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ABSTRACT

Strategies for instruction in performance oriented tasks were developed in three phases. Phase one was the preparation of appropriate strategies for a performance-oriented technician course. This phase (determination of current course status, current strategies, relevant characteristics of students and instructors, the course environment, and innovative strategies) emphasized innovative uses of training techniques with attention to know course problem areas. In Phase Two, the 56 strategies generated during the first phase were assigned to one of nine application groups (student selection and career field introduction, cognitive skill instruction, individual manual skills, team training, evaluation, incentive management, games, course development, and miscellaneous), and five strategies were selected for development for the course. During Phase Three, the feasibility of using the five different strategies was demonstrated by developers in brief oral presentations and illustrations with the materials. (Author/SH)

AFHRL-TR-72-74

AIR FORCE

HUMAN RESOURCES LABORATORY

INSTRUCTIONAL STRATEGIES FOR A PERFORMANCE ORIENTED TECHNICIAN COURSE

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March 1973

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS

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FOREWORD

The study reported here is a portion of the preliminary work for development of the Advanced Instructional System (AIS). It was performed under Project 11930B, Advanced Instructional System. The study was performed for the Technical Training Division, Lowry Air Force Base, Colorado. The Project Scientist was Mr. Joseph Y. Yasutake, and the Technical Monitor was Dr. Edgar A. Smith. Applied Science Associates, Inc. performed the work under Contract F33615-71-C-1908. Mr. William J. Pieper was the Project Director.

Substantial contributions were made to the study by the cooperation and assistance of the administrators, instructors, and students of the Weapons Mechanic Course (TAC), 3ABR-46230-2. Their efforts are greatly appreciated.

This technical report has been reviewed and approved.

Harold E. Fischer, Colonel, USAF
Commander

ABSTRACT

A study was initiated to devise innovative instructional strategies to be used in a performance oriented technical training course. The strategies devised were student centered and applicable for self-pacing in a proposed computer based Advanced Instructional System (AIS). A detailed examination was made of the current course, concentrating on course content, instructional strategies, student characteristics, instructor characteristics, and course administration. Strategies were then generated based on data gathered during the course analysis. Of the 56 strategies generated, 5 were chosen for detailed development and demonstration of their feasibility in the current Weapons Mechanic (TAC) Course. An evaluation of selected strategies will be performed in the near future.

SUMMARY

Pieper, W. J., Foss, F. C., & Smith E. A., INSTRUCTIONAL STRATEGIES FOR A PERFORMANCE ORIENTED TECHNICIAN COURSE. AFHRL-TR-72- 74. Lowry AFB, Colo: Technical Training Division, Air Force Human Resources Laboratory, March 1973.

Problem

The objective of this program was to devise innovative instructional strategies to be used in a performance oriented technical training course that includes team performance of tasks. The strategies devised were student centered and applicable for self-pacing in a proposed computer based Advanced Instructional System (AIS).

Approach

A detailed examination was made of the current course, concentrating on course content, instructional strategies, student characteristics, and course administration. Fifty-six strategies were generated based on data gathered during this analysis.

Results

Of the 56 strategies generated, 5 were chosen for detailed development. Demonstration instructional segments were implemented to provide course related procedures for development of software and description of requisite instructional hardware associated with each strategy.

Conclusion

Observation and utilization by technical and administrative personnel resulted in the conclusion that the strategies are relevant to course objectives and do bear promise. It is recommended that specific portions of the course be implemented utilizing appropriate strategy to determine instructional value and cost effectiveness as compared to instructional techniques presently employed.

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SECTION I

INTRODUCTION

Background

In a continuing effort to improve the cost and effectiveness of Air Force technical training and education, an Advanced Instructional System (AIS) is being developed. The AIS will be a prototype computer-oriented training system as well as a research facility. The system will enable the systematic evaluation of innovations in instructional technology and will be used to develop methods for integrating the latest advances in individualized instruction into the training environment. The areas of primary and immediate concern are instructional techniques and media, instructional systems management, and computer hardware and software. The approach to AIS development is modular and consists of the initial acquisition of a minimum configuration which will be expanded to a full-scale system applicable to the Air Force technical training environment and, eventually, to other training and educational environments. The objective of the overall effort is to develop, demonstrate, and test the feasibility of a potentially large-scale, computer-managed instructional system in the Air Force training environment.

In support of AIS development, a series of related yet independent investigations are being conducted. For these investigations, courses have been selected which represent diverse skill learning and include a course which emphasizes administrative and clerical skills, a course which emphasizes complex technician skills, and a course which emphasizes gross motor skills and team performance. The investigation being reported here dealt with the Weapons Mechanic (TAC) 3ABR46230-2 Course which emphasizes gross motor skills and team performance. It is anticipated that the Weapons Mechanic (WM) course will ultimately be developed into a completely self-paced, computer-managed, individualized instruction course for utilization within the AIS. The present effort, however, was concerned with the development of instructional strategies appropriate to the anticipated AIS training environment for the WM course.

The development of instructional strategies was selected as the starting point for this initial effort because of the stage of development of the existing course. Normally, development of any performance-oriented technical training course would follow the six steps of the instructional system development approach listed below:

1. Perform a behavioral task analysis

2. Develop a set of terminal performance (behavioral) objectives

3. Develop hierarchical organization of learning objectives

4. Specify course content

5. Determine instructional strategies or approaches

6. Prepare necessary training materials.

However, it was felt that the objectives and content of the existing course were sufficiently well specified to permit starting with the fifth step; determine instructional strategies or approaches. The objective of this study, therefore, was to determine instructional strategies which provided for the following:

1. Individualized and team instruction

2. Performance-oriented instruction

3. Computer-managed and/or assisted instruction.

Related Efforts

The determination of strategies for individualized performance-oriented courses is not a new problem in the area of instructional technology development. Early attempts at individualizing instruction employed Skinner's linear programming technique (Skinner, 1954) which provided for individual differences in rate of learning. A more recent technique, intrinsic programming (Crowder, 1960), provided for individual differences in mastery of previously learned skills and knowledges as well as differences in learning rates. In intrinsic instructional programs, the content of each program frame is contingent upon the student's response to the preceding frame. The intrinsic programming technique provided a means of allowing students to skip segments of instruction or receive remedial instruction depending on their responses to criterion questions. The linear and intrinsic

programming techniques were developed primarily for use with paper and pencil-oriented materials covering verbal and cognitive information. The development of these techniques was not aimed at technician performance-oriented training.

There have been several recent attempts to develop strategies for individualized performance-oriented instruction by developing instructional programs in media other than paper and pencil (e.g., tape, slide). One example involved learner-centered instruction (Pieper, et al, 1968). This work emphasized the teaching of job behaviors rather than job knowledges. Part-task trainers, equipment simulators, and actual equipment items provided hands-on practice and were used in conjunction with programmed texts, audio-visual programs, and lecture-demonstrations. A recently developed strategy, applicable to both high- and low-aptitude students, utilized programmed audio-visual materials for an on-job training course to teach behaviors relevant to the job of Air Force Security Policemen (Pieper, et al, 1972). Although these strategies were performance-oriented and utilized individualized instructional materials, they were not developed for team training.

Some techniques for teaching team performance have been investigated and some principles for team training have been outlined (Klaus and Glaser, 1968). These principles emphasized (1) avoidance of team member redundancy, (2) importance of mastery of needed skills by the individuals within the team prior to attempted team practice, (3) importance of reinforcement schedules during individual learning which matches the individual's reinforcement schedule in the team, and (4) the importance of team reinforcement. Overall, there have been few efforts aimed at developing strategies for teaching team performance. One recent example, however, is Project APSTRAT (Weingarten, et al, 1970). In this project, teams were trained by utilizing a strategy of peer instruction in an operational context.

Each of the attempts at refining the technology of training (i.e., developing individualized techniques, developing performance-oriented techniques, developing team training techniques) has improved our ability to train job performers effectively. Almost all instructional strategies developed to date, including those involving student-paced learning, have been designed for use in a "classroom" which is a portion of an instructor-managed training system. Until now, little attention has been directed at instructional strategies designed for use in a computer-managed training environment. The goal of this investigation was to generate strategies capable of being managed in a computer-oriented instructional system which provided for individualized instruction, performance-oriented instruction, and team instruction.

Problem

The problem was to generate instructional strategies that were (a) applicable to performance-oriented courses and courses involving team training (as typified by the WM course), and (b) appropriate for use in a computer-oriented instructional system. Since this study was a portion of the initial effort of the AIS development, selected strategies were to be developed and their feasibility demonstrated to Air Force WM instructional cadres to facilitate strategy utilization and implementation later in the AIS development cycle.

The specific problems posed for the generation of the instructional strategies were as follows:

1. Develop an operational definition of an instructional strategy
2. Describe existing course in terms of objectives, content, and instructional strategies
3. Evaluate the current instructional strategies
4. Determine student and instructor characteristics
5. Determine the anticipated AIS and current training environment (i.e., administration practices, classroom or study locations, training equipment, instructional media, etc.)
6. Generate instructional strategies relevant to the objectives, instructors, students, and training environment which are particularly applicable to a computer-oriented instructional system.

The general problems posed for the development of selected strategies were as follows:

1. Select strategies representative of performance-oriented individual and team instruction
2. Develop each selected strategy, using typical content, and prepare sample materials
3. Develop descriptions of materials development and strategy-application techniques.

The specific considerations relevant to the development of each selected strategy were unique to the respective strategies and are discussed in the appropriate portion of Section III of this report.

The problems posed for the demonstration of the selected strategies were:

1. Procure all necessary equipment and supplies for application of the developed strategy

2. Demonstrate the development and application techniques for each developed strategy.

This investigation was performed in three sequential phases as follows:

Phase I - Generate Strategies

Phase II - Develop Selected Strategies

Phase III - Demonstrate Selected Strategies

This report is the final project report and summarizes all project phases. The detailed description of the objectives, approach, and findings for each of the three phases is presented in Sections II, III, and IV, respectively.

SECTION II

GENERATION OF STRATEGIES

Objective

The generation of strategies relevant to a computer-managed instructional system required the performance of several activities (e.g., identification and evaluation of current strategies, identification of instructor and student characteristics, and identification of relevant aspects of the training environment). Once all relevant parameters of the instructional environment were identified and described, the information was summarized and used as the basis for the generation of appropriate strategies. Finally, appropriate strategies which could be implemented within the computer-oriented training environment were either selected from the current strategies or created. Specific objectives were formed to guide the generation of the strategy pool. These objectives were:

1. Write a working definition of a strategy to provide a framework for strategy descriptions and later development

2. Determine existing course objectives, content, and instructional strategies including methods, media, and equipment

3. Evaluate existing strategies in the context of their implementation

4. Determine student characteristics relevant to individual learning differences

5. Determine instructor characteristics which could affect strategy selection or development

6. Describe the training environment in which the strategies would be implemented

7. Generate strategies appropriate to course objectives, course content, students, instructors, and instructional environment.

Approach

Strategy Definition

The term "instructional strategy" was considered synonymous to "instructional approach." The type of definition developed was operational as opposed to that appropriate to a dictionary. The categories of information included were designed to allow application of the described strategy in any appropriate training course. The format of the definition was also designed to facilitate systematic comparisons of common elements between strategies. Several definition formats, each containing different categories of information, were developed and evaluated. The evaluations consisted of describing known strategies in the various formats and determining which of the formats provided all required information with the least amount of extraneous information.

The definition accepted as best was one which defined the strategy in terms of five elements:

1. Student activity

2. Instructor activity

3. Instructional media, including equipment

4. Student evaluation techniques, if applicable

5. Description of the implementation including functional interaction between elements.

These five elements adequately defined each instructional strategy.

Description of the Course

Course objectives, content, and current instructional strategies were identified through examination of course documents which included:

1. Course Chart

2. Plan of Instruction

3. Lesson Plan

4. Specialty Training Standard 462X0

5. Programmed Texts

6. Workbooks/Study Guides

7. End-of-Block Examinations.

In addition, observation of operating classes and discussions with course instructors and course administrators were employed to eliminate any ambiguities which remained following examination of the course documents.

The course documents were first examined, and a tentative outline was prepared which indicated the objectives, content, and instructional strategy for each block and lesson in the course. Classes were then observed to verify the information extracted from the course documents. Differences in content or strategies were noted, and the outline was accordingly revised. The specific information recorded for the instructional strategies was:

1. Teaching Method (Student and Instructor Activities)

   a. Lecture

   b. Demonstration

   c. Discussion

   d. Practice

   e. Other

2. Media

   Presentation media, training aids or devices, and operational equipment used for training

3. Measurement

   Formal written tests and informal instructor evaluations

4. Rationale for Strategies

   The rationale for each strategy as explained by course developers and administrators

Evaluation of Existing Strategies

Strategies currently in use were evaluated by observing their application in ongoing classes. In addition, instructors were questioned concerning their judgments of the effectiveness of the strategies. During discussions with the instructors, those elements of the strategy that were considered exceptionally good were identified, as well as those elements which caused problems for either students or instructors. Each instructor was asked how he would like to see the strategy changed to enable him to improve his teaching effectiveness. The relative effectiveness of each instructional approach was evaluated according to its judged appropriateness for meeting stated course objectives and its reported effectiveness in the training situation. These judgments were based on state-of-the-art training technology.

Determination of Student Characteristics

Student Airman Qualifying Examination (AQE) scores were supplied to the contractor. Additional information was gathered by a specially constructed student survey form. The form contained items designed to (1) gather descriptive information about the student's educational and technical background; (2) determine student knowledge of the range of tasks performed by weapons mechanics; and (3) examine student opinions about the tasks performed by weapons mechanics in terms of perceived task complexity, task danger, task necessity, and task acceptability.

Determination of Instructor Characteristics

Instructor characteristics associated with teaching activities were examined. These data gave insight into the range of strategies which instructors could be expected to use. Structured interviews were held with instructional and administrative personnel from all three of the class shifts and from all areas of the XII Block course. Topics explored during the interviews included previous job experience as a weapons mechanic, instructor assignment to the teaching position, instructor training, and elements of the course which instructors particularly liked or disliked. Interviewees were also encouraged to suggest changes in the existing instructional strategies or to recommend new strategies.

Examination of the Training Environment

Since the physical environment of the course will be somewhat changed under the AIS (i.e., it will be expanded to include dormitories,

lounges, hallways, etc., and will include computer interface), an effort was made to create strategies which were not dependent upon the existing physical environment for their implementation. Existing course administration procedures were carefully examined through interviews with course administrators, review of Air Force regulations (ATC Regulation 52-26, Air Force Regulation 35-99), and review of course administrative documents such as the Training Flow Chart. Formal end-of-block written examinations were reviewed and discussions with instructors revealed other methods used to evaluate students' task performance ability. This investigation focussed upon factors affecting student acceleration and failure.

Generation of Strategies

The instructional strategies were developed during a two-day working conference. Inputs for the conference were obtained from the members of the ASA staff, who had extensive and previous experience in the design of instructional strategies. Inputs were also made by staff members of AFHRL/TT, representatives of the USAF School of Applied Aerospace Sciences, and the Weapons Mechanic Course instructors and supervisory personnel. Collectively they possessed a wide range of knowledge and experience in state-of-the-art instructional technology. Prior to the conference, all conferees were provided with data assembled from the analysis of the course documents, observations, and interviews. Strategy generation emphasized innovative techniques such as self-confrontation, closed-circuit television, and computer-aided instruction techniques. In addition, special attention was given to problem areas identified in the existing course (i.e., student motivation,performance evaluation, and the use of part-task and whole-task training devices). The conferees suggested new strategies for teaching technical material of the type presented in the course, while considering the characteristics of the students who would be participating in the course. Consideration was also given to the unique process of conducting training in the instructional environment of a military technical training center. Each recommended strategy specified student activity, instructor activity, training media (including equipment requirements), and a description of its application.

Findings

The findings of the course analysis and the results of the strategy generation conference are presented here.

Course Description

The Weapons Mechanic (TAC) Course was designed to provide airmen in the 462X0 Career Field with the basic skills and knowledges necessary

to identify bombs, fuses, and ammunition; maintain and load guns, bombs, rockets, and missiles on aircraft; and troubleshoot gun firing and weapons release systems. The course provided Tactical Air Command-(TAC)-oriented training for troubleshooting, maintaining, and modifying conventional and nuclear weapon release and launching systems and associated components. Students were also taught the loading and unloading procedures of conventional and nuclear bombs, rockets, and missiles, as well as the inspection, loading, maintenance, and modification of aircraft guns and their associated components. The use of publications and tools, fundamentals of electricity, and application of safety precautions were integral parts of the course.

The course required two general types of learning activities, those requiring primarily cognitive skills and those requiring primarily performance; the latter included both individual manual skills and team performance. The first three blocks of instruction were primarily academic, but the remaining blocks provided "hands-on" activities of two types: (a) weapon nomenclature, functioning, disassembly (four blocks), and (b) loading and troubleshooting (five blocks).

Programmed texts were used to present more than half of the content during the first two blocks of the course. The student performed each task as specified in the text without previous lecture or demonstration by the instructor. The instructor served as a monitor to insure that the trainees worked through the programs as required. The bulk of the remainder of the course was presented by instructor lecture/demonstration, followed by student practice. A typical sequence was:

1. The student read or "studied" a text or study guide materials

2. The instructor discussed the material and asked questions

3. The instructor demonstrated the task(s) to be performed, either before the first team practiced, or using the first team for demonstration

4. The students performed the task, usually in teams.

Beginning with Block III of the course, the students practiced gun, bomb, and rocket checkout and maintenance in teams of two. All procedures were practiced in-accordance-with (IAW) the relevant Technical Order (TO). Beginning with Block VIII, the trainees practiced loading/unloading and aircraft system checkout procedures in teams of four or five.

The existing team instructional strategy involved the assembly of a team of novices and the demonstration of the team task to be performed. Following this, the team attempted to perform the task. No attempt was made to provide individual learning experiences for the various team positions before assigning students to team positions and whole team practice. Typically, one member of a four- or five-man team was appointed as team leader to read the procedure from the TO and to see that all steps were performed IAW the TO procedure. The remainder of the team members performed the procedural steps. Instructors monitored team performance and assisted team members when they had difficulty in performing their assigned tasks.

Cognitive aspects of equipment maintenance (i.e., troubleshooting), were taught by describing functional aspects of component parts with the expectation that students would then be able to diagnose causes of malfunctions. Typically, the student first learned to associate a description of a component's function with the component. He then observed the normal cycle of operation. Troubleshooting ability was later assessed by requiring the student to recall or associate equipment parts with their functional descriptions. Extremely limited facilities were provided for practicing the diagnosis of malfunctions in an operational system.

All procedures were taught using the appropriate TO and actual equipment items. Instruction for maintenance procedures was group paced. Equipment simulators, although available in some cases, were used only as back-up devices in case the actual equipment malfunctioned. Part-task trainers, those designed to teach a specific task element or behavior, were almost nonexistent. Likewise, specially designed learning aids which could be used in place of the actual TO during the initial phases of learning were not available.

Due to the method of equipment utilization and the size of classes, student participation varied over a wide range. While one four-man team performed a procedure (e.g., loaded a bomb), a second four-man team observed and followed the procedure in the applicable TO. The remainder of the students in the class were supposed to use the time to study applicable text and reference materials.

Evaluation of Current Strategies

The use of programmed texts in Blocks I and II was an acceptable instructional approach for this content; however, two problems existed with this material. First, the material on basic electricity was presented too early in the course sequence, and thus required extensive review later in the course. Secondly, examination of the programmed texts revealed that they did not appear to perform adequately

the function of programmed instruction (i.e., provide frequent reinforcement based on successful achievement of small learning steps). Aside from these problems, the utilization of self-paced programmed materials for this content is an appropriate approach.

The general strategy of student preview, instructor discussions, instructor demonstration, and student practice is appropriate to almost any performance-oriented course. However, as it was being used, this strategy did not appear to be effective in teaching team performance. The instructor provided assistance to team members experiencing difficulty, but a single instructor could assist only one member at a time. The remainder of the team could not continue until the assist was completed. This procedure interrupted the continuity of task performance and slowed the learning process. Furthermore, if only one team member performed incorrectly, causing failure of the team, all members received negative feedback.

The technique of having nonperforming teams observe the performance of another team is also subject to question. A student learning to perform a new task usually commits errors. Students observing the performance see the errors and, if the errors are not detected by the instructor, the observers will probably learn the incorrect performance. In addition, observation of an entire team performing may not help the observer to learn to perform the task(s) required in an individual team position.

The use of functional descriptions of component parts to teach troubleshooting skills provided no practice in troubleshooting equipment malfunctions. This approach did not teach troubleshooting skills as the strategy did not teach how to isolate a part as the cause of a malfunction, but served only to relate a component part's function to system performance.

Although final task performance must be accomplished on the aircraft using actual TOs, the practice of using these items as training aids appeared to be inefficient. Since the number of available aircraft was small, only one of each type, the teams had to practice sequentially instead of simultaneously. The interpolated activity of observing another team's performance or studying the TO procedure is not always beneficial to task learning. In addition, the TOs were designed to be used by skilled technicians as aids for job performance and did not contain the additional cues desirable in learning aids.

There were some indications that initial learning of the procedures should not be group paced. Individual differences in ability to learn manual skills were pronounced in the early phases of learning

and the team's progress was slowed by having to wait for one member to gain proficiency.

As all members of a team approached criterion performance on a team task, group-paced practice appeared to be beneficial for achieving required speed and accuracy. One possible explanation for this result is that only after each individual member learned to perform his portion of the task could the members begin to learn to cooperate and perform as a team.

It was concluded that the existing strategies, although generally applicable to performance-oriented courses, could be improved to provide:

1. More practice on job skills
2. More assistance to individuals early in the learning process
3. Better utilization of available equipment and student time
4. Better opportunity for team learning.

Student Characteristics

The students had similar educational backgrounds; all possessed high school diplomas as required for course entrance. A second entry requirement was a minimum score of 60 percentile on the Mechanical Aptitude Index (AI) of the Airman Qualifying Examination (AQE). The frequency distributions of student scores on the Electrical, Administrative, and General AIs were essentially normal, with the median score on these AIs above the 50-percentile level.

Few of the trainees had chosen the 462X0 career field; most were assigned because of Air Force needs. Students knew upon entering the Air Force that they would be in a mechanical specialty, but were not aware that they would become a Weapons Mechanic. In fact, it was stated that most incoming students were unaware of the existence of an Armament Specialist. This lack of information was seen by the instructors as causing some student motivational and attitudinal problems.

A student attitude survey was administered to 459 students enrolled in Blocks VIII through XII. It was also filled out by 49 instructors who had responsibility for the classes in which the survey was administered. It was, therefore, possible to examine current student opinion during the later stages of the course, and to compare these opinions with their instructors'.

The survey indicated that most students in the later stages of the course were aware of the range of tasks performed by weapons mechanics; however, over 20 percent believed that they would not personally perform tasks which involved a knowledge of the principles of electricity or troubleshooting procedures. Students viewed the tasks to be moderately easy to easy, and to be moderately dangerous to safe. Only fusing bombs was felt to be dangerous by a plurality of students. Interestingly, instructors held a wider range of opinions concerning the complexity and safety of a number of tasks than did students; however, where most instructors agreed about a task, students tended to agree with the instructors about the task. Finally, students were inclined to believe that all tasks were necessary and acceptable; thus there did not appear to be a student motivation problem due to moral reservations.

The single factor found during analysis of the student questionnaire which may affected student motivation was the perceived ease of the task. This lack of challenge may result in a lack of intrinsic satisfaction in task performance.

Instructor Characteristics

The instructors, for the most part, had from four to six years of job experience. Under normal circumstances, the instructors volunteered for the teaching duty, but during periods of high student load, instructors were assigned on the basis of need rather than their ability or desire for the assignment. The result was that some of the instructors were not highly motivated.

All instructors had received an eight-week instructor training course, five weeks of instruction in teaching techniques with an additional three weeks of classroom practice under close supervision. Instructors also monitored segments of the Weapons Mechanic course with which they were not familiar (i.e., instructors teaching the course for command unique aircraft and armament systems with which they had had no job experience monitored the course segments covering those aircraft and armaments).

Instructor morale was adversely affected by oversized classes and cancelled leaves during overload periods. However, even under these conditions, most instructors seemed genuinely concerned with getting the students trained regardless of additional effort required on the instructor's part. Most instructors interviewed desired increased interaction with small groups of students or, if possible, with single students.

Training Environment

The Weapons Mechanic (TAC) 3ABR46230-2 Course was conducted at Lowry Air Force Base, Colorado. The existing course was 16 weeks in length and was being conducted with three six-hour shifts each day. Each shift consisted of approximately 15 classes, with 14 or 15 students per class. Classes were group-paced (i.e., all students progressed at the same speed). Classes met in standard classrooms for the academic units of the course and in laboratories for the hands-on practice elements.

Student administration provided for student washouts, washbacks, and acceleration. Students could be eliminated from the course for either academic or human reliability reasons. Approximately one percent of the students were eliminated for academic reasons, while nearly 10 percent were eliminated due to human unreliability (as specified in Air Force Regulation 35-99). Most academic eliminations occurred during the first three blocks of the course and were based upon work which was not performance-oriented, and which was only marginally related to job performance.

Student washbacks (moving back to the preceding class) were most often due to illness rather than academic problems. Rather than being washed back, students were usually assigned to remedial sessions. Assignment to remedial training sessions was mandatory if a student had unacceptable test scores; however, any student could voluntarily request remedial help. Remedial sessions were conducted outside of regular class time and in addition to regular classes.

Student acceleration (by-passing selected course segments) was predicated upon passing tests normally used to measure proficiency in the content of the by-passed course segment. Only students who had had prior training, practical experience, or who were exceptionally rapid learners were recommended by supervisory personnel as eligible for acceleration.

Existing job-knowledge measurement instruments appeared to be adequate; however, job performance ability was measured only informally, primarily by unguided instructor evaluation. There was, therefore, considerable potential for variation in evaluations between instructors, and between classes of the same instructor which cast considerable doubt upon the reliability and validity of these evaluations. The existing emphasis on individual evaluation for team tasks was also questionable. If the students were aware that they were being evaluated on an individual basis, competition could develop between team members. This competition would be detrimental to developing team cooperation. It was, therefore, determined that a more effective performance evaluation technique was needed for individuals and teams.

Generated Strategies

Fifty-six strategies were generated during the two-day working conference. Although the background materials were the objectives, content, and ancillary characteristics of the Weapons Mechanic (TAC) Course, the generated strategies were appropriate to any course teaching manual skills and team performance. The strategies, described in Appendix A, will serve as a pool of applicable techniques for teaching task performance in an individualized computer-oriented, instructional environment.

All the strategies with the same or similar purpose are presented together in Appendix A. The strategies are presented in nine groups as follows:

1. Student Selection and Career Field Orientation
2. Cognitive Skill Instruction
3. Manual Skill Instruction
4. Team Training
5. Evaluation
6. Incentive Management
7. Games
8. Course Development
9. Miscellaneous

Each strategy is presented on a separate page and is described in terms of the following information:

1. A description of the content, student activity, instructor activity (if appropriate), and materials
2. A statement of the suggested application
3. A statement of the limitations of the strategies in the suggested application
4. A brief description of the means for implementing the strategy
5. A general description of the equipment requirements for the implementation described.

SECTION III

DEVELOPMENT OF SELECTED STRATEGIES

Objectives

Phase II activities required the selection of several of the strategies from the strategy pool created during Phase I, and the development of these strategies in sufficient detail to allow knowledgeable personnel to apply the strategy in a variety of contexts. Specific objectives which guided the development process were:

1. Select strategies for detailed development which were representative of the various elements of individual and team performance learning

2. Develop the selected strategies including specification of all equipment and techniques involved

3. Write detailed descriptions of the strategy application procedure in terms which would allow persons generally knowledgeable in instructional technology to apply the strategies in a variety of contexts.

This section of the report describes the procedure followed to achieve the Phase II objectives. In addition, the strategies as developed are described in this section.

Approach

Selection of Strategies

Selection of strategies for detailed development was a cooperative effort involving the contractor, the Air Force Technical Monitor, and course administrative and instructional personnel. Of the 56 strategies generated during Phase I, 12 were initially selected as candidates for development by the contractor and Technical Monitor. The criteria governing selection were:

1. The strategies chosen had to be usable in the current Weapons Mechanic Course as well as the proposed AIS Course

2. The selected strategies had to be implementable without requiring extensive retraining of current instructional personnel

3. The range of the strategies selected had to represent individual and team tasks

4. The strategies selected had to represent both knowledge and performance learning.

The 12 selected strategies were formally presented to course administrative and instructional personnel. The course personnel were asked to indicate which of the strategies they thought would be useful to them, and which they would like to have fully developed. The instructors and administrators were consulted in the hope that this would increase the probability of utilization of the strategies in the course following development. Of the initial 12 strategies recommended, the following were chosen for detailed development:

1. Programmed Instruction for Schematic Symbol Recognition

2. Audio Team Coaching

3. Television Team Coaching

4. Television-Aided Remedial Study

5. CAI for Troubleshooting Performance.

Development of the Strategies

The development process was aimed at describing the strategy in enough detail to allow its use by existing instructional personnel. In addition, even though specific content material was included for illustrative purposes, the developed strategy was general in nature. All activities needed to apply each strategy were identified along with the specification of equipment and supplies needed to implement the strategy.

Findings

Section III-A describes the development of Programmed Instruction for Schematic Symbol Recognition. This section is intended as a guide for the application of the strategy to different content areas.

Section III-B describes the preliminary steps for the development of Audio Team Coaching, Television Team Coaching, and Television-Aided Remedial Study. Section III-C describes the development of material for Audio Team Coaching and Section III-D describes the development of material for Television Team Coaching and Television-Aided Remedial Study. Section III-B and III-C can be used together as a guide for the development of Audio Team Coaching materials, and Section III-B and III-D together guide the development of material for production of the television strategies.

Section III-E describes the development of flow diagrams for the CAI for Troubleshooting Performance strategy.

III-A

Intrinsic Programmed Instruction for Schematic Symbol Recognition

General Characteristics of Applicable Areas

Programmed instruction can be used independently for the instruction of knowledges which do not require the manipulation of hardware. Examples of these knowledges include equipment nomenclature, identification of the components and their location, function of components, and standard practices and procedures (e.g., filling out maintenance report forms, learning mathematics, etc.). However, when used to teach procedures, programmed instruction can only supplement hands-on practice of task performance.

Material being considered for programmed instruction should be capable of being broken into small steps, preferably based upon some underlying hierarchy of skills, or knowledges. This hierarchical structure enhances the usefulness of programs because it allows students to move easily from the known to the unknown without disrupting gaps. If gaps are unavoidable, they may be eliminated by dividing the material into more than one instructional segment.

Programmed material should be organized in a way which requires only discreet responses by the students. The student must be able to actively participate in the program by producing or choosing a specific statement. In order to provide the appropriate feedback, student's responses must be interpretable by the instructional program presentation device (book, machine, computer, etc.). The types of responses easily interpreted in programmed instruction include true-false, identification, matching, and short completion answers (cued recall). Free recall responses are difficult to evaluate and should, therefore, be avoided.

Programmed instruction can be used to supplement teaching in several areas of the Weapons Mechanic (TAC) Course. These areas include basic principles of electricity, use of standard forms and routines, sequences of task events, and nomenclature and function of equipment items. Appendix B lists specific tasks, at least one element of which can be

taught by programmed instruction. It should not be concluded that programmed instruction can be used to teach the entire task, nor that programmed instruction is the best way to teach the entire task. For instance, students can learn the nomenclature and functions of various parts of the M3 20mm Automatic Gun through programmed instruction, but hands-on practice is needed to learn assembly and disassembly of the weapon.

Instructional Program Development

Figure 1 illustrates the procedure followed to produce an instructional program for teaching students to read and interpret electrical schematic diagrams. This procedure is outlined in AFM 50-1. The same procedure can be applied to produce instructional programs in other subject areas.

Select Material. The reading of electrical schematic drawings was suggested and finally selected for programming. After selecting the topic, the programmer wrote a topic statement, "Teach students to read electrical schematic drawings." This statement allowed the programmer to concentrate on the chosen topic and helped avoid the temptation to include irrelevant material. The topic statement served as a reference against which each proposed objective and piece of content material was compared to ascertain if the material was appropriate for the program.

Develop Behavioral Objectives. As stated in AFM 50-1, the programmer's first task was to convert general educational or training objectives into specific behavioral objectives. These objectives were to be clear, concise statements describing terminal behaviors. In order to write the behavioral objectives, the programmer required a clear understanding of the performance requirements for the course, and the nature of the material to be taught. This required information was obtained from technical manuals, from training standards, from discussions with technical experts, and from direct observation.

The terminal objective was written first. The terminal objective was closely tied to the topic statement, and described the desired level of student achievement upon completion of the program. The terminal objective for the example at hand was:

ACTION

Identify descriptions of operational components in an electrical circuit schematic

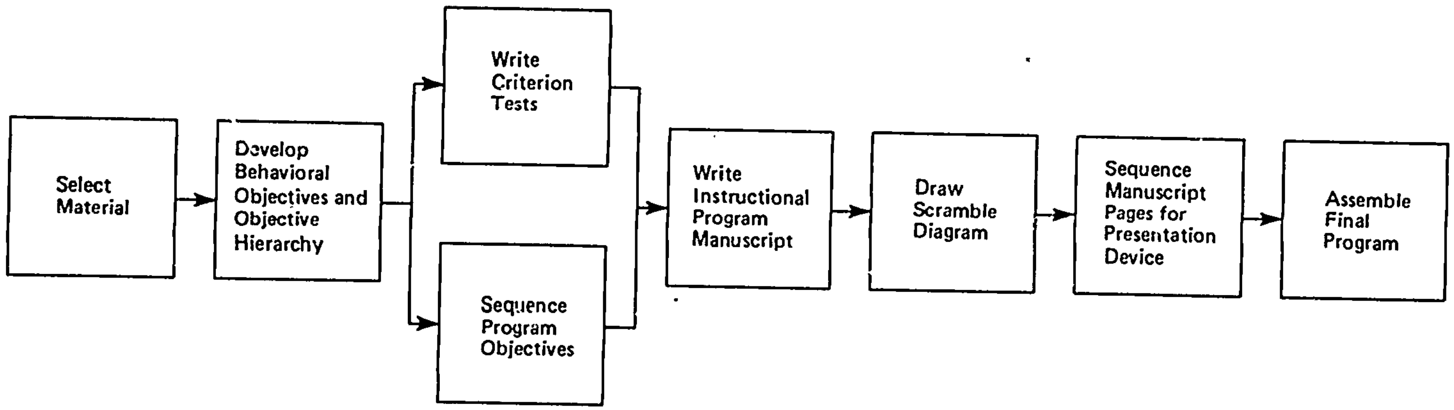


Figure 1. Development Procedure for Programmed Instruction

CONDITION

1. Circuit configuration given

2. Complex schematic containing all required symbols

3. Multiple-choice questions

STANDARD

No errors in two trials

To assure that program objectives were written so that they would support program development, the following questions were asked of the objectives:

1. Does the stated objective accurately reflect the skill or knowledge to be learned?

2. Has the student's behavior been sufficiently described to allow detection of the behavior when it occurs?

3. Are the measurement conditions clearly specified?

4. Is a standard for the measurement specified?

A hierarchy of objectives was begun, by questioning the terminal objective: "What skills and knowledges are needed before this task can be performed?" The answer served as the basis for the development of subordinate objectives. To answer the question, a skill statement was written, describing the underlying skill or knowledge requirements. This was followed by a statement of a behavioral objective which would provide a demonstration of the skill. This process of writing an objective, then asking what skills and knowledges were required to achieve the objective, continued until a task was described which the programmer assumed all incoming students could perform. This process yielded an exhaustive hierarchy of objectives, which insured that the program would consist of properly sequenced material for teaching all necessary skills and knowledges. Figure 2 shows a segment of the hierarchy developed. The objective statements shown contain only the action part of the objective. Actual program development used complete statements, including the actions, conditions, and standards.

Prepare Criterion Tests. In accordance with AFM 50-1, criterion tests were written for each objective. The tests were the first program components written; however, they were frequently changed at later stages of program development as necessary, to fit the needs of the

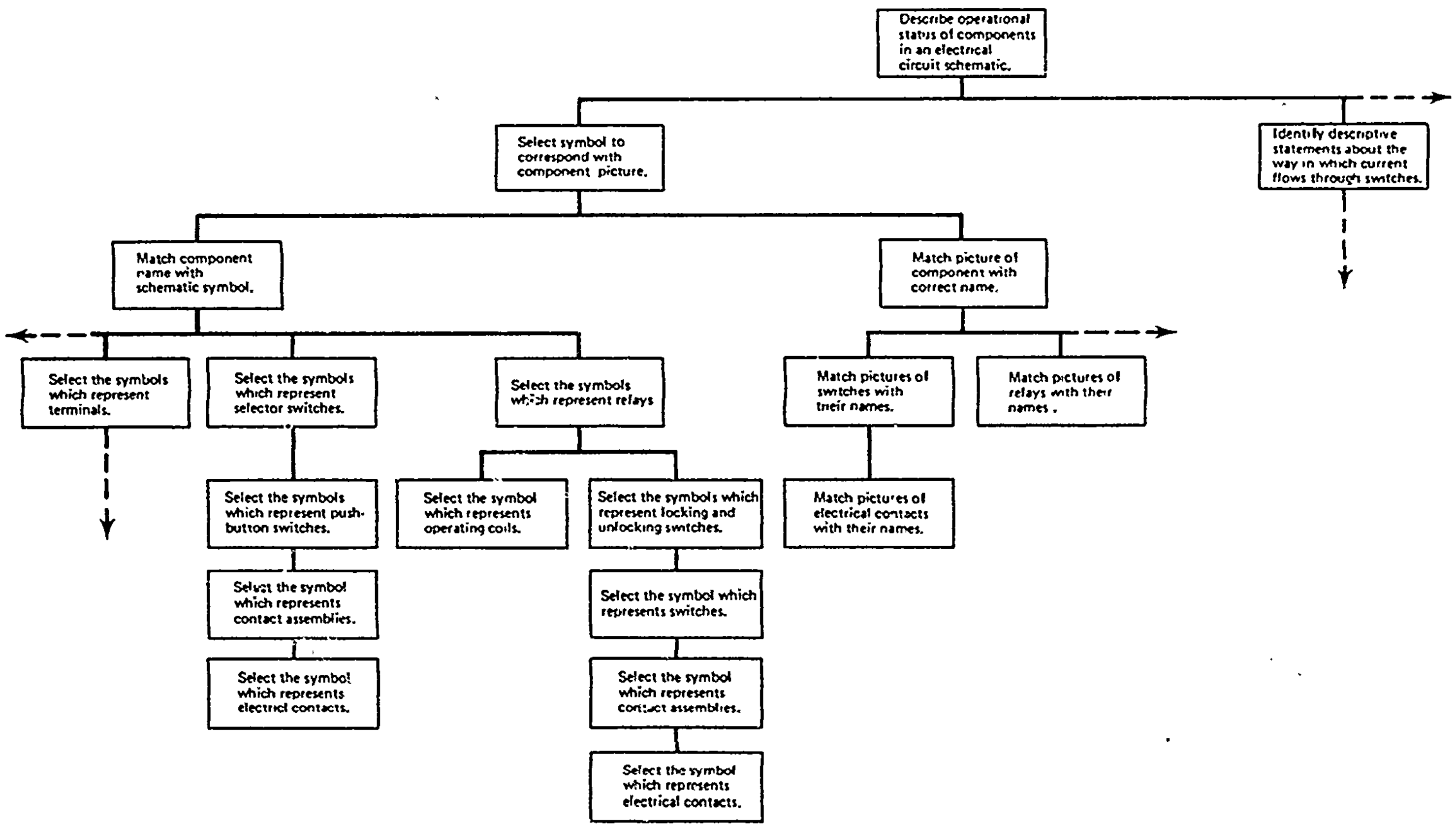


Figure 2. Hierarchy of Objectives

program. The tests served as a bridge between the program objectives and the programmed instructional material.

The criterion tests were designed to allow a student to demonstrate his ability to perform the activities associated with given objectives, at a prescribed level of competence. In order to reduce the probability that a student would achieve an objective through chance alone, two or more test questions were developed for most objectives (e.g., if the student's performance was checked with a four-alternative multiple-choice question, the probability that he would get the answer correct by chance is 1/4; however, if two 4-choice questions were used, the probability of guessing both answers correctly is 1/16).

To insure uniform good practice in writing test questions, a number of guidelines were followed. Some of the more important ones are summarized below:

1. Trick questions were not used; words such as "always," "never," and ambiguous terms were avoided.

2. The questions tested one objective at a time. This practice facilitated the identification of specific skills not learned.

3. Test questions were not used to introduce new material.

4. Questions were written positively (e.g., "Which alternative is correct?", not "Which alternative is false?").

<u>Sequence the Program</u>. The hierarchy of objectives was used to guide the sequencing of programmed materials. Several guidelines were considered while using the hierarchy of objectives during this process:

1. The hierarchy represented only a suggested sequence of steps through which learning could proceed effectively.

2. Some parts of the hierarchy were based on a necessary prerequisite ordering (i.e., it would not be possible to master a given objective unless the one immediately prior to it had been mastered).

3. Other parts of the hierarchy were based on a judgment ordering (i.e., it would be most efficient to master the objectives in a given order).

The hierarchy of objectives served the following essential purposes during the sequencing process:

1. It provided the programmer with a clear specification of his problem area, that of producing materials which would permit the student to acquire the skills defined by the objectives.

2. It assured that the student would have been taught all requisite skills and knowledges prior to his attempt to achieve each subsequent objective.

3. It provided the programmer an indication of the branching routines required should a student have difficulty achieving an objective.

Since the hierarchy for the program developed had several branches, the principle of recency was used in developing the preliminary program sequence (e.g., early segments were placed in sequence as close as possible to subsequent segments for which the early segments were prerequisite). This principle can be illustrated by referring to Figure 3; materials for objectives 32, 34, and 36 were taught just prior to material for the program's terminal objective. In addition, in order to minimize time lapse between learning the first objective in the program and applying it, segments were sequenced to cover the longest branch first (i.e., branch A). The principle of recency was applied to determine sequence each time a branch in objectives occurred (e.g., points X and Y). The preliminary sequence developed on the basis of recency and necessary prerequisite objective ordering is indicated by the numbers printed inside the boxes in Figure 3.

The final sequence was developed on the basis of programmer judgments concerning the efficiency of material presentation. It was felt that it would be most efficient for the materials concerned with the identification of electrical <u>components</u> to be presented simultaneously with the materials concerned with the identification of component schematic <u>symbols</u>. This resulted in the combining of branches A and B of the hierarchy (Figure 3). Table I gives the final sequencing of objectives for the production of the instructional program.

<u>Write the Instructional Program</u>. The program's "prime path" was prepared first. The prime path consisted of the series of pages to be presented to a student who made only correct responses. Care was taken to assure that all subordinate objectives were tested in the prime path. After the prime path was prepared, the programmer prepared the secondary path which consisted of the pages to be presented to a student who made incorrect responses. Pages in this path were written

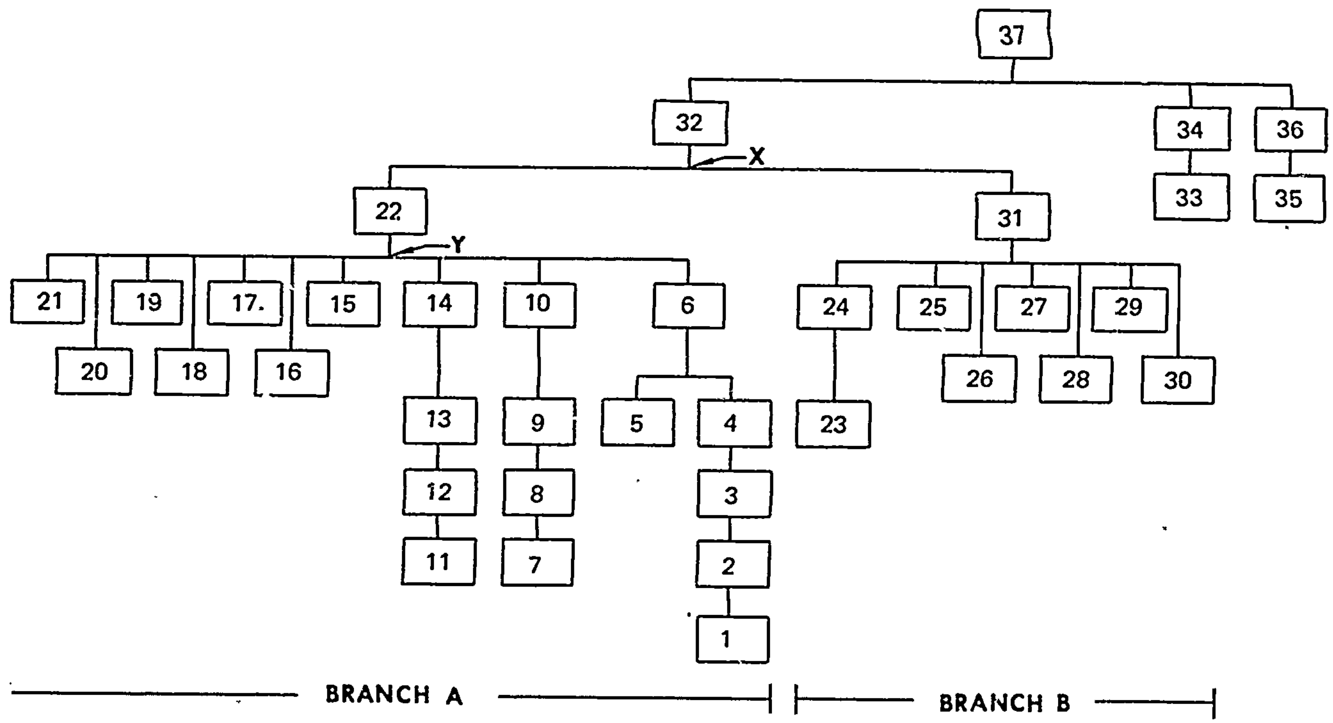


Figure 3. Teaching Sequence for Objectives

Table I

Sequence of Objectives

1. Match pictures of electrical contacts with their names.
2. Select the symbol which represents electrical contacts.
3. Select the symbol which represents contact assemblies.
4. Match pictures of switches with their names.
5. Select the symbol which represents switches.
6. Select the symbols which represent locking and unlocking switches.
7. Match pictures of relays with their names.
8. Select the symbol which represents operating coils.
9. Select the symbols which represent relays.
10. Match pictures of pushbutton switches with their names.
11. Select the symbol which represents pushbutton switches.
12. Match pictures of selector switches with their names.
13. Select the symbols which represent pushbutton switches.
14. Select the symbols which represent conductors.
15. Select the symbol which represents circuit breakers.
16. Match pictures of connectors with their names.
17. Select the symbols which represent connectors.
18. Match pictures of terminals with their names.
19. Select the symbols which represent terminals.
20. Select the symbols which represent batteries.
21. Select the symbol which represents electrical ground.
22. Select the symbols which represent lamps.
23. Match pictures of resistors with their names.
24. Select the symbols which represent resistors,
25. Select the symbol which represents transformers.
26. Select the symbols which represent amplifiers.
27. Select the symbols which represent rotating machinery.
28. Match a picture of a component with its correct name.
29. Match component name with schematic symbol.
30. Select symbol to correspond with component picture.
31. Select correct list of elements necessary for electrical circuit.
32. Identify descriptive statements about the way in which current flows through switches.
33. Identify descriptive statements about the way in which current flows through relays.
34. TERMINAL OBJECTIVE. Select descriptive statements of operational status of components in an electrical circuit schematic.

with a remedial orientation (i.e., were designed to aid the student to return to the prime path).

A right answer page followed each correct response. Figure 4 gives an example of a right answer page. The major parts of the page include:

1. The statement, "YOUR ANSWER," followed by a description consisting of the stem of the question and the answer choice.

2. An indication that the student was correct (e.g., "You are correct") followed by a brief summary of the reason the choice was correct.

3. Presentation of material for the next objective, usually consisting of a short descriptive paragraph including an example.

4. A question about the new objective.

In some cases, parts 1 and 2 were included on a single page, with instructions to advance to the next page for presentation of new material. In other cases, parts 1, 2, and 3 were presented on one page, and the question covering the new material was presented on the next page.

A wrong answer page (Figure 5) was written to follow incorrect responses. The wrong answer page reiterated the student's answer, explained why that choice was wrong and provided additional instruction about the objective being tested. The wrong answer page included:

1. The statement "YOUR ANSWER," followed by a description of the stem of the question and the answer choice selected by the student.

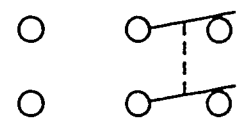
2. A statement of the reason why the choice was wrong.

3. Additional instruction about the objective being tested.

4. Directions to the student about what to do next (i.e., return to the preceding question and make another choice or continue to a different question).

After completion of all right and wrong answer pages, introductory frames were written which described the content and structure of the program, and contained instructions for the operation of the presentation

YOUR ANSWER: You indicated that the symbol represents a double-pole-double-throw (DPDT) switch.



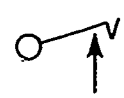
You are correct, very good. There are two movable contacts, constituting the two poles. Each of the movable contacts can be placed in one of two positions, thereby making a double-throw switch. The dotted line between the movable contacts indicates that there is a mechanical connection between them. This means that the two movable contacts will be operated at the same time by just one operator motion.

In addition to the number of poles and number of throws which differentiate switches, they can also be either locking or nonlocking switches. The toggle switches which have been used as examples in the past few frames have been of the locking variety.

A locking switch is one which will remain in a set position. For instance, if the operator flips an on-off switch from the OFF to the ON position, the switch will remain in the ON position until the operator flips it back to OFF. Two symbols are used to indicate locking switches. They are:

Toggle Switches

Relays, keys, jacks, etc.



A locking switch will remain in the position in which it is set until an operator resets it.

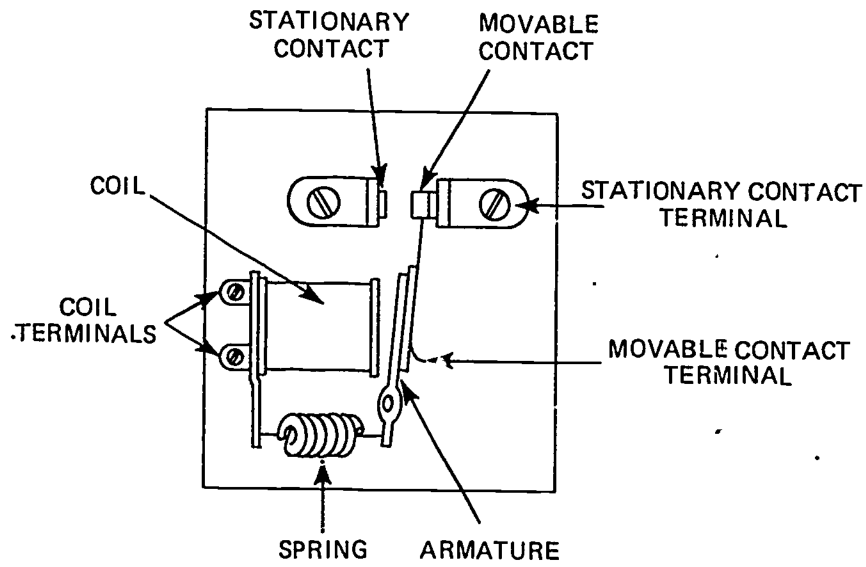
True Press Button A

False Press Button B

Figure 4. Sample Right Answer Page

YOUR ANSWER: You chose Alternative D.

Reexamine the following information:



A relay is merely a set of contacts which are operated by an electromagnetic coil or a magnetic coil rather than by the operator's finger. Power is supplied to the activating coil through the coil terminals. When the coil is activated, the relay armature is drawn to the coil, which causes the movable contact to change position. Return to the previous frame and choose a different answer.

Press Button R

Figure 5. Sample Wrong Answer Page

device. A final program frame was written which congratulated the student for successfully completing the program. The final frame also reiterated the program objectives by describing the tasks which the student should be able to perform having completed the program. Finally, the manuscript was edited and checked for technical accuracy.

Draw the Scramble Diagram. The scramble diagram was developed to graphically illustrate the paths a student could follow through the program. The scramble diagram was constructed by examination of the edited and revised program manuscript. Figure 6 shows the initial segment of the scramble diagram. Construction of the diagram began with the first introductory page of the program manuscript as shown at the far left of Figure 6. The second, third, fourth, and fifth circles represent pages arranged in a fixed presentation order. The sixth manuscript page required the student to make one of two different responses. Each response alternative required a different manuscript page, one a right answer page and the other a wrong answer page. The right answer page was represented by the next circle drawn along a horizontal line (prime path), while the wrong answer page was represented by a circle drawn above the horizontal line. The position of wrong answer circles (above or below the line) was determined by the position of the correct answer alternative among the possible choices. For instance, the question presented on Page 9 had four alternatives. The second alternative was correct and, therefore, its correct answer page was represented with a circle on the horizontal line from Page 9. The first choice in the list of answers was incorrect and its wrong answer page was represented with a circle above the horizontal line since this answer choice preceded the correct answer. Likewise, wrong answer pages for the third and fourth choices in the list of answers were drawn below the line since they followed the correct answer choice.

To facilitate later sequencing of the pages for the program presentation device, the manuscript page numbers were written in each circle of the scramble diagram. Note that the right answer choice was always given the highest page number of the alternate choices. This allowed all right and wrong answer pages to be grouped with their respective question page in the manuscript.

Figure 7 shows a section of the program in which an incorrect answer choice did not result in a return to the preceding question. In this case, the student was directed to a remedial branch for additional instruction. Manuscript Page 99 presents a question with four alternatives. The second alternative was correct and the student was routed to Page 109, the next page in the program's prime path. If the student chose the first or third alternatives, both incorrect, he was directed back to the previous frame. If the student incorrectly chose the fourth alternative, he began a remedial branch. In this branch, the student had to correctly

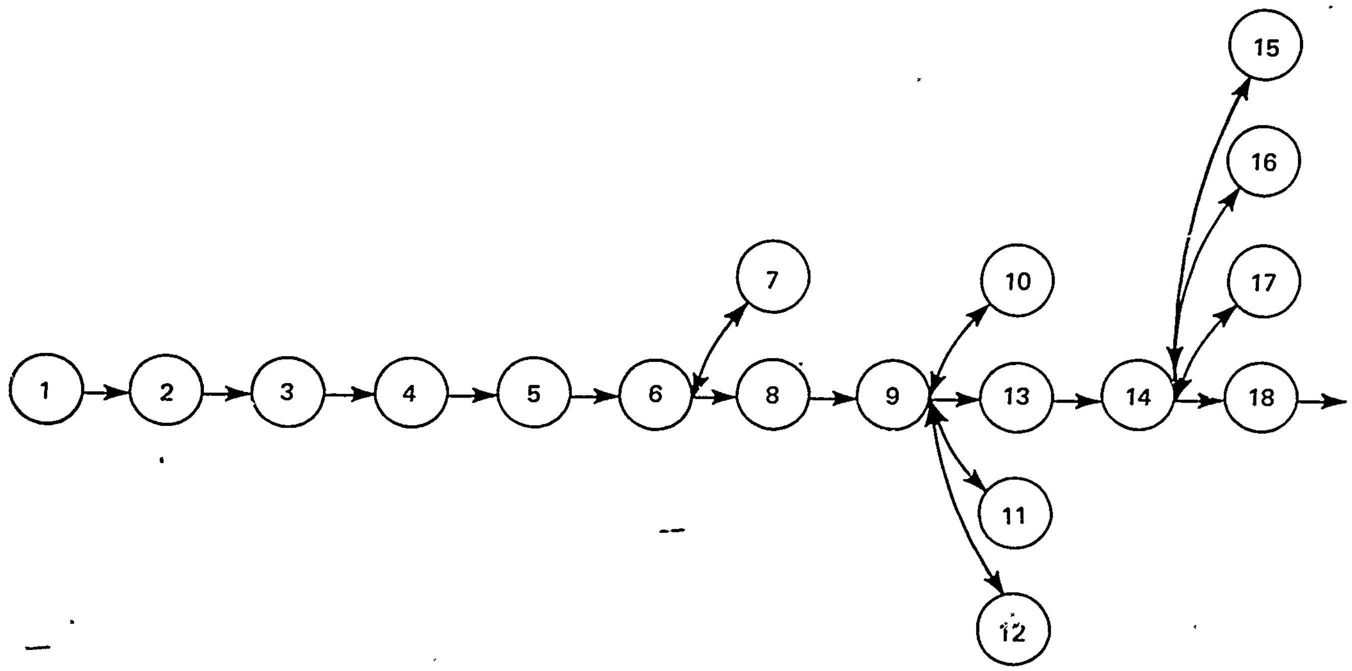


Figure 6. Scramble Diagram for Manuscript Pages 1 Through 18

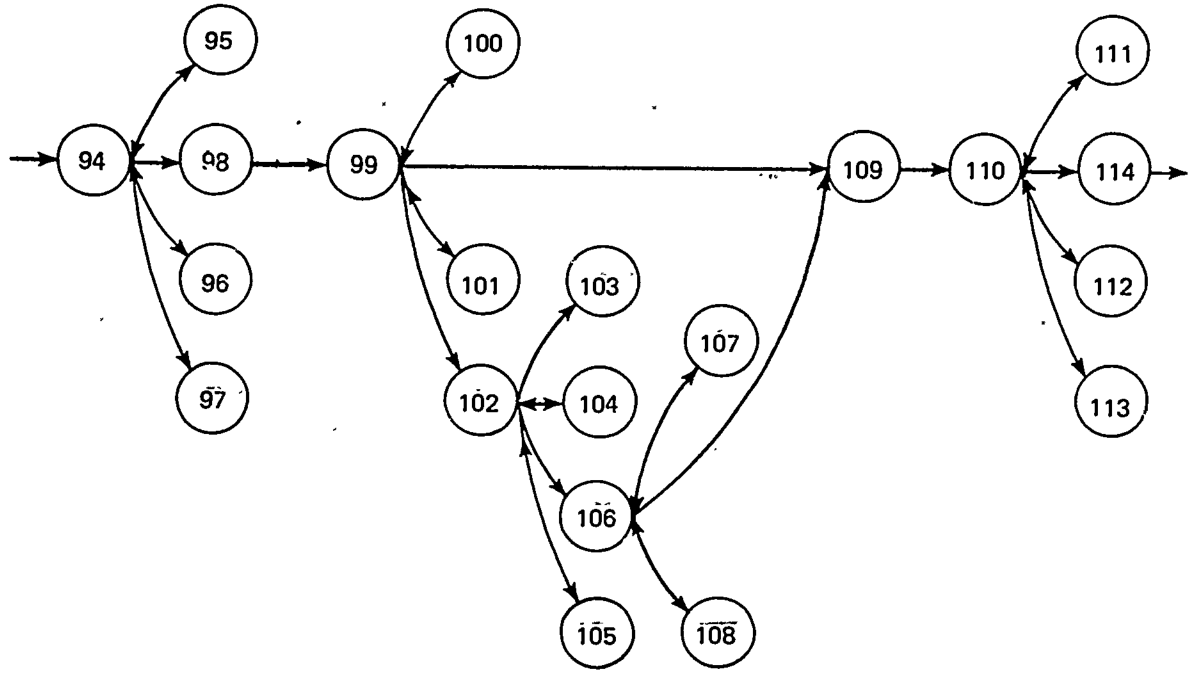


Figure 7. Scramble Diagram Showing
a Remedial Sequence

answer a four alternative question on Page 102 then a three alternative question on Page 106, before he reached the next page in the program's prime path, Page 109.

<u>Sequence for the Program Presentation Device</u>. The program manuscript pages were reorganized to allow their presentation by a teaching machine.* The reorganization of the pages was guided by the scramble diagram and the programming manual furnished with the teaching machine.

The teaching machine was capable of limiting student response possibilities. Therefore, each page of the manuscript was coded to indicate response possibilities which would operate the machine. Right answer pages were coded to allow machine operation for all response possibilities. Wrong answer pages, requiring a return to the question, were coded so that only the return button would operate the machine. Wrong answer pages which required the student to continue through a remedial branch were coded to permit machine operation on all response possibilities except the return button.

Sequencing the program manuscript pages was performed with care to avoid any errors in the page orderings. A single error would have prevented the program from functioning in the machine. The procedure given in the programming manual was meticulously followed and a number of steps were performed twice as a check to assure that any errors were caught. After a final editing, the reorganized program manuscript was photographed on 35mm film for machine presentation.

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*The AutoTutor Mark II Teaching Machine distributed by the Welch Scientific Company, Skokie, Illinois.

III-B

Preliminary Task Outline Development for Auaio Team Coaching, Television Team Coaching, and Television-Aided Remedial Study

Sections III-B, III-C, and III-D of this report deal with Audio Team Coaching, Television Team Coaching, and Television-Aided Remedial Study. Discussion of the early development stages for these three strategies has been combined since they are quite similar (i.e., all three were designed to provide instruction for a single team job). Figure 8 shows the suggested student flow from Television Team Coaching through Audio Team Coaching to unaided performance or task mastery. Television-Aided Remedial Study can be used to help students master tasks if they have had difficulty during Audio Team Coaching. Television Team Coaching provides a preview of tasks by presenting an overview of job sequence and team member coordination. Audio Team Coaching provides audio cues for performance of each job step. Television-Aided Remedial Study provides a special visual review of individual team position performance skills.

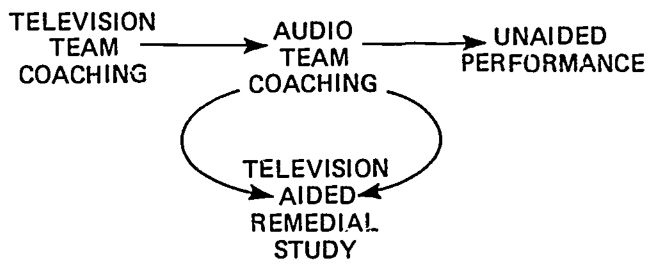

Figure 8. Suggested Student Flow Through the Television Team Coaching, Audio Team Coaching, and Television-Aided Remedial Study Strategies

The early development of all three instructional strategies involved the establishment of goals and objectives, and the systematic

examination of the target task (i.e., the task for which training was to be developed). Analysis of the target task culminated in the production of a task outline. As shown in Figure 9, the task outline was used as the basis for the production of the audio and videotape strategies. This section will discuss the procedure for development of the preliminary task outline.

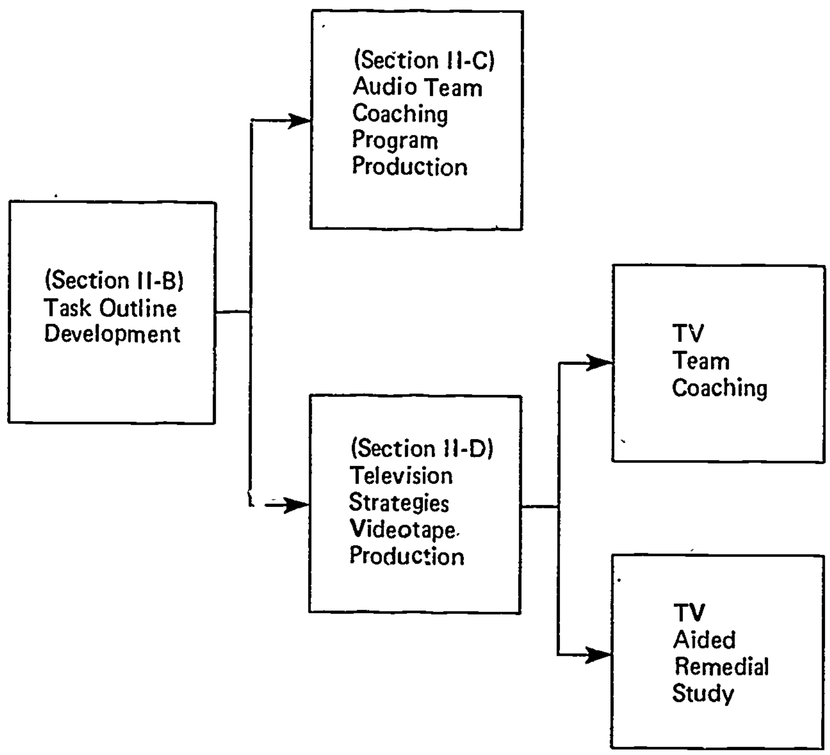

Figure 9. Relationship of Task Outline Development to Audio Team Coaching, Television Team Coaching, and Television-Aided Remedial Study

General Characteristics of Applicable Areas

The three strategies discussed here were designed to be used with team tasks which required a student to follow a prescribed procedure, while coordinating his activities with other team members. An example of a task which can be taught with these strategies is installing a preloaded Multiple Ejection Rack (MER) on the F-4D aircraft.

Although the strategies developed were oriented toward team task performance, they could be modified to teach individual tasks. For example, an airman could preview the use of the AN/PSM-6 multimeter, using the Television Coaching strategy; then be coached through a series of practice exercises, using the Audio Coaching strategy; and then, if necessary, be reviewed on individual elements of the use of the multimeter, using the Television-Aided Remedial Study strategy).

Preliminary Task Outline Development

Figure 10 shows the procedure which was followed to develop a validated task outline. Each of the steps are discussed separately below.

Establish Goals. Instructional goals were established to guide the development of the Television Team Coaching, Audio Team Coaching, and Television-Aided Remedial Study strategies. The goals were general descriptive statements of the characteristics of the instructional materials. The goals included limitations for the application of materials (e.g., materials had to be capable of being used by the students without requiring substantial instructor support). The goals differed from instructional objectives, in that they were general statements of desired instructional outcomes. The primary goal for this project was to develop materials which would allow students to achieve proficiency in team coordination for the performance of specified team tasks. In general, the goals were:

1. To familiarize students with the overall organization and work flow of the task prior to their first attempt at task performance

2. To provide each team member with individualized coaching tailored to the stage of practice and team proficiency.

3. To provide remedial instruction for individual students having difficulty performing the duties of their team position.

The target task selected by the Weapon Mechanic (TAC) course personnel for development was the installation of a preloaded Multiple Ejection Rack (MER) on the outboard pylon of the F-4D aircraft.

Choose Strategy and Media. The decision to utilize audio and video strategies was based on an examination of the instructional goals, the characteristics of the tasks to be learned, and the cost-effectiveness parameters (e.g., materials preparation time, student working time, equipment requirements, etc. as outlined in Air Force Manual 50-2, Instructional Systems Development).

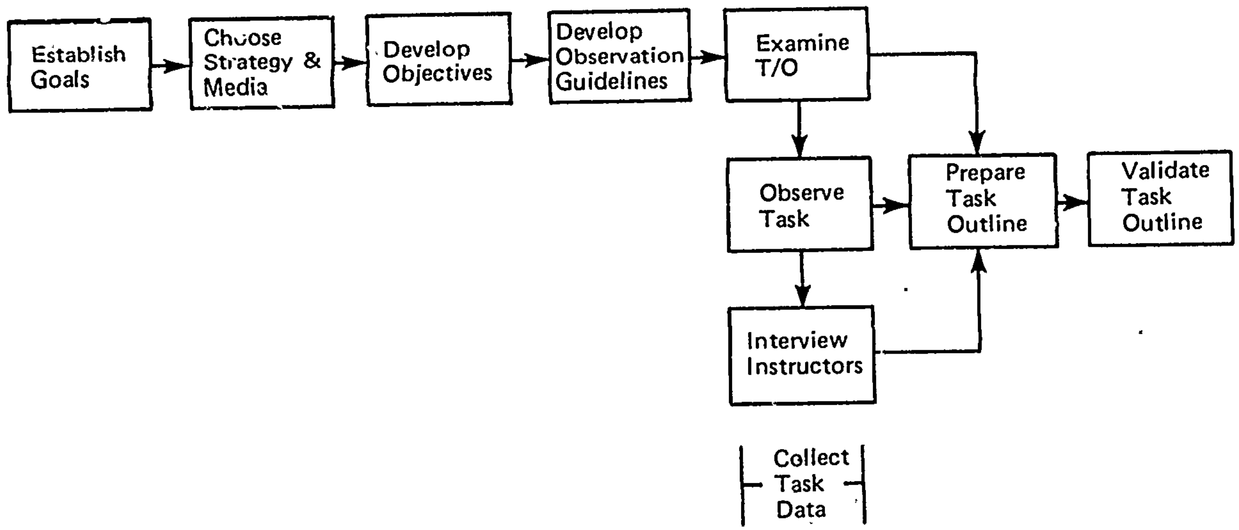

Figure 10. Task Outline Development and Validation Procedure

The decision-making process used for selection of the optimum strategy/media combination is illustrated in Figure 11. The general procedure was to examine the types of stimuli associated with the task to be taught (e.g., visual, auditory, etc.); the required student performance (e.g., use of hand, communication with others, etc.); and the instructional goals. If the task contained substantial visual stimuli, the strategy required a visually oriented medium. If the task was largely manual, the strategy was to employ visual stimuli, together with the action of the student's hands. If the instructional goal required minimum instructor support, the strategy was to feature student-controlled or equipment-controlled presentations.

In the case of loading a preloaded MER, visual stimuli were important and students were required to work with their hands. Therefore, the appropriate instructional strategy had to incorporate visually oriented media identifying the stimuli and depicting the manual performance required of the students. However, no single strategy could satisfy all three instructional goals. Therefore, it was necessary to select a separate strategy for each goal. A visually oriented strategy was selected to familiarize the students with the overall work flow of the task. Strategies incorporating both visual and auditory media were also selected since visual and auditory cues had to be presented as well as the position and actions of job performers. Television was selected for these uses because of low materials preparation costs. An audio-oriented strategy was selected to provide coaching to each team member during task practice. The audio strategy was chosen primarily because of the necessity of providing individualized coaching to team members performing coordinated job tasks in different locations. Finally, a television-oriented strategy was selected to provide remedial instruction to individual team members.

Develop Behavioral Objectives. The general instructional goals were converted into specific learning objectives. To assure that objectives were written to support the development of the instructional material, the following questions were asked:

1. Does the behavior described actually reflect the underlying goal which is to be achieved?

2. Has the student's behavior been described in such a way as to allow detection of the behavior when it occurs?

3. Are the conditions under which the performance is to be observed clearly specified or implied?

4. Is a standard of performance given?

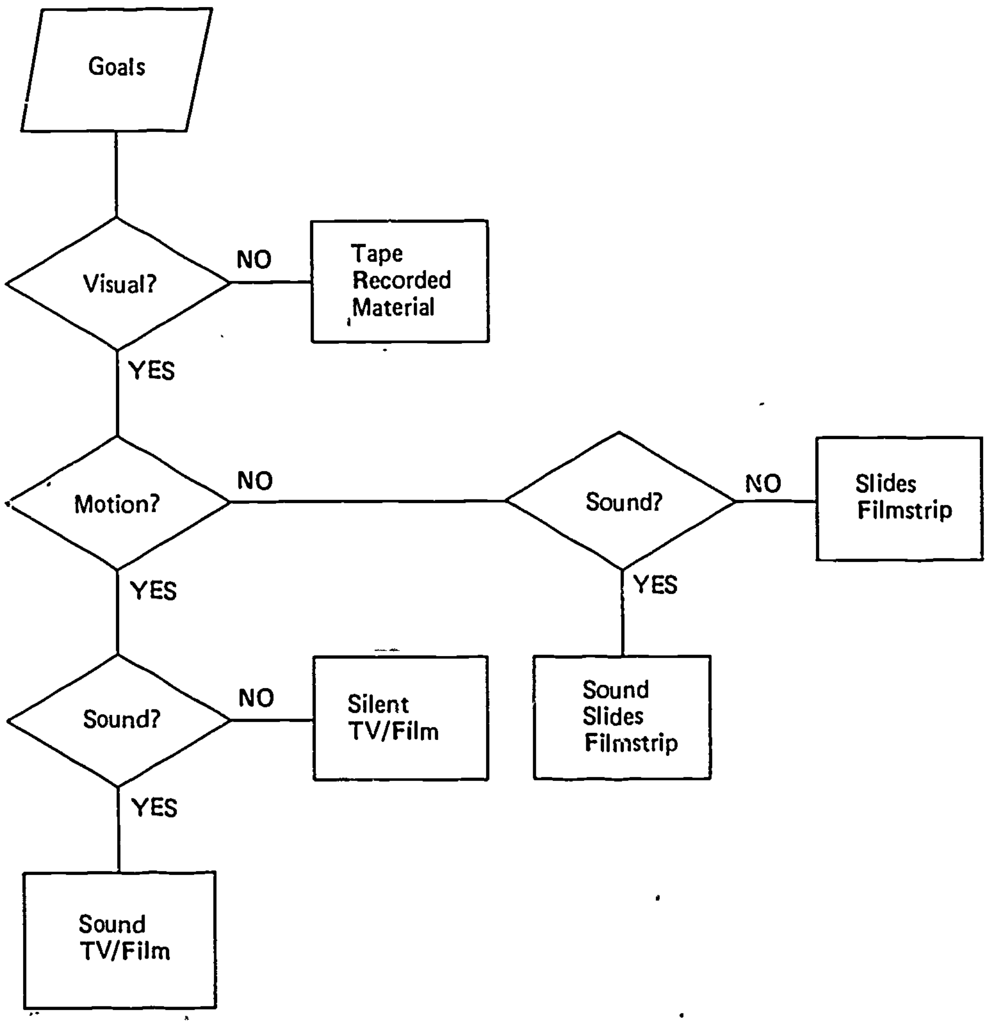

Figure 11. Sample Decision Tree for Selecting Appropriate Instructional Media

Table II shows the program goals and the behavioral objectives developed for each of the goals. It should be noted that not all goals have objectives. In these cases it was decided that the goal statement itself was sufficiently explicit to specify its achievement. Several assumptions were made concerning the prerequisite skills and knowledges of incoming students. These assumptions were based on the location of the material in the course. It was assumed that the students would be familiar with the aircraft, weapons, and tools (i.e., they would know the nomenclature, location, and operation of necessary equipment items). Given these assumptions and the nature of the task to be learned (i.e., a fixed procedure requiring coordination among team members), it was felt that a hierarchy of objectives was not required for the instructional segments being developed.

Develop Task Observation Guidelines. Task parameters relevant to the goals and objectives were identified to limit the task observation. Task data sources were identified first. Three data sources were identified for the MER installation task and included Technical Order 1F-4C-33-1-2, direct observation of the task, and instructor interviews. Following identification of the data sources, the range of possible data elements was narrowed to include only those which were directly relevant to achieving the specified goals and objectives (e.g., since team member coordination was important, relative position of team members to one another would be noted). The duties of each team member had to be determined and recorded. Likewise, special hazards were noted, along with any discriminations which might be required. On the other hand, some elements of the task were judged to be unimportant to the achievement of the goals and objectives (e.g., selection of tools, due to the assumption that incoming students would already be familiar with tools and their use). In addition, ambient environmental conditions, if within acceptable ranges, were judged insignificant.

Collect Detailed Task Data. The task data collection procedure began with a review of the MER installation procedure as described in the Technical Order. A task outline was developed from steps identified during the development of task observation guidelines. Once the observer was thoroughly familiar with the task as described in the task outline, he observed actual task performance in the Weapons Mechanic school. Discrepancies between the original task outline and observed performance were noted for later clarification. The school method of task performance differed in several instances from the method given in the Technical Order. For instance, in the on-line environment, team members three and four were located on opposite sides of the aircraft and worked on different pylons. However, during training only one pylon is loaded at a time and therefore, team members three and four assist each other on the same side of the aircraft. Since student

Table II

Instructional Goals with Their Associated Behavioral Objectives

GOAL	OBJECTIVE
Install preloaded MER on outboard pylon of F-4D Aircraft.	Each student team member will perform each individual step procedure with not more than a 10 percent error rate. The student team will perform all steps - each step in its proper sequence. The student team will install the preloaded MER within a specified time limit.
Achieve proficient team member coordination.	Students will communicate only appropriate verbal instructions to one another using the proper terminology and format. Student teams will work together to accomplish all procedure steps without conflicting actions. Students will respond with only appropriate response upon completion of each task step.
Familiarize students with the task prior to their attempt to perform the task.	Student team members will make no position errors in locating equipment items. Students will be able to describe the sequence of tasks assigned to their team positions prior to attempting the task.
Students will receive a large amount of task support during early stages of practice.	Students will commit no more than 5 percent procedural errors in the early stages of practice.
Students will receive diminishing amounts of task support in later stages of practice.	
Remedial support will be provided for areas in which a student may have difficulty in achieving the performance criterion.	Each student team member will achieve criterion performance in the assigned team positions.

achievement in the course is evaluated in the training environment, the school method was chosen in preference to the on-line technique. Task performance was video taped in order to allow reviewing a task while correcting the task outline.

After observing task performance, the developer interviewed course instructors to assure accuracy in his observations and interpretations. Discrepancies between school method and Technical Order procedure were reviewed to be certain that differences were intentional and not the result of an oversight or misunderstanding on the part of the developer. Interviews with instructors were guided by specific questions based upon the data collected from the Technical Order and task observation.

Prepare Final Task Outline. Data collected from the Technical Order, from direct observation of the task being performed, and from interviews with instructors were used to write a final task outline. The outline described the MER installation task as it was performed in the Weapons Mechanic school. Special care was taken to specify tolerances, stimuli needed for discriminations, and other special characteristics (e.g., position of swaybraces, positions of cockpit switches, etc.).

Validate Task Outline. The completed task outline was carefully compared to the list of goals and objectives to insure that all objectives related to task performance could be met (e.g., students would be able to prepare the aircraft for loading if they followed the procedure outlined). Some of the objectives could not be supported until a specific strategy was further developed. An example of such an objective was the requirement that students be able to describe the sequence of tasks assigned to their respective team positions prior to attempting the task. Support of this objective could not be checked until material for the Television Team Coaching strategy had been developed and tested. The task outline was submitted for review to technical experts who were familiar with the task. Problems found during the validation process were corrected and the corrections rechecked for accuracy.

The validated outline served as the basis for the production of Audio Team Coaching tapes (described in Section III-C) and Television Team Coaching or Television Aided Remedial Study videotapes (described in Section III-D).

III-C

Audio Team Coaching

General Characteristics

Applicable Areas. Audio Team Coaching was developed for use by students in the later blocks of the course since it was assumed that students would be familiar with the aircraft, weapons, and tools (i.e., they would know the nomenclature, location, and operation of necessary equipment items). This strategy was designed to teach students the skills needed to successfully perform tasks which required coordination between two or more individuals. The tapes for the Audio Team Coaching strategy provided all information required to talk each team member through a task. All cues and instructions needed for task performance were to be provided to each team member individually. Only those instructions required for a given team position would be given to the man working in that position (e.g., team member number 1 would receive only instructions relevant to position 1, while member number 3 would receive only instructions for position number 3). This was made possible through the use of a multitrack tape recorder with the instructions for each team member recorded on a separate tape track. Instructions were transmitted to the team members through earphones. However, since communication between team members was required, a single earphone was used by each student team member, thereby allowing the wearer to hear verbal commands and responses from fellow team members.

Description of Developed Materials. The Audio Team Coaching materials consisted of three separate tapes, designed for use at different stages of the learning process. Tape 1, used early in the learning experience, was the most complete of the three. It provided preparatory cues, performance instructions, and feedback information. The preparatory cues told the trainee what he would be doing next, and prepared him to receive the information given by the team leader reading the Technical Order, and by the coaching tape. Following the preparatory cue, detailed performance instructions were given, which told the student exactly what to do. These instructions included a description of stimuli essential for decision-making. The student was also given the verbal response with which to acknowledge completion of the step. Finally, a feedback cue was provided, to serve as a performance reinforcer (i.e., the student was told

what he should have done, and what the status of the equipment should have been, with correct performance of the step). Below is an example of a typical sequence of instructions provided to a single team member.

<u>Anticipatory cue</u>

"You will check canopy struts and seat pins."

<u>Performance instructions</u>

"Check that canopy safety struts are installed on canopy actuating arms just aft of ejection seat in each cockpit."

"Check that forward and aft ejection seat safety pins are installed. Slide your hand along the entire length of each streamer to verify that all safety pins are properly installed."

"If the struts and pins are missing, ask for assistance from the team leader, if the struts and pins are correctly in place, call out, 'Struts and safety pins installed'."

<u>Feedback cue</u>

"All safety struts and safety pins should be correctly installed."

Whenever possible, the wording used on the coaching tape coincided with the wording of the appropriate Technical Order, even if the tape repeated the step description as read by the team leader.

The second tape in the Audio Team Coaching package was used after the students mastered the task using tape 1. The second tape lacked most of the performance instructions, and provided students with only anticipatory and feedback cues. Tape 3 provided only feedback cues and was to be used after students had mastered each of the task steps and were familiar with the step sequence. Complete memorization of the step sequence was unnecessary, since the team leader was required to read the steps from the appropriate Technical Order as the task was performed.

<u>Makeup and Use of the Tape</u>. The Audio Team Coaching tape began with an introductory segment, which was identical for all team members. The introduction included:

1. Identification of the tape and a description of its objectives (e.g., "you will install a preloaded Multiple Ejection Rack on the outboard pylon of the F-4D aircraft").

2. Instructions to the students about how they were to perform and how they should use the audio coaching equipment (i.e., a brief description of the strategy).

3. Special instructions about safety procedures which had to be observed.

4. Identification of the team member position to which the student was listening. If the position was not correct (i.e., team member number 2 was listening to position number 3), students were told to exchange earphones.

Following introduction, the tape stopped automatically, to allow exchange of earphones as necessary. When the team was ready, the team leader restarted the tape, and the team position was repeated to assure that each member had the correct earphone. The first preparatory cue followed a short pause, during which the tape could be stopped and phones exchanged again.

Figure 12 gives a graphic representation of the action of the tape during a typical coaching segment. The tape stops automatically after the first preparatory cue. Following the preparatory cue, team member number 1, the team leader, reads the first step from the Technical Order and then restarts the tape. When the tape is restarted, performance instructions are given to each of the team members. When the last (longest) performance instruction has finished, the tape automatically stops. As each team member finishes his task, he reports verbally to the team leader. When all team members have finished, the team leader restarts the tape. The tape then provides a feedback cue, which is a statement of the required equipment status. If the equipment is not in the required status, an error has been made and the tape is stopped by the team leader until the error has been corrected. If no error was made, the tape continues to run until the next preparatory cue is given. The tape recorder again stops while the team leader reads the appropriate section of the Technical Order. Following this, the leader restarts the tape. The tape then gives the next set of performance instructions to the team, and stops. When all team members have reported completion of the step, the team leader restarts the tape which gives the feedback cue, followed by the next preparatory cue. This procedure continues throughout the remainder of the coaching tape.

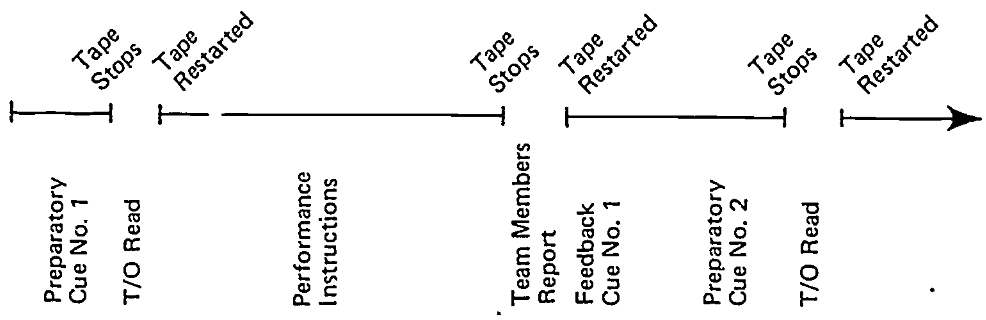

Figure 12. Tape Recorder Action During Typical Audio Team Coaching Segment

Audio Team Coaching Tape Production

As shown in Figure 13, production of Audio Team Coaching materials was a continuation of the procedure used to produce a validated task outline. The tape production procedure as shown in Figure 14 is described here.

Assign Steps to Team Members. The task selected to demonstrate the use of the Audio Team Coaching Strategy was the installation of a preloaded Multiple Ejection Rack (MER) on the outboard pylon of the F-4D aircraft. This task involved a four-man team, although variations of this strategy could be used for teams with any number of members as well as for individual task performance. (However, a four-man team was the largest number that could be handled with a single four-track tape playback unit, which was necessary to provide simultaneous instructions to four team positions.)

Each of the task steps given in the task outline was reviewed by instructor personnel, and a team member was assigned to perform the task. The use of instructor personnel to assign steps to team members assured that the resulting Audio Team Coaching tape would reflect standard procedures used by the school.

Prepare Script. The script for all team positions was written and worded to reflect the relevant sections of Technical Order 1F-4C-33-1-2 (i.e., the steps and instructions found in the Technical Order were repeated in the tape script verbatim whenever possible). This was done to facilitate positive transfer from the learning environment to the job situation since students would eventually have to rely entirely

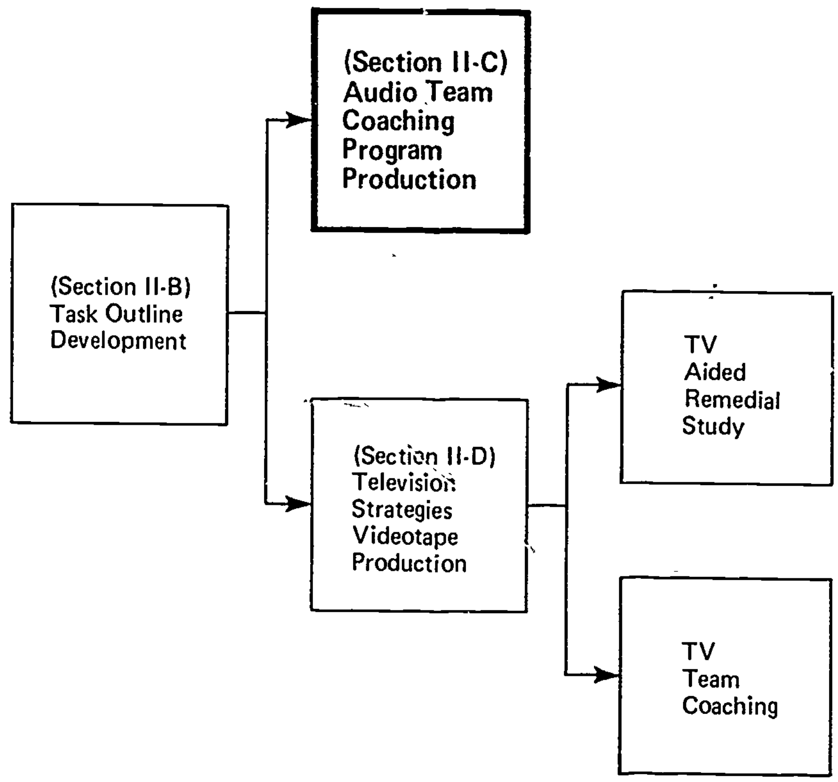

Figure 13. Relationship of Audio Team Coaching Program Production to Task Outline Development

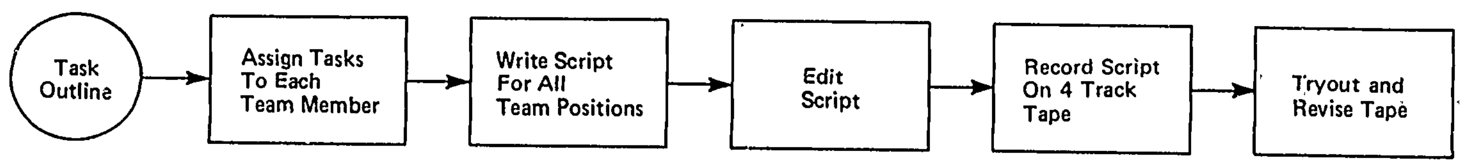

Figure 14. Production Procedures for Audio Team Coaching Tapes

upon information found in the Technical Order. Figure 15 is a sample segment of the script showing both the team member designation and the narration provided.

The script for Audio Team Coaching tape 1 was written first since this script was the most complete of the three team coaching tapes. The script contained preparatory cues, detailed performance instructions, and feedback information for all task steps. The scripts for tapes 2 and 3 were created by eliminating material from the script for tape 1 (i.e., performance details were eliminated for tape 2, and performance details along with preparatory cues were eliminated for tape 3). The product which emerged from the script writing activities was an account of all preparatory cues, performance instructions, and feedback information for each team position.

Edit the Script. The script was edited to eliminate potential problems. Technical inaccuracies were identified and corrected. The script was compared to the task outline to insure that it followed the procedure specified. Special attention was given to the identification of superfluous and trivial information which could be eliminated without impairment to the comprehensibility of the script. Preparatory cues were examined to assure that they specified the step which was to be performed. Performance instructions were inspected to insure that enough detail was provided to allow the student to perform the task step. An instruction was rewritten if it was decided that the student might have to ask for clarification or search for additional information before he could successfully perform the step. Feedback cues were checked to assure that they accurately described the equipment's condition when the step had been correctly performed. Once it had been determined that the material was complete and accurate, the language style was reviewed to insure that it would be easily comprehended by the student. Whenever possible, words which were judged to be foreign to the student were eliminated. Where elimination was impossible, suspect words were defined.

Record the Script. The script sections associated with each team position were recorded separately on a single track of a 4-track tape. The recording environment was quiet and free from distractions. Before beginning recording, several practice segments were made to allow the narrator to establish the desired voice inflections, intonations, and speed. The narrator spoke at a moderate rate and with a steady voice.

The narrative for each of the four team positions was recorded on its respective tape track for each task step before proceeding to the next step. This procedure assured that there would be adequate spacing on the tape for all information pertaining to any step before any information was recorded for the next step. Figure 16 illustrates the necessity for recording all tracks simultaneously. Narration of the

Team Member	Narration Script
3&4	You will now check that the cartridges are removed.
1	Read from the T.O., "Check that cartridges are removed from all pylon, racks, launchers, and SUU-20 dispensers."
3&4	You should now examine pylon breech. The cartridge has been removed from the breech if sleeve is visible.
3&4	If the hex head of retainer is visible, unscrew the retainer with a wrench and remove the cartridge from the breech. Now reverse the retainer (open end out) and screw into the empty breech. When finished, call out, "Cartridges removed."
1,3&4	All cartridges should be removed and breech sleeves visible.
2	You will now check the canopy struts and seat pins.
1	Read from the T.O., "Check that canopy struts and seat pins are installed."
2	Check that canopy safety struts are installed on canopy actuating arms just aft of ejection seat in each cockpit.
2	Check that forward and aft ejection seat safety pins are installed. Slide your hand along the entire length of each streamer to verify that all safety pins are properly installed. When finished, call out, "Struts and safety pins installed."
1&2	The canopy and seats are safe to work around if the struts and seat pins are in place.
2	You will now check Form 781.
1	Read from the T.O., "Check Form 781 for aircraft status."
2	Check aircraft Form 781 for aircraft status and configuration for weapons loading. When finished, call out, "781 checked."
1&2	The aircraft status as indicated on Form 781 should confirm that weapons can be loaded.

Figure 15. Sample of Audio Team Coaching Script

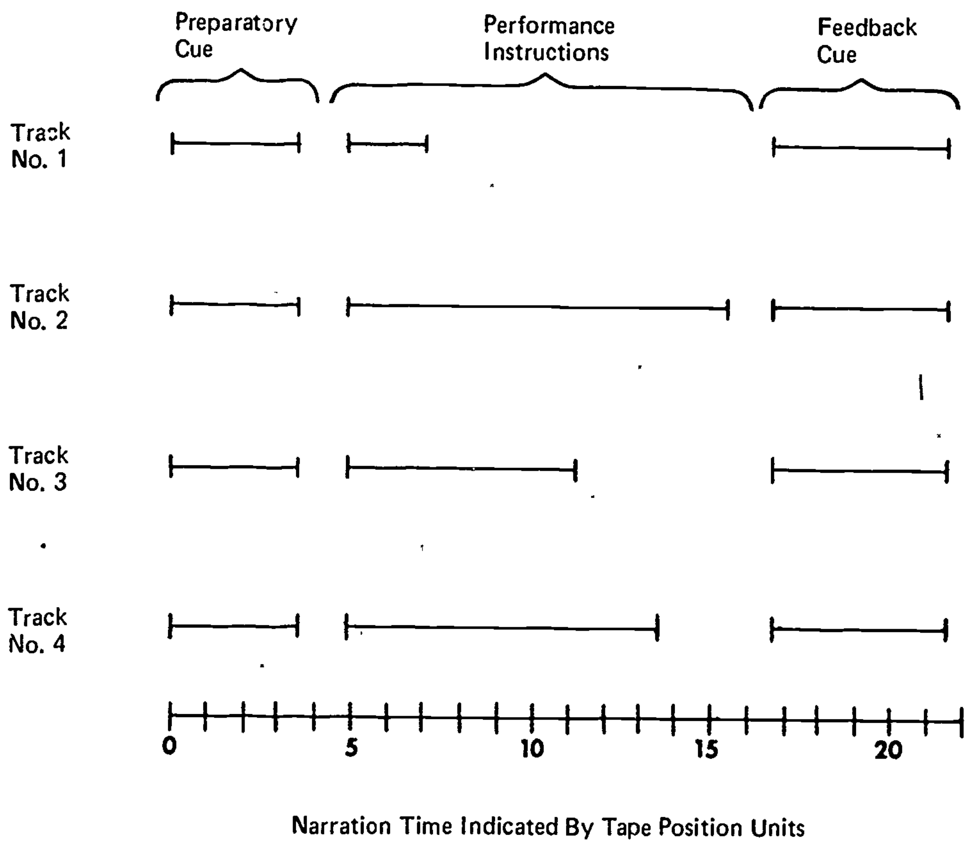

Figure 16. Illustration of Tape
Narration Time Relationships

preparatory cues recorded on tracks 1 through 4 respectively, took an equal amount of time for each position. Since the time required for the preparatory cue was 0 to 3 tape units, it was possible to start the narration of the performance instructions at tape position 5. The performance instructions required from 2 to 10 tape units for the various team positions (i.e., the tape would reach position 15 before team member number 2 had received all of his instructions). Since the next element of information, the feedback information, could not begin until team member number 2 had completed his task, feedback for all team positions could not be begun until tape position 17, as shown in Figure 16. Since nothing had been recorded for team members 1, 3, and 4 between the end of their performance information and tape position 17, these team members would hear nothing from the end of their performance instruction to the feedback cue. Because of these necessary silence intervals, students were alerted by a short beep signal recorded just before the beginning of audio instructions.

<u>Test Final Tape</u>. The accuracy of the final tape was evaluated by comparing each tape track against the script. This evaluation also included examination of the quality of the recording (e.g., absence of garbled instructions and background noise) and the synchronization between the various tape tracks.

Once the master tape (original tape) had been verified, additional tapes were made to prevent loss of the taped information through the accidental destruction of the master from incorrect operation of the tape playback machine or other causes.

III-D

Television Strategies

(Television Team Coaching and
Television-Aided Remedial Study)

General Characteristics

Applicable Areas for Television Team Coaching. This strategy was developed for use by students in the later Blocks of the Weapons Mechanic Course. While the materials developed for this project were designed to provide students with a preview of task procedures prior to their first attempt to perform the task, the materials could also be used to support student review of the task, to refresh their memories, and to reemphasize critical aspects of selected task steps (i.e., bolt positions, safed components, etc.). The task chosen to demonstrate the videotaping procedure was the installation of a preloaded Multiple Ejection Rack (MER) on the outboard pylon of the F-4D aircraft.

Description of Television Team Coaching Materials. These materials consisted of a videotape presentation of an entire team task, minus dead time. (Dead time refers to periods when team members were not actually performing--waiting for a bomb lift truck to move into position, waiting for the next task step to be read, etc.

A typical Television Team Coaching videotape began with an introductory segment consisting of an identification of the videotape and a description of its objectives (e.g., "You will view the installation of a preloaded Multiple Ejection Rack (MER) on the outboard pylon on the F-4D aircraft"). The remainder of the tape showed each of the steps necessary to accomplish the objective. Whenever critical task elements occurred (i.e., difficult, dangerous, or otherwise exceptionally important steps), the videotape highlighted these elements by focusing upon the critical aspects of performance. As a step was shown, it was verbally described on the audio track of the videotape. Special instructions, comments, and warnings were also provided.

Television Team Coaching videotapes could be viewed by individual students or by entire teams. Each student viewing the presentation followed the procedure in a copy of the appropriate Technical Order,

which provided him with the opportunity to associate the Technical Order procedure with a visual representation of the task. The only limitations on the number of students who could simultaneously observe a presentation were the size and number of the television monitors and the number of copies of the Technical Order available. For maximum usefulness, the tape had to be viewed by a single student to allow reversing and replaying of tape segments as desired. A nondistracting viewing environment was essential.

Applicable Areas for Television-Aided Remedial Study. This strategy was intended for use by students who found difficulty in achieving the specified performance criteria. The strategy was designed to provide students with a detailed review of the procedures associated with a single team position.

Description of Television-Aided Remedial Materials. For this strategy, the focus of the videotape was on the behaviors of a single team member (e.g., a tape of the actions for team member Number 3 showed the step-by-step activities required of that team member). The Remedial Study tape presented the task minus dead time (i.e., time during which team member was not actually performing). If other team members were performing, their tasks were briefly described on the audio portion of the tape.

Television Aided Remedial Study has the same advantages as Television Team Coaching in terms of accuracy, repeatability, and flexibility. The tape begins with an identification segment which specifies the tape's objectives (e.g., "You will review the behavior sequence of load team member Number 3 during the installation of a preloaded Multiple Ejection Rack on the outboard pylon of the F-4D aircraft"). The remainder of the videotape shows the steps necessary to accomplish the objective. Difficult, dangerous, or otherwise exceptionally important steps are emphasized.

Videotape Production

Both Television Team Coaching and Television Aided Remedial Study shared the same development process; therefore, no distinction is made between them in the following discussion of the videotape production. The production of videotapes used in the television strategies, as shown in Figure 17, is a continuation of the procedure used to create the task outline described in Section III-B. The television videotape production procedure is depicted in Figure 18.

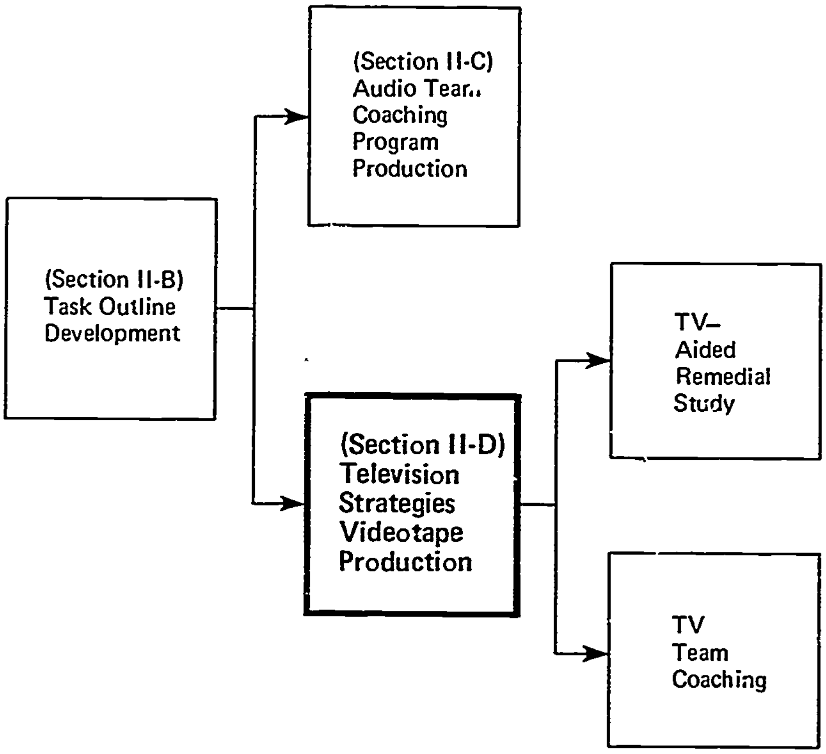

Figure 17. Relationship of the Television Strategies Videotape Production to Task Outline Development

Writing the Script. The videotape script consisted of two parts, camera directions and audio script. Figure 19 is a segment of the script. The scene description, camera location, camera motion, etc., were determined by studying the task outline. In addition, instructor personnel were questioned about the task to assure that all appropriate activities would be recorded on tape.

There were two categories of scenes to be taped. The first consisted of shots showing team members performing their duties. These scenes were taped during actual task performance and did not require special staging or interruption of on-going activities. The second category of scenes consisted of those which required special setups (e.g., close-ups of special features, such as sway brace settings, switch positions, etc.). The two categories of scenes were recorded at different times and combined later to form the finished videotape.

An audio script was also written for each scene. Wherever possible, the audio script followed verbatim the relevant sections of Technical

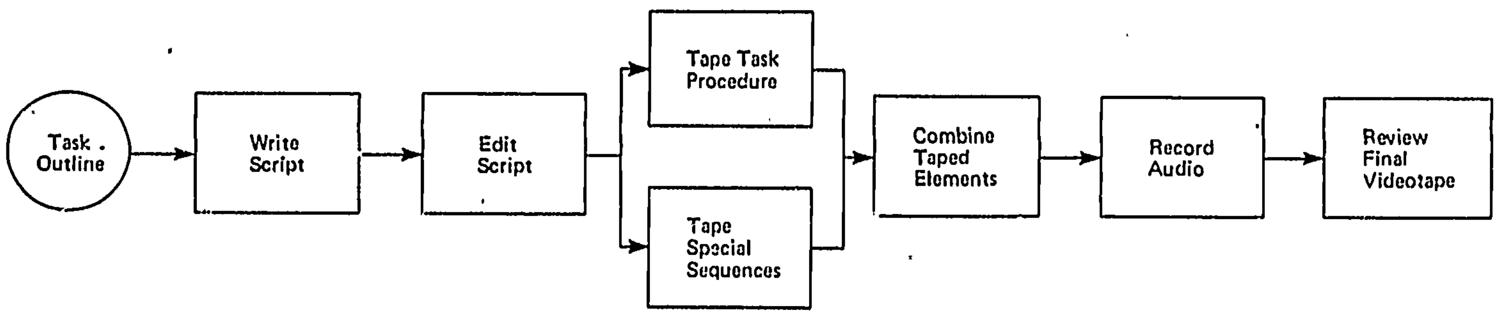

Figure 18. Production Procedure for Videotape Strategies

Scene	Video	Audio
48	Camera; Forward of wing and inboard of pylon. Action; Show team members 3 & 4 check the forward and aft inboard swaybrace bolts and ejector feet.	"Check that lower swaybraces on MER shoulder stations and outboard armament pylons and ejector feet are present."
49	Camera; Cut to close-up of swaybrace bolt.	"Eleven threads should be showing above the lock nut on the inboard swaybrace bolts."
50	Camera; Cut to close-up of ejector feet.	"Ejector feet should be backed off until three threads are showing."
51	Camera; Dolly from inboard of pylon position to outboard of pylon -- remain forward of wing. Action; Show team members 3 & 4 checking outboard swaybraces.	"Check that all other swaybraces are backed off."
52	Camera; Cut to outboard side view of pylon and zoom to close-up of hook lock indicator.	"Check that rack hooks are open." - pause - "Red shaft should not be visible on hook lock indicator."
53	Camera; Cut to view of rack hook, camera to outboard side of pylon. Action; Show team members 3 or 4 close and open rack hook using a wrench.	"Close and open the rack hook to verify the hooks are open."

Figure 19. Segment of Television Team Coaching Script

Order 1F-4C-33-1-2. This was done to facilitate transfer of training to the work situation in which students would have to rely on information found in the Technical Order.

Edit the Script. Technical inaccuracies were identified and corrected by comparing the script to the task outline. Superfluous and trivial information was identified and eliminated wherever possible without impairment to the comprehensiveness of the script. The camera script was carefully reviewed to assure that all camera positions indicated in the script could be accomplished (i.e., impossible requirements were not written into the script). Once completeness and accuracy had been determined, the language of the audio script was examined to insure that it could be comprehended by the students. Words which were judged to be foreign to the student were eliminated if possible, or defined.

Tape Task Procedure. A backpack portable television camera and a half-inch videotape recorder were used. The cameraman carefully followed the shooting script to be certain that all necessary activities were recorded. However, unexpected movements by team members and the presence of stray light which would shine directly into the camera lens made it necessary to deviate slightly from the shooting script. Nevertheless, the activities which were designated in the script were recorded as directed. Careful attention was given to noting all errors in task performance as they occurred so that they could be eliminated from the final tape.

Tape Special Sequences. The taping of the special setups was accomplished with the portable backpack television camera. The special sequences included close-ups, stills, and special staging effects (e.g., a finger pointed to parts of the ejection rack as they were named). The cameraman carefully followed the shooting script to assure that all necessary elements were recorded. Errors in recording were noted for later removal from the finished videotape.

Combine the Video Recordings. The two tapes were combined to form the final video tape. Two half-inch videotape recorders were used to combine the tapes. A recorded tape was placed on one of the machines while a blank tape was placed on the other. Desired segments of the recorded tapes were transfered to the blank tape. The script (procedure and special sequence shooting scripts combined) was used as a guide for sequencing scenes in their proper order. Whenever possible, poor quality pictures were edited from the final tape as was dead time (i.e., time during which the team members were not actually performing). Errors in team performance or camera scenes noted during filming were also edited from the final tape. The result of the tape editing process was a single videotape showing the steps required to install the MER including close-ups and still pictures of critical aspects of the task.

Record the Audio Portion. The audio portion of the videotape presentation was recorded as the narrator viewed the final tape on a television monitor. The recording environment was quiet and free from distractions. Before beginning the initial recording, several practice segments were made to allow the narrator to establish the desired voice inflections, intonations, and speed. During the recording activities, the narrator spoke at a moderate rate and with a steady voice. As the narrator read the script, he carefully compared the scene description from the script with the picture on the monitor to insure that the narration and picture were matched.

Review of the Final Tape. The completed videotape with its narration was reviewed to assure that it followed the script and that the sound was correctly associated with its corresponding scene. Garbled narration was corrected and surviving rough spots in the video portion were eliminated if possible (essential material could not be eliminated from the tape even if it was rough). Once the master tape (original tape) had been checked, additional tapes were made to prevent the accidental loss of the taped material through incorrect operation of the videotape playback machine or other causes.

III-E

Computer-Assisted Instruction (CAI) for Troubleshooting Performance

General Characteristics

Applicable Areas. The CAI for Troubleshooting Performance strategy was developed for use early in the Weapons Mechanic Course. The development assumed only that students could read component block diagrams. The CAI strategy was designed to teach a general approach which could be used in troubleshooting any complex hardware system and was not tied to any specific hardware system. To tailor the general strategy for use in teaching troubleshooting procedures in specific systems, the generalized component items of the component block diagrams can be replaced with the names of specific equipment items. Likewise, the relationships between components may also be adjusted to correspond with the target system.

By using both the general and specific applications of this strategy, students can be taught a general troubleshooting approach early in the course. This is followed with practice using the general approach on actual system configurations as they occur throughout the course (e.g., after learning the general approach, students can practice the approach by troubleshooting malfunctions in a simulated F-105D Linkless Feed System). The strategy can be further elaborated to include use of test equipment in conjunction with system simulators to provide actual troubleshooting performance on a unique hardware system.

Description of the Strategy. The CAI for Troubleshooting Performance provides practice in the cognitive skills required for troubleshooting performance. The student is presented with specific stimuli. Based upon these stimuli, he then decides what action should be taken. The stimuli in a CAI troubleshooting practice sequence typically consist of a malfunction symptom (e.g., there is no output signal from a system of components). Given the symptom (lack of an output), the student must decide what action to take. The initial action usually consists of some sort of check (e.g., is the system turned on, is there an input signal). Feedback provided by the computer is based upon the action taken by the student and provides the student with additional or altered stimuli which he uses as the basis for further action. In

essence, the computer simulates the operational characteristics of the system being troubleshot and the student makes the decisions and indicates the actions to be taken. Figure 20 illustrates the interactive relationship between the computer and the student.

CAI Program Development

The CAI strategy development process, as shown in Figure 21, ended with the production of a program flow chart. Further development was contingent upon software development, which was in abeyance, pending the acquisition of hardware for the Advanced Instructional System (AIS).

CAI is a sophistication of the earlier programmed instruction (PI) strategies. Many of the activities required for the creation of CAI are similar to those used for the production of PI. Therefore, some of the procedures described in Section III-A of this Report, Programmed Instruction for Schematic Symbol Recognition, will be repeated here. This duplication eliminates the necessity for referring to a separate section of the report while describing the CAI strategy.

Develop Behavioral Objectives. The CAI developer's first task was to convert general educational or training goals into clear, concise statements describing terminal behaviors.

The terminal objective was written first. This objective described what a student should be able to do when he finished the CAI program. The terminal objective was:

ACTION

Identify the malfunctioning component in a block diagram of a complex system incorporating feedback loops and switches which change the system's configuration

CONDITION

1. Given the sytem block diagram

2. Given the system state (i.e., configuration as defined by switch settings)

3. Given a symptom pattern (i.e., a list of system outputs and whether each is in- or out-of-tolerance) for each possible system state

4. Given the condition of the signal at the output of each system compon

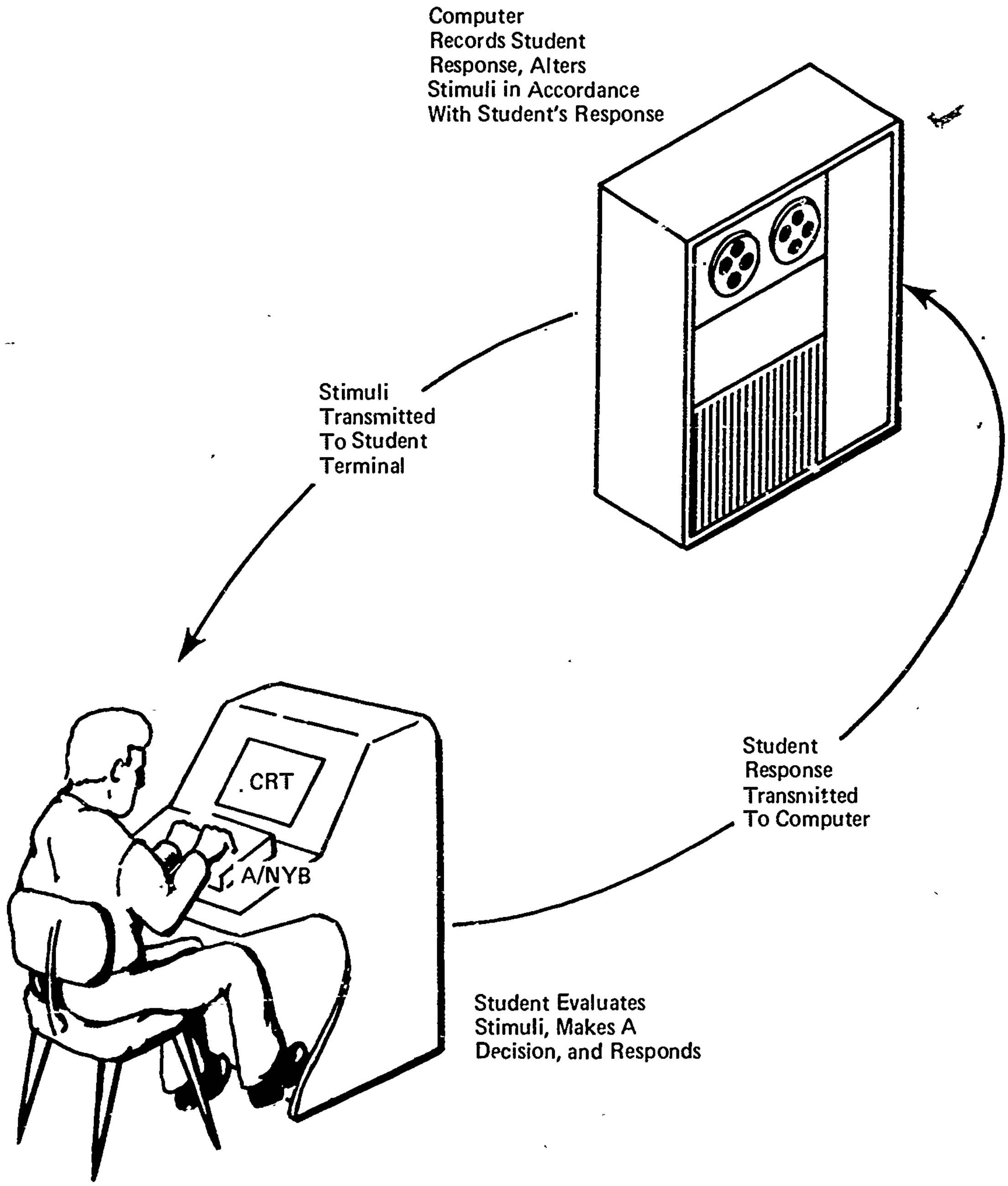

Figure 20. Relation Between Student and Computer in CAI System

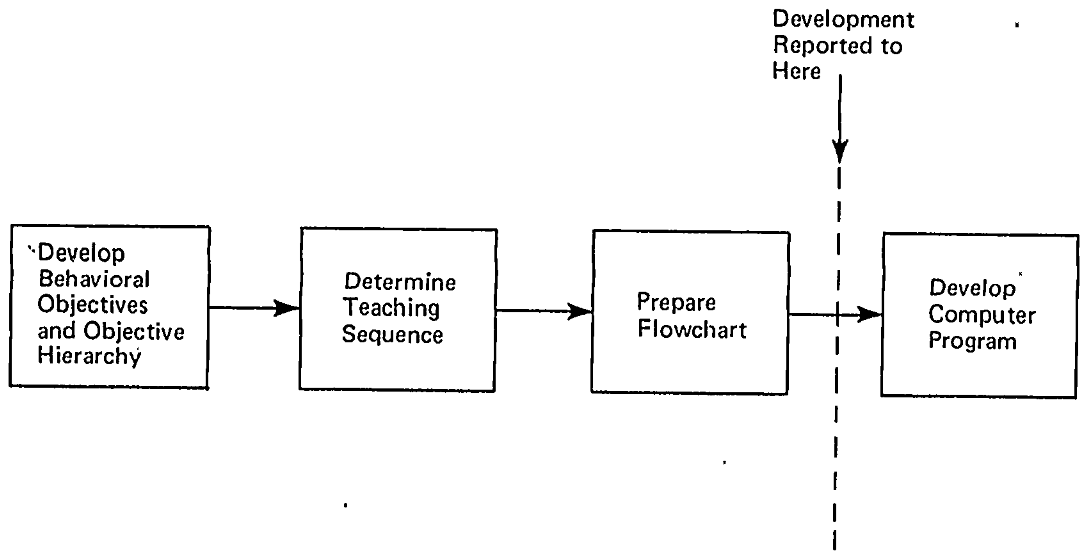

Figure 21. Development Procedure for CAI for Troubleshooting Performance

STANDARD

Not more than one error will be made in ten problems.

To assure that behavioral objectives were written to support program development, the following questions were asked:

1. Does the stated objective accurately reflect the skill or knowledge to be learned?

2. Has the student's behavior been described in a manner which will allow a computer to detect the behavior when it occurs?

3. Are the measurement conditions clearly specified?

4. Is a standard for the measurement specif. :d?

A hierarchy of objectives was started by questioning the terminal objective, "What skills and knowledges are needed before this task can be performed?" The answer served as the basis for the development of subordinate objectives. To answer this question, a skill statement was written describing the underlying skill or knowledge requirements. This was followed by a statement of a behavioral objective which would provide a demonstration of the skill. This process of writing an objective, then asking what skills and knowledges were required to achieve the objective, continued until a task was desc-ibed which the programmer assumed all incoming students could perform. This process yielded an exhaustive hierarchy of objectives which insured that properly sequenced material for teaching all necessary skills and knowledges would be included in the program. Figure 22 shows a segment of the hierarchy. The objective statements in Figure 22 contain only the action part of the objective. However, complete statements, including the actions, conditions, and standards were used for actual program development. The objective statement located below the dashed line in Figure 22 was considered a prerequisite skill which would be possessed by incoming students. Prerequisite skills and knowledges were tested at the beginning of the CAI program. If a student demonstrated inadequate mastery of the prerequisite skills, he was not allowed to continue the program and was directed to the appropriate remedial instructional unit.

<u>Determine Teaching Sequence</u>. The hierarchy of objectives was used to guide the sequencing of program materials. Several guidelines were considered while using the hierarchy of objectives to guide program sequencing:

1. The hierarchy represented only a suggested sequence of steps through which learning could proceed effectively.

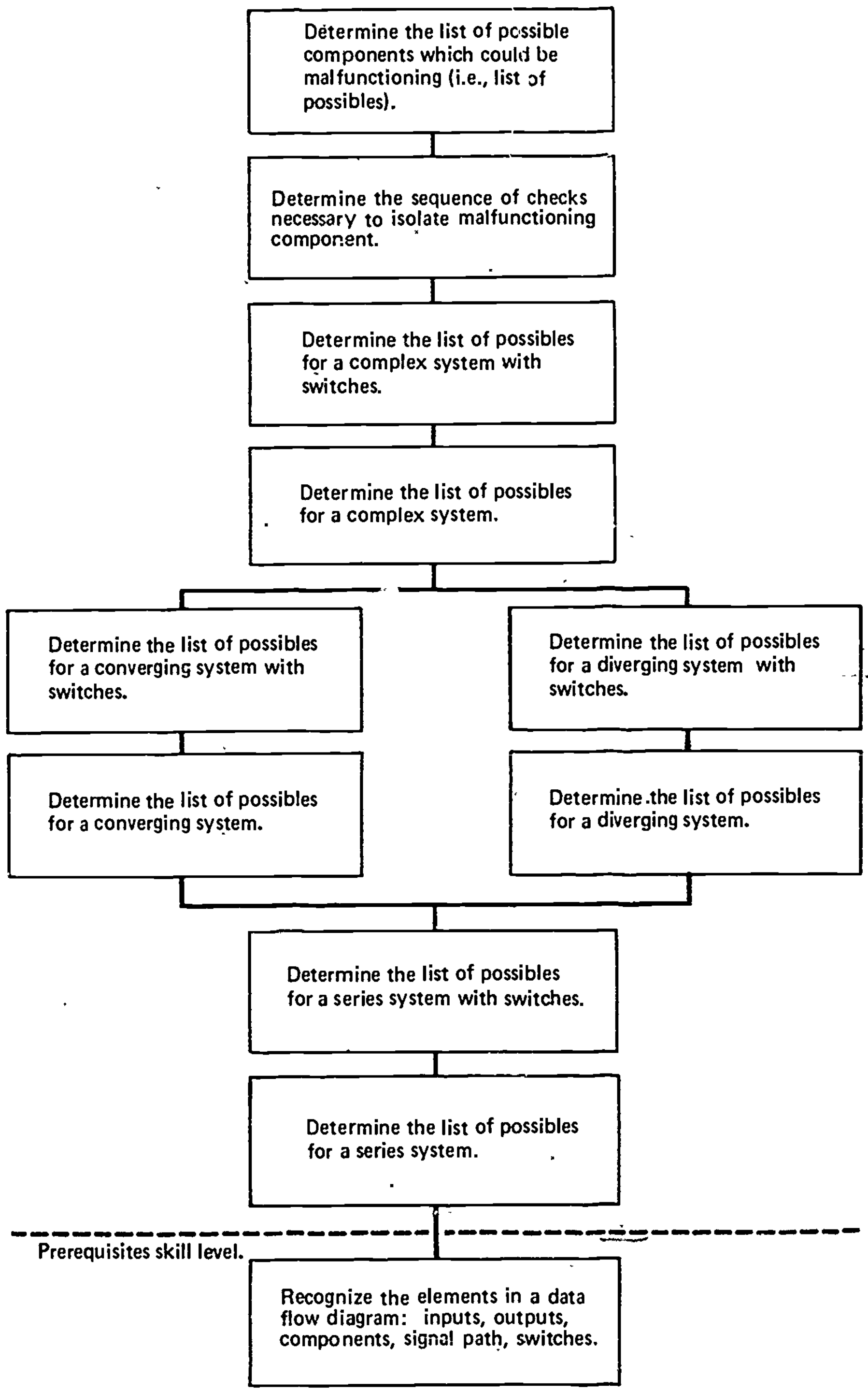

Figure 22. Partial Hierarchy of Trouble-shooting Performance Objectives

2. Some parts of the hierarchy were based on a necessary prerequisite ordering (i.e., it would not be possible to master a given objective unless the one immediately prior to it had been mastered).

3. Other parts of the hierarchy were based on a judgment ordering (i.e., it would be most efficient to master the objectives in a given order).

The hierarchy of objectives served the following essential purposes during the sequencing process:

1. It provided the program developer with a clear specification to guide the production of materials which would permit the student to acquire the skills defined by the objectives.

2. It assured that the student would have been taught all requisite skills and knowledges prior to his attempt to achieve an objective.

3. It provided the program developer with an indication of the branching routines required should a student have difficulty achieving an objective.

The hierarchy of objectives contained two major divisions (Figure 22) one dealing with skills required for the performance of malfunction isolation checks, and the other dealing with skill required for the development of a list of possible malfunction causes. It was decided to combine the two divisions into a single linear instructional sequence. This decision was based upon two educational principles:

1. Learning is facilitated by moving from simple to complex concepts, and

2. Retention is enhanced by minimizing the time lapse between the acquisition of a new concept and its application.

The resulting structure for the CAI program is illustrated in Figure 23. The program began with a test of the prerequisite skills and knowledges, and proceeded to introduce simple series systems (i.e., systems containing few components which were linearly associated with one another). After introduction of the simple series system, students were given appropriate isolation checks. This was followed by procedures for determining the list of possible malfunction causes in the simple system. Once mastery of these concepts was demonstrated by the student, the program introduced a more complex system (i.e., series systems with switches). The student would then apply the learned concepts to a more complex

situation. When the student had successfully applied the old concepts, additional concepts were taught. This procedure of introducing progressively more complex systems, requiring the application of previously learned concepts, and the teaching of new concepts continued until the terminal objective was obtained.

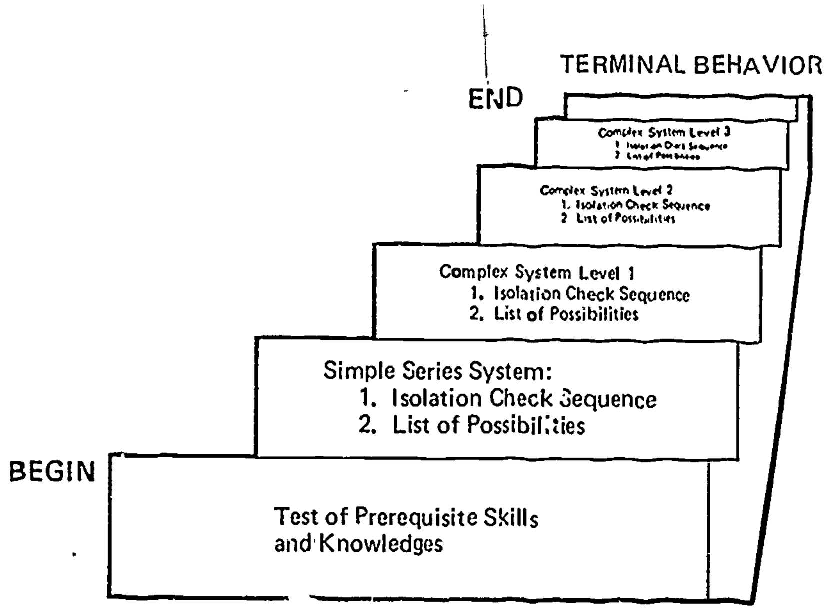

Figure 23. Program Structure

The student's progress was evaluated through his performance on practice problems related to each objective. Remedial sequences were developed for each evaluation point in the program. Figure 24 illustrates a typical remedial sequence. The remedial sequence usually provided the student with additional instruction on the single concept needed to achieve a given objective. In later portions of the program, remediation was accomplished by directing the student to see his instructor since the program could not discriminate between careless errors and concept [illegible]s. The instructor, through questioning of the student, could eliminate the possibility of careless errors, and then either tutor the student or reenter him into the program at the appropriate point.

Prepare Flowchart. The program flowchart was drawn following the determination of the teaching sequence. The flowchart guided the computer programmer in the execution of his duties. The complete flowchart is presented in Appendix C. Standard flowchart symbols are used; circles represent inputs and outputs, rectangles represent instructional operations, and diamonds represent decisions based upon student performance.

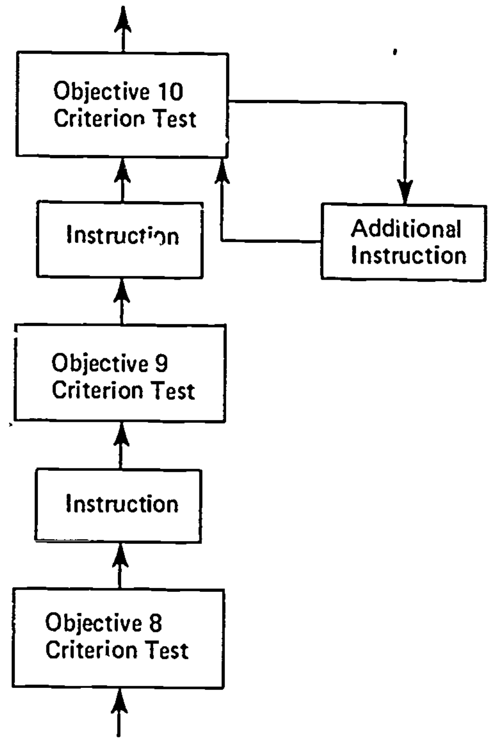

Figure 24. Illustration of the Relationship of a Typical Remedial Sequence to the Main Program Flow

The flowchart shows only the concepts to be taught and the decisions to be made based on student performance. Details of computer record keeping and specific characteristics of the systems diagrams to be used as teaching aids are not included. Since the nature of these items depends upon the specific materials used and computer program requirements, completion of the flowchart is contingent upon the production of actual teaching materials and the identification of computer programming language characteristics. Development of the flowchart was based on a set of assumptions concerning the type of computer terminal to be used by the students. It was assumed that the terminal would be interactive and would possess the capability to present graphic stimuli. In addition, it was assumed that the terminal would be capable of accepting and displaying student responses in English text. It would be desirable for the response display to be local, thus providing the student an opportunity to evaluate his response before transmitting it to the computer for evaluation and scoring.

SECTION IV

DEMONSTRATION OF SELECTED STRATEGIES

Objectives

Phase III of the project demonstrated the feasibility of applying several of the developed strategies. The feasibility demonstrations were not intended to show that a given strategy could be used to achieve specific instructional objectives. The demonstrations concerned only the practicability of applying the developed strategies to produce instructional segments within the scope of a team performance-oriented course. Objectives for the demonstrations were:

1. Select strategies which could be used in the current Weapons Mechanic (TAC) Course.

2. Obtain and furnish all requisite hardware and detailed instructions, as well as adequate supplies for one year's use of the strategy.

3. Demonstrate the developed strategy to research and instructional cadres.

Approach

Strategy Selection

Selection of strategies was based upon two factors. First, demonstration of strategies was limited to those most favored by the school administrators and instructors; secondly, strategies were chosen which could be demonstrated within the constraints of the contract. The strategies demonstrated were:

1. Programmed Instruction of Schematic Symbol Recognition

2. Television Team Coaching

3. Television-Aided Remedial Study.

Television Team Coaching and Television-Aided Remedial Study differed only in the way they were to be used in the course. Therefore, because the same procedure was followed to create materials for both strategies, only one television presentation was used to demonstrate both strategies. Material for a fourth strategy, Audio Team Coaching, was also prepared, but was not demonstrated since the school personnel indicated that this strategy would not be used at the present time.

Strategy Demonstration

The strategies were demonstrated to Air Force Weapons Mechanic Course administrators and instructional personnel in charge of the course blocks in which the strategies would be used. The Programmed Instruction for Schematic Symbol Recognition demonstration began with a short oral familiarization by the program developer. The advantages of programmed instruction were also discussed including the ability of the programmed instruction to allow self-pacing, its ability to allow students to review material when they felt the need, and its ability to free the instructor to provide individual assistance. It was also pointed out that programmed instruction would not reduce an instructor's work load, but would change it from a lecture/discussion orientation to an individual/tutorial orientation. During the demonstration, instructors operated the teaching machines and worked through as much of the program as they desired. While the instructors worked the program, the program developer answered questions about this strategy and its uses.

The Television Team Coaching and Television-Aided Remedial Study strategies demonstration began with the strategy developer outlining the development procedure and the ways in which the strategy could be used in the Weapons Mechanic Course. It was pointed out that the taping of a task and the presentation of the task to students could serve as an initial familiarization for a task. Students could also use the tapes to review the task for remedial study. It was emphasized that taped material could zero in on one aspect of a task which might be too obscure for observation (e.g., critical hand positions, supports, bolts, etc.). It was also pointed out that the video tapes showed only correct performance, which eliminated the possibility of students learning incorrect performances which could occur when observing student teams.

The strategy presentation continued with a discussion of how instructors and supervisors could produce their own video tapes for

television team coaching. It was emphasized that the tapes are easily corrected and updated, which results in a flexible and relatively inexpensive technique for producing training materials. Furthermore, a library could be assembled which would allow updating of old tapes, thereby minimizing the time required to create new tape sequences. In addition, the videotapes could be easily reproduced on super 8mm film to facilitate distribution and utilization. This would allow the use of inexpensive and durable film cartridges and less sophisticated projection equipment.

The assembled instructors were shown a taped presentation of the installation of a preloaded Multiple Ejection Rack (MER) on the outboard pylon of an F-4D aircraft to illustrate the strategies. As questions arose, the tape was stopped and the questions were answered by the strategy developer. The flexibility of the videotape was demonstrated by stopping the tape, reversing it to review a sequence, and then continuing.

SECTION V

SUMMARY

The development of strategies for instruction in performance oriented tasks was accomplished in three phases. Phase I, the Preparation of an Overview of Appropriate Strategies for use in presenting a performance-oriented technician course, Weapons Mechanic (TAC) 3ABR46230-2, was performed in six steps. First, the current course objectives, content, and instructional strategies were determined by examining course documents, observing classroom activities, and interviewing course instructors and administrators. Second, the current course strategies were evaluated in context by judging their appropriateness to course objectives and their observed effectiveness. Third and fourth, relevant characteristics of the students and instructors were determined from personnel records and interviews. Fifth, the course environment, including administrative procedures, was reviewed by interviews with instructors and course administrators. Finally, strategies were generated during a two-day working conference involving seven conferees who were experienced in training and training program development and evaluation. Generation of the strategies emphasized innovative uses of training techniques with attention to known course problem areas. However, the resulting strategy pool was general in nature (i.e., responsive to the characteristics of the content and learning situation rather than specific to the Weapons Mechanic (TAC) Course) to facilitate its use by instructional systems designers.

A total of 56 strategies were generated. The strategies were assigned to one of nine application groups; however, there was considerable overlap and most of the strategies could be used in more than one area of application. The nine groupings used were:

1. Student Selection and Career Field Introduction
2. Cognitive Skill Instruction
3. Individual Manual Skills
4. Team Training
5. Evaluation

6. Incentive Management

7. Games

8. Course Development

9. Miscellaneous

During project Phase II, Development of Selected Strategies, five of the 56 generated strategies were selected for development for use in the Weapons Mechanic Course. The strategies selected were:

1. Programmed Instruction for Schematic Symbol Recognition

2. Audio Team Coaching

3. Television Team Coaching

4. Television-Aided Remedial Study

5. CAI for Troubleshooting Performance.

The Programmed Instruction for Schematic Symbol Recognition, Audio Team Coaching, Television Team Coaching, and Television-Aided Remedial Study strategies were fully developed. Sufficient supplies and equipment were provided for implementing these strategies for at least one year. The CAI strategy was developed to the level of a flow diagram. Further development was not possible due to uncertainty concerning the final selection of computer hardware and software.

During Phase III, Demonstration of Selected Strategies, the feasibility of using Programmed Instruction for Schematic Symbol Recognition, Television Team Coaching, and Television-Aided Remedial Study was demonstrated to Weapons Mechanic Course instructors and administrators. The demonstration began with a brief oral presentation by the strategy developers. The developers described the techniques used to produce materials for the three strategies, and allowed the instructors and administrators to examine the materials, operate the equipment, and question the developers about the various strategies and their potential use in the Weapons Mechanic Course.

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APPENDIX A: INNOVATIVE STRATEGIES

Introduction

The st tegies presented here resulted primarily from a two-day working con ence. Although the background material was the objectives, content, and materials of the Weapons Mechanic (TAC) Course 3ABR46230-2, an attempt was made to generate strategies appropriate to any course teaching manual skills and team performance.

All strategies with the same or similar purpose are presented together; however, neither the groups of strategies nor the strategies within groups are presented in any particular order. The strategies are presented in nine groups, as follows:

1. Student Selection and Career Field Orientation
2. Cognitive Skill Instruction
3. Manual Skill Instruction
4. Team Training
5. Evaluation
6. Incentive Management
7. Games
8. Course Developm :
9. Miscellaneous

Each strategy is presented on a separate page and is described in terms of the following information:

1. A description of the content, student activity, instructor activity (if appropriate), and materials.
2. A statement of the suggested application.
3. A statement of the strategies limitations in the suggested application.

4. A brief description of the means for implementing the strategy.

5. A general description of the equipment requirements for the implementation described.

GROUP I

Student Selection
and
Career Field Orientation

STRATEGY: Preference Questionnaire

Description:

- Prospective Weapons Mechanics would fill out a questionnaire indicating their interest in armament related hobbies and activities, e.g., model rocketry, handloading, etc. Selection preference would be given to persons with armament related interests.

Suggested Application:
Supportive selection tool.

Limitations:
Provides insufficient information for independent utilization, or utilization as the only selection tool.

Implementation:
Develop a preference questionnaire for administration to potential Weapons Mechanics. The questionnaire could be developed for use in selecting candidates for this career field as well as candidates for other career fields.

Equipment Requirements:
None.

STRATEGY: Career Field Orientation

Description:

The trainees would view an audio-visual presentation of the jobs performed by a Weapons Mechanic. The presentation would be available to airmen in basic training for the purpose of acquainting them with the career field. Content would be organized around preparation for aircraft missions and/or maintenance operations on armament system components. Different presentations could be developed for each of the major air commands ADC, SAC, TAC, etc. The role of the Weapons Mechanic in the aerospace team would be highlighted using both military missions and competitive situations (William Tell gunnery meets) as illustrations. The presentation would be placed in either hallways or break areas of housing units or some other central location. The viewer would start the presentation, but have no other control over its operation. Visuals and narration would be presented by tape-slide, motion picture, or a combination of media depending on the exact information content.

Suggested Application:

Use for motivational or introductory materi. applicable for viewing in informal settings as opposed to a formal educational presentation.

Limitations:

There is no provision for viewers to respond to the presentation; hence formal educational materials, i.e., those requiring stimulus presentation, stimulus acceptance, response acceptance, and feedback cannot be used in this approach.

Implementation:

Generate materials using standard audio-visual material preparation techniques. Visuals would be slides, movies, or large transparencies.

Equipment Requirements:

A custom-designed rear screen projection cabinet containing off-the-shelf projectors and/or tape recorders is required for the presentation.

STRATEGY: Performance Motivation

Description:

An audio-visual presentation showing post-military application of "armament" skills in civilian jobs would be viewed by airmen during training, and before training by airmen assigned non-voluntarily to this career field. The presentation would be oriented toward motivating trainees to perform well, thus enhancing their chances for a desirable post-service job. Presentation devices would be table-size audio-visual devices which would be placed in course study areas or dormitory study areas. Presentations would be either the overview type, i.e., showing a sample of all skills and civilian job applications, or the skill-specific type, i.e., showing many applications of a single skill, appropriate to the performance currently being learned.

Suggested Application:

Counselling, to demonstrate benefits of acquiring skills and informal viewing.

Limitations:

There is no provision for viewers to respond to the presentation, hence formal instructional materials cannot be used.

Implementation:

Develop presentations in tape-slide, tape-filmstrip, or motion picture format, depending on the device and content selected for the presentation.

Equipment Requirements:

Audio-visual devices appropriate to the presentation format selected.

STRATEGY: Weapons Mechanic Course Orientation

Description:

A modification of the Career Field Orientation strategy would be used for a classroom introduction to the career field and the course at Lowry Air Force Base. Students would participate in a session using a combination of prerecorded, audio-visual, and live presentations. The content would emphasize the role of the Weapons Mechanic in aircraft preparation for a military mission and the relationship of the course to job requirements. The presentation would include students viewing work being done in the course. Where space or other considerations would not allow the presence of an observing class, closed-circuit television could be employed for remote viewing.

Suggested Application:

A formal introduction to the course at the beginning of training.

Limitations:

Content has to be selected to insure that the students obtained the desired task emphasis and expectations concerning the training to follow.

Implementation:

Select media for presenting various segments of the presentation to provide variety, and for appropriateness to the course.

Equipment Requirements:

Standard audio-visual presentation devices and surveillance television equipment are to be used during the session.

STRATEGY: Aerospace Team

Description:

A visual dynamic chart would be used to show the student his relationship to other members of the aerospace team. Emphasis would be placed upon the effects of Weapons Mechanics' actions on the function of the team. The viewer would press the button associated with a given task to insert the activity into the chart. The visuals would consist of backlighted illustrations, and each would be accompanied by an auditory presentation. The display would be placed in school break areas.

Suggested Application:

Introductory and motivational presentations.

Limitations:

This approach is not effective for formal educational material because it is limited to stimulus presentation. No provision is made for response acceptance and feedback.

Implementation:

Prepare standard overhead transparencies and standard cassette tapes.

Equipment Requirements:

Large backlighted transparencies and multiple cassette tape recorders are to be placed in a suitable enclosure.

GROUP 2

Cognitive Skill Instruction

STRATEGY: Computer Interactive Instruction

Description:

Each student would take a computer-administered pretest to identify his entrance knowledge level. The computer would specify required course segments based on the results of the pretest. Cognitive tasks, e.g., troubleshooting, would be presented in a computer-interactive environment. Content would include problem solving rules as well as equipment functioning. Simulated or simplified system diagrams would be used initially with more realistic diagrams being incorporated as the trainee's proficiency increased. The computer graphic display would present the problem. The student would respond by using a light pen to indicate the information he required or the action he would take. The computer would provide feedback by giving the results of the action or the requested information, if the student's choice was correct. If the student's choice was incorrect, the computer would indicate the choice was incorrect, give the rules for a correct choice, and request the student to choose again. The computer would count errors by type. If one type of error were made consistently, the student would be routed through a remedial loop. Problems would be presented in order of increasing difficulty. A student would proceed to a higher level of difficulty only after he reached criterion performance on the more simple problems. If a student exhausted the supply of computer problems at any one level of difficulty without reaching criterion, he would be channeled into a tutoring session with an instructor. After achieving criterion performance, the student would return to the computer-interactive situation and resume the problems at the next level of difficulty.

Suggested Application:

Primary and remedial instruction.

Limitations:

Constraints are related to computer capabilities and availability. This approach should probably not be used for nomenclature and other rote learning tasks.

Implementation:

Prepare programmed instruction material suitable for use in CAI situations. Presentation media would depend on computer control capabilities and the equipment available in the learning environment.

Equipment Requirements:

The equipment required includes a graphic-computer terminal, and, depending on the skills being learned, computer-sensed equipment items and diagrams.

STRATEGY: Media Selection

Description:

Each student would be assigned to an instructional regime which is best suited to his particular abilities, i.e., program selection would take into consideration student-by-treatment interactions. To determine the best selection of alternatives for each student, a systematic analysis must be conducted during the early stages of AIS implementation. At first, students would be assigned to techniques on a semi-random basis, i.e., they would be assigned based on *a priori* psychological and educational principles. The results of initial assignments would be analyzed to identify the student-by-treatment interactions which would serve as the basis for assignment of the next student group. As increasing amounts of data became available, the placement techniques would become more accurate. To adequately accomplish this approach, materials must be developed in more than one format, where possible. While some types of content can be taught using any of several presentation media, e.g., textbook, programmed text, audio-visual program, etc., other types can logically be presented through only one medium. This approach would obviously be used only for content capable of being presented in at least two formats.

Suggested Application:

Primary and remedial instruction.

Limitations:

Some content may not be appropriate for presentation in more than one medium.

Implementation:

Presentation media combinations could include textbook/programmed text, lecture-demonstration/audio-visual program, and programmed instruction/computer assisted instruction.

Equipment Requirements:

The equipment requirements are unknown at present and depend on the presentation media selected.

STRATEGY: Equipment Nomenclature

Description:

The student would work through a visual or audio-visual programmed instruction segment on weapon classification and names,or on equipment nomenclature and location. During initial instruction, reinforcement would be 100 percent and feedback would occur immediately. As learning progressed, reinforcement rate and feedback frequency would be reduced until all classifications, names, and locations could be recalled without the need for prompting or external reinforcement.

Suggested Application:

Initial or remedial training for weapons identification and equipment operation.

Limitations:

This approach is oriented toward visual identification and the association of equipment-indicator and control names, locations, and functions, without the use of actual equipment items.

Implementation:

Black-and-white or color photographs would be incorporated in programmed books or equipment simulators, or projected visuals could be incorporated in programmed filmstrip or in audio-visual programs.

Equipment Requirements:

Programmed books or teaching machines for visual or audio-visual presentations.

STRATEGY: Visual Malfunction Discrimination

Description:

The student would use discrimination panels to select in- and out-of-tolerance equipment components. During initial instruction sessions the panels would contain an in-tolerance master component and matched components (real or simulated) which were out-of-tolerance in one or more ways. During practice sessions, the panels would contain pairs of components which were both in-tolerance, both out-of-tolerance, or one in-tolerance and one out-of-tolerance. The student would identify the state of each component on the panel and what was wrong with those that were out-of-tolerance. During evaluation sessions, one-of-each of several components would be on the panels and the student would identify the state of each component and what was wrong with those that were out-of-tolerance. During evaluation, a response acceptance capability would be provided to allow scoring of student responses.

Suggested Application:

Initial or remedial training for identification of equipment status and identification of equipment malfunctions.

Limitations:

This approach is oriented to visual identification and discrimination learning.

Implementation:

The panels could contain black-and-white or color photographs, actual equipment parts, or the panels could be built into a learning carrel with projected visuals and visual or auditory feedback.

Equipment Requirements:

The equipment required would be either identification panels like those currently being used in the course,or projectors and tape playback units.

STRATEGY: Computer Managed Instruction

Description:

Each student would take a computer-administered pretest covering the reading of equipment schematic and wiring diagrams. The test would cover symbol recognition, illustration conventions, function sequence or signal flow, etc., and would be presented on a CRT graphic display. The student would respond with a light pen or with a typewriter. Results of the test would be used by the computer to assign learning segments designed to provide instruction in areas of student weakness. Instruction would be computer-assigned independent instruction, either programmed or lecture/demonstration depending on the extent of the student's weakness. Upon completion of the learning segment(s), the student would take a diagnostic post-test. Based on the results of the post-test, the student would go on or be recycled through remedial material.

Suggested Application:

Determination of course segments and sequence, or determination of remedial instruction requirements.

Limitations:

The extent to which this approach can be implemented depends on the segmentation of course materials and on the availability and capability of the computer.

Implementation:

Develop course segments so that each segment can be administered independent of the other segments. In addition, develop a diagnostic test for each segment to evaluate the student need for that segment.

Equipment Requirements:

A computer for test administration and any equipment used for presenting the individual course segments.

STRATEGY: Troubleshooting Practice

Description:

The student would practice making troubleshooting decisions using actual equipment diagrams and simulated test results (cards stating the result). A malfunction symptom would be described to the student and several alternative courses of action would be offered. The student would select the action he believed to be correct by choosing a card for that action. If the choice was incorrect, the card would present no information or would give the rules for a correct choice; the student would then choose another card. If the choice was correct, the card would present the results of the action, the current problem, and the remaining alternative actions. The student would continue selecting actions until he selected a repair action which solved the problem. In a test mode, all cards would present results of an action whether the choice was correct or not.

Suggested Application:

Primary or remedial training for troubleshooting or other problem solving tasks which require the performer to follow a "rule-of-thumb" at each choice point.

Limitations:

This simple simulation is not appropriate for problem-solving tasks which require the generation of all possible alternatives and the selection of the alternative which best meets the criteria.

Implementation:

Equipment diagrams, symptom patterns, and test results representative of those encountered on the job would be used in this approach. Each problem would consist of a symptom pattern and test results (on cards) for all components which could cause that symptom pattern.

Equipment Requirements:

Paper and pencil materials are the only requirements for this approach.

STRATEGY: Hand Tool Utilization

Description:

Students would learn the use of hand tools immediately prior to working on equipment which required hand tool utilization. Instruction would be programmed and practice would be mediated by performance boards, i.e., boards which contained fasteners typical of those found on the equipment. In situations where torque or pressure on the fasteners was critical, transducers would be connected to the fasteners and to a computer or other indicator to provide feedback to the student.

Suggested Application:

Primary and remedial instruction in hand tool usage.

Limitations:

Instruction is general in nature and is not equipment-specific.

Implementation:

Develop performance boards and programmed instruction for common hand tools, i.e., those used with more than one piece of equipment. Instruction on equipment-specific tools would be taught in conjunction with the equipment-related tasks.

Equipment Requirements:

Performance boards with and without transducers are required, along with a computer or other indicators.

GROUP 3

Manual Skill Instruction

STRATEGY: Test Equipment Usage

Description:

The student would learn test equipment operation using programmed-instruction in book form. For the multimeter, instruction would include measuring voltages (AC or DC) and resistance on a device like the DC Trainer currently used in the course. The student would first be instructed to make certain test equipment settings. After making the settings, he would be shown the correct position of all controls before making the test. Initially, all tests would be made on special fixtures or devices providing "known signals". As the student gained proficiency, he would perform tests on actual equipment not containing malfunctions. Practice with malfunctions could occur later in the course during troubleshooting practice.

Suggested Application:

Initial and remedial instruction on the usage of test equipment.

Limitations:

This approach is intended to teach only usage of the test equipment and would not cover rules of troubleshooting.

Implementation:

Develop a programmed book teaching control nomenclature, location, and function; simple measurements; and complex measurements. Feedback would be provided by using photographs or drawings.

Equipment Requirements:

Actual test equipment and special fixtures for generating the necessary signals are required for this approach.

STRATEGY: CAI for Troubleshooting Performance

Description:

Each student would take a computer-administered pretest covering troubleshooting techniques (electrical, mechanical, hydraulic, etc.) used on aircraft armament systems. Based on the results of the pretest, the student would be given prescribed sets of problems. Using simulated computer-sensed aircraft diagrams, the student would make checks at appropriate locations on the diagrams to determine the cause of a stated malfunction symptom. The computer would provide signals being checked, feedback on the correctness of the sequence of test points selected, and feedback on the correctness of the test equipment control settings.

Suggested Application:

Initial and remedial troubleshooting practice.

Limitations:

The limitations are related to the capabilities and availability of the computer and the CAI program.

Implementation:

Develop a CAI program in which the diagrams are presented on the graphic terminal. The student selects the point at which he wishes to make the check, sets the test equipment controls, and the computer provides the test equipment indication.

Equipment Requirements:

Equipment requirements include special test equipment, diagram boards, and a graphic computer terminal.

STRATEGY: Equipment Disassembly-Assembly

Description:

For the process of disassembling, assembling, or performing other maintenance tasks on equipment, the student would observe two simultaneous visual presentations. One view would show an overall picture of the equipment indicating the area where the next step is to be performed. The other view would show a close-up picture of the hand or tool position. These views would be used to coach the student and to provide feedback. As the student gained proficiency, the close-up views would be removed, leaving only the cues for the general area where the next step is to be performed.

Suggested Application:

Initial or remedial instruction and practice of equipment assembly.

Limitations:

Presentation format is determined by the presentation equipment capability available at the maintenance station.

Implementation:

Use pictures of actual task performance as instructional, coaching, and feedback visuals. Hand tool usage could also be taught using this approach.

Equipment Requirements:

This approach could be implemented using anything from black-and-white photographs to motion pictures.

STRATEGY: Augmented Technical Orders

Description:

Early practice of maintenance tasks would be performed using augmented TOs. Performance aids showing overall and close-up views of equipment components and elaborated text including call-outs would be used to coach students through tasks. As student proficiency increased, text from actual TOs would be substituted for the elaborated text, and finally the actual TOs would replace those containing special equipment views.

Suggested Application:

Initial and remedial instruction for manual tasks.

Limitations:

If done improperly, the student might become dependent on the special TOs. Learning to do the task using the actual TOs might be impeded instead of facilitated.

Implementation:

Develop elaborated text for steps in which novices typically make errors and add equipment views for steps that do not adequately identify the equipment item location of the part being maintained.

Equipment Requirements:

No special equipment is required for this approach; however, the special performance aids would have to be developed.

GROUP 4

Team Training

STRATEGY: Team Position Training

Description:

Students would individually learn the skills and knowledges required for each team position. The initial training of the skills and knowledges would be under control of a 100 percent reinforcement schedule. As criterion performance was approached, the rienforcement schedule would be altered to match the schedule that will be in effect in the team environment. After the student had reached criterion performance for each team position under partial reinforcement, he would be placed in a team situation. Each time the team performed, clear and immediate team reinforcement would be provided. Coupled with the team reinforcement would be individual reinforcement, e.g., "team performed the task correctly, but too slowly; however, team member A executed each of his duties efficiently and adequately". Team practice would continue until team performance reached criterion. If any individual within the team had not reached individual criterion performance, he would be recycled through appropriate remedial training.

Suggested Application:

Initial learning of team position skills.

Limitations:

This strategy may not be practicable if it is not possible to duplicate reasonably closely the reinforcement schedule provided on the job.

Implementation:

The exact nature of the implementation depends on the team skills being taught.

Equipment Requirements:

Equipment utilized depends on the team skills being taught, and the instructional environment.

STRATEGY: Team TV Highlights

Description:

Prior to participating in team performance, students would view prerecorded video tape presentations which highlighted one member of the team. Each team member would be highlighted in separate presentations, but only one member at a time. The students' attention would be directed to a demonstration of a single members' job but the job would be shown in the context of the team effort. Critical portions of each member's job would be viewed in detail using slow motion or stop motion techniques.

Suggested Application:

Preview for team task practice or remedial for individual team members.

Limitations:

Only one team position can be highlighted in one presentation.

Implementation:

Make one television tape of team task performance for each team position. Although the position of interest will be highlighted, all other visual or aural cues provided by other team members should be included to place the performance in context.

Equipment Requirements:

The students view the presentations on a large screen television monitor, driven by a video tape recorder.

STRATEGY: Team Position Simulation

Description:

Students would individually learn the jobs performed by each of the team members in the context of team performance. All positions other than the one being learned would be simulated or performed by instructors, or part-task trainers would be employed which required only the one team member's actions. Any of the coaching or reinforcement techniques given for individual manual skills could be employed for each position.

Suggested Application:

Initial and remedial instruction for team position learning.

Limitations:

The extent to which this approach can be implemented depends on the fidelity with which positions not being learned can be simulated.

Implementation:

The exact nature of the implementation of this approach depends on the team task being taught and the availability of the instructors, part-task trainers, or other means for simulating the cues provided by the other team members.

Equipment Requirements:

Required equipment includes actual equipment, or part-task trainers and equipment required for the coaching or reinforcement techniques utilized.

STRATEGY: Novice Team Performers

Description:

Team positions would be learned by introducing a novice performer into the first position of a team composed otherwise of experienced performers. After the novice performed to criterion in the first position, he would move to the second position and another novice would come into the first position. Each time the team and each of its members achieved criterion performance, the members would each move to the next higher position and a new novice would move into the first position.

Suggested Application:

Initial learning of team position skills.

Limitations:

This approach is particularly effective when the positions are hierarchical in nature, i.e., the top position in the team requires the performance of some of the skills performed by lower team members.

Implementation:

The exact nature of the implementation depends on the team task being learned; however, it may be necessary to use an artificial reinforcement schedule for the first team position if the normal reinforcement schedule is not sufficient to enhance learning.

Equipment Requirements:

Equipment required for this approach includes actual equipment, and the equipment required for the coaching or reinforcement technique utilized.

STRATEGY: Team Preview Models

Description:

Before working as a team on actual equipment, members would preview the entire task on a scale model to get a picture of the geography of the task. All participants in the task would be represented and their movements relative to one another and sequence of step performance would be depicted. Students would participate in a lecture/demonstration by moving the models of men and equipment to appropriate positions when requested by the instructor.

Suggested Application:

Orientation to task performance.

Limitations:

This approach is designed to provide an overview of the team's performance and is not for use in teaching details of task performance.

Implementation:

Build all major elements in the situation into a table-sized, scale model so that the positions and movement of each element can be depicted during the preview.

Equipment Requirements:

Required equipment includes a scale model of the aircraft, support equipment, weapons, and men involved in the task.

STRATEGY: Team Audio Coaching

Description:

Team members would be coached during task practice by audio recordings. Each team member's instructions would be recorded on a separate channel of a multi-channel audio tape recorder. Individual members' earphones would pick up only the instructions appropriate to his position. The instructions would be transmitted by wire or radio depending on situational circumstances. Tapes for early training would contain detailed instructions which identify cues for preparing to perform, itemized list of tools or other equipment required to perform, delineated step-by-step performance instructions, and described end-of-step criterion conditions. Later tapes would provide fewer and fewer cues until all team members were able to perform using only the TO. All tapes would provide the instructions properly synchronized to facilitate team cooperation. Any team member would be able to stop the tape (at specific locations) to ask for assistance if he was having difficulty. Early tapes would require performance at a slow pace; however, later ones would require faster performance.

Suggested Application:

Initial and remedial team instruction and team practice.

Limitations:

All team members are working at a pace controlled by the audio device; therefore, all members have to be at approximately the same level of performance ability.

Implementation:

Narrate each team member's instructions on one track of the tape recorder. Performance would be synchronized by either stopping the tape while the task was performed, or by allowing sufficient time to perform the task by giving preparatory and feedback information to the other members.

Equipment Requirements:

One multi-track tape recorder is required. Depending on situational circumstances, each student would also require either (a) one audio amplifier and set of headphones, or (b) one radio transmitter and set of headphones.

STRATEGY: Team Observation

Description:

Members of an observing team would individually observe their counterparts on the performing team. Each observer's task would be to detect any errors in performance made by his counterpart and to note these for critique at the conclusion of the task. If audio coaching was being provided to the performing team members, it should also be provided to the observers. If special performance aids were being used by the performers, they should also be used by the observers.

Suggested Application:

Initial and remedial team performance instruction.

Limitations:

The observing team has to be capable of performing at the same rate or at a rate slightly below that of the performing team.

Implementation:

The exact nature of the implementation depends on the task being performed and the performance aids being used.

Equipment Requirements:

Equipment requirements depend on the equipment being used by the job performers.

STRATEGY: Team Whole-task Practice

Description:

Team performance near the end of training would be done under time stress. A simulated aircraft turn-around loading operation would be performed by each team using actual equipment and TOs. Other elements of aircraft turn-around procedures, e.g., fueling, would be simulated by "holds" or appropriate time delays. Team members would determine team positions and their objective would be performance in minimum time without errors. All elements of task performance would be included, e.g., necessary paperwork. During performance, assists would be given if the team was unable to proceed.

Suggested Application:

Final or criterion task practice or performance evaluation.

Limitations:

This approach is not intended to provide a practice situation for novices; only teams which are ready should be placed in this situation.

Implementation:

No additional cues to performance should be provided to the performing team; the situation should be as realistic as possible.

Equipment Requirements:

The equipment for this approach includes all equipment used in performing the task.

STRATEGY: Television Team Coaching

Description:

Teams would view a pre-recorded video tape presentation depicting a task. The scene would suddenly stop or the screen would go blank, and the appropriate team member would be required to state what should be done next. The scene would be resumed with the correct next action being shown.

Suggested Application:

Coaching prior to initial team performance or remedial instruction for team performance.

Limitations:

This approach is not intended to teach individual member performance, but is intended to teach the sequence of member actions at a greater level of detail than the Team Preview Models strategy (page 104).

Implementation:

Record an entire task on video tape. Base planned interruptions during viewing on the difficulty, importance, etc., of the next action.

Equipment Requirements:

A large screen television monitor and a video tape recorder are required for this technique.

STRATEGY: Experienced Member Coaching

Description:

A team of novice performers would be paired with a team of experienced performers. The experienced performers would coach the novices on a one-to-one basis for each team position. Team positions would be rotated until each experienced member had coached his partner in all positions. In this approach, the experienced performers would be used in lieu of the multi-track tape recorder (page 105); however, experienced men would have to be instructed as to the cues and feedback to be given his partner.

Suggested Application:

Initial and remedial performance instruction.

Limitations:

Experienced performers must be capable of pointing out cues for performance, and providing reinforcement.

Implementation:

The cues identified, preparatory information provided, and reinforcement provided depend on the performance being learned.

Equipment Requirements:

The equipment requirements are limited to the equipment for performing the task

STRATEGY: TV Production

Description:

Teams who reach criterion on a task in less than the planned time would be permitted to make a video tape of a task they had not previously performed, but had previewed. The objective is for the team to learn to perform the task while making a video tape for other teams to use as preview material. Each tape of their performance would be reviewed and critiqued by their instructor. The team would continue making tapes of their performance until they reached criterion performance. Emphasis would be placed on task performance - not on television technique. Since this would be their initial training on the task, special performance aids or some other assist should be provided to the team members.

Suggested Application:

Reward for superior team performance.

Limitations:

This approach may not provide optimal learning conditions but should provide increased student motivation.

Implementation:

Students would be taught to operate the TV camera and tape recorder, assigned the task to be learned and taped, and reviewed for task performance as taped.

Equipment Requirements:

Equipment for this approach includes one television camera, one video tape recorder, and one television monitor.

GROUP 5

Evaluation

STRATEGY: Performance Comparison

Description:

Student and team performance would be recorded on video tape and played back immediately following task practice. A pre-recorded tape which showed criterion task performance would be shown simultaneously. The instructor and/or class would critique the practice performance tape by comparing it to the criterion tape. All errors in performance and well performed portions of the task would be illustrated and acknowledged by the instructor.

Suggested Application:

Performance evaluation.

Limitations:

This approach is limited to evaluation; any need for remedial instruction identified would have to be provided by another approach.

Implementation:

Performance would be taped by an instructor, not by the team members (cf. page 110).

Equipment Requirements:

One camera, two video tape recorders, and two monitors are required for this type of evaluation.

STRATEGY: Evaluation by Students

Description:

A pre-recorded video tape of students' or team's task performance would be viewed by the students or team who had completed the task. The students or team would critique the performance without the aid of a criterion tape. Each member of the team or class would independently record the errors in performance and violation of safety practices he observed. The evaluators would be scored on their ability to detect errors in performance and safety violations.

Suggested Application:

Evaluation of student's task performance knowledge.

Limitations:

This approach should only be used for tasks which the students can perform to criterion.

Implementation:

Make pre-recorded tape of instructors making common errors of task performance.

Equipment Requirements:

The equipment required consists of a pre-recorded tape containing known errors, a video tape recorder, and television monitors.

STRATEGY: TV Standard Evaluation

Description:

Students would view a pre-recorded video tape presentation of task performance. The presentation would suddenly stop and the students would be required to state what should be done next in the task. The presentation would continue with another "question". The evaluation could be conducted as an open- or closed-book examination using the TOs.

Suggested Application:

Evaluation of student's task performance knowledge.

Limitations:

The approach is useful for evaluating only knowledge of task performance since the students are not actually required to perform.

Implementation:

The "question" on the tape would not be a continuous presentation of properly sequenced steps for a single task, but would be steps out-of-sequence or steps from different tasks.

Equipment Requirements:

This approach could be implemented with anything from pencil-and-paper fill-in or multiple-choice responses, to an Edix-type system.

STRATEGY: Functional Context Testing

Description:

Cognitive skills and knowledges would be tested in functional context situations. For example, ability to make troubleshooting decisions would be tested in the context of performing malfunction diagnosis and repair on simulated or actual equipment. The test task would be structured so that it would be possible to independently identify areas of student difficulty, e.g., test equipment usage, TO usage, selection of checks and check sequence, etc. Checklists would be used by the test administrators to insure all phases of task performance were observed and evaluated for each student.

Suggested Application:

Evaluation of student or team performance ability.

Limitations:

The limitations are determined by the malfunction insertion capability of the equipment.

Implementation:

Use standard or frequent problems as the "questions". Also, use only problems which can be solved in a practical length of time.

Equipment Requirements:

Performance tests of this type require actual or simulated equipment and actual test equipment and performance aids.

STRATEGY: Continuous Student Evaluation

Description:

Part-task performance or job knowledge evaluations would be performed by adapting any of the instructional strategies employed for cognitive skills, individual manual skills, or team performance to evaluation strategies. This would be done by eliminating feedback or coaching information and recording student responses or performance in a manner suitable for scoring. This would provide continuous student evaluation and eliminate the need for using formal end-of-block tests.

Suggested Application:

Continuous evaluation of student performance.

Limitations:

An instructional approach can be converted to an evaluation situation if all cues not normally in the performance environment can be removed; otherwise, the evaluation will not show the extent to which the student could perform in the field.

Implementation:

Remove all cues and feedback relevant to only the instructional situation. Provide a means for permanently recording student performance or responses.

Equipment Requirements:

The only additional equipment required is student-response recording equipment. In many instances, no additional equipment would be required.

GROUP 6

Incentive Management

STRATEGY: Individual Tangible Rewards

Description:

Students would be given tangible rewards for achieving criterion performance in planned or less than planned time. The rewards would consist of desirable privileges such as time off from class, extra passes, or armament related activities, e.g., model rocketry supplies or use of handloading equipment for sport ammunition. Early in the course, each student would complete a questionnaire assessing his desire for various rewards. Each student's responses to the questionnaire would be stored in the computer and rewards would be individualized.

Suggested Application:

Rewards for individual achievement.

Limitations:

This approach should be used only where performance involves the individual and not where it involves teams.

Implementation:

The exact nature of the implementation depends on the performance being rewarded and on the rewards to be given.

Equipment Requirements:

Equipment requirements depend on the rewards to be given.

STRATEGY: Group Privileges

Description:

Groups of students (load teams or classes) would be compared to other groups in terms of learning rate and excellence of performance. Groups which perform in a superior fashion compared to other contemporary and historical groups would receive special group privileges.

Suggested Application:

Rewards for group achievement or performance.

Limitations:

This approach is not appropriate for assigning individual rewards.

Implementation:

Give group-oriented rewards, i.e., things which the members would receive or do as a group.

Equipment Requirements:

The equipment required depends on the rewards given.

STRATEGY: Individual Intangible Rewards

Description:

Superior student performance would be rewarded by allowing students to create training materials from their performance which would be used for training subsequent classes. For example, the students might be the subjects in a video tape of gun disassembly and assembly. The student would serve as the subject-matter expert, and would be recognized as such.

Suggested Application:

Rewards for individual achievement of performance.

Limitations:

Rewards of this type are valued only if the individual intrinsically values good training materials; otherwise, the "reward" may be perceived as punishment.

Implementation:

Inform the recipient that his excellent performance has earned him the privilege of suggesting and developing (if he so desires) training materials for a specific course segment.

Equipment Requirements:

The equipment required depends on the student's suggestions.

STRATEGY: In-depth Study

Description:

Each student would be given the opportunity to choose the achievement level he wishes to attain in any given content area, e.g., a student interested in the mechanical operation of guns might opt for examination of the principles of mechanics which pertain to gun operation. The students achieving a specified criterion level in the content area would be allowed to pursue in-depth study. All in-depth study would be performed on an available time basis during normal class sessions, providing other course segments were successfully completed.

Suggested Application:

Motivation through student interests.

Limitations:

This approach is useful only as a motivation tool. No assumptions about the extent of in-depth learning are possible since no degree of learning is required.

Implementation:

Procure engineering texts for those areas slated for possible in-depth study.

Equipment Requirements:

Engineering-type texts are required for the in-depth studies.

STRATEGY: Student Program Planning

Description:

Students would be provided with a "shopping list" which described a given instructional unit's objective. It would also describe the course segments which must be completed to meet the objective and the various teaching techniques available for each segment. The student would "plan" his training program for each objective by selecting the sequence of instructional segments and the teaching techniques used to cover the content material. Individual restrictions would be placed on the range of choices available to each student based on the student's experience, past performance, capabilities, type of content to be covered, time parameters, etc.

Suggested Application:

Motivation through student participation in program planning.

Limitations:

This approach is limited to the course segments where choices are available, and to students for whom a choice is appropriate. The capabilities and availability of a computer may limit the refinement possible in this approach.

Implementation:

In addition to identifying the alternative course segments, the relationship between student parameters and teaching techniques would be investigated to allow the identification of appropriate "shopping list" alternatives for each student.

Equipment Requirements:

A computer-and-management program is required for determining the restrictions placed on each individual student.

STRATEGY: Instructor Tangible Rewards

Description:

Instructors would be given tangible rewards for students achieving criterion performance in planned time or in less than planned time. Instructors would be assigned classes containing a cross-section of entering students, i.e., all classes would be matched as nearly as possible for AQE score distributions, to prevent one instructor getting all low ability students. Each instructor would take "his" class all the way through the course. To improve rapport between instructor and students, instructors would become acquainted with the students' educational backgrounds, reward preferences, etc. This would enhance instructor identification with "his" men and make him aware and involved with their individual learning problems. Instructor rewards would be in accordance with a preference schedule completed by each instructor and would be coordinated with class rewards during the course or would be given between 10-week classes.

Suggested Application:

Instructor motivation.

Limitations:

The usefulness of this approach depends on the degree to which feasible rewards coincide with the instructor's reward preference.

Implementation:

The instructors would identify reward preferences, the feasibility of the most preferred rewards would be determined, and the feasible rewards would be offered to the instructor whose class reached criterion performance in planned or less than planned time.

Equipment Requirements:

No equipment is required for this approach.

GROUP 7

Games

STRATEGY: Emergency Procedure Review

Description:

Students would review emergency procedures on a lap-sized device which presented a statement of a problem and two alternative solutions. The student would press the button for the solution selected and receive public feedback as to his accuracy. A pleasant tone would be used for positive feedback and an unpleasant sound (raspberry) would be used for negative feedback. The devices would be placed in school lounges and break areas.

Suggested Application:

Productive utilization of student time in break areas.

Limitations:

This approach is limited to informal evaluation or identification of remedial training requirements.

Implementation:

Type several problems, each consisting of a problem statement and two alternative solutions, on special scrolls for use in the lap-sized device.

Equipment Requirements:

A special lap-sized device which makes two audible sounds, one pleasant for correct choices and one unpleasant for incorrect choices, is required.

STRATEGY: Skills and Knowledge Review

Description:

Students would review cognitive skills and job knowledges during breaks by taking short quizzes, and earning games on pinball machines. Subject matter covered by the quizzes would depend on the student's location in the course, block and lesson, or would be fixed and changed daily. Each subject matter area would be covered by a number of quizzes, each containing slightly more difficult questions. The student would identify his location in the course and the simplest quiz for the appropriate subject matter would be presented first. If he achieved criterion performance, he could either take the game(s) earned or try the next quiz (more difficult) for double or nothing. Quizzes would be short, five or ten questions, to permit as many students as possible to play. Equipment required would be a presentation-and-response recording device which would dispense tokens or would be connected directly to a pinball machine. The presentation device could be self-contained or a computer terminal. If a computer terminal was used, students could enter their social security number and review questions would be presented, tailored to their individual needs.

Suggested Application:

Productive utilization of student time in break areas.

Limitations:

This approach is most effective in informal evaluations and identification of remedial training requirements.

Implementation:

Prepare short quizzes for administration on a special device utilizing printed or photographic material.

Equipment Requirements:

A special device which dispenses tokens or provides free games on pinball machines is required for stimulus presentation, response acceptance, and response scoring.

STRATEGY: Weapons Loading Game

Description:

Students would review corrective actions for emergency situations by attempting to complete a simulated loading operation while an opponent inserted simulated emergencies. This approach would consist of a card game played by two players, each attempting to complete the same loading operation. Each player would have normal sequence cards, emergency cards, and corrective actions cards. Each player in his turn, could: (a) play a normal action card on his operation pile if his opponent had not placed an emergency card there, (b) play only the appropriate corrective action card for the emergency card played by his opponent, or (c) play an appropriate emergency card on his opponent's operation pile. A player would lose his turn if he played the wrong normal action card, or if he played an inappropriate corrective action card, or if he played an inappropriate emergency card on his opponent's operation pile. (An inappropriate corrective action card would be one which would not resolve the problem, and an inappropriate emergency card would represent an emergency that couldn't logically happen at that point in the opponent's operation.) The game would be won by the player who completed his operation first.

Suggested Application:

Productive utilization of time in break areas or of time away from school.

Limitations:

This approach is most effective for informal evaluation, self evaluation, or identification of remedial training requirements.

Implementation:

Develop the special deck of cards.

Equipment Requirements:

The only equipment required is the deck of cards.

STRATEGY: Task Review Game

Description:

Gross task sequence would be reviewed by the student who would use an electric-eye gun to select the view of the correct next task step. Photographs (large transparencies) of tasks would be mounted on a board, with a light sensor below each view. The student would identify the correct sequence of steps by "shooting" each sensor in the proper sequence. Correctly identifying the sequence would result in some tangible or public positive feedback. These devices would be placed in hallways, break areas, etc.

Suggested Application:

Productive use of student free time.

Limitations:

This approach is not an effective primary instructional technique.

Implementation:

Task views would be large backlighted transparencies which would be visible until the appropriate sensor was hit in the correct sequence.

Equipment Requirements:

Required equipment includes a custom-designed display board containing task views, and sensors connected to an electric-eye gun.

GROUP 8

Course Development

STRATEGY: Student Planning Discussions

Description:

Students would participate in small group discussions of training strategies and course content. The groups would consist of five or six students and a discussion leader. Issues discussed would include course content areas, e.g., safety, effect of Weapons Mechanic's performance on the Air Force mission, etc., or the discussion could deal with techniques for presenting content material. Results of these sessions would be used to provide continual data for use in updating the course structure.

Suggested Application:

Obtaining student input for course revision or update.

Limitations:

This approach will be ineffectual if the student's ideas are not utilized or if the discussion leader cannot establish rapport with the students.

Implementation:

Have students from each class select the student representatives to attend the discussions. Hold the discussions during normal class time.

Equipment Requirements:

None.

STRATEGY: TV for Course Development

Description:

Color films and color video tapes would be developed for use in class. For flexibility and economy, black-and-white video tape would be employed for the initial sequencing of events. This would permit alterations in the presentation, without consuming expensive color film. The carefully-tailored black-and-white tape would then serve as the "script" for the final color production.

Suggested Application:

Development of revised or new course presentations.

Limitations:

This approach is most effective for use in developing and evaluating new or revised material. It is not as effective when used for final production.

Implementation:

Record course material on video tape, administer on a tryout basis, and revise as required. The revised material may then be produced in final form, using the tape as the script or plan.

Equipment Requirements:

A video system consisting of cameras, monitors, and tape recorders with editing capability is required.

STRATEGY: Course Sequence Development

Description:

Organization of course content would be based on a task analysis of each team position. Data sources for this analysis would include on-line task performance descriptions as well as current training procedures. Common elements found in more than one team position would be grouped into a general instructional segment, while skills and knowledges unique to a team position would be placed in sequence according to team position, type of activity, etc., in which the skills were used. Since students are required to learn the skills and knowledges for all team positions, the sequencing of unique skills and knowledges should be dependent upon learning and training criteria rather than the sequence of task performance.

Suggested Application:

Determination of teaching sequence for job skills.

Limitations

This strategy is limited to sequencing the course segments and is not applicable to developing the instructional sequence within a segment.

Implementation:

First identify the common and unique job skills; then develop a hierarchical organization of these skills to determine the teaching sequence.

Equipment Requirements:

None.

STRATEGY: Sequencing Supportive Task Training

Description:

Training for supportive tasks, e.g., manhour reporting and test usage, would be positioned in sequence near the training for the tasks they supported, e.g., troubleshooting or whole-task practice. Where possible, supportive tasks would be taught in a functional context situation. This would be done to avoid extensive review or remedial instruction required because of forgetting.

Suggested Application:

Sequencing instructional segments for supportive tasks.

Limitations:

The approach is applicable only to supportive tasks; decisions regarding sequence of primary tasks must be made on the basis of other criteria.

Implementation:

Complete the sequencing of primary tasks; then sequence the supportive task training segments.

Equipment Requirements:

None.

GROUP 9

Miscellaneous

STRATEGY: Irrational Fear Eliminees

Description:

All potential Weapons Mechanic students would be given a questionnaire to identify those who had an irrational fear of explosives The students identified would be eliminated from consideration. The questionnaire should probably be developed using a technique other than direct questioning to reduce the possibility that students will fake answers because they see this career field as less desirable than other career fields. One possible method of development would be to administer the questionnaire to all students presently in the course and to all entering students, and then develop a profile for all students eliminated due to attitudinal or human reliability problems. This procedure would be continued until the profile was reliable enough to allow prediction of eliminees.

Suggested Application:

Reduction of high accident risk personnel.

Limitations:

The limitations of this approach depends on the reliability and validity of the questionnaire.

Implementation:

Develop a questionnaire sensitive to irrational fear of explosives employing questions similar to those of a preference record or forced choice questionnaire.

Equipment Requirements:

None.

STRATEGY: Safety Training Requirements Identification

Description:

Hazard potentials and the nature and kinds of accidents which have occurred in the field would be ascertained through a systematic examination of accident reports. Study of these data would identify potential hazards and causes which are not presently covered in training or require more emphasis.

Suggested Application:

Determining the need for new or revised safety training.

Limitations:

This approach will not indicate how the material should be taught or its sequence in the course.

Implementations:

Examine accident reports and near-accidents to identify causes, and, if possible, the critical incident associated with the accident.

Equipment Requirements:

None.

STRATEGY: Explosion Components

Description:

Students would learn the relationship between the components and sequence of events required for an explosion and the safety steps to be followed when handling ordnance. Presentations would be factual and would avoid eliciting emotional responses or stressful reactions from the students. Presentations would show lines of component interactions necessary for an explosion and how safety precautions block these lines. This information would be presented in lecture/demonstrations incorporating graphic display boards and overhead transparencies utilizing polarized materials.

Suggested Application:

Initial and remedial training on the importance of safety precautions.

Limitations:

This approach does not teach the student how to effect th safety precaution. It only shows how the precaution prevents an explosion.

Implementation:

Develop one presentation board for each aircraft loading procedure. Use the boards in a lecture/demonstration before the students practice the procedure, and during their first practice session, to emphasize the importance of the safety precautions.

Equipment Requirements:

The graphic display boards would employ large backlighted transparencies; lighting would be controlled by the instructor or students.

STRATEGY: Hazard Simulation

Description:

In later portions of the course, adherence to safety precautions would be reinforced by wiring safety devices and safety interlocks to horns and sirens. If a student removed a safety device or performed a task sequence incorrectly, thus defeating a safety interlock, a loud horn or siren would sound immediately. The reinforcement devices would be battery-operated and built into bombs, rockets, canisters, pylons, etc.

Suggested Application:

Later task practice, whole-task practice, and performance evaluation situations.

Limitations:

This approach does not indicate to the student what his mistake was, only that a mistake was made.

Implementation:

Connect small solid-state sound-generating devices to safety pins, etc. through the use of microswitches or other switching devices, and to electrical or electronic circuits through the use of simple logic circuits.

Equipment Requirements:

Solid-state battery-operated sound generators, microswitches, and logic circuits are required for this strategy.

STRATEGY: Student Operated Polaroid

Description:

Polaroid cameras would be available to students in remedial instruction or to students in any other self study environment. The students would photograph any equipment or equipment indicators which were the object of a problem or question. The student would present the photograph to an instructor or supervisor as an illustration of the problem he had encountered.

Suggested Application:

Preservation of a problem situation for appraisal or review at a future time.

Limitations:

This approach is limited to visible conditions and will be effective only if all relevant controls settings are photographed along with the equipment condition or indication.

Implementation:

Make polaroid cameras and instructions for their operation available at a central location, for students to check out and use when required.

Equipment Requirements:

Automatic-exposure-control polaroid cameras, film, and flashbulbs or lights are required for this strategy.

STRATEGY: After-hours Viewing

Description:

Student after-hours study would be facilitated through the use of closed circuit television. Students would be able to view critical equipment components even though the school facilities were closed. Television cameras would be located at selected points in the training building(s) and a camera control and monitor would be located in a dormitory study hall.

Suggested Application:

Viewing of equipment whenever a student cannot be present personally.

Limitations:

In most cases, close-up views of equipment details are not possible.

Implementation:

Mount cameras on wall brackets with student-operated remote control of pan and tilt, lens zoom, focus, and iris functions.

Equipment Requirements:

Television cameras, camera mounts, remote control pedestals, remote-control zoom lenses, and television monitors are required for this approach.

STRATEGY: First Aid Practice

Description:

Students would practice mouth-to-mouth artificial respiration and closed-chest heart massage on an automated manikin. The manikin would be programmed or computer-driven to respond in a manner characteristic of humans suffering cardiac arrest and suffocation. Special instructors would be available to provide assistance, answer questions, and evaluate student performance.

Suggested Application:

Training for first aid to electrical shock victims, etc.

Limitations:

This approach is expensive and a high level of utilization is required in order to make it economically feasible.

Implementation:

Purchase a manikin of the type required from an equipment manufacturer.

Equipment Requirements:

The special automated manikin and associated equipment are required for this approach.

STRATEGY: Team Member Assignment

Description:

Students would be assigned to competitive teams on the basis of their past performance and characteristics. Teams within each class would be matched as nearly as possible, to prevent one team from having a consistent advantage in terms of cognitive skills, manual skills, etc. Matching would be accomplished by a computer.

Suggested Application:

Assigning students to teams for learning, practice, and performance evaluations.

Limitations:

The limitations depend on the information available for each student and the capabilities and availability of a computer.

Implementation:

Develop a computer program to order students in a class with regard to skill and knowledge levels and then assign the ordered students to teams in a way which produces, as nearly as possible, matched teams.

Equipment Requirements:

A computer and the appropriate program are required for this approach.

STRATEGY: Esprit de Corps

Description:

Weapons Mechanics would wear a special symbol or emblem (like paratroopers, for example) because of the special hazards associated with their job. This would help to develop esprit de corps, especially among new graduates. The emblem would be awarded at graduation from the course.

Suggested Application:

Job performance motivation and career field identification enhancement.

Limitations:

The practicability of this approach depends on Air Force regulations.

Implementation:

Solicit designs for the symbol and select the three best ones for artist renderings. Have the men in the career field select the preferred one and make a public award to the person who designed it.

Equipment Requirements:

None.

STRATEGY: Procedure Following Evaluation

Description:

A student's ability to follow the proper sequence in disassembly-assembly tasks, e.g., guns, would be evaluated using computer-sensed simulated equipment items. The student would perform the task following the TO procedure and the computer would record his sequence of steps. Any sequence error would be recorded and immediate feedback would be provided to the student, e.g., a flashing red light. The student would be informed that an error had been made but would not be told what the next step should be. Should the student be uncertain as to the proper next step, he could request assistance from the instructor.

Suggested Application:

Final evaluation of disassembly-assembly tasks or other procedure following tasks.

Limitations:

Error indications signify that an error had been made but do not inform the student of the required correct action.

Implementation:

Develop a real time computer program which would match the correct step sequence to the step sequence used by the student (as indicated by the equipment sensors) and which would indicate an error when a difference was encountered.

Equipment Requirements:

This approach requires simulated equipment interfaced with the computer.

APPENDIX B: SPECIFIC TASKS TAUGHT IN THE WEAPONS MECHANIC (TAC) COURSE WHICH CAN BE SUPPORTED WITH PROGRAMMED INSTRUCTIONS

Table III

Specific Tasks Taught in the Weapons Mechanic (TAC) Course Which can be Supported with Programmed Instructions*

Block	STS 462X0 Ref.	Description of Skill or Knowledge
I	1a	Progression in career ladder 462X0
	1b	Duties of AFSCs 46230/50/70
	2b	Determine proper classification of official information as Top Secret, Secret, Confidential, or For Official Use only
	4a	Locate desired information in technical orders
	5b(1)	Air Force training resources, programs, and training assignment procedures
	6a	Function and responsibilities of the Chief of Maintenance Staff
	6b	Basic functions of management units that make up the Chief of Maintenance Staff
II	11a	Basic electron theory
	11b	Principles of DC
	11c	Electrical components and symbols
	11e	Relays/solenoids
	11f	Principles of AC
	11g	Transformers
	11h	Schematics/wiring diagrams

*NOTE: Tasks were included in this table if any element of the task could be taught with programmed instruction. It should not be concluded that programmed instruction can be used to teach the entire task, nor that programmed instruction is the best way to teach the task.

Table III (Continued)

Block	STS 462X0 Ref.	Description of Skill or Knowledge
III	12a	Identify and inspect guided missiles
	12b	Identify and inspect aircraft rockets
	12c	Identify, inspect and perform electrical check-out of aircraft rocket launchers
	13a	Identify and inspect bombs and related components
	13b	Identify and inspect fuses
	13d	Identify and inspect selected aircraft pyrotechnic devices
IV	4a	Locate desired information in technical orders
	14a(1)	Nomenclature, function of parts, and cycle of operation of the M39 and M61 20mm Automatic Guns
	14b(1)	Nomenclature, M3 20mm Automatic Gun, M60 7.62mm Machine Gun, and GAU 2 B/A
	14b(2)	Principles of Operation
	16a	Identify ammunition
V	4a	Locate desired information in technical orders
	14a(1)	Nomenclature, function of parts, and cycle of operation, of the M39 and M61 20mm Automatic Guns
VI	4a	Locate desired information in technical orders
	15a(1)	Nomenclature, function of parts, and cycle of operation, Internal Gun Systems
	15b(1)	Nomenclature, function of parts, and cycle of operation of Gun Pods

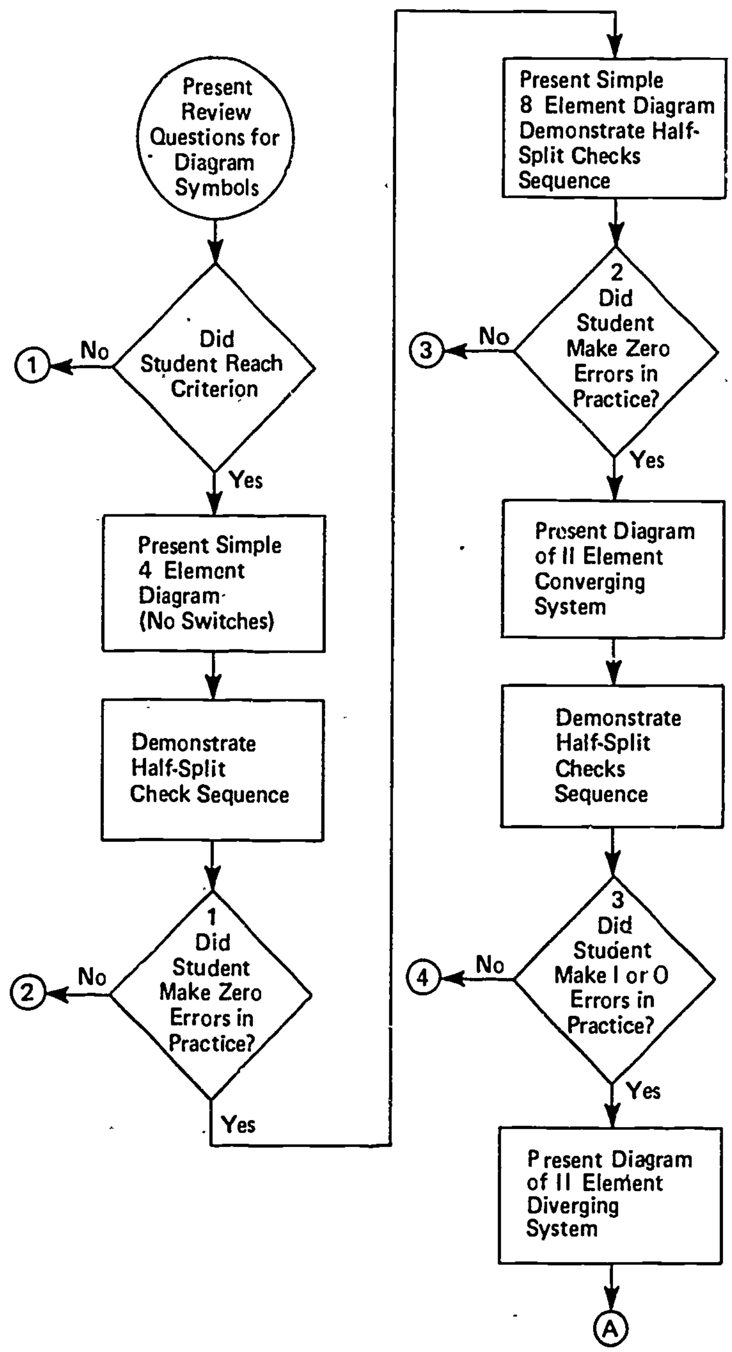
Table III (Continued)

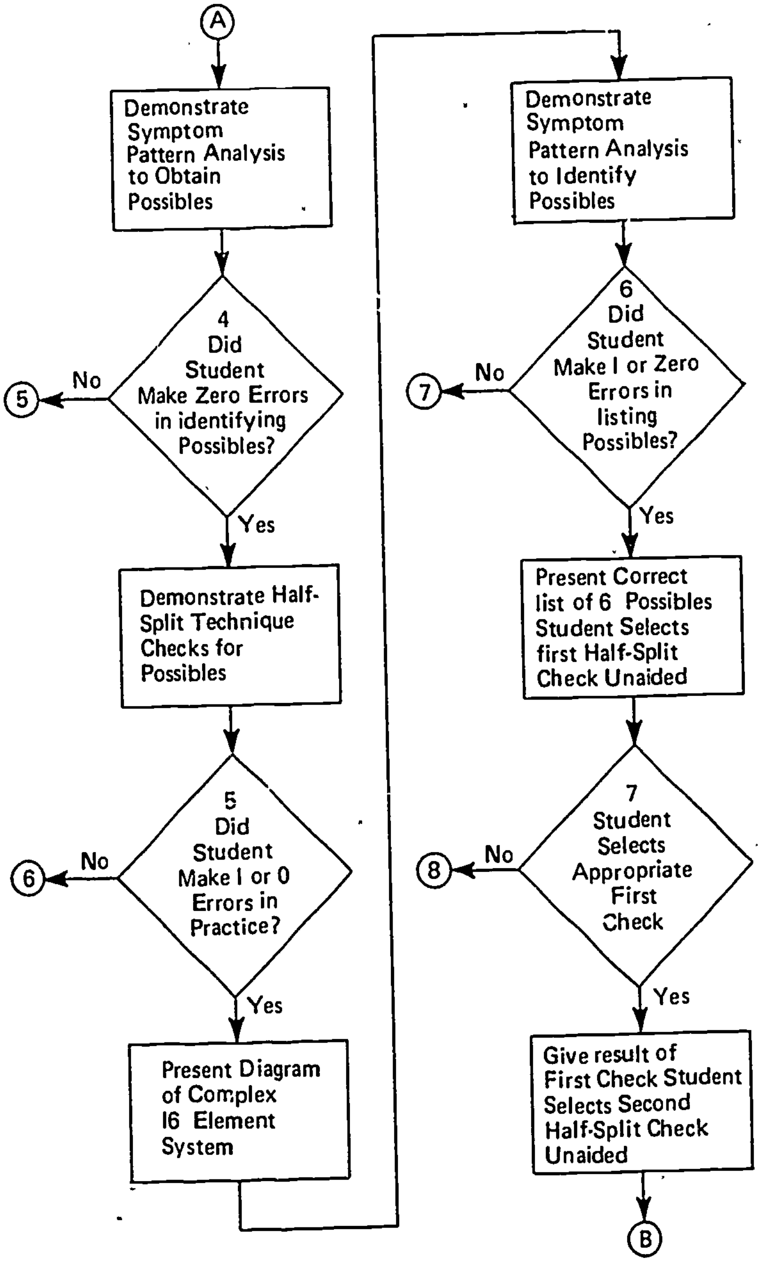
Block	STS 462X0 Ref.	Description of Skill or Knowledge
VII	4a	Locate desired information in technical orders
	14b(1)	Nomenclature of M3 20mm Automatic Gun, M60 7.62mm Machine Gun, and GAU 2 B/A
	14b(2)	Principles of operation of M3 20mm Automatic Gun, M60 7.62mm Machine Gun, and GAU 2 B/A
	15b(1)	Nomenclature, function of parts, and cycle of operation of gun pods
VIII	8	Procedures for corrosion control
	11c	Electrical components and symbols
	11h	Schematics/wiring diagrams
	11i	Troubleshoot basic electrical systems using schematics/wiring diagrams
	21b	Identify, inspect, maintain, and use munitions handling trailers
IX	4a	Locate desired information in technical orders
	11c	Electrical components and symbols
	11h	Schematics/wiring diagrams
	11i	Troubleshoot basic electrical systems using schematics/wiring diagrams
X	4a	Locate desired information in technical orders
	11c	Electrical components and symbols
	11h	Schematics/wiring diagrams
	11i	Troubleshoot basic electrical systems using schematics/wiring diagrams

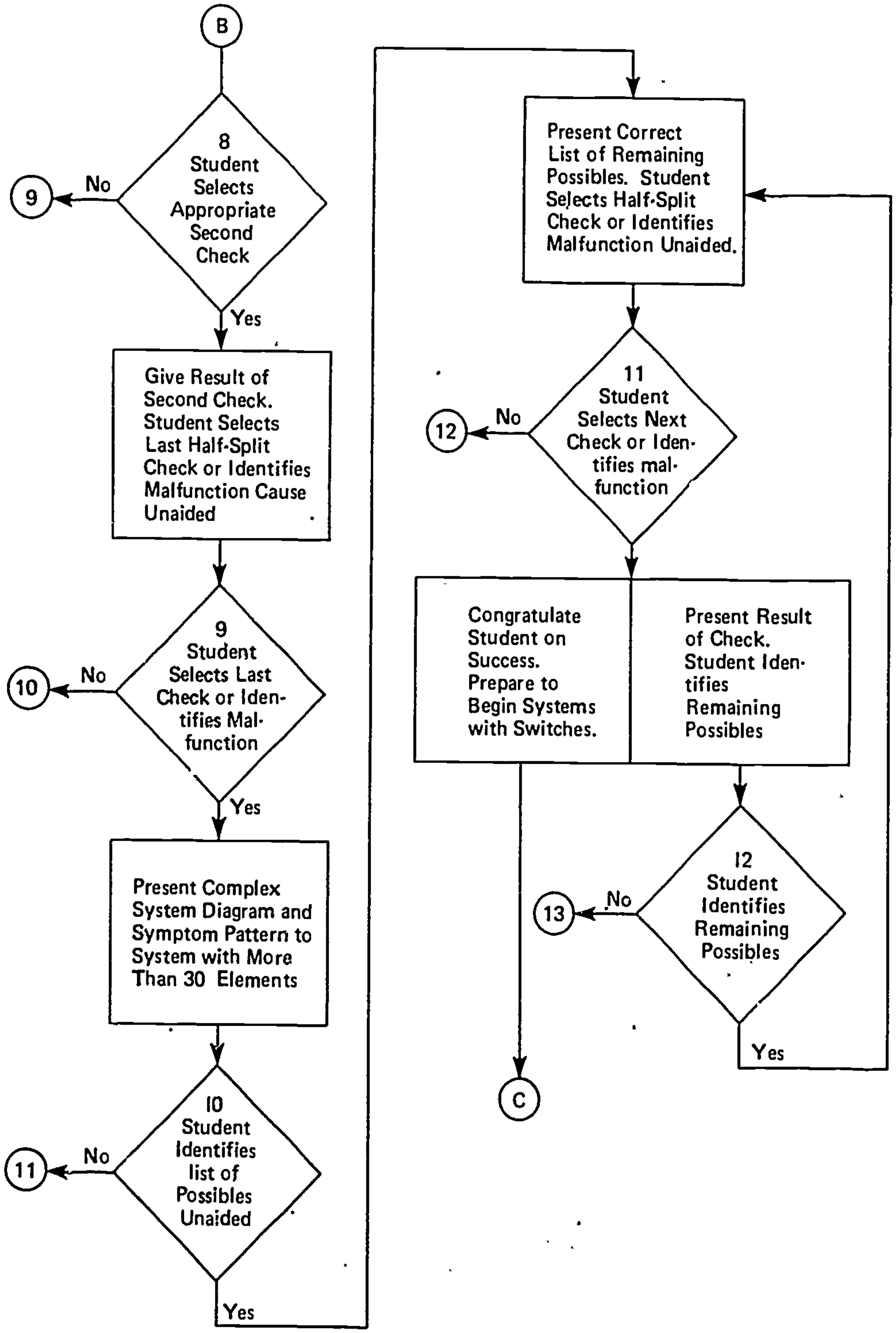
Table III (Continued)

Block	STS 462X0 Ref.	Description of Skill or Knowledge
XI	4a	Locate desired information in technical orders
	11c	Electrical components and symbols
	11h	Schematics/wiring diagrams
	11i	Troubleshoot basic electrical systems using schematics/wiring diagrams
XII	2a	Identify information as classified, unclassified, or of possible intelligence value
	2b	Determine proper classification of official information as Top Secret, Secret, Confidential, or For Official Use only
	2c	Select and recommend mode of transmission dictated by security and expediency required
	4a	Locate desired information in technical orders
	11c	Electrical components and symbols
	11e	Relays/solenoids
	11h	Schematics/wiring diagrams
	11i	Troubleshoot basic electrical systems using schematics/wiring diagrams

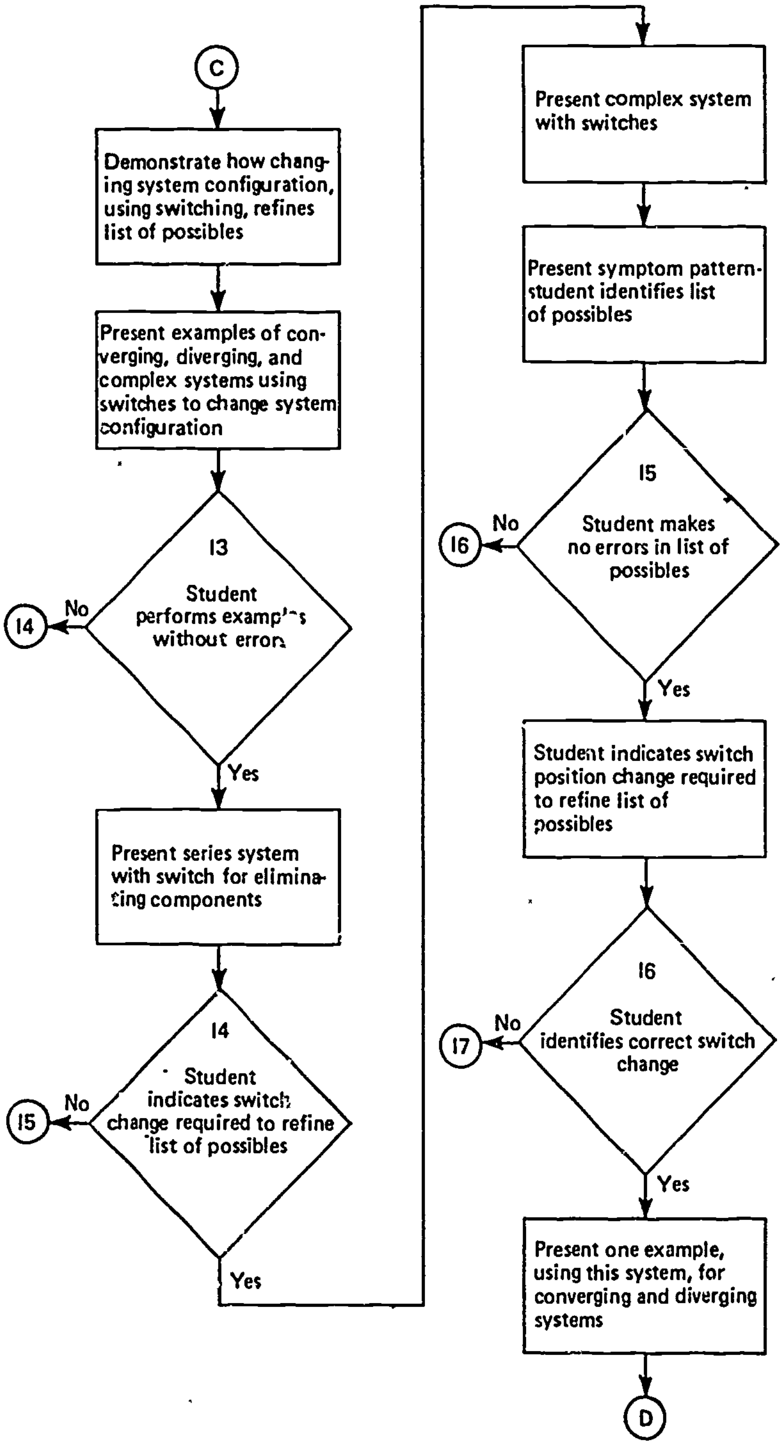
APPENDIX C: FLOWCHART FOR COMPUTER ASSISTED INSTRUCTION (CAI) FOR TROUBLESHOOTING PERFORMANCE

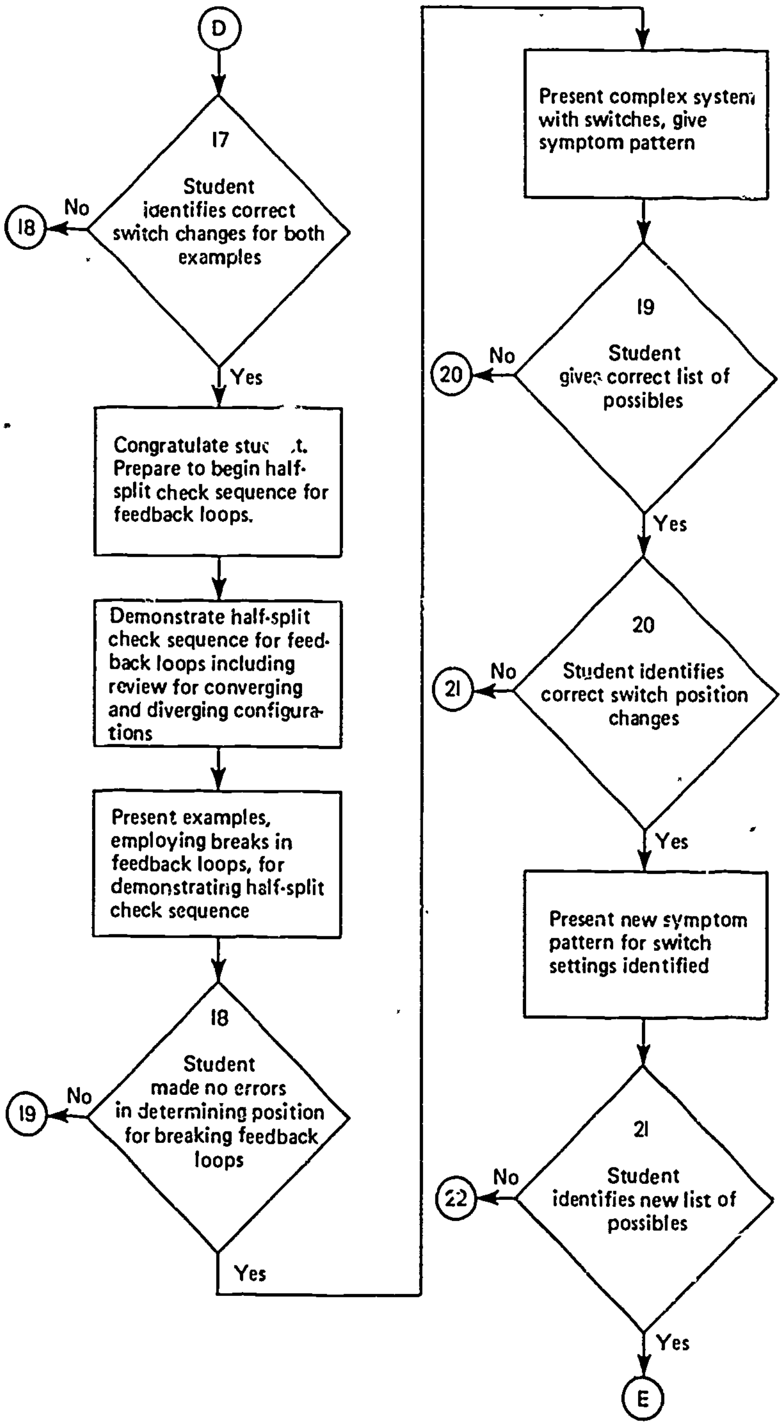


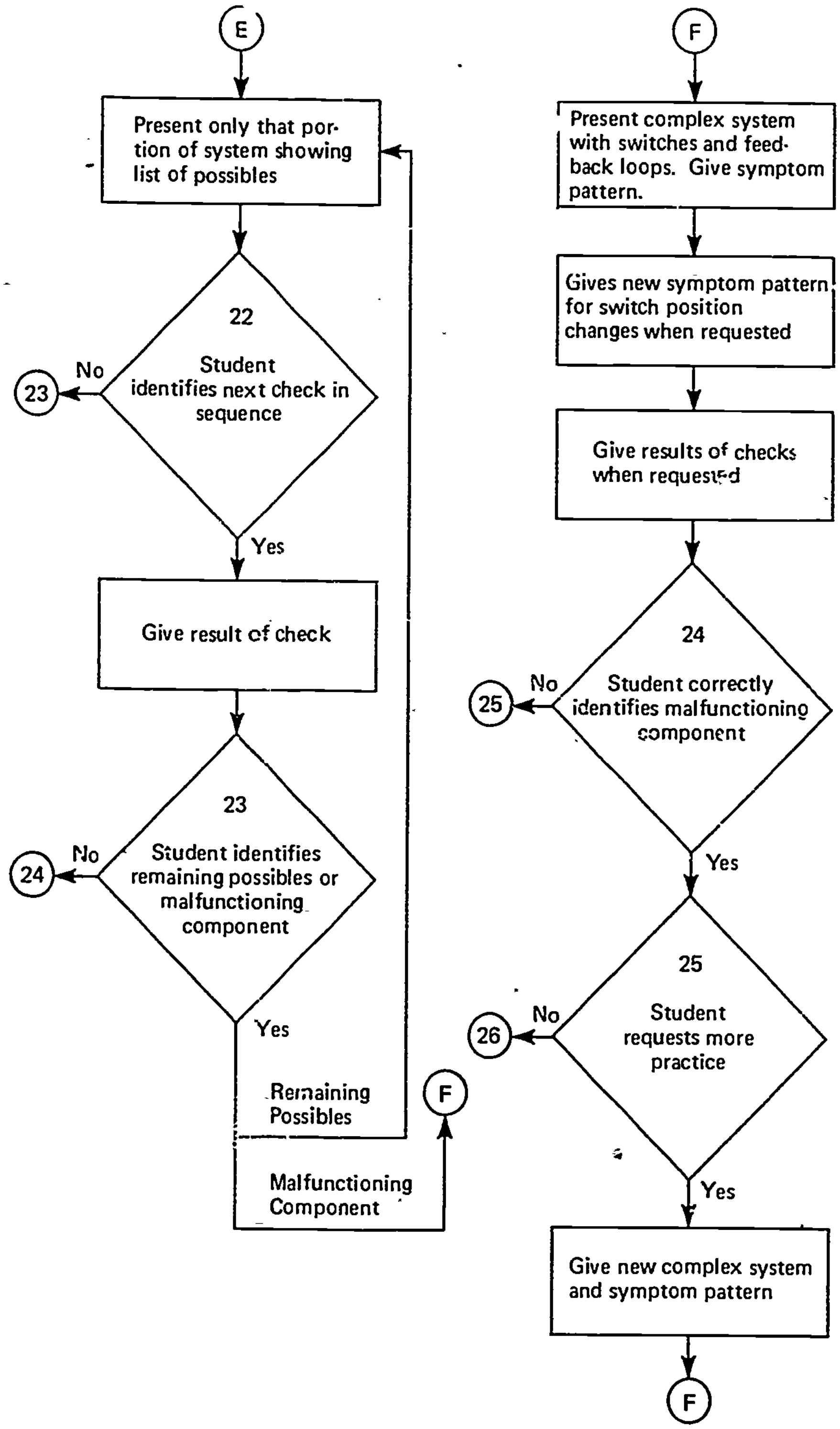

A
Demonstrate Symptom Pattern Analysis to Obtain Possibles
4 Did Student Make Zero Errors in identifying Possibles?
No
5
Yes
Demonstrate Half-Split Technique Checks for Possibles
5 Did Student Make I or 0 Errors in Practice?
No
6
Yes
Present Diagram of Complex I6 Element System
Demonstrate Symptom Pattern Analysis to Identify Possibles
6 Did Student Make I or Zero Errors in listing Possibles?
No
7
Yes
Present Correct list of 6 Possibles Student Selects first Half-Split Check Unaided
7 Student Selects Appropriate First Check
No
8
Yes
Give result of First Check Student Selects Second Half-Split Check Unaided
B

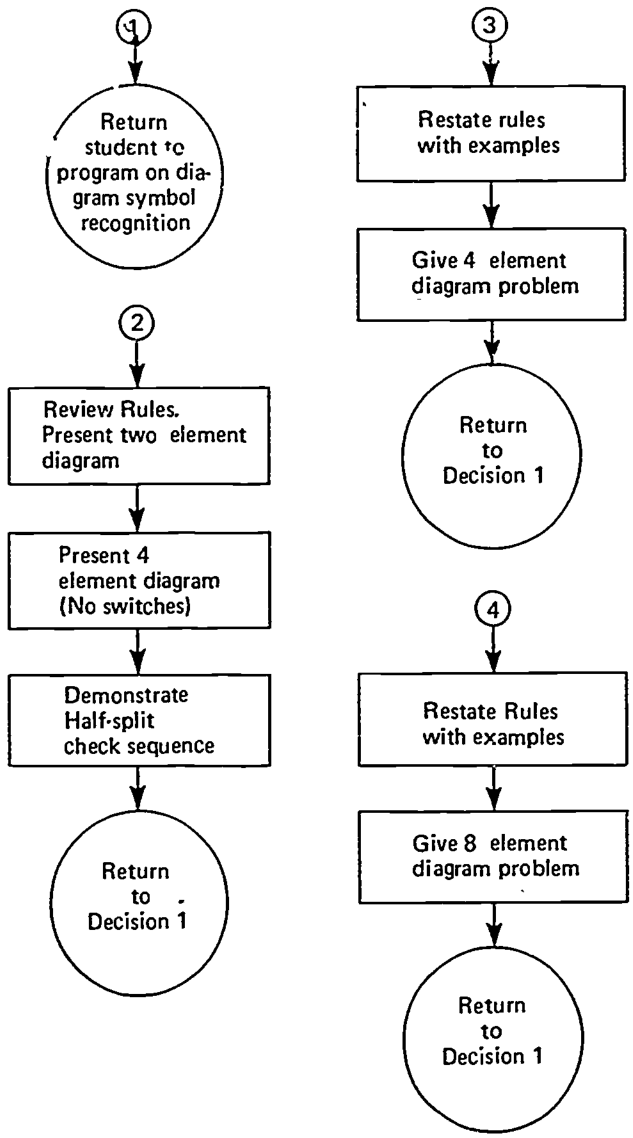


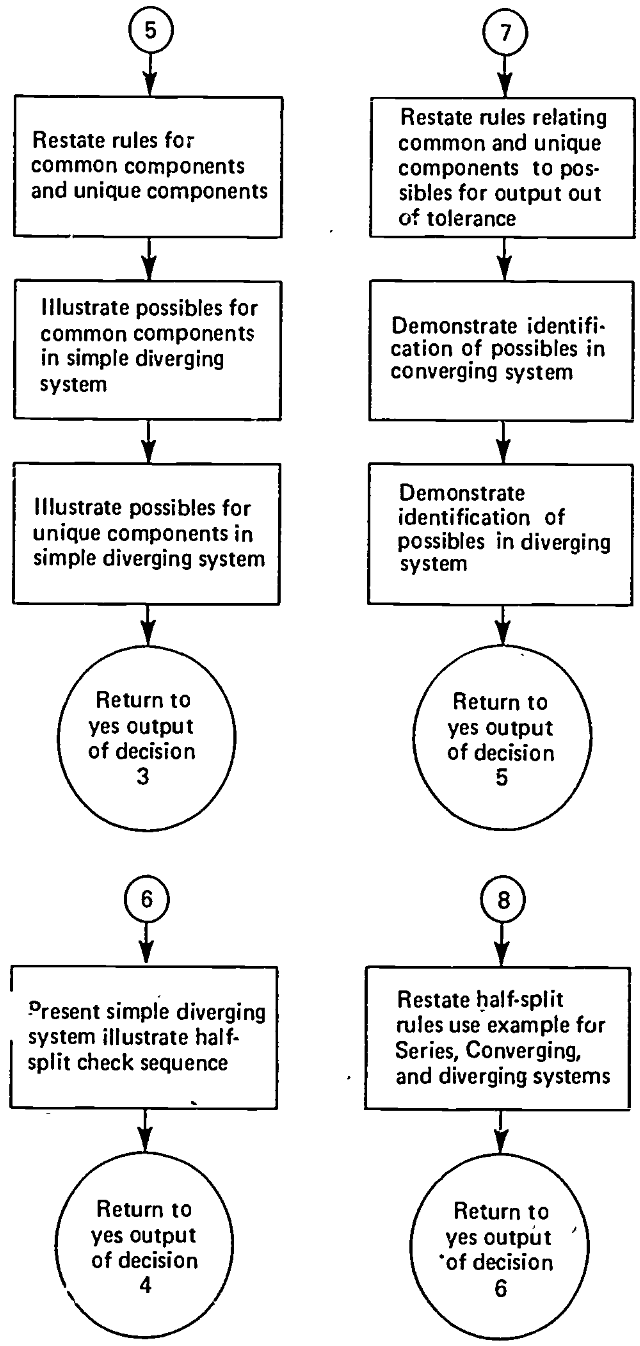
B
8 Student Selects Appropriate Second Check
No
9
Yes
Give Result of Second Check. Student Selects Last Half-Split Check or Identifies Malfunction Cause Unaided
9 Student Selects Last Check or Identifies Malfunction
No
10
Yes
Present Complex System Diagram and Symptom Pattern to System with More Than 30 Elements
10 Student Identifies list of Possibles Unaided
No
11
Yes
Present Correct List of Remaining Possibles. Student Selects Half-Split Check or Identifies Malfunction Unaided.
11 Student Selects Next Check or Identifies malfunction
No
12
Congratulate Student on Success. Prepare to Begin Systems with Switches.
Present Result of Check. Student Identifies Remaining Possibles
12 Student Identifies Remaining Possibles
No
13
Yes
C

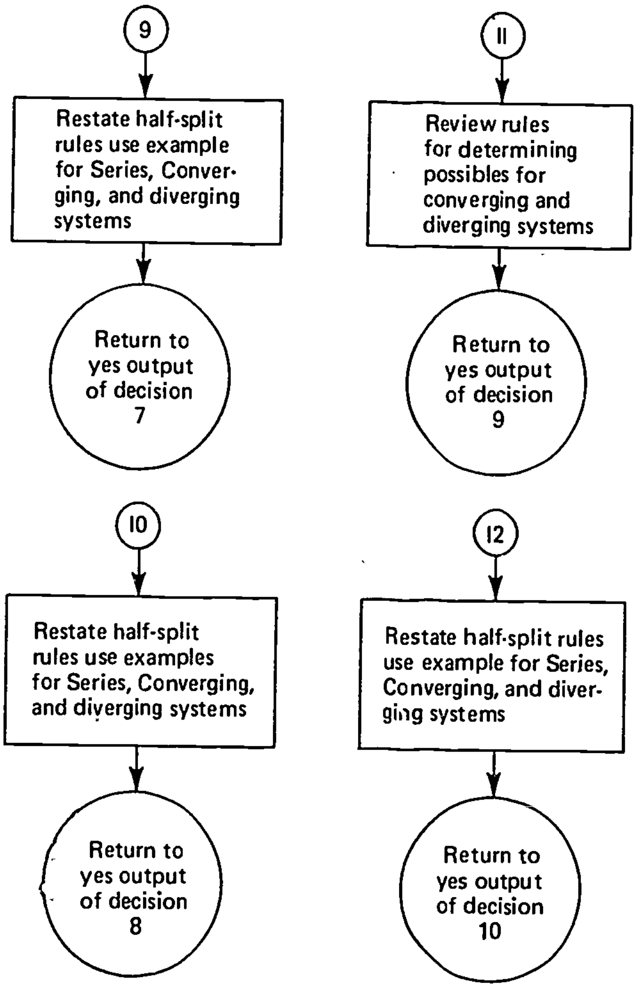

C
Demonstrate how changing system configuration, using switching, refines list of possibles
Present examples of converging, diverging, and complex systems using switches to change system configuration
13
Student performs examples without error
No
14
Yes
Present series system with switch for eliminating components
14
Student indicates switch change required to refine list of possibles
No
15
Yes
Present complex system with switches
Present symptom pattern-student identifies list of possibles
15
Student makes no errors in list of possibles
No
16
Yes
Student indicates switch position change required to refine list of possibles
16
Student identifies correct switch change
No
17
Yes
Present one example, using this system, for converging and diverging systems
D

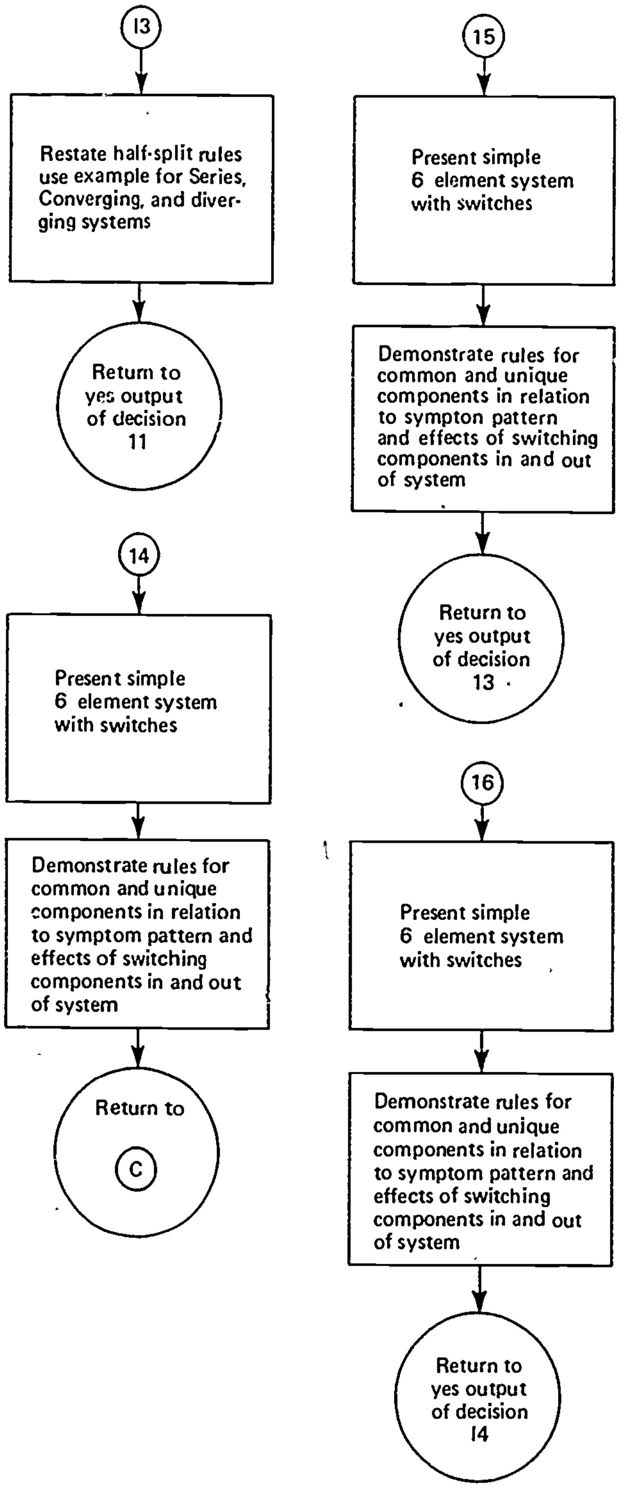

D
17
Student identifies correct switch changes for both examples
No
18
Yes
Congratulate stuc .t. Prepare to begin half-split check sequence for feedback loops.
Demonstrate half-split check sequence for feed-back loops including review for converging and diverging configura-tions
Present examples, employing breaks in feedback loops, for demonstrating half-split check sequence
18
Student made no errors in determining position for breaking feedback loops
No
19
Yes
Present complex system with switches, give symptom pattern
19
Student gives correct list of possibles
No
20
Yes
20
Student identifies correct switch position changes
No
21
Yes
Present new symptom pattern for switch settings identified
21
Student identifies new list of possibles
No
22
Yes
E

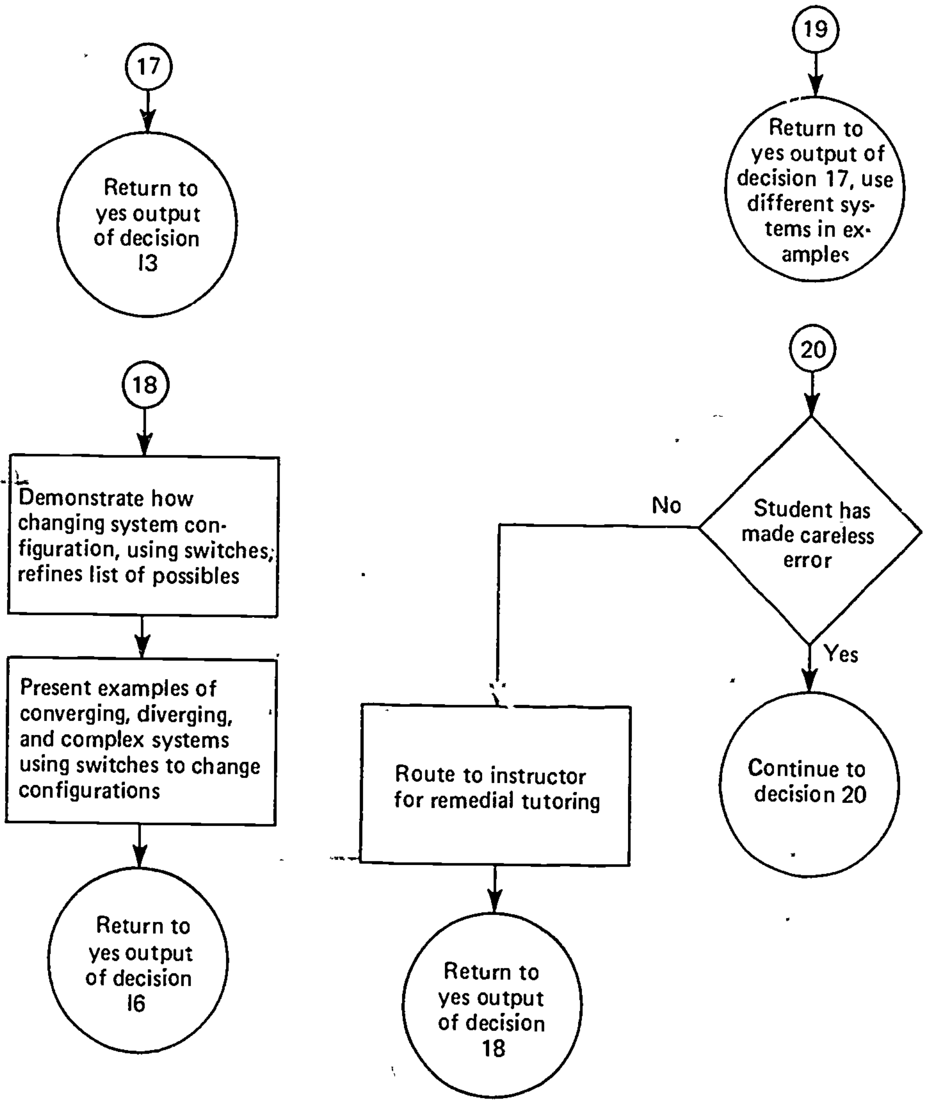

E
Present only that portion of system showing list of possibles
22
Student identifies next check in sequence
No
23
Yes
Give result of check
23
Student identifies remaining possibles or malfunctioning component
No
24
Yes
Remaining Possibles
Malfunctioning Component
F
F
Present complex system with switches and feedback loops. Give symptom pattern.
Gives new symptom pattern for switch position changes when requested
Give results of checks when requested
24
Student correctly identifies malfunctioning component
No
25
Yes
25
Student requests more practice
No
26
Yes
Give new complex system and symptom pattern
F

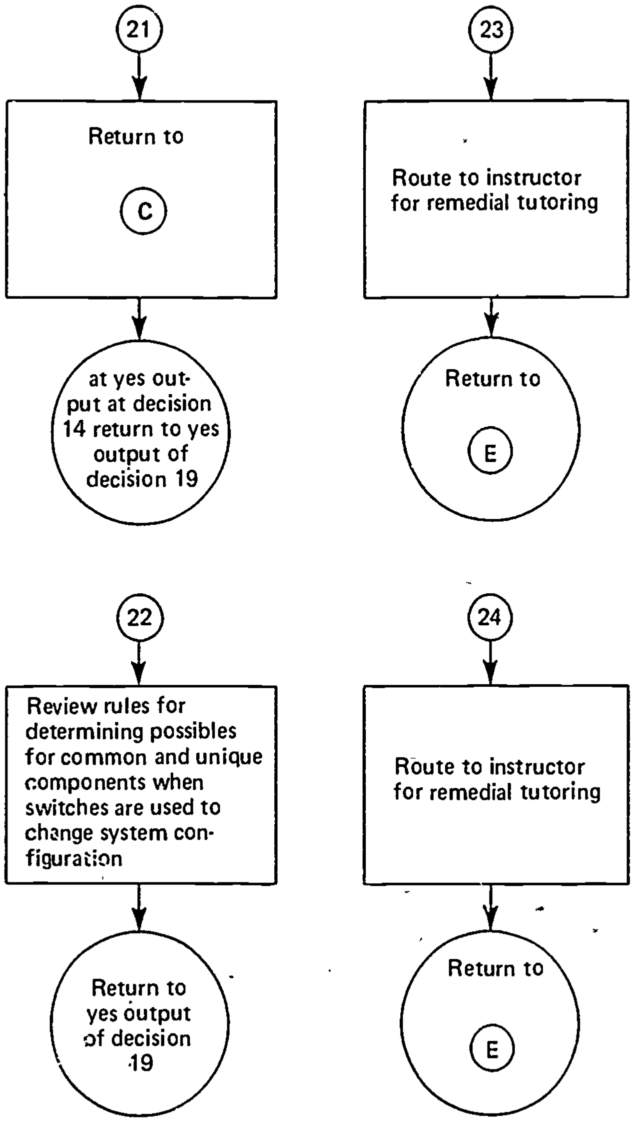

1
Return student to program on diagram symbol recognition
2
Review Rules. Present two element diagram
Present 4 element diagram (No switches)
Demonstrate Half-split check sequence
Return to Decision 1
3
Restate rules with examples
Give 4 element diagram problem
Return to Decision 1
4
Restate Rules with examples
Give 8 element diagram problem
Return to Decision 1

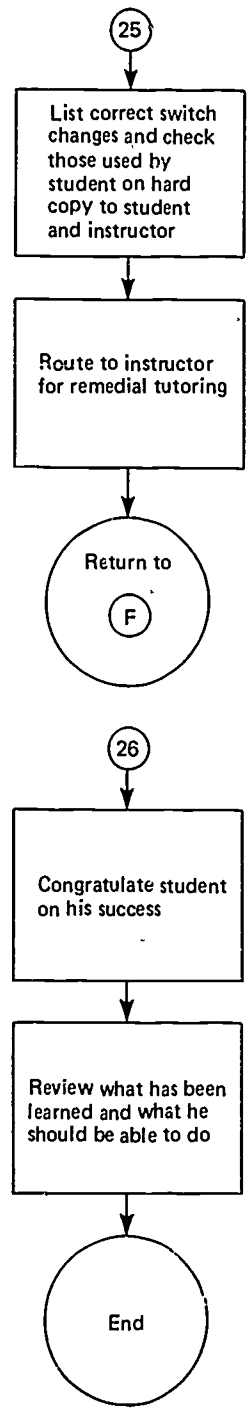

5
Restate rules for common components and unique components
Illustrate possibles for common components in simple diverging system
Illustrate possibles for unique components in simple diverging system
Return to yes output of decision 3
7
Restate rules relating common and unique components to possibles for output out of tolerance
Demonstrate identification of possibles in converging system
Demonstrate identification of possibles in diverging system
Return to yes output of decision 5
6
Present simple diverging system illustrate half-split check sequence
Return to yes output of decision 4
8
Restate half-split rules use example for Series, Converging, and diverging systems
Return to yes output of decision 6


9
Restate half-split rules use example for Series, Converging, and diverging systems
Return to yes output of decision 7
11
Review rules for determining possibles for converging and diverging systems
Return to yes output of decision 9
10
Restate half-split rules use examples for Series, Converging, and diverging systems
Return to yes output of decision 8
12
Restate half-split rules use example for Series, Converging, and diverging systems
Return to yes output of decision 10


13
Restate half-split rules use example for Series, Converging, and diverging systems
Return to yes output of decision 11
14
Present simple 6 element system with switches
Demonstrate rules for common and unique components in relation to symptom pattern and effects of switching components in and out of system
Return to C
15
Present simple 6 element system with switches
Demonstrate rules for common and unique components in relation to sympton pattern and effects of switching components in and out of system
Return to yes output of decision 13
16
Present simple 6 element system with switches
Demonstrate rules for common and unique components in relation to symptom pattern and effects of switching components in and out of system
Return to yes output of decision 14


17
Return to yes output of decision 13
18
Demonstrate how changing system configuration, using switches, refines list of possibles
Present examples of converging, diverging, and complex systems using switches to change configurations
Return to yes output of decision 16
19
Return to yes output of decision 17, use different systems in examples
20
Student has made careless error
No
Yes
Route to instructor for remedial tutoring
Return to yes output of decision 18
Continue to decision 20


21
Return to
C
at yes output at decision 14 return to yes output of decision 19
23
Route to instructor for remedial tutoring
Return to
E
22
Review rules for determining possibles for common and unique components when switches are used to change system configuration
Return to yes output of decision 19
24
Route to instructor for remedial tutoring
Return to
E


25
List correct switch changes and check those used by student on hard copy to student and instructor
Route to instructor for remedial tutoring
Return to F
26
Congratulate student on his success
Review what has been learned and what he should be able to do
End

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13. ABSTRACT

A study was initiated to devise innovative instructional strategies to be used in a performance oriented technical training course. The strategies devised were student centered and applicable for self-pacing in a proposed computer based Advanced Instructional System (AIS). A detailed examination was made of the current course, concentrating on course content, instructional strategies, student characteristics, instructor characteristics, and course administration. Strategies were then generated based on data gathered during the course analysis. Of the 56 strategies generated, 5 were chosen for detailed development and demonstration of their feasibility in the current Weapons Mechanic (TAC) Course. An evaluation of selected strategies will be performed in the near future.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Automated Instruction						
Television						
Training Devices						
Training Films						
Training Methods						
Learning Centers						
Technical Training						
Weapons Mechanic Course						