsible for the planning, direction, and control of the allocation and utilization of all resources authorized for the execution of the approved program. This includes, as applicable, definition, development, testing, procurement, production, distribution and logistical support. Further, he is responsible for assuring that planning is accomplished and implemented by the organizations responsible for the complementary functions of evaluation, logistics and maintenance support, personnel training, operational testing activation and deployment of the system. The Product Manager is supported by the offices and organizations identified in paragraph VI.b for execution of specifically assigned tasks.

IV. ASSIGNED RDTE PROJECTS AND TASKS

The Army RDTE funding will be provided directly to the Product Manager through an Intra-Army order for reimbursable services (DA Form 2544).

V. OTHER ASSIGNED PROGRAM TASKS OR ITEMS

The Product Manager is responsible for overall management of:

a. PEMA program for his assigned system.

b. OMA as assigned.

c. Other tasks when assigned by the Commander, US Army Training and Doctrine Command.

VI. INTERFACES AND PARTICIPATING ORGANIZATIONS

a. Interfaces:

(1) Office of the Secretary of Defense

(2) Department of the Army

(3) US Army Training and Doctrine Command

(4) Human Resources Research Organization

(5) Department of the Navy

(6) Department of the Air Force

(7) US Marine Corps

b. Participating Organizations

(1) US Army Training and Doctrine Command

(2) Department of the Army

(3) US Army Training and Doctrine Command

(4) Human Resources Research Organization

(5) Other schools and activities within TRADOC as applicable

(6) Contractors

(7) Consultants

VII. COMMUNICATIONS CHANNELS

The Product Manager is authorized direct communications between his office, participating organizations and organizations with which he has interface.

VIII. RESOURCE CONTROL

Army resources approved to accomplish the mission will be provided to the Product Manager through Headquarters, US Army Training and Doctrine Command and the host US Army activity/installation. (See exception in para IV.)

IX. LOCATION AND ADMINISTRATIVE SUPPORT

a. The Product Manager's office is presently located at the US Army Signal Center and School, Fort Monmouth, New Jersey. Necessary facilities and administrative support will be provided by that organization, while the Product Manager is a tenant at that activity.

b. Upon approval of the Commander, US Army Training and Doctrine Command, field offices may be established by the Product Manager, as required, without change of Charter. Necessary facilities and administrative support will be provided as mutually agreed.

X. SPECIAL EXEMPTIONS

None

XI. SPECIAL DELEGATIONS

None

APPROVED (Signed) Gruenther DATE 2 Nov 73

Appendix B

Prototype Computerized Training System

Management Plan

1. Purpose

The purpose of this plan is to delineate the Army command and control channels and procedures to be followed for the design, hardware-software development, course development, operation and evaluation of a prototype Computerized Training System (CTS) to be accomplished by the Office of the Product Manager. The responsibilities and interrelationships of the organizations and agencies participating in the Prototype CTS project are illustrated for guidance of all concerned.

2. Background

As a result of CAI Task Group Report recommendations, CONARC directed the implementation of a CAI Prototype System (CONARC letter, ATIT-STM, 29 June 1972, Subject: Computer Assisted Instruction Prototype Program Implementation). The recommendations intiiating the prototype included the use of an integrated CAI-CMI system, use of minicomputers for the central system, and the use of the system for a variety of course types.

3. Management Concept

a. Organizations and Agencies. The following are the primary organizations and agencies which will contribute to the CTS Project.

(1) Product Manager (PM), Computerized Training System, US Army Training and Doctrine Command (TRADOC).

(2) US Army Training and Doctrine Command (TRADOC) (to include TRADOC schools).

(3) US Army Signal Center and School (USASCS).

(4) US Army Southeastern Signal School (USASESS).

(5) Chief of Research and Development (CRD).

(6) Steering Advisory Group (SAG).

(7) DA, Management Information Systems Directorate (DA, MISD).

(8) Deputy Chief of Staff for Personnel (DCSPER).

(9) DA, Computer Systems Support & Evaluation Command (DA, CSSEC).

(10) Contractors: Multi Minicomputer System (MMS); Acceptance Testing; Evaluation; and others, as required.

(11) Consultants.

b. Responsibilities.

(1) The Product Manager (PM) has the overall responsibility for the accomplishment of the mission as set forth in the Charter; to design, develop, implement, and evaluate a CTS. The PM shall recommend the type of system and courses, produce or coordinate production of the required instructional programs and management procedures, and supervise the implementation of the selected courses on a scale which will provide a valid evaluation. All coordination with other concerned agencies and organizations will ensue from the PM.

(2) TRADOC will provide guidance in the form of approval of the plans and progress of the project as submitted thru direct channels and the SAG. TRADOC will provide the courses required by the CTS based upon the recommendation of the PM. Funding of the administrative and personnel requirements of the project will be provided by TRADOC through HQ, USASCS with OMA funds. Funding for the procurement of the hardware/software system will be provided for by Army RDTE and OMA funding as specified in paragraph IV and VIII of the Product Manager Charter.

(3) The host activity/installation, presently HQ, USASCS, will provide administrative and logistics support to the PM. Funds will be provided to the host activity/installation for the management and expenditure by the PM. TRADOC will authorize the personnel required by the PM through the commander of the host activity/installation, presently Cdr., USASCS. The Comdt., USASESS will monitor and support all courses involved in the operational phase of the CTS for the PM. The Office of the Product Manager will be initially located at USASCS. The CTS prototype site will be located at USASESS for the purpose of a valid test and evaluation.

(4) The SAG will monitor the CTS Project for the Department of the Army.

(5) HQ, DA, MISD will review areas of interest within the CTS project and furnish membership on the SAG. DA, CSSEC will provide support to the PM in contracting, as required.

(6) HQ, DA, DCSPER will ensure that personnel procedures are established to adequately support the CTS Project.

(7) Future contractors involved with the CTS will provide:

(a) Hardware/software system.

(b) Secondary display device.

(c) Other services as required.

(8) Consultants will be utilized as required in the CTS preparation of the final evaluation plan for the project.

c. Procedures:

The basic relationships of the PM and SAG are defined. The PM has total responsibility and control of the CTS Project based upon directives from DA and TRADOC. The SAG is the reviewing and coordination group which monitors the project for DA.

4. DA Steering Advisory Group

a. The Group will meet at a time and place designated by the Chairman. The Product Manager as Executive Secretary of the Group is responsible for preparing a draft agenda, notifying members of meetings, preparing and distributing minutes of meetings, and insuring that actions required as a result of meetings are taken.

b. The functions of the SAG are:

(1) Monitoring the progress of the Prototype CTS Project for the Department of the Army.

(2) Providing a mechanism for coordination, exchange of information and review of the Prototype CTS Project by all interested parties.

(3) Exercising control over functional requirements and technical characteristics of the prototype CTS.

c. Membership on the Steering Advisory Group is as follows:

(1) Director of Army Research - Chairman

(2) Prototype CTS Product Manager - Executive Secretary

(3) DA, MISD

(4) DA, DCSPER

(5) DA, OCRD

(6) TRADOC

(7) USASCS

(8) USASESS

5. General Development Plan

a. This project is divided into five functional phases as outlined below:

Phase I - System Specification. This phase has been accomplished by the PM. This phase ran through 18 April 1973 when the Request for Proposals (RFP) was released.

Phase II - System Development. This is to be accomplished by a future contractor and will end eighteen months after contract award. Delivery will be phased as specified in the RFP.

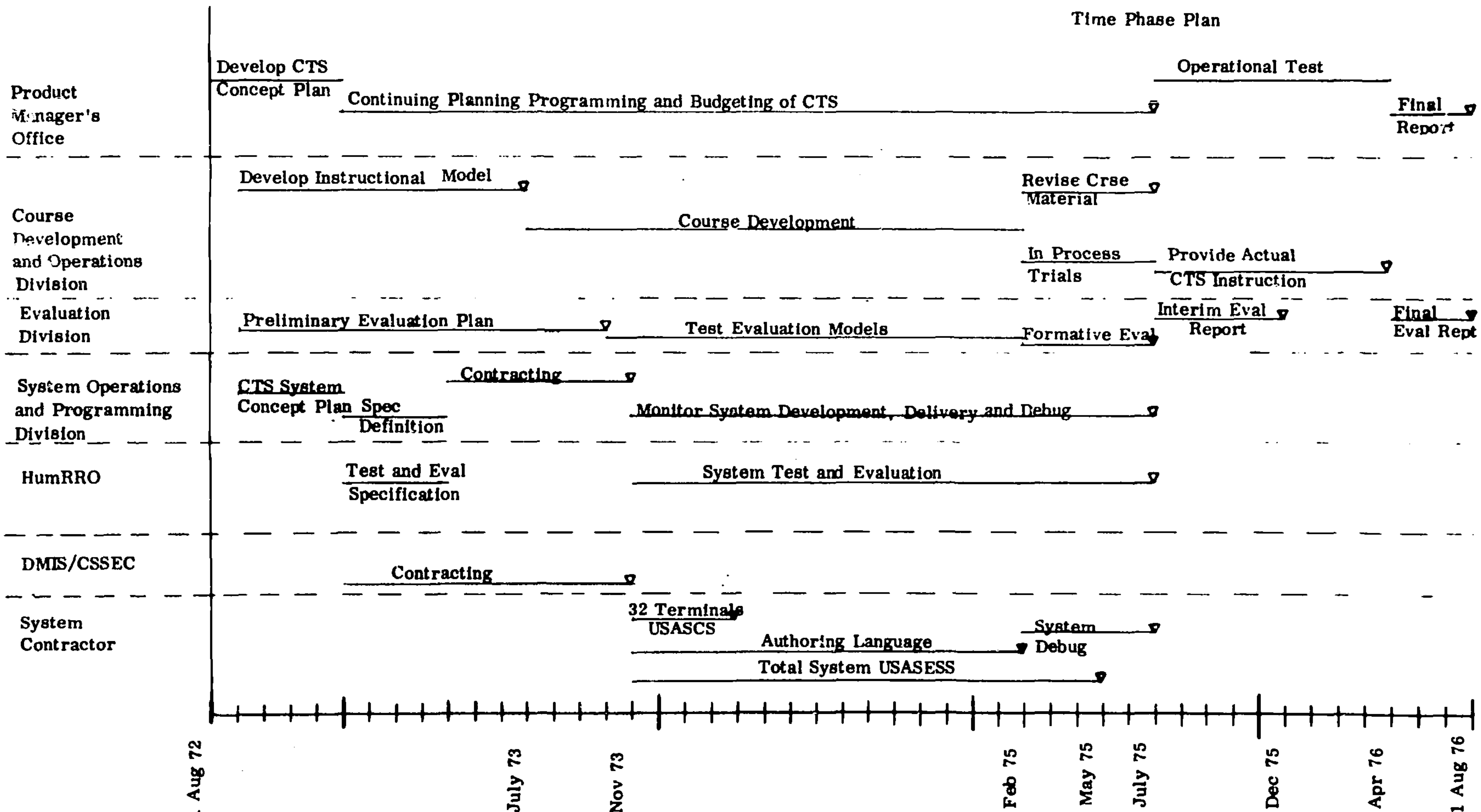
Phase III - Course Development. This phase will run concurrently with Phase I and II and will be accomplished by the PM.

Phase IV - CTS Operation. This phase is concerned with the preliminary testing and evaluation of the prototype CTS to include student trials. The operation of the one year prototype test and evaluation of the CTS and student performance will follow. This phase commences in the thirty-third month and runs through the forty-fifth.

Phase V - CTS Evaluation. This phase will be conducted by the PM concurrently with Phase IV and is concerned with the feasibility and effectiveness of the entire system. This phase will start in month thirty-three and conclude in month forty-eight. A final report will be prepared at the conclusion of the evaluation phase to include recommendations for future actions. Consultants/contractors will be utilized in evaluation as appropriate.

b. The time frames presented in this plan are required for project completion to meet a 1 August 1976 deadline.

OFFICE OF THE PRODUCT MANAGER
COMPUTERIZED TRAINING SYSTEM
FORT MONMOUTH, NEW JERSEY



Appendix C
CTS Time Phase Plan

TAB 1 to Appendix D: Operational CTS Time Phase Plan (Preliminary)

1. General. The process of life-cycle costing is predicated upon the time phasing of events throughout the life of the system. Periods of amortization, discounting techniques, recurring costs are all dependent upon when the cost occurs and for how long. Accordingly, estimates will be made concerning the time phasing of major life-cycle costs (developmental, investment, operational) based upon data obtained during the CTS prototype testing.

2. Time Phase Activities. The activities that must be accomplished as part of the operational life of the CTS are shown in figure D1-1. As this is a preliminary plan, exact timing of activities are not known. The exact timing and critical path relationships will be determined after the prototype testing period. The specific activities anticipated at this time are as follows:

(a) Acquisition Process:

(1) GFSR Approval
(2) Staff Organization
(3) Develop DFSR
(4) DFSR Approval
(5) Product Master Plan Dev & Approval
(6) Prepare System Specifications
(7) RFP and Vendor Reply
(8) Evaluate Proposals
(9) Contract Negotiations
(10) System Delivery and Installation

(b) Manpower Planning:

(11) Initial Manpower Plan
(12) Organize and Finalize Plan
(13) Acquire Initial Staff
(14) Acquire Additional Staff

(c) Facilities:

(15) Determine Plant Requirements
(16) Approve and Coordinate New Construction
(17) Plant Remodeling
(18) Classroom and Outside Plant Installation and Test

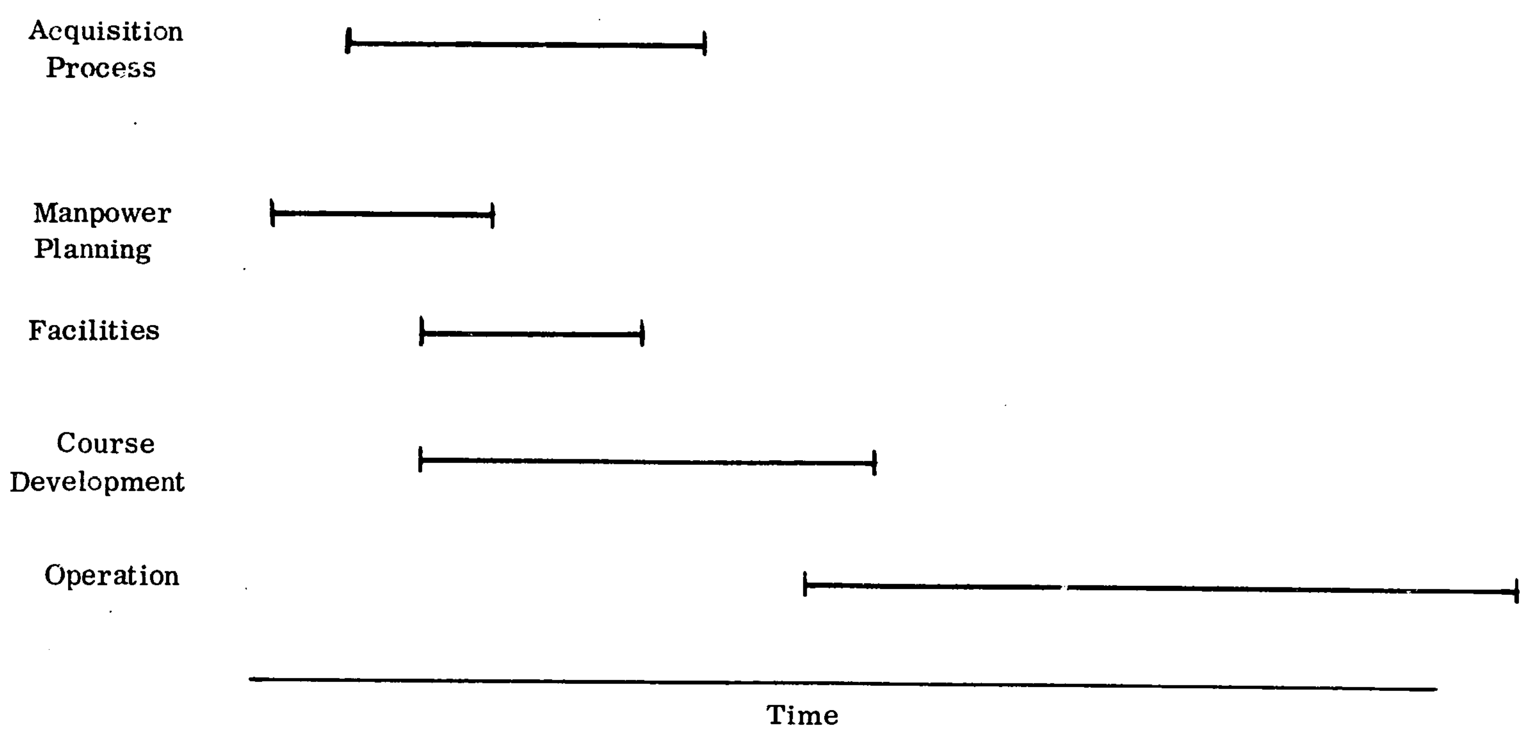


Figure D1-1

Operational CTS Time Phase Plan (Preliminary)

(d) Course Development:

(19) Specialized Training for Authors
(20) Structure Course Content
(21) Develop Off-line Course Material
(22) Off-line Coding of Lessons
(23) Finalize Lessons
(24) Enter and Debug Lessons
(25) Student Trials and Debugging

(e) Operation:

(26) Operation with Course Evaluation and Updating

3. Summary. Based upon the above events and when they occur the time phase plan will become input data for the operational CTS Cost-Effective Model (TAB 2). The time phase plan will also provide a time frame for the life-cycle operational CTS for future planning consideration.

TAB 2 to Appendix D: Operational CTS Cost-Effective Model

1. General. A CONARC Task Group, in their April 1972 report on Computer Assisted Instruction, developed a computerized cost model for predicting operational life-cycle costs for CI and CAI at selected CONARC schools. The model was programmed and run at Fort Monmouth, NJ and the results included in the Task Group Report. For purposes of predicting the life-cycle cost of an operational CTS and comparing it to existing CI costs, the model has been reviewed, updated and will provide the basis for the CTS cost-effective model.

2. Assumptions:

a. The results of the CTS prototype project concerning anticipated percent reduction in training time, percent utilization of student terminals, and equal or better student effectiveness remain valid for technical training throughout TRADOC.

b. The flow of students into the courses will be evenly distributed throughout the year so that the number of student terminals will not have to be increased to handle peak student loads, nor will student terminals be idle during the slack periods.

c. Yearly student input will remain constant for the life-cycle of the CTS operational system.

d. Funds will be available to acquire all required equipment and personnel at the proper time.

e. Students will be effectively utilized upon completion of their self-paced course.

f. The operational life of a CTS is 10 years.

3. Inputs:

a. Data required by the model will be provided by selected TRADOC schools concerning general school data and specific course data. The remaining data will be provided by the CTS evaluation team and will be based upon results of the CTS prototype testing.

b. Data items by type and origin are as follows:

A. External:

(a) School Data:

(1) Average Classroom Size
(2) Classroom Remodeling Cost
(3) Computer Room Remodeling Cost
(4) Average Distance from Computer to Terminal
(5) Administrative Area
(6) Administrative Remodeling Cost
(7) Cost of Any New Buildings or Existing Amortization
(8) Utility and Maintenance Factor for Buildings
(9) Civilian Staff, Existing
(10) Military Staff, Existing

(b) Course Data:

(11) Student Input
(12) Modal Grade
(13) POI Hrs per Course
(14) Hours of Course Development per POI Hours
(15) Number of Shifts per Day
(16) Number of Hours per Shift
(17) Number of Days per Week
(18) Number of Weeks per Year
(19) Modal Grade of Course Authors
(20) Modal Grade of Course Instructors
(21) Number of Course Authors Required
(22) Number of Instructors Required
(23) Night Shift Operation
(24) Training Equipment Costs
(25) Training Equipment Maintenance Factor
(26) Training Aids Cost
(27) Course Attrition and Recycle Rates
(28) Number of PE Hours per Course

B. Internal:

(a) Prototype:

(29) Terminal Utilization
(30) Reduction in Training Time Due to CTS
(31) Reduction in Attrition Due to CTS
(32) Time Phase Plan
(33) Carrel Cost
(34) Terminal Cost
(35) Hardware/Software Cost
(36) Terminal Maintenance Cost Factor

(37) Hardware/Software Maintenance Cost Factor
(38) Ratio of Staff Terminals/Student Terminals
(39) Carrel Size
(40) Cost per Ft of Outside Plant (CPU to Terminals)
(41) Author Hours Required per CAI/CDI Hour of Course Development
(42) " " " " CMI " " " "
(43) Support " " " CAI/CDI " " " "
(44) " " " " CMI " " " "
(45) Optimal Number of Instructors per 50 Terminals
(46) Optimal Number of CMI Instructors per 50 Terminals
(47) Military Staff Requirements
(48) Civilian Staff Requirements

(b) Other:

(49) Civilian Pay Table
(50) Military Pay Table
(51) Present Value Table

4. Cost Estimating Relationships:

a. A Cost Estimating Relationship (CER) is a function of various input and other CER. Figure D2-1, CTS and CI cost flow, indicates the input of data items from paragraph 3 and the flow through various CER terminating in major subsystems as indicated by capital letters.

b. The following lists the CER for CTS and CI operational costs. The letters of Column A, B and C refer to Figure D2-1, and the numbers of Column B and C refer to the input data listed in paragraph 3.

A. Factors to be Computed	as a function of	B. CTS	Inputs and Other CER	C. CI
a.		(b., 12, 50)		same
b.		(11, 13, 27, 30, 31)		same
c.		(6, 7)		(7)
d.		(11, 13, 24, 30)		(24)
e.		(13, 28, 32, 41, 42)		(13, 14, 28)
f.		(13, 28, 32, 43, 44)		(13, 14, 28)
g.		(5, 8)		same
h.		(e., 19, 49, 50)		same

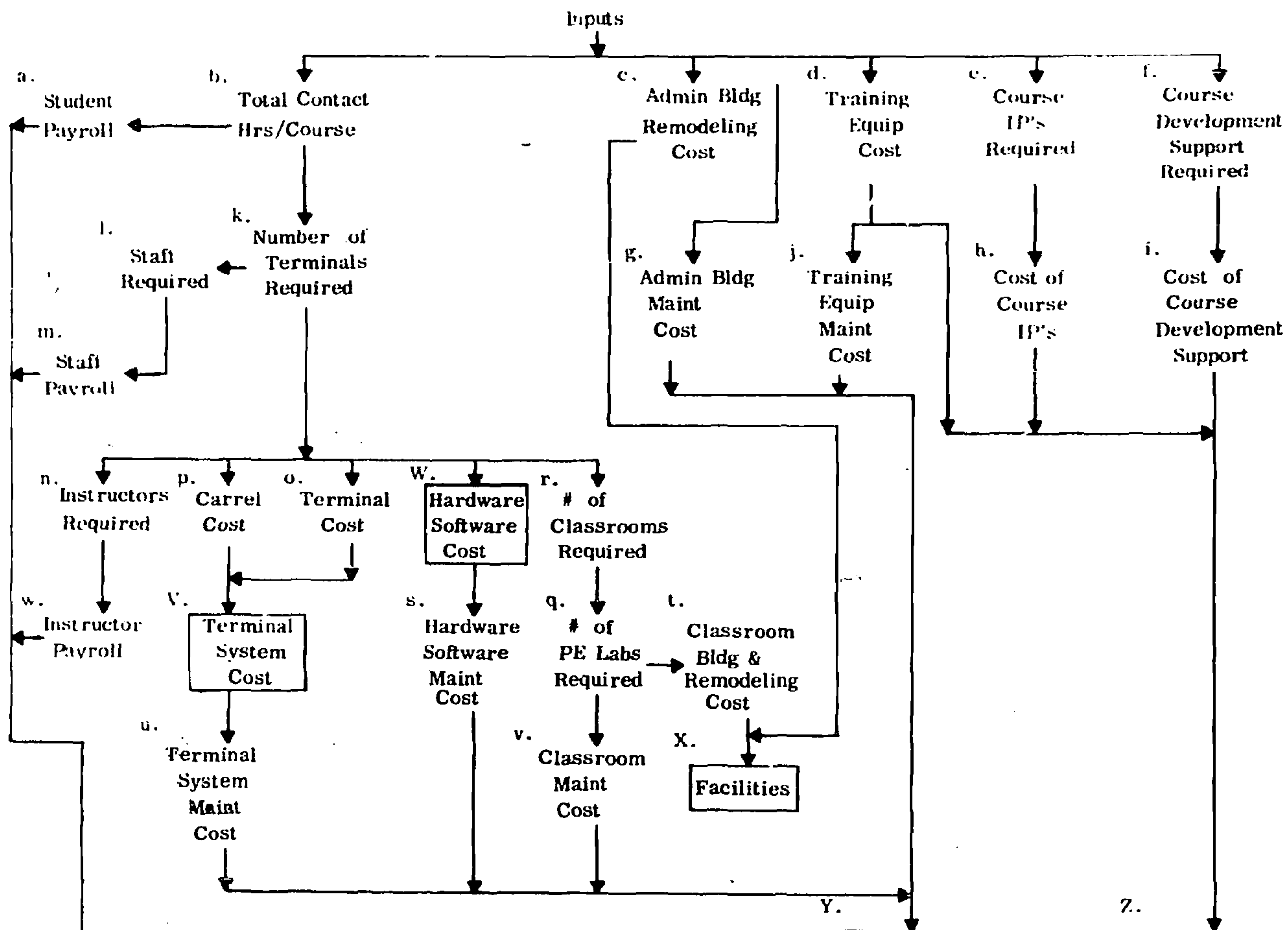


Figure D2-1

Operational CTS Cost Flow

A. Factors to be Computed	as a function of	B. CTS	Inputs and other CER	C. CI
i.		(f., 26, 47, 48, 49, 50)		same
j.		(d, 25)		same
k.		(b, 15, 16, 17, 18, 29, 38)		N/A
l.		(k, 9, 10, 16, 23, 32, 47, 48)		(b., 9, 10)
m.		(1., 49, 50)		same
n.		(k, 23, 45, 46)		(b., 22)
o.		(k., 4, 34)		N/A
p.		(k., 33)		N/A
q.		(r., 13, 28)		same
r.		(k., 1, 23, 39)		(b., 1, 23)
s.		(W., 37)		N/A
t.		(r., q., 2, 7)		(r., q., 7)
u.		(V., 36)		N/A
v.		(r., q., 1, 8)		same
w.		(n., 49, 50)		same
U.		(a., m., w)		same
V.		(o., p.)		N/A
W.		(k., 35)		N/A
X.		(e., t., 3)		(c., t.)
Y.		(g., j., s., u., v.)		(g., j., v.)
Z.		(d., h., i.)		same

5. Output. The operational CTS Cost Effective model will perform the calculations as indicated above and then summarize the data for output. The output will include life-cycle costs for each course, school and representative TRADOC operational system for a CTS and CI environment. Based on the time phase plan of TAB 1, the model will include transition cost from CI to CTS, total system cost discounted yearly at an appropriate discount rate, break even points, and cost per POI hour. Where appropriate and practical, a sensitivity analysis will be made concerning items such as varying student input, discount rates, etc.

6. Summary. The operational CTS Cost Effective Model provides information relative to TRADOC decisions concerning what courses and schools will have a CTS capability, and to what extent, based on cost effectiveness and a realistic estimate of the life-cycle cost for an operational TRADOC CTS.

Appendix E

Glossary

This glossary is provided to define the use of terms within the context of this report.

- CTS: Computerized Training System. The integration of the computer into a totally self-paced training system. In a CTS, the computer serves as a teaching medium (via its peripheral display terminals), a surrogate instructor, a classroom management tool, and as well as performing many school administrative functions associated with training.

- CAI: Computer Assisted Instruction. The use of the computer as a multiple instructional mode teaching medium, functioning interactively with the student, providing him with lesson material and evaluating his interaction with the lesson material. The lesson material and teaching logic is stored within the computer memory.

- CDI: Computer Directed Instruction. The interactive use of the computer as an adjunct to and a director of other media of instruction. In this mode, the computer is used to interact periodically to check the student's progress and provide remediation of needed, and further directions on how to proceed.

- CMI: Computer Managed Instruction. The use of the computer as a classroom management tool. In this mode, the computer is used to grade tests, prescribe remedial work, prescribe lessons to be studied, designate media to be used, schedule equipment and media, and monitor student progress.

- Instructional Method: General method by which instructional material is organized and developed for teaching to include: tutorial, drill and practice, simulation and gaming, problem solving and others.

- Presentation Mode: Specific mode of presenting/conducting instructional material to include: CAI, CDI, CMI (defined above).

- Lesson Type: General characteristic of instructional material indicating its theoretical versus practical orientation to include: conceptual and functional lesson types.

- Instructional Model: A specific set of instructional strategies (cf. below) structure the interactive process between the individual student and the subject matter.

- o Instructional Strategies: Decision mechanism that allows for selection from alternative plans of instruction the one that hopefully will lead to an optimal performance level. This decision mechanism involves the characteristics of the learner, the structure of the curriculum material being developed, the behavioral processes being utilized by the student, as well as the student's coping behavior that results in maximizing his rewards and minimizing his efforts.

- o Instructional Programmer: The individual responsible for developing lessons for CTS. The instructional programmer's duties under the "one man concept" in a CTS encompass the following: authoring of lesson text, both for on and off-line presentation; preparation of the computer coding essential to the execution of the on-line lesson material; testing, debugging and editing the lessons; and design and development of associated graphics and training devices.

- o Display: The presentation of text and graphics on the display device using contiguous display commands which is limited to a single screen presentation.

- o Frame: A component in the instructional process. A frame will contain one or more displays, e.g., a Skill Frame will consist of a message display, a question display, and the remediation and reinforcement displays.

- o Student Terminal: A configuration of input and output devices and their environment which have been human-engineered for use by a student in a CAI/CMI application.

- o Technical Training: A course which results in the award of a Military Occupational Specialty (MOS) and/or an Additional Skill Identification (ASI) in which the major portion of training is devoted to the development of hard skills associated with the installation and maintenance of equipment.