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Research Report 1383

Training Strategies for the M1 Abrams Tank Driver Trainer

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U. S. Army
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The research objective was to develop guidelines for applying the M1 Abrams tank driver trainer (DT) to train tank drivers, including determining tasks trained, developing rules for applying the training device features, justify g the use of these rules using principles of learning, identifying potentia device features, and integrating the DT into the Armor program of instruction.

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cont. The research classified the DT tasks according to the Training Effectiveness and Cost Effectiveness Prediction Model (TECEP) which prescribes learning guidelines based on the behavioral activities, conditions, standards, and feedback of the tasks. Most of the tasks are procedural, but many of the procedures require voice communications, decision making, or both. One set of the DT programs presents the continuous movement tasks of driving such as steering.

Some learning guidelines are common to all DT tasks (e.g., providing active practice and feedback) while others are specific to the type of task (e.g., high fidelity, continuous feedback for continuous movement tasks). Potential DT features pertain to all tasks (e.g., scoring tasks) or to specific tasks (e.g., increasing the number and repetition of decision-making tasks). Integration of the DT into the program of instruction considers use of the M1 tank technical manual, new programs orienting the trainee to the driving block of instruction and the driver's intercom, and changes in the device hardware and software.

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Simulation and Training Devices

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

A major research focus of the Fort Knox Field Unit is the effectiveness of training devices, device mixes, media, and techniques for the improvement of armor training and for determining the potential solutions to Army training systems problems.

The M1 Abrams tank is more complex than any previous U.S. tank. The faster and more responsive M1 tank requires highly skilled drivers to fully utilize the tank's increased agility and mobility. The driver's contribution to the success of tank tactical engagements is critical. At the present time, most tactical driving training is conducted in the units. Prior to unit training, however, it is mandatory that drivers be trained effectively on how to operate the tank under varying terrain and weather conditions. As these demands require more training time, the rationale for an acceptable driver simulator is strengthened.

Armor training is rapidly changing to incorporate new simulators and training devices to specialize training for specific MOS and to achieve and sustain high levels of combat readiness. The devices have training capabilities that are new in armor training programs. Since the device capabilities cannot all be evaluated directly in operational tests, research is required to determine whether methods useful in other simulators would generalize to devices for armor training. Furthermore, effective uses for such capabilities remain to be established in the armor context.

This report describes the results of research conducted to determine guidelines for applying one of the devices, the M1 Abrams tank driver trainer. The results of this research can have implications for USAARMC and PM TRADE decisions on devices that will provide effective training of M1 drivers.

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Technical Director

TRAINING STRATEGIES FOR THE M1 ABRAMS TANK DRIVER TRAINER

EXECUTIVE SUMMARY

Requirement:

The research objective was to develop guidelines for applying the M1 Abrams tank driver trainer (DT) to the training of tank drivers. The research includes determination of the tasks to be trained, development of rules for applying the device features to train the tasks, justification of the rules, identification of potential device features, and integration of the DT into the M1 Abrams tank program of instruction.

Procedure:

The research process analyzed the driving tasks in the documentation provided by the DT manufacturer and in the M1 Abrams tank technical manual. Steps in the tasks were categorized according to the Training Effectiveness and Cost Effectiveness Prediction (TECEP) model, which prescribes learning guidelines based on the behavioral activities, conditions, standards and feedback needed. Procedures for determining the existing and potential device features included analysis of the DT documentation, questionnaires, and interviews with M1 Abrams driver instructors. Selected literature on computer-controlled training devices was reviewed for potential features.

Findings:

The DT trains basic procedures, malfunctions, and driving skills. Most of the tasks are procedural, but many of the procedures require voice communications, decision-making or both. One set of the DT programs presents the continuous movement tasks of driving (e.g., steering) including procedural, voice communications, and decision-making components.

Some learning guidelines are common to all DT tasks (e.g., active practice and feedback), while others are specific to the type of task (e.g., high fidelity, continuous feedback for continuous movement tasks). Potential DT features pertain to all tasks (e.g., scoring improvements) or to specific tasks (e.g., increasing the number and repetition of decision-making tasks). Integration of the DT into the program of instruction considers the use of the M1 Abrams tank technical manual, new programs (orienting the trainee to the driving block of instruction and the driver's intercom), and changes in the device hardware and software.

Utilization of Findings:

The learning guidelines and uses of the potential DT features are designed for instructors and training developers of one-station unit (OSUT) training. During the research, interviewers collected information about how the instructors were integrating the DT into the training and, at the same time, presented

ideas on its potential uses and features. Thus, most ideas described herein have been tried, suggested, or are in use with the DT. Some hardware and software changes are proposed for future consideration.

TRAINING STRATEGIES FOR THE M1 ABRAMS TANK DRIVER TRAINER

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TRAINING STRATEGIES FOR THE M1 ABRAMS TANK DRIVER TRAINER

The M1 Abrams tank driver trainer (DT) was designed to familiarize new drivers and provide transition training for drivers trained on other tank models. The objective of this research is to develop guidelines for applying the DT device features to the training of M1 tank drivers. The research includes determination of tasks to be trained, development of rules for applying the device features to train the tasks, justification of each rule using principles of learning and transfer of training, identification of potential device features, and integration of the DT into the program of instruction (POI).

The remainder of this section describes the DT and programs, models for prescribing training strategies, and classes of DT tasks according to the models. The next section presents guidelines for training all DT tasks and for the specific tasks trained in the DT programs. A section designed for instructors who integrate the DT into the POI starts on p. 27. The last three sections present ideas for automated training device features, apply the ideas to the DT, and summarize uses of existing and potential DT features.

DESCRIPTION OF THE DT AND PROGRAMS

The DT contains five trainee stations controlled by instructors who monitor the DT instruments and controls on the main instructor's station (MIS) console or auxiliary instructor stations (AIS). The DT presents visual and audio simulations of tank starting and stopping procedures, instrument monitoring, and driving. DT training programs incorporate emergency situations and malfunctions that, if induced in the tank, endanger the trainee or equipment.

Tasks trained in the DT are described in the device developer's engineering reports (Sperry SECOR, 1980, Vols. 1-4, with 1981 revisions) and the M1 Abrams tank operator's manual (TM 9-2350-255-10, January 1980 or with revisions when available). The tasks are organized into procedure, malfunction, and driving programs (Appendix A). The first four programs contain 20 simple procedures, and programs 5-12 contain 37 malfunctions and emergency situations. The driving programs present driving scenarios incorporating 5 procedures and 12 malfunctions that were presented in earlier programs.

The number of steps in a procedure ranges from zero to forty-five. Procedure 88, Battery Cable Disconnect, for example, has no steps; the narrated tape tells the trainee what to do if the battery cable becomes disconnected. Many of the early programs have only one monitored step; that is, the trainee performs one action that is detected, scored, and recorded by the DT. The first procedure familiarizes the trainee with warning and caution lights. The narrator describes the functions of the

Table 2

Steps in TECEP Learning Categories

	Number of Steps	
Learning Categories	**Steps**	**Percent**
Making Decisions	6	1
Voice Communication	167	23
Recalling Procedures, positioning movement (Procedures)*	514	71
Guiding and steering, continuous movement (Continuous Movement)*	36	5
TOTAL	723	100

* In parentheses are shortened forms of the learning category titles that will be used throughout text.

category contain all three types of steps. For example, if malfunctions occur during the driving (continuous movement) tasks, the trainee must communicate with the tank commander and make decisions while driving. Tasks in each learning category are listed in Appendix C.

RULES FOR USE OF DT FEATURES TO TRAIN TASKS

Classification of the driving tasks according to the TECEP categories prescribes training for each type of task. Rules for the training strategies are based on task characteristics, trainee ability levels and training phase, and are justified by fundamental principles of learning. Some training guidelines apply to all of the tasks while others apply only to tasks within a specific category.

GENERAL LEARNING GUIDELINES

The procedures for instructional system development cite four principles that enhance learning of all task types (Department of the Army, 1975):

1. Inform trainee of the objectives
2. Guide and prompt the trainee
3. Provide for active practice
4. Provide feedback to the trainee

As shown in Table 3, the DT has features which relate to each of the general learning guidelines. The following paragraphs explain, under the heading of each guideline, how the DT features meet these general training requirements.

Inform the Trainee of Objectives

Each program contains an audio instructional script in which the narrator describes the task to be learned, initial conditions, and end of the procedure or program (Fig. 1).

Guide and prompt the trainee

Step-by-step instructions prompt the trainee in the sequence of steps, explain reasons, alternatives and consequences of performance (Fig. 1, Lines 4 - 38). The training guidelines recommend dividing the task into parts, depending on the ability of the trainees, complexity of the task, and length of the task. Practice should be on specific components prior to practice on the whole task. The DT meets this requirement by providing step-by-step instructions in the programs the first time that the trainee must perform task segments. Later in the programs the same tasks must be performed by the trainee without the aid of detailed instructions. For example, in Procedure 85, "Alternator Failure," of the Procedure programs, the indications of alternator failure are demonstrated and explained to the trainee. The trainee is also guided through the steps necessary in handling the problem. "Alternator Failure," Malfunction 6 of Driving Program 25, happens while the trainee is driving. The preprogrammed instruction tapes do not tell the trainee when the malfunction occurs, what malfunction it is, or what to do. The trainee must draw upon his earlier procedure program training to recognize the symptoms of malfunction and remember the proper steps to take in resolving it.

Table 3

DT Features for General Learning Guidelines

General Learning Guidelines			
Inform Traines of Objectives	**Guide and Prompt Trainee**	**Provide for Active Practice**	**Provide Feedback to the Trainee**
Preprogrammed audio tape stating training objectives	Preprogrammed audio tape giving step-by-step instructions	Capability for instructor to manage training; monitor and evaluate trainee performance through the MIS and AIS	Freeze
			CTR Displays
			Score printout
	Graduated levels of task complexity	Simulated tank driver compartments	Visual and audio feedback
	Graduated levels of stress and distraction	Capability for trainee to repeat programs and procedures	
		Capability for instructor to develop manual programs	
		Repetition of a specific procedure several times within the DT programs	

Introductory Statement: You are now going to perform Procedure Number 83, Brake Failure. We will start the procedure now.

Step No. Audioscript Line

1 First, observe that the brakes seem to be opearting normally. Apply the service brakes several times. Note the travel of the brake pedal and the force it takes to push it down.

2 We will now fail the brakes. Before we do, however, remember that with the turbine engine there is no compression or drag from the engine. You cannot downshift to slow down. Now apply the brakes again. Note how easy it was to push. If moving, brake failure will be even more apparent when you apply the brakes and nothing happens.

3 When the brakes fail your first concern again is to get the tank stopped safely. The method you use will depend on the situation. If terrain permits, just coast to a stop. Remember that when the tank slows down to 3 or 4 miles an hour, you can put the parking brake on.

If going up hill you can slow down and hold the tank with the throttle or slow then apply the parking brake. You may also choose just to continue up the hill to a level place.

The worst situation is a brake failure going down a steep hill. If it is too dangerous to attempt making it all the way down the hill, you should consider making a turn across the slope. If this is not possible you have no alternative but to run into something that will stop the tank.

Whatever the situation it is imperative to notify the TC and crew that the brakes failed so they can brace themselves. Now key your mike and say "Sgt., the brakes failed." You should also tell him how you plan to stop.

4 The TC will respond and perhaps suggest how to stop. Once stopped, the chances are that Organizational Maintenance will be required. That concludes this procedure. Stand by for futher instructions.

Figure 1. Audioscript for Procedure 83 "Brake Failure"*

* From Sperry SECOR, 1980, Vol. 3, pp. 730-733.

The training guidelines also emphasize the need to increase stress and distractors in the later phases of training so that the training environment approximates the level of stress found in the operational context. The DT meets this requirement by first introducing the trainee to an isolated task and later embedding the same task in the driving situation. Thus, the trainee must perform despite the presence of distractors and stressors such as turbine engine noise, moving visual scene, the necessity of continuing to drive the tank, and the lack of guidance from the narrator. For example, when brake failure occurs in Malfunction 3 of the later programs, the trainee is driving and he is given no guidance by the audioscript to warn him of the failure or to tell him what to do.

Provide for Active Practice

Training programs. The driver trainer is furnished with 19 prerecorded programs which contain over 60 procedures and malfunctions for the trainee to practice. Many of these procedures and malfunctions appear more than once throughout the programs and so allow for repeated practice (e.g., "engine shutdown").

The procedure programs familiarize the trainee with skills he must learn before driving. During these programs the trainee does not practice driving and, hence, does not view the visual scene through his periscope. These procedures guide the trainee through operations such as: power-up hull and engine shutdown; indications of malfunctions (e.g., loss of power, alternator failure, thrown track); steps to take to handle malfunctions; and the feel of the throttle, T-bar and brake pedal.

During the driving programs the trainee practices driving while viewing a video tape of a scene external to the tank. The driving programs contain both procedures and malfunctions. The procedures teach the trainee skills directly involved with driving the tank, such as "placing the tank in motion" and "driving over an obstacle." Repeating the malfunctions gives the trainee the opportunity, within the context of a driving situation, to practice skills he gained in the procedure programs.

Instructors can also construct manual programs using the contents of procedure and driving programs to provide the trainee with additional practice. Up to 69 manual programs can be stored to augment the automatic programs.

Instructor's stations. The instructor's stations assist the instructors in training management and allow them to monitor, evaluate, and control trainee practice sessions. The main instructor station (MIS) is designed for one or two instructors. It features a double console with alphanumeric keyboards, and two visual monitors for each console. The visual monitors are 12-inch color cathode-ray tubes (CRT) on which the instructors can view the visual scene being presented to the trainee and monitor the trainee's progress.

Auxiliary instructor stations (AIS) attached to each trainee station allow direct monitoring of the instruction. The AIS have fewer features than the MIS (Table 4).

The controls for training managment (e.g., those for performance displays, communications, training programs, etc.) are summarized in Table 5. These controls enables the instructor to select programs in any sequence; stop programs at any time (FREEZE); repeat, advance, or hold procedures (the HOLD function stops training at the end of each procedure); and store, print and clear performance records for the five trainees.

The instructor can obtain several CRT displays that facilitate training management. For the automatic programs, displays present the individual procedures and malfunctions so that the instructor can select programs that meet the needs of the trainee. Displays are also available for the titles and contents of the automatic procedure programs. If the instructors construct manual programs, the DT provides for their display also.

Instructors at the MIS can monitor the progress of trainees at all five stations at once by using the Training Status Display which presents the following data for each station:

1. Trainee station number (1-5)

2. Number and name of the programs in progress

3. Number of procedures and malfunctions in the program

4. Audio (step-by-step instructions) on or off

5. Four procedures in the program (procedure names scroll upward so the instructor can always see the procedure just completed, in progress and to be presented)

6. Number of steps in each of the four procedures

7. Step in progress

8. Trainee score on the step in progress

9. Final score on procedure just completed

Table 4

Instructor Station Features

Main Instructor Station
1. Two-Operator Console
2. Line Printer
3. Two Alphanumeric CRT Displays
4. Two Visual Monitor Displays
5. Two Keyboards
6. Lighted Switches Indicate Trainee Status
7. Two Headsets
8. Set of Function Controls
9. Set of Display Controls
10. Set of Communication Controls
11. Set of Audio Controls
Auxiliary Instructor Station
1. CRT Monitor
2. Power Controls
3. Function Controls
4. Communication Controls
5. Audio Controls
6. Headset
7. Shelf - Workspace

Table 5

Instructor Function and Program Controls

PROGRAM READY	enters the selected program
RUN/FREEZE	causes the designated trainee station to start/stop the procedure or program selected. FREEZE automatically flashes at the end of a program or when the trainee makes an error
HOLD PROCEDURE	causes program to stop automatically after each procedure in the program
REPEAT PROCEDURE	cause simulation to return to the start of a procedure and repeat
ADVANCE PROCEDURE	bypasses all elements of a procedure; repeated activation skips a number of procedures
PREVIEW	displays first page of stored performance data for designated trainee station; repeated activation presents subsequent pages
REPEAT PROGRAM	returns to the start of a program and repeats
PRINT	activates the line printer to produce hardcopy printout of all stored performance data for the designated trainee station
INSTRUCTION OFF	deletes the step-by-step instructions during procedures and malfunctions; the introduction, initial conditions, tank commander voice simulation, and end statement play in all cases.
STEERING OFF	removes from the trainee's view the steering indicator needle for the designated trainee station (steering indicator needle will be described later)
VISUAL REVERSE/ NORMAL/FORWARD	moves the visual scene tape backward or forward; returns to the normal position when released; the visual scene and the audio are synchronized by the machine; can skip parts of the driving program or reset the scene to correspond to where the trainee stoppped the tank

Individual performance displays present the training in progress for an individual trainee. Data elements are:

1. Trainee station number (1-5)

2. Name and social security number of the trainee

3. Program number, number of procedures in the program, and audio (step-by-step instructions) on or off

4. Name and number of the procedure in progress and the number of steps

5. Content of procedure steps and action to be taken

6. Trainee score on each step (performed correctly or FREEZE-FAIL)

7. Status of switches, lights, controls, and instrument readings, (e.g., tachometer, speedometer, fuel, voltmeter, etc.)

Physical simulation of tank driver's compartment. DT equipment features simulate physical and operational characteristics of the tank in the five trainee stations. These stations provide the setting for trainees to practice procedure sequences using apparatus similar to the equipment in the actual tank. DT features include the throttle and brake controls, intercommunication headsets, switches, meters, circuit breakers, periscopes, and other items. Through the headset the trainee hears background sounds (turbine engine whine, vehicle track noise, transmission engage and disengage, etc.). In the driving programs, audiovisual scenarios simulate environmental conditions and pre-recorded voice tapes simulate communication from the tank commander.

Provide Feedback

Feedback is a rather generic term which encompasses such processes as reinforcement and providing knowledge of results. Most behavior involves feedback of some kind. A feedback process involves comparison of a potential or ideal state against an actual state. For example, in a negative feedback system, the actual state (e.g., a thermostat reading of 50^{o}F) is compared to a potential state (e.g., a thermostat reading of 80^{o}F). The difference between these states is feedback to a system (e.g. heater) and this enables a regulation process to begin (e.g., the heater to turn on until the difference disappears). For the purposes of describing driver trainer tasks, the potential state can be thought of as "correct" behavior and the actual state as "error" behavior. Information about the trainee's behavior is fed back to him/her in order that it may govern future behavior.

One type of feedback is reinforcement. Reinforcement involves either the presentation of a reward (positive reinforcemet) or the removal of an aversive stimulus (negative reinforcement). The definition of reinforcement also involves a functional relationship, that is, not only must a stimulus be present or removed but its effect on behavior must be to increase its occurrence. Reinforcement is feedback but feedback is not necessarily reinforcement.

Providing knowledge of results is another type of feedback. By providing individuals with information about their performance (e.g., verbally, test scores, etc.), they are able to discriminate which behavioral repertoires are appropriate or correct in a given situation. To be effective, the information must be salient and the individual must attend to and comprehend the information and its relationship to the behavior in question.

The procedure and driving programs provide opportunities for instructors to give feedback to the trainee through automatic "freeze" upon trainee error and displays of performance measures. If the trainee violates one of the scoring rules, the station for that trainee "freezes" and the trainee is failed on the incorrectly performed step. In the FREEZE condition, the audio and visual simulation halts and a five-second siren tone sounds in the trainee's headset. Thus, the FREEZE condition provides the trainee with external information about his performance--it signifies that an error has been made. Whether or not it acts as a punisher of the "error producing" behavior is uncertain. If participation in the procedure and driving programs are reinforcing events then it would be reasonable to expect FREEZE to act as a punisher since it involves time out from a reinforcing situation. Furthermore, the siren may be an aversive stimulus and act as a punisher in its own right. To demonstrate whether punishment is involved in FREEZE, the error producing behavior must be shown to decrease contingent upon the halting of the simulation and/or the sounding of the tone.

A printout of scores is provided after the program as a result of performance measures displayed on the instructor's CRT (these diplays were outlined under "Instructors' Stations"). The DT provides a copy of the individual trainee's scores containing detailed diagnostic information, including:

1. Trainee, program and procedure identification

2. Trainee performance on each step (OK, ERROR, SLOW, VERY SLOW, or OBS for a step that requires only passive observation)

3. Summary data for procedures (times attempted, number of steps, steps performed correctly and incorrectly, and trainee score for the steps)

4. Driving program speed and steering scores by driving segment

5. Driving scores combined with procedure and malfunction scores for overall program score

The feedback on the DT audio and visual tapes is not adaptive to trainee performance and, thus, may present incorrect cues. The feedback does not seem to affect performance and thus it appears that neither reinforcement nor punishment are operating. This problem will be discussed in greater detail under the section on continuous movement tasks.

DT FEATURES FOR SPECIFIC TASK TYPES

TECEP guidelines for specific task categories vary in their requirements for support from the DT features. Some learning guidelines such as feedback and reinforcement are common to all task types; that is, they apply regardless of specific task categories. Thus, all the DT features that provide scores to the instructor support the task types described in the following paragraphs. However, the following discussions focus on those training guidelines unique to the tasks in question.

Procedures

Procedural tasks require two different types of skill. The first is the physical skill to position controls and manipulate equipment, which is usually not challenging and is within the trainee's repertoire. Training emphasis is on the second type of skill, the recall of procedural steps and sequences.

The procedural sequence is often predetermined and routine so that it requires minimal judgment and decision-making. Memory may be required, but cues from the equipment, environment, fellow crew members, one's own behavior, or checklists facilitate recall. The TECEP guidelines for procedural tasks emphasize three factors: Restructuring the task to take advantage of part-task training, reduction of memory demands, and extensive practice with feedback (Table 6).

Table 6

DT Features for Procedure Learning Guidelines

	Learning Guidelines for Procedures		
	Divide tasks into steps, then train the sequence	**Memory**	**Practice with feedback**
DT Features	Step-by-step instructions	Narrative links steps to displays	Repetition of procedures occurs during the programs
	Early programs contain simple groups of tasks	Program demonstrates displays	Trainee can repeat programs
	Late programs train complete set of steps	Trainee practices with guidance	Manual programs augment repetition
	Train sequences of tasks	Instructors need to incorporate technical manual, job aids	Feedback (was described for all tasks)

Training algorithms for procedural tasks also emphasize the need to divide the procedure into steps, train progressively larger groups of steps, and train the chaining of the steps into the total procedural sequence. Memorization demands are reduced by the chaining since each step cues the performance of the subsequent step. These guidelines are especially important if the procedures are long, difficult, or must be performed in stressful conditions, and if the trainees are low in aptitude. Tank driving has these problems in the operational setting. The DT restructures the tasks early in training by dividing them into many simple steps and then chains the steps in sequence to form whole procedures.

Recall of procedures requires that the trainee learn cues to reduce the memory load. The TECEP guidelines suggest demonstrations of the correct performance, verbal explanations by the trainee of the cues and their associations, and use of mnemonics (especially in early stages of learning). The DT step-by-step instructions guide the trainee through practice of the procedures while providing the names of the equipment components. The programs automatically turn indicator lights on and off according to the audio script to identify displays and switches. Labels for displays and controls normally in the driver's compartments are reproduced in the DT, and the coupling of prompts with labels under actual practice conditions meets the requirement of the guidelines.

Step-by-step instructions appear in the tank technical manual (operator's manual) and in other job aids. The DT does not, at present, incorporate the use of the manual and aids. Thus, the instructors need to explain use of the manual with the DT programs. The technical manual and job aids serve as the memory aids suggested by the TECEP guidelines.

The training guidelines recommend extensive practice to enhance retention of the procedural skills through internal (e.g., kinesthetic) feedback generated by positioning movement. The DT programs allow repeated practice to develop this internal feedback. Many procedures such as "Warning and Caution Lights" occur again and again throughout the programs. Also, the instructor can locate procedures as desired. The manual program capability enables the composition of programs containing procedures that need more practice than others. Isolating these procedures in a separate program facilitates their use and repetition.

Performance evaluation, scoring, and feedback are critical to training of procedural tasks. TECEP guidelines recommend immediate and frequent feedback and specifically positive reinforcement early in training. Trainees of low ability need more reinforcement than others. Although the need for positive reinforcement as well as other types of feedback is the most notable characteristic in the training algorithm for procedural tasks, the features for feedback in the DT are minimal. The Driver Trainer does not automatically provide behavioral information. Instead, the DT freezes when the trainee makes an error so that the instructor can give feedback as to the nature of the error and what to do to correct it. Thus, substantial instructor intervention is needed to provide adequate information and postiive reinforcement, especially for low-ability trainees. By monitoring performance displays instructors can determine which trainees have high failure rates and consequently give them more instruction and feedback, while allowing trainees who need less help to progress through the automatic programs on their own. Instructors can use the AIS to work closely with a trainee who is having trouble. Trainees who perform poorly on even the simple procedures may need additional training materials, instructions from the instructor, and positive reinforcement after correctly performed procedures.

Training effectiveness is increased in all types of tasks trained in the DT through features that link procedural steps to cues and enhance memorization by feedback, high levels of initial learning, and performance practice. These features also apply to procedural tasks and hence to all DT programs since each program contains some procedural steps regardless of whether the majority of steps are in some other category (e.g., continuous movement). Other DT features have special uses for "Voice communication," "Continuous Movement," and "Making Decisions" task categories.

Voice Communication

Voice communication in the military context comprises conversations using standardized message formats. Ordinary speech patterns must be altered to meet military requirements. Messages must be brief, have a single meaning common to all participants, and be delivered in the presence of noise. Learning principles for voice communication tasks are: teach anticipation of certain messages, model correct voice communication procedures, and enhance ability to perform with distractions by overlearning. How the DT features fulfill these training guidelines is discussed below and summarized in Table 7.

The learning guidelines recommend demonstrating the correct communications and emphasizing critical cues and responses. They also advise teaching the trainee to expect certain messages, given a particular situation. The following excerpt from the audio tape typifies how the DT exercises prepare the trainee for TC messages and demonstrate for the trainee the correct communication procedure (Sperry SECOR, 1980, Vol. 2, pp. 267-268):

Table 7

DT Features for Voice Communication Learning Guidelines

	Learning Guidelines	
	Teach anticipation of certain messages and model correct voice communication procedures	Enhance ability to perform with distraction by over-learning
DT Features	Narrator tells trainee what TC would say or what to say to TC under particular circumstances	Audio tapes which realistically simulate TC orders
		100 out of the total 118 DT tasks require trainee to practice voice communication formats which are often quite similar
		Graduated levels of stress and distraction

"At this point you are connected to the tank NBC system and should make a communications check. Press the mike button, and say 'Driver Commo Check' then release the mike button."

"You should now make a commo check which the TC will again acknowledge. Press the mike button, say 'Driver Commo Check' and release the mike button."

In order to make voice communication training resistant to the pressures of the operational setting, learning guidelines recommend gradually increasing distraction and stress during training sessions. DT programs meet this requirement by starting with simple voice communication demands in the early procedure programs and then increasing the demands in the driving programs. For example, in the early procedure programs, the trainee is guided through communication exercises with demonstrations and prompts. By contrast, in the driving programs the communications occur without prompts, in the presence of ambient noise, and while the driver must also attend to steering, speed control, and malfunctions.

To increase the trainee's ability to perform under stress, learning principles suggest that the student practice correct performance to the point of overlearning. One hundred out of the total 118 DT tasks provide communications practice. Many of these tasks require the trainee to report to the tank commander and listen to a prerecorded tape that simulates the tank commander's voice. Approximately half of the voice communication is passive listening by the trainee.

Practice requires feedback to reinforce correct behavior. DT feedback for communication skills (FREEZE, CRT display, and score printout) is inadequate because it is not immediate or natural. Although the DT audio tapes are realistic in simulating tank commanders' orders, the DT training is degraded because the voice tapes are not responsive to the performance of the trainee. The trainee can pratice repeatedly on the DT, but will not receive feedback concerning his communications since the device cannot detect them. For example, the simulated tank commander's response is the same no matter what the driver says. Thus, this feature decreases the credibility of communications exercises and may even frustrate the trainee.

Continuous Movement

Continuous movement tasks, such as driving a vehicle, require continuous physical response to a constantly changing visual stimulus. All of the segments of the driving programs that have the trainee control the motion of the simulated tank are of this type.

Since guiding and steering tasks demand constant compensatory movement, the learning guidelines recommend that training emphasize prediction or anticipation of future conditions, to teach the trainee to control the dynamic nature of the task and provide continuous and accurate stimulus cues, reinforcement and feedback. Table 8 illustrates how the DT features meet these learning guideline requirements. All of the DT features that were listed for the general training guidelines (e.g., feedback) apply to continuous tasks.

Table 8

DT Features for Continuous Movement Learning Guidelines

	Learning Guidelines	
	Provide continuous accurate/ high fidelity/appropriate stimulus cues, reinforcement and feedback	Emphasize prediction of future conditions to teach trainees to control the dynamic nature of the task
DT Features	Audio/Visual simulation tapes Steering indicator Speedometer T-bar and brake pedal resistance	Step-by-step instructions for driving aspects that are new to the trainee TC tells driver what to anticipate and how to respond

The guidelines recommend that the training emphasize prediction of future conditions to teach to the trainee the dynamic nature of the task. The driving programs in the DT furnish step-by-step instructions for the driving aspects that are new in the terrain shown in the visual tapes. The DT audio narrative includes several segments where the tank commander tells the driver what to anticipate and what driving skill will be required. Thus, while the trainee views the terrain, the tank commander provides instructional prompts, delivered in a manner that simulates what the driver will hear in the operational setting. This feature is illustrated in an excerpt from an audio instructional script (Fig. 2).

Training guidelines for continuous steering tasks emphasize (1) the necessity for continuous realistic cues, feedback and reinforcement, and (2) that "natural" feedback is superior to "artificial." Natural feedback for driving consists of knowledge that steering, acceleration and other guidance and control responses are successful in maintaining the correct speed and direction. It is critical that feedback be continuous because the nature of the task is such that the trainee must learn to adjust his performance continually depending on the cues he gets from the environment. Training guidelines emphasize overlearning to produce internal (e.g., proprioceptive) cues.

The DT itself does not provide informative feedback, but uses a FREEZE mode, as described for the procedural tasks, to enable the instructor to provide performance information. Furthermore, the visual and audio simulations in the driving programs are not responsive to the trainee's performance. The visual scene accelerates only up to the speed that the tape was recorded; so that if the trainee speeds, the tape will not remain synchronized with his driving. The speedometer registers speeds higher than an actual tank can go and the tape does not respond at all to steering. To compensate, the DT has an indicator for steering deflection which appears in the trainee's periscope view (the instructor can delete this indicator). This feature is intended to show the trainee the extent of error in deflection of his steering compared to the correct track. However, instructors and trainees state that the indicator detracts from training.

<u>Making Decisions</u>

Decisions-making requires the application of a logic model when multiple solutions to problems are possible. The successful course of action and the penalties for failure are not readily apparent and the relative values and tradeoffs of possible solutions must be considered, often in a short time interval. Examples in tank driving are the diagnosis of equipment malfunction and selection of tactics.

Learning guidelines for making decisions ensure that the trainee acquires the knowledge to identify the problems, generate reasonable solutions, evaluate these solutions, select and execute the best solutions, and provide knowledge of the results, focusing on predictability, timeliness, completeness, and consistency of decisions (Table 9).

Instructor	You are now going to move forward again, so when the TC tells you to move out, place the transmission in drive, release the brake and twist the throttle grips toward you.
TC:	Driver, slowly move out.
TC:	Driver, prepare to make a hard right followed by a hard left.
TC:	Driver, hard right.
TC:	Straight ahead.
TC:	Hard left.
TC:	Straight ahead. Drive toward the center of those bleachers.
TC:	Driver, stop.
TC:	Driver, slowly back up.
TC:	Driver, we're going to proceed down the center of this stream. It's less than four feet deep so we won't need the Fording Kit. Make sure the drain valves are closed, and take it easy so you don't create a bow wave. Okay, move out.
TC:	Keep it right down the center of the stream.
TC:	Okay, follow the tracks on the right.
TC:	Follow the tracks to the right.
TC:	Bear left, follow the tracks.
TC:	Follow the fresh tracks to the right.
TC:	That's an old AVLB up there--take it easy and make sure you're lined up.

Figure 2. Audio Script for a Continuous Task*

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* From Sperry SECOR, 1980, Vol. 4, pp. 771-772 and 959-960.

Table 9

DT Features for Decision Making Learning Guidelines

	Learning Guidelines	
	Ensure that the trainee acquires the knowledge to: identify the problem, generate reasonable solutions, select and execute the solution that seems best.	Provide knowledge of the results, focusing on predicability, timeliness, completeness, and consistency of decisions.
DT Features	Audioscript in Procedure Programs presents information needed to make a decision. Trainee practices decision-making in driving programs.	DT Does not have enough variety in decision-making problems to this information.

The first consideration in the decision-making strategy is to ensure that the trainee acquires the ability to: identify the problem, generate reasonable solutions, evaluate the solutions, select the solution that seems best and execute it. For example, the driver is required to make a decision when the tank brakes fail. Brake failure is presented in two of the DT programs: Procedure Program 11, Procedure 83 and Driving Program 22, Malfunction 3. In Procedure 83, the narrated, step-by-step instructions tell the trainee how to recognize the failure and alternative ways to stop the tank. The trainee must learn all the possible ways to stop the tank and must learn to use the one that fits the situation. Later, in Driving Program 22, Malfunction 3, the brakes fail and the driver must recognize the malfunction and decide how to stop the tank without prompting.

The second consideration is to provide knowledge of the results, focusing on predictability, timeliness, completeness, and consistency of decisions. Knowledge of results in training decision-making tasks should focus on four critical areas. Were the trainee's solutions predictable; i.e., were they based on perceptual sets and response biases? Were the execution times appropriate? Were decisions complete in considering all the information? Were the solutions consistent with the information? The DT does not give feedback at this level of diagnosis because it does not contain enough decision-making problems. For example, the handling of brake failure is taught using only one situation where just two possible solutions apply. Thus, the DT as currently configured, does not contain a wide enough range of trainee solutions to assess the quality of decision-making. Use of the DT might be improved by including programs that present a greater variety of malfunction situations (e.g., brake failure that requires different types of solutions based on the terrain, tank speed, etc.).

SUMMARY

The strengths of the DT as a procedural training device are the capabilities for repetition of guided, active practice. The tasks in the programs are those the driver must learn before driving the tank. They include malfunctions and emergencies that cannot be inserted safely in the tank. Some of the weaknesses of the DT such as inadequate feedback can be overcome by the instructors as presented in the following section.

INTEGRATION OF THE DT INTO THE PROGRAM OF INSTRUCTION

The overriding consideration concerning application of the DT is its use in the POI for tank drivers. The types of steps in the tasks, and thus the training strategies recommended by TECEP, form clusters of DT programs (Figure 3). While there are exceptions, it is generally true that the first five DT programs contain procedures with a few voice communications and no decisions or continuous movements. However, the trainee must be oriented to the intercom before Program 2. Voice communications occur in a few of the procedures in Programs 3 and 4 and in almost all of the procedures in Programs 6 through 12. The instructors can enhance the DT training by integrating use of the tank technical manual and job aids developed for the driver and by providing feedback, especially for slow learners.

Repeated practice on procedures and malfunctions that require the driver to make decisions, such as the ones used during the driving programs, facilitates learning. A practice strongly supported by the training strategies in TECEP is the development of manual procedures and malfunction programs by the instructors. Such programs allow students to practice these procedures and malfunctions prior to the driving programs. Thorough preparation of the trainees before practice on the driving programs is expected to facilitate the integration of the procedural, voice communication, and decision skills with the continuous driving tasks.

As of the summer of 1981, the tank driver POI allowed approximately two days for the blocks of instruction dealing with the topics presented in the DT. The DT appears to require more time for the instruction than scheduled in the POI. The trainee requires approximately 16 hours to complete the 12 procedure programs and another 20 hours for the driving programs. The regular POI does not necessarily provide active, guided practice for all trainees on all of the tasks; hence, it requires less time for instruction than the DT. If the DT is improved to provide practice with feedback, the additional time is likely to be worthwhile judging from the TECEP guidelines. If it does not provide adequate feedback, however, the additional time is difficult to justify.

The repeated practice on decision tasks adds even more to the time required to complete the DT programs. If the trainees can be separated into those who do and do not need the extra practice, then the additional time could be spent with the slow learners and time could be saved by decreasing the time for fast learners.

In summary, integration on the DT into the POI can be facilitated by the following activities on the part of the instructors:

1. Before training begins:

    - prepare briefings to introduce the use of the DT in the driver's block of instruction, the driver's intercom and the use of job aids, including the technical manual.

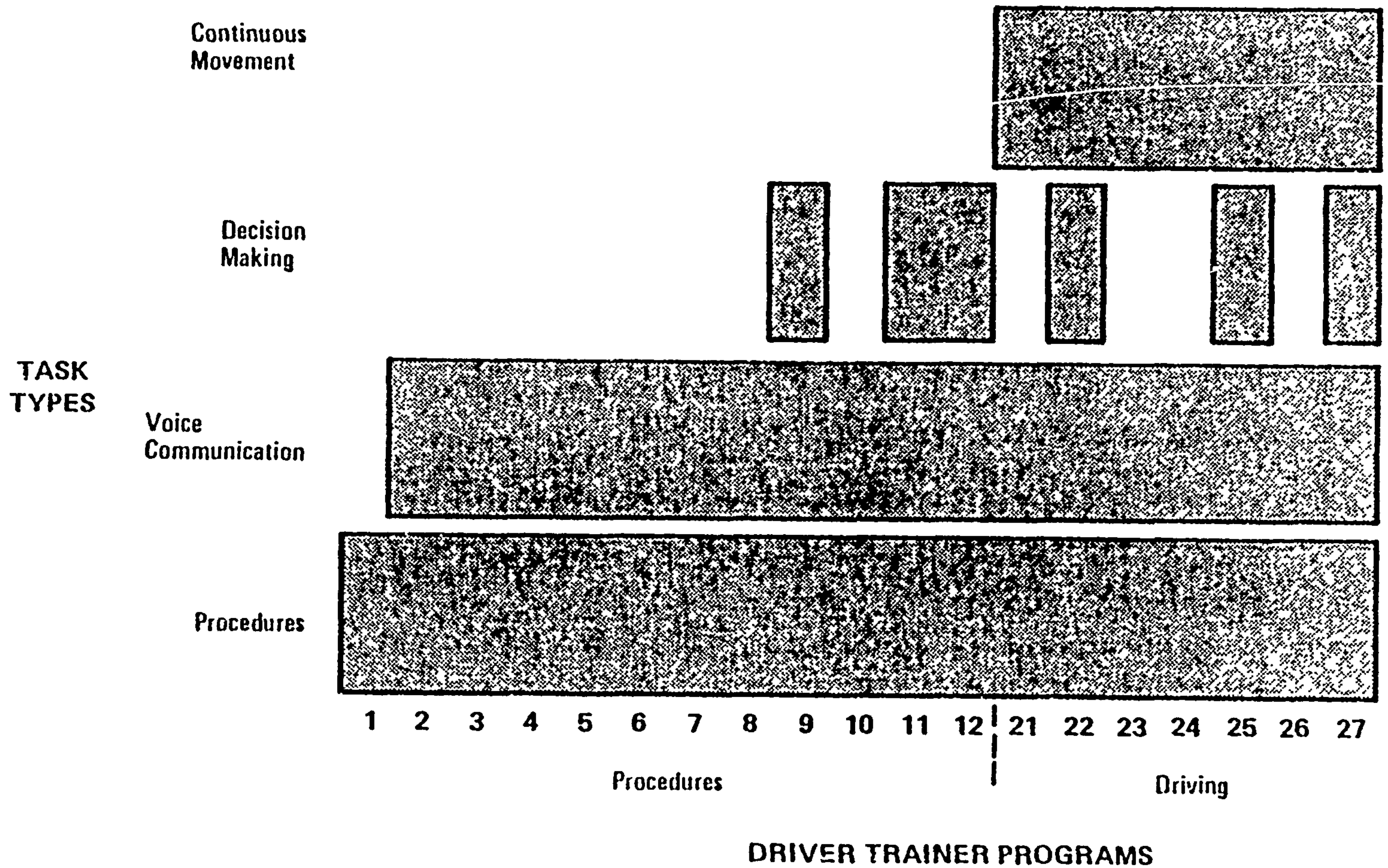

Figure 3. Types of Tasks in Driver Trainer Programs

- prepare a training schedule that provides rest breaks, especially as reinforcement for faster learning, and a time standard with which trainees can compare their performance.

- make manual programs of the procedures and malfunctions that occur in the driving programs.

2. At the start of DT use in the POI, brief the trainees on:

   - the use of the DT as it applies to the objectives of the driver's block of instruction

   - the driver's intercom

   - the use of the technical manual for procedures, malfunctions, troubleshooting and other job aids that are available.

3. Early in the DT programs, identify particularly fast and slow learners.

   - Fast learners can give peer instruction to the others using the AIS. This will reduce the number of assistant instructors required and increase the level of learning for the fast learners, who serve as instructors, as well as for the slow learners.

   - Fast learners should have breaks to reinforce their performance. Arrange for other positive reinforcers when possible (e.g., allowing them to have more time to drive the tank).

   - Provide more feedback and positive reinforcement to the slow learners.

4. Provide more specific feedback when the DT freezes.

5. Immediately before the driving programs, repeat the procedures and malfunctions that occur in those programs by using the manual programs. Have trainees repeat these programs until they perform correctly, then have them proceed with the driving programs.

6. During the driving programs, turn off the steering indicator. If trainees focus on the indicator, they do not attend to the visual scene and speedometer that they need to observe while driving.

7. After DT programs, provide practice in the tank for tasks not covered in the DT and for the decision-making and continuous movement tasks for which the DT feedback and coverage are not adequate.

AUTOMATED TRAINING DEVICE FEATURES

The literature on instructional features of computer-controlled training devices reveals innovative instructional concepts, some of which are within the DT capabilities and others suitable for a future driver trainer. Isley and Miller (1976) provided guidelines for incorporating automated training features in simulator design for Army flight training. While they deal with simulators for flight training, the same principles apply in the training of tank driving and other armor skills. Hughes (1978, 1979) expanded Isley and Miller's model by devising, a taxonomy of instructional features for automated devices, and Pohlmann, Isley and Caro (1979) developed design guides for the following instructional features:

1. Demonstration preparation
2. Demonstration
3. Store/reset current conditions
4. Manual freeze
5. Parameter freeze
6. Record/playback
7. Remote display
8. Hardcopy
9. Malfunction simulation
10. Automatic malfunction insertion exercise preparation
11. Automatic malfunction insertion exercise

Simulation technology is moving away from reliance on equipment and physical fidelity toward instructional capabilities for producing more efficient and effective training. Approaches for such improvements include adaptive automated training and performance measurement, reduction of instructor time, manipulation of the task cues and restructure of the task during training (Eddowes & Wagg, 1980; Hughes, Paulsen, Brooks & Jones, 1978; Kottas & Bessemer, 1979; Pohlmann, Isley & Caro, 1979). These four advances comprise the categories of active instructional features in Hughes's Taxonomy.

TAXONOMY OF DEVICE FEATURES

Hughes first classified training device features into enabling and instructional features. Enabling features provide physical conditions and events, but do not provide instructional manipulation of them. Instructional features manipulate the enabling features to produce the desired changes in trainee performance.

Enabling features, which are the "conditions" given in the typical training objective, have equipment and environmental subclasses (Table 10). Equipment features consist of the simulations of physical and operational characteristics of the tank. Enabling features in the DT are presented to the trainees in the five trainee stations that contain the throttle and brake controls, indicators, and other physical characteristics of the tank driver's compartment. The second subclass of enabling features contains environmental conditions, either man-made or natural. DT simulations of environmental conditions include the audiovisual scenarios for driving programs.

Table 10

Conceptual Framework for Training Features

A.	Enabling Features
	1. Equipment (Tank)
	2. Environmental
B.	Instructional Features
	1. Passive
	2. Active
	(a) Substitute for instructor
	(b) Increase training efficiency
	(c) Augment cues and methods
	(d) Restructure task

Instructional features, which may or may not be physical entities, are designed to produce the learning effect. They are assessed not by level of fidelity but by improvements in driver performance. Instructional features have two subclasses: passive and active. Instructional features that have little or no contact with the trainee are passive. Passive instructional features include the hardware and software for the instructor's stations, automatic scoring, and training management functions. These features assist the instructor in monitoring and evaluating performance. Examples are the functions available in the MIS and AIS (Table 4, page 12).

Active instructional features have direct contact with the trainee and are the ones of most interest in training research and development. Isley and Miller's review of simulator capabilities provides illustrations of each type of active instructional feature: substitute for instructor, increase training efficiency, augment cues and methods, and restructure task (Table 11).

Substitute for the Instructor

Active instructional features substitute for the instructor by presenting pre-training briefings, demonstrations, instructions, prompts, and simulations of crew members. Automatic briefings present training objectives, procedures and activities the trainee will perform. They include information on displays and controls, instrument settings, criteria of correct performance, and other training information. Automatic pre-briefings are usually used in conjunction with other automated features (Isley & Miller, 1976).

An automatic demonstration is a preprogrammed maneuver, series of maneuvers, or segment of a maneuver conducted under computer control to demonstrate ideal conditions (Isley & Miller, 1976). The computer actuates the indicators, controls, and simulations of vehicle and environmental conditions. It provides a model of the performance expected of the trainee. Pohlmann et al. (1979) distinguish the demonstrations themselves from the capability of the instructor to prepare a demonstration for repeated use. Demonstrations are recommended in the training algorithms for the continuous movement and voice communications tasks in the DT. However, demonstrations take up time that might otherwise be spent in active practice by the trainee and might, therefore, be counterproductive.

Simulated crew members, such as the tank commander, assist the trainee in conducting realistic operations during the training, particularly with regard to voice communications. For example, a simulated tank commander generates command information required for the mission. The information may be provided by a tape, as in the DT, or by voice synthesizing equipment. It may be activated by the voice of the trainee or may entail full speech understanding (the latter may be prohibitively expensive; see Popelka & Knerr, 1980). Unfortunately, the simulated tank commander in the DT is not responsive to the trainee.

Table 11

Active Instructional Driver Trainer Features

Categories of Active Features	**DT Features**
Substitute for Instructor	Automatic briefing Simulated tank commander Step-by-step recorded instructions Demonstration of displays
Increase Training Efficiency	Preprogrammed initial conditions Reset conditions Freeze Recorded explanation of steps omitted Expedited processes
Augment Cues and Methods	Preprogrammed malfunctions and procedures Automatic scoring and performance recording Steering indicator
Restructure Task	Performance-oriented guided practice Progression from simple to complex exercises

Instructional features that substitute for the instructor in the DT include the audio tapes which describe the training objective, initial conditions, step-by-step instructions, tank commander simulation and end statement. The DT does not show demonstations, but leads the trainee through active practice at the driving tasks. The very early programs show the trainee the location of displays and instruments by activating them with little active practice. However, after the first few programs, the DT provides active performance.

<u>Increase Training Efficiency</u>

Instructional features make training more efficient by managing the training sequence and reducing the dead time. Examples are preprogrammed initial conditions, reset to specified condition, and freeze (Hughes, 1978; Isley & Miller, 1976; Pohlmann et al., 1979).

Preprogrammed initial condition sets, or exercise setups, create in the simulated vehicle and environment a specific location with conditions appropriate for the start of the exercise. Parameters include location, engine and instrument readings, vehicle configuration, weapon and ammunition availability, and environmental conditions. The computer sets the vehicle controls, displays, and instruments. These are among the most widely used automated device features (Isley and Miller, 1976). The DT provides this type of initial condition situation for each audio only and audiovisual program.

A store/reset current conditions capability permits the program or the instructor to establish the simulated conditions that existed at a particular point in the training (e.g., when the trainee made a critical error) and return to those conditions to review the trainee's performance (Pohlmann et al., 1979). The DT resets conditions when the program freezes.

Hughes (1978) describes the use of freeze for the instructor to explain trainee errors, draw attention to particular aspects of the equipment or environment, or terminate an exercise. He also notes that the freeze capability is difficult to use effectively, and may be aversive to the trainee (Hughes, 1978, 1979, 1981).

Features in the DT that increase training efficiency are the initiation of vehicle conditions, narration explaining what the trainee would normally do (if the training setting does not allow performance of the whole task), and simulation of time-consuming events (e.g., fuel transfer).

The freeze capability of the DT does not increase training efficiency or relieve the instructor of training responsibilities. If the trainee violates one of the scoring rules, or if the program fails to run properly, the computer freezes and the instructor must additional present feedback as to the nature and correction of the error (if any).

Augment Cues and Methods

Automated training devices can present situations and behavioral cues that cannot be presented in the operational equipment, and can monitor, record, and reproduce performance scores.

Preprogrammed event insertions simulate malfunctions, system failures, and emergency conditions that cannot be induced in the operational equipment without risk to the trainee or equipment. Pohlmann et al. (1979) distinguish malfunction simulation, automatic malfunction insertion exercises, and preparation of the malfunction exercises. The malfunction simulation capability allows the instructor to simulate failure of a system component. The automatic malfunction insertion exercise has preprogrammed emergency or malfunction situations that occur when prespecified conditions are met or at specified points in the program. The malfunctions during driving progams in the DT are of the latter type. Automatic malfunction insertion exercise preparation refers to the capability of the instructor to prepare the exercises for repeated use. Thus, insertions can be either preprogrammed or under manual control of the instructor. Isley and Miller (1976) report that instructors prefer to insert malfunctions manually because the automatic ones often occur at inappropriate times and conditions. Some of the suggested additions to the programs for the DT are those that present malfunctions, emergency situations, and other conditions that require decision-making by the tank driver.

Automated performance measurement recording and display is a major advantage of training devices. The scores are based on predefined, lists of standards or parameter tolerances. During the exercise the scores are used by the computer to determine application of freeze or audio or visual performance cues and feedback. Adaptive feedback alerts the trainee to deviations from the performance tolerances and may introduce additional cues or coaching messages (Isley & Miller, 1976). Examples are ground plots and expanded graphic presentations. However, augmented cues may not produce better performance and may produce significant disruption of performance upon their removal (Hughes, Paulsen, Brooks & Jones, 1978). The steering indicator in the DT is an example of an augmented cue with questionable effectiveness.

Isley and Miller (1976) describe performance playback as an automatic, partial record of trainee performance, such as the last five minutes of an exercise. The playback repeats the exact instrument readings, control movements, equipment settings, environmental conditions, and voice recordings. Controls may allow freeze or replay of segments in real time or slow time. Playback applies self-confrontational notions of training. Variations include tape recordings and closed circuit television. The DT does not provide performance playback.

Remote display refers to alphanumeric and graphic presentation of trainee performance at CRT or other types of output terminals. If both the trainee and instructor can see the display, it facilitates communication concerning correct and incorrect performance. The DT provides displays for the instructor but not for the trainee.

Performance score printouts are produced by high speed printers or similar devices that provide permanent records of trainee performance. Printouts are valuable if the number of parameters is small and the record is easily interpreted by the instructor and trainee. The printout is not likely to be used if the number of parameters is large (Isley and Miller, 1976). Graphic displays are useful, since the cumulate scores for instructional management such as scheduling of training.

Many of the suggestions for improvements in the DT relate to better scoring and the display and printout of the scoring.

Restructure Task

Instructional features that permit the instructor to alter the task during training include performance-oriented guided practice and adaptive training. In performance-oriented guided practice, the computer retains control of a segment of the exercise by controlling one or more subtasks. It provides part-task learning in which the trainee can become familiar with part of the task before performance of the whole task. Isley and Miller (1976) recommend performance-oriented guided practice in tasks that are too long and demanding for the trainee to complete at first. The DT programs incorporate this feature since they start with simple part-tasks, such as the early procedure and malfunction programs, and then combine the parts with the driving demands in later programs.

Adaptive training tailors the complexity and difficulty of the task to the proficiency level of the trainee. These exercises are sequenced under computer control to increase or decrease the level of difficulty based on the trainee's performance. A prerequisite for adaptive training is a proficiency measurement system that accurately measures, records, and uses the information to determine the level of proficiency and to select the subsequent exercises.

Non-adaptive exercises contain complete or part-task maneuvers or procedures that have predetermined, fixed conditions. They are not modified or adapted to changes in trainee proficiency. The programs in the DT are of this non-adaptive type. While the programs do progress from simple to complex, the progression is fixed and does not adapt to the trainee's performance.

SUMMARY

Capabilities of the DT, as it is currently configured, cover all four subsets of Hughes's active instructional features. A comparison of the DT capabilities with features cited in the computer-controlled training device literature indicates potential DT improvements in all subsets and especially in performance measurement, freeze, and feedback, as described in the next section.

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APPLICATION OF POTENTIAL DT FEATURES

Hughes's taxonomy of instructional features organizes the domain of recommendations for the DT. Enabling features, especially equipment and program changes, were reported by Campbell (1980, 1981) and by the new equipment training (NET) team instructors; they will not be repeated here. The present research focuses on the instructional features.

Questionnaires containing the suggested DT features were administered to three tank driver instructors during preliminary evaluations of the Abrams tank driver trainer at Fort Knox, Kentucky (Burroughs, 1981). One instructor was from the NET team and the other two were from the 194th Armored Brigade. Interviews (conducted after the questionnaire evaluation) supplied details about the instructors' responses. While the sample is inadequate for statistical inference, the instructors corrected perceptions concerning the device and its potential uses, and generated new ideas. Their comments are incorporated into the following discussions.

The literature on automated training device features and the applications of present DT features suggest potential DT features. Some of the features pertain to all task types, while others pertain specifically to voice communication, continuous movement, and decision-making task categories.

FEATURES FOR ALL TASK TYPES

The learning guidelines that apply to all types of tasks call for a statement of objectives followed by guided, active practice with feedback. The DT provides such practice through the narrated, preprogrammed audio tapes during automated exercises. The trainee can practice repeatedly within time constraints set by the training schedule. Potential DT improvements for implementing these general learning guidelines are discussed within Hughes's categories of active instructional features (Table 12).

Potential Features to Substitute for the Instructor

The automated briefings, narration and tank commander simulation in the DT programs relieve the instructor for other duties. The utility of the DT in the Armor program of instruction (POI) would be enhanced by additional programs incorporating the following material:

1. Orientation to the driver's block of instruction in the POI.

2. Orientation to the intercom in the driver's compartment.

3. Use of the technical manual for procedures and troubleshooting where it is recommended by doctrine.

The instructors recommended that the DT discuss use of the technical manual for troubleshooting prior to reporting problems to Organizational Maintenance (the programs currently refer the problems to Organizational Maintenance without prior use of the manual). However, the instructors did

Table 12

Potential DT Features for All Task Types

Instructional Feature Category	Potential Feature
Substitute for the Instructor	Orientation program for driver's block of instruction
	Orientation program for driver's intercom.
	Integration of tank Technical Manual
Increase Training Efficiency	Repeat malfunctions without repeating driving on roads and trails
	Reduce freeze
Augment Cues and Methods	Improve scoring of steps, sequences, slow responses and repeated or omitted procedures
	More lenient scoring to reduce freeze
	Improve feedback and reinforcement
	Use manual programs to repeat malfunctions
Restructure Task	Cues to improve use of malfunctions without narrative to test the trainee

not recommend programs to teach the troubleshooting tasks, since portions of these tasks must be performed outside the driver's compartment and thus are not supported by the DT equipment.

Increase Training Efficiency

The driving programs return to the start of the driving sequence preceding a malfunction if the trainee fails a step in the malfunction. The instructors noted that the training would be more efficient if the program returned to the start of the malfunction so that the trainee repeated only the malfunction.

Reduced use of freeze would also decrease training time. The instructors suggested that scoring be more lenient (in specific ways described below) so that the program freezes less often.

Augment Cues and Methods

Automated performance measurement and reporting is a major advantage of computer-controlled training devices. Some suggested improvements for scoring in the DT are:

1. Do not penalize for actions that are doctrinally correct, such as communications with the tank commander at times other than the particular ones programmed.

2. Distinguish relevant from irrelevant sequencing of steps and do not penalize for steps out of order if the sequence is irrelevant.

3. Scale final performance scores for slow or very slow responses.

4. Scale final performance scores if the trainee repeats programs or procedures because of prior failure.

5. Do not score trainee zero percent for procedures skipped because he passed them before.

The instructors expressed concern about interpretation of the printed performance scores, since the scoring does not account for skipped or repeated procedures or for slow and very slow performance. If the trainee has previously passed some procedures and repeats those he failed, the performance printout should show the previous scores along with the new scores on the repeated procedures.

Procedural steps are programmed in specific order in the DT programs; if the trainee performs a step out of order or inserts an extra step, the program freezes and he fails. In reality, for many procedures the order is irrelevant, more than one order is permisible, or steps may be inserted (e.g., the driver can communicate with the tank commander at points in addition to those programmed). To pass these DT programs, the trainee must memorize sequences that are not necessary in the operational setting. The instructors recommend corrections of the program to allow the whole array of step sequences.

One of the advantages of automated measurement is its application to immediate and detailed performance feedback. The present DT does not provide positive reinforcement. The automatic freeze after incorrect performance, for example, may even be aversive to the trainee. The TECEP learning algorithms recommend high levels of positive reinforcement for low-ability trainees. High rates of reinforcement are difficult to provide for slow learners since they have low rates of correct responses. The DT instructors use the CRT displays at the MIS and AIS to identify slow learners and provide them with additional instruction and feedback. They reported that they use the AIS to work directly with trainees who need extra help. However, extra attention from the instructors does not necessarily have a positive effect on behavior. Reinforcement and improved programming to aid slow learners through automated means is more desirable.

Positive reinforcement is supplied at the end of blocks of instruction, since trainees who finish early have longer breaks than the others. The instructors reported that all of the students need breaks because they become frustrated when the machine freezes.

The instructors did not believe that a performance playback capability would help with the training and feedback. Instead, they favored more instruction, feedback, and positive reinforcement.

Another major advantage of computer-controlled training devices is the ability to insert malfunctions and emergency situations that are not possible in the operational equipment. The insertion of these events is an asset in the driving programs; they are treated in the following section on specific task types.

The instructors agreed with and implemented the idea of making manual programs of the malfunctions and procedures for trainees to practice on, before starting the driving programs where they are embedded. The driving programs increase the trainee's proficiency in handling malfunctions by presenting them without verbal instructions to warn the trainee. Repeated training is degraded if the driving program is interrupted due to errors made during a procedure or malfunction. Thus, use of the driving program appears to be optimized if the trainees are proficient in the basic procedures and malfunctions.

Experience with the manual programs indicated that their performance scoring and reporting need to be improved. The DT provides a score for each procedure but not an overall score if the procedure is used in a manual program. The instructors asked for overall scores for manual programs.

<u>Restructure Driving Tasks During Training</u>

The instructor can turn off the narrative instructions in the DT programs to make the trianing more difficult and test the trainee without the instructional prompts. At present, however, removal of the narration leave insufficient cues from the equipment and environment for the trainee to determine what, if any, action to take. The situation is too ambiguous and requires that the trainee memorize sequences of steps in order to pass the unnecessary memorization. Such cues might be supplied through the simulated tank commander. The capability of restructuring the task by changing the difficulty could be valuable if programmed correctly.

POTENTIAL INSTRUCTIONAL FEATURES FOR SPECIFIC TASK CATEGORIES

Some of the potential instructional features pertain to specific types of tasks. These features are summarized in Table 13, according to the TECEP task categories and associated training algorithms.

Voice Communication

Two possible improvements in the training of voice communication skills have been mentioned earlier: addition of a program to orient the trainee to the intercom and adaptation of the voice tapes to the trainee's responses. A program on the intercom could free the instructor from having to orient the trainee and could model the correct communication procedures. Automatic response of the voice tapes might be too expensive, but a simple, voice-activated system might be worthwhile. The instructors reported that some kind of automated adaptive system would improve the communication training.

In one DT program, the driver communicates with the gunner as well as with the tank commander. The instructors did not believe that the need was sufficient to simulate the gunner.

Continuous Movement

Potential features to improve training of continuous movement tasks involve feedback and additional driving situations. Learning of continuous tasks requires perceptual discrimination to detect and respond properly to cues from the tank and environment. Training links the audio, visual, and tactile cues to internal cues (e.g., proprioceptive) arising in the muscles, joints, and other body structures that supply information in human control of force, extent, and duration of movements. The training goal is to achieve a high degree of internal control so that performance becomes automated. The TECEP guidelines emphasize a high degree of realism in the external cues and the trainee's responses. The reinforcement needs to be contingent on characteristics of the responses. Therefore, training in the DT would be improved by video simulation responsive to the trainee's actions.

Removal of the steering indicator might also improve training. The instructors reported that the steering indicator may provide incorrect or confusing feedback and that the trainee cannot focus on the indicator and the video tape at the same time. They saw the steering indicator as a distraction that provided no training benefit. Rather than the steering indicator, the instructors favored reactive video capabilities that respond to, and provide feedback concerning, the trainee's steering, throttle, and brake controls.

Table 13

Potential DT Features for Specific Task Types

Task Type	Potential Feature
Voice Communication	Orientation program for driver's intercom
	Adaptation of voice tapes to trainee's responses
Continuous Movement	Remove steering indicator
	Adaptation of video tapes to trainee's responses
	Reduce driving exercises on roads and trails
	Increase driving exercises in cross-country and tactical situations
Decision-Making	Add programs, situations, and repetitions of decision-making tasks
	Make decision situations more realistic

Most of the DT driving tapes depict roads and trails. The instructors favored reducing the extent of training devoted to these situations, and favored production of new programs that contain a variety of driving situations, including those that demand tactical driving (how to select a firing position, cross open areas, use woodlines, etc.).

Decision-Making

The potential improvements for decision-making tasks center on the need for more situations and programs involving decision tasks, more information concerning the driver's decisions, and repetition of the decision programs. The DT does present programs with decision tasks and an array of situations and possible outcomes; the recommendation is for more of these programs. Specifically, the instructors favored more information and training on the decisions that are already included and an even wider variety of decision situations. The decision-making program should be repeated prior to the driving programs to improve the training of the situations shown. Additional training on decision-making tasks is desirable, since they are one of the more difficult kinds, especially for low aptitude trainees.

The DT trains the malfunctions and emergency situations that require the decisions. The instructors recommended, however, that two of the malfunction programs be improved. In "engine shutdown" and "thrown track" the cues supplied for the trainee to detect the problems are substantially less apparent that in the operational equipment. Thus, increasing the level of cues would make the training more realistic.

SUMMARY OF POTENTIAL FEATURES FOR THE DT

At one extreme is the view that the DT should incorporate the state-of-the-art in technological sophistication, including computer-generated imagery, fully adaptive monitoring, feedback of continuous movement tasks, and a speech understanding and voice synthesis system. However, device enhancements of this magnitude are contrary to the training device requirement (Department of the Army, 1978) which stipulates that the sophistication should not significantly exceed that of the driver trainer for the M60A1 tank. Thus, most of the potential features involve minor modifications of the DT or enhanced uses of the existing features.

The literature on automated instructional features presents two reasons that computer-controlled device features are not implemented (Isley & Miller, 1976; Pohlmann et al., 1979). First, the features are designed and used in ways that are inefficient or awkward. The use of freeze in ways that are antagnostic to the trainee without providing information or positive reinforcement is an example. The instructor must provide the feedback. The second reason is the incorporation of inappropriate features such as the steering indicator in the DT. The continuous movement tasks required in driving need continuous natural feedback for realistic training.

On the positive side, however, are the performance measurement capabilities and the insertions of events, such as malfunctions, that cannot be trained in the tank and which are difficult for low aptitude trainees. The capability repeating these decision-demanding tasks is a valuable asset of the DT.

SUMMARY OF DT FEATURES FOR TRAINING DRIVING TASKS

The benefits of the DT lie in the familiarization training of driver procedures. Training is enhanced by the automatic briefings, prerecorded instructions, demonstrations of displays and controls, preprogrammed initial conditions, and repeated guided practice in programs that progress from simple to complex (Table 14). Some DT features are especially useful for specific tasks, such as the simulated tank commander for voice communications. These features and their applications for training all types of driver tasks and the specific task in the DT programs have been described in detail in the fourth section (pages 31 through 37).

Suggested new programs for the DT have the potential of assisting the instructor by presenting orientation briefings on the drivers' block of instruction, drivers' intercom and use of the tank technical manual. They extend the scope of the training program by presenting a wider variety of decision-making situations (e.g., malfunctions and emergency situations) and of continuous movement scenarios. However, the greatest potential gains from improvements in the DT are in performance scoring, recording, freeze, and feedback (Table 15). The fifth section of this report describes the potential features and how to incorporate them (pages 39 through 46).

Although the learning guidelines and potential training features are designed for Armor instructors and training developers, the device features and their uses in the POI apply to devices other than the DT. The discussions of potential features supply a menu of automated features and their uses to be considered in the design of a driver trainer. The TECEP guidelines describe the features and applications required for an automated device such as the DT, to improve training over that possible with a low-cost device. Unless the DT is improved in scoring and feedback, for example, the TECEP guidelines suggest that it will not be more effective than a low-cost device.

The instructors recommended practice beyond one correct performance of the task and more time for training in general. Research indicates that high level of initial learning produces longer retention of the skills (Shields, Goldberg, & Dressel, 1979). Thus, repetition of programs during initial training can be a valuable assest to training, especially if the recommended improvements are made.

Table 14

Summary of Training Features by Task Types

TRAINING FEATURES	TASK TYPES			
	Procedural	Voice Communications	Decision Making	Continuous Movement
Substitute for Instructor				
Automatic briefing	x	x	x	x
Simulated tank commander	x	x	x	x
Recorded instructions	x	x	x	x
Demonstration of displays	x			
Increase Training Efficiency				
Preprogrammed initial conditions	x	x	x	x
Reset conditions	x	x	x	x
Freeze	x	x	x	x
Recorded explanations	x		x	x
Expedited processes	x			
Augment Cues and Methods				
Preprogrammed malfunctions, procedures			x	x
Automatic scoring, recording	x	x	x	x
Steering indicator and other controls			x	
Restructure Task				
Performance-oriented guided practice	x	x	x	x
Progression from simple to complex	x	x	x	x
Repeated practice	x	x	x	x

Table 15

Summary of Potential DT Features by Task Types

POTENTIAL FEATURES	TASK TYPES			
	Procedural	Voice Communication	Decision Making	Continuous Movement
Substitute for Instructor				
Orientation program for driver's block of instruction	x	x	x	x
Orientation program for driver's intercom	x	x	x	x
Integration of TM	x	x	x	x
Increase exercises in cross-country, tactical situations				
Make decision situations more realistic			x	
Increase Training Efficiency				
Reduce freeze	x	x	x	x
Avoid unnecessary repetition of simple driving sequences				x
Augment Cues and Methods				
Improve scoring of sequences, etc.	x	x	x	x
More lenient scoring	x	x	x	x
Improve feedback and reinforcement	x	x	x	x
Manual programs to repeat malfunctions			x	
Adaptive voice tapes		x		
Restructure Task				
Add cues when narrative is not in use	x	x	x	x

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APPENDIX A
Tasks in DT Programs

The DT tasks are organized into procedure programs (Table A-1) and driving programs. The driving programs are presented in two parts: procedures and malfunctions (Table A-2) and continuous movement tasks (Table A-3).

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Table A-1

Procedures Programs for the Driver Trainer

Program	Procedures and Malfunctions	
1 System Introduction I	1	Warning and Caution Lights
	2	Hull Circuit Breakers
	3	Fuel Systems
	4	Exterior Lights
	5	Personnel Heater
2 System Introduction II	6	Gas Particle Filter
	7	Transmission Shift Control
	8	Brake Controls
	9	Steering/Throttle Control
	10	Night Vision Viewer
3 Start Up/ Shut Down	11	Preparing the Station for Operation/Power-Up Hull
	12	Starting the Engine
	13	After Start Checks
	14	Engine Shutdown
	15	Powers Down Hull
	16	Secure Driver Station/After Operation Check Procedure
4 Fire Extinguishers	17	Fire Extinguisher/ Engine Compartment Automatic
	18	Fire Extinguisher/ Engine Compartment Manual
	19	Fire Extinguisher/ Crew Compartment Automatic
	20	Fire Extinguisher/ Crew Compartment Manual
5 Engine Start Malfunctions	41	Engine Will Not Crank
	42	Engine Cranks but will Not Start
	43	Engine Cranks but Aborts Start
	44	Engine Starts then Shuts Down
6 Engine Shutdown Malfunctions	45	Engine Will Not Shut Down
	46	Engine Stops Turning Too Quickly After Shutdown
	47	Engine Idles Too Fast
7 Loss of Engine Power	48	Loss of Power/Fuel Control Faulty Light
	49	Loss of Power/Fuel Control Faulty Light Not Lit
	50	Fuel Control Faulty Light/No Loss of Power
	51	Engine Shuts down After Momentary Power Loss
8 Engine/Transmission Oil Malfunction	52	Engine Oil Temperature High
	53	Engine Oil Pressure Low
	54	Engine Oil Low
	55	Transmission Oil Temperature High
	56	Transmission Oil Pressure Low
	57	Transmission Oil Low
	58	Transmission Gear Shift Control Circuit Breaker

Table A-1 (Continued)

Procedures Programs for the Driver Trainer

Procedure Program and Number	Step Title and Number
9 Miscellaneous Warning/ Caution Lights	59 Engine Overspeed
	60 Engine Gas Overtemp
	61 Low Battery Charge
	62 Clogged Filters
	63 Master Panel Circuit Breaker
	64 Maintenance Monitor Circuit Breaker
	65 Low Fuel Level
10 Miscellaneous Fuel Pump Malfunctions	66 Right Fuel Pump Failure
	67 Transfer Pump Failure
	68 Left Pump Circuit Breaker
11 Emergency Procedures I	81 Engine Failure
	82 Steering Failure
	83 Brake Failure
	84 Throttle Failure
12 Emergency Procedures II	85 Alternator Failure
	86 Loss of Vehicle Track
	87 Cable Disconnect
	88 Battery Cable Disconnect
	89 Hydraulic Pump Failure

Table A-2

Procedures and Malfunctions in Driving Programs

Program Number	Procedure/Malfunction Titles
21	Procedure 21 Placing the Tank in Motion
	Malfunction 9 Clogged Air Filter
	Malfunction 8 Fuel Control Faulty
	Malfunction 19 Transmission Gear Shift Control
22	Malfunction 12 Engine Oil Temperature High
	Malfunction 18 Low Fuel Level
	Procedure 32 Fording Deep Water
	Procedure 23 Driving Over Obstacle
	Malfunction 3 Brake Failure
23	Malfunction 20 Master Panel CB Pops
	Malfunction 5 Right Fuel Pump Failure
	Procedure 24 Driving Over Ditch
	Malfunction 10 Engine Compartment Fire Auto
	Malfunction 4 Engine Failure
24	Procedure 25 Smoke Generator
	Malfunction 16 Engine Gas Overtemp
	Malfunction 13 Engine Oil Pressure Low
25	Malfunction 6 Alternator Failure
	Malfunction 14 Transmission Oil Temperature High
	Malfunction 15 Transmission Oil Pressure Low
	Malfunction 11 Automatic Crew Compartment Fire Extinguisher
26	Malfunction 21 Maintenance Monitor CB Pops
	Malfunction 7 Thrown Left Track
27	Malfunction 17 Engine Overspeed
	Malfunction 1 Throttle Failure
	Malfunction 2 Steering Failure

Table A-3

Continuous Movement Tasks in Driving Programs

Program Number	Continuous Movement Tasks
21	Basic Maneuvering Move out down the road at 15 MPH Accelerate to 25 MPH Stop and pivot 180° Drive back down the road Turn left onto side road
22	Proceed down a hard-surfaced road in convoy with service lights on Proceed down dirt road at 15 MPH with service lights off Proceed along river bank following set of tracks Ford shallow stream Cross obstacle Add power and move up the hill Move down the hill at 40 MPH
23	Drive up and down a small steep hill Proceed into a gravel road Follow trail down hill and across narrow washout Proceed up hill through a grove of trees, then down hill Drive along rough trail Drive on hardtop road
24	Move out at 20 MPH and proceed along a series of dirt and hard-topped roads, dirt trails, through muddy areas, small shallow creeks, over hills and make sharp turns Move along fire trail at 15 MPH
25	Move out at 10 MPH down a rough dirt trail Move out down the trail; up a hill, turn Move out down the trail; turn Move out down the trail; stop, backup, turn
26	Move out down the hill and over a narrow bridge Turn left onto a rough trail Proceed along the side of a stream Enter water and drive down center of stream Move out up the steep, muddy trail to top of hill Cross AVLB Climb an obstacle
27	Move out at 45 MPH down hardtop road Slow down and turn left onto obstacle course Proceed through a narrow space between two buses Follow dirt trail Move out down the back side of obstacle course Proceed slowly along rough trails and over steep terrain

APPENDIX B

The DT trains tasks in four of the TECEP categories:

1. Recalling Procedures and Positioning Movement
2. Voice Communication
3. Making Decisions
4. Guiding and Steering, Continuous Movement

The training algorithms for these task categories are quoted from Aagard and Braby in this Appendix.

1. RECALLING PROCEDURES AND POSITIONING MOVEMENT

This task category combines two quite different kinds of tasks. Recalling procedures is basically a mental skill, whereas positioning movement is a physical skill. They are combined in these guidelines since they often occur together in the operational setting. They concern carrying out routinized activity, executed as standard operating procedures in some predetermined sequence. Relatively little judgment and analysis are required and a minimum of alternative behavior is involved. Controls are manipulated in an identifiable procedural sequence. Motor movements for control positioning are, at the outset, within the response repertoire of the student; therefore, the emphasis is placed on recalling the sequential procedures and on the accuracy of the positioning movement. An example is the checkout of a piece of communication equipment, using a checklist to determine if the equipment is operating within acceptable tolerances. These types of tasks are common and have often been studied with the goal of improving training efficiency.

Guidelines for this behavior are listed below. The algorithm representing these guidelines is presented in Figure B-1.

1. State clearly the behavioral objectives to be achieved. Describe how the learning materials are organized to achieve this desired behavior. Relate the objectives to the student's future real-world assignments.

2. Break the positioning movement task into appropriate parts and provide subdivisions of organization for each procedure.

3. Divide the procedural steps into small parts if any of the following conditions exists:

    a. Students are of low ability

    b. The procedures are complex

    c. The entire procedure is lengthy

4. Present a demonstration of each task performance (a positioning response to a checklist cue) on an observable model.

5. Show checklist cues and require the student to explain differences in similar cues that serve as association devices for different procedures that have been confused in the past.

6. Use mnemonics which will cause an affective reaction in the student whenever possible to aid in the recall of the procedures to be learned for this task.

7. Use mnemonics (associating procedural steps with imagery, rhymes, or rhythms) to aid in recalling difficult to remember steps. Provide directions for the student to develop his own mnemonics where he is able and willing to do it.

8. Direct the student to practice the following sequence of events to help him remember a chain of procedures.

   a. When presented with each checklist item, explain (or perform) its corresponding procedural step.

   b. Then, when presented with a group of checklist items (as many as the student can handle at once), explain or perform their corresponding procedural steps. The first item of each group should overlap the last item of the previously studied group of steps.

   c. Then when presented with a single list of all of the checklist items in the entire procedure, explain (or perform) their corresponding procedural steps.

9. Encourage students to rehearse mentally the procedures called for by the steps in the checklist, using mnemonics to aid in the recall of these procedures.

10. Ensure extensive practice early in the training by requiring the learner to:

    a. Understand the objective(s)

    b. Observe the skilled performance of a model

    c. Strengthen the individual (or component) steps of the desired movement by practicing these steps, obtaining knowledge of results (KOR) and by correcting performance errors

    d. Integrate the steps into a smooth sequence of positioning movements by practicing the sequence of steps

11. Provide the following conditions for corresponding stages for training:

    a. Early in training, use:

       (1) immediate and frequent KOR

       (2) immediate and frequent reinforcement

(3) little or no operational distractors

(4) learning material broken-down into small, easily learned parts

(5) items required to be learned which are relatively easy to acquire

(6) guiding or prompting of responses

b. Late in training:

(1) use delayed and infrequent KOR

(2) use delayed and infrequent reinforcement

(3) increase distractors to operational level

(4) a given procedure will be required to be recalled (or performed) in response to the same cues as on the job

(5) the level of complexity of the procedural cues and distractor cues should be the same as on the job. Add stressful conditions equivalent to that in the operational setting

(6) eliminate guides or prompts (other than those provided in the operational setting)

12. Make the time interval following KOR much longer than the time interval between the response and KOR, to provide time for the student to sort out errors.

13. Identify features of the operational environment which could be used as mediators to trigger the student's recall of checklist items.

14. Practice should be distributed; i.e., the timing of rest periods should be determined by:

a. need for rest as judged by the student

b. requirements of the specific learning material as judged by the instructor

15. Arrange for extensive repetition (overlearning) by the student to take advantage of the internal feedback properties generated by performing these types of tasks (positioning movement) accompanied by external feedback. Simple repetitive movements may become

reinforcing; i.e., the student experiences feelings in muscle and joints which he identifies as cues that he is performing the task correctly.

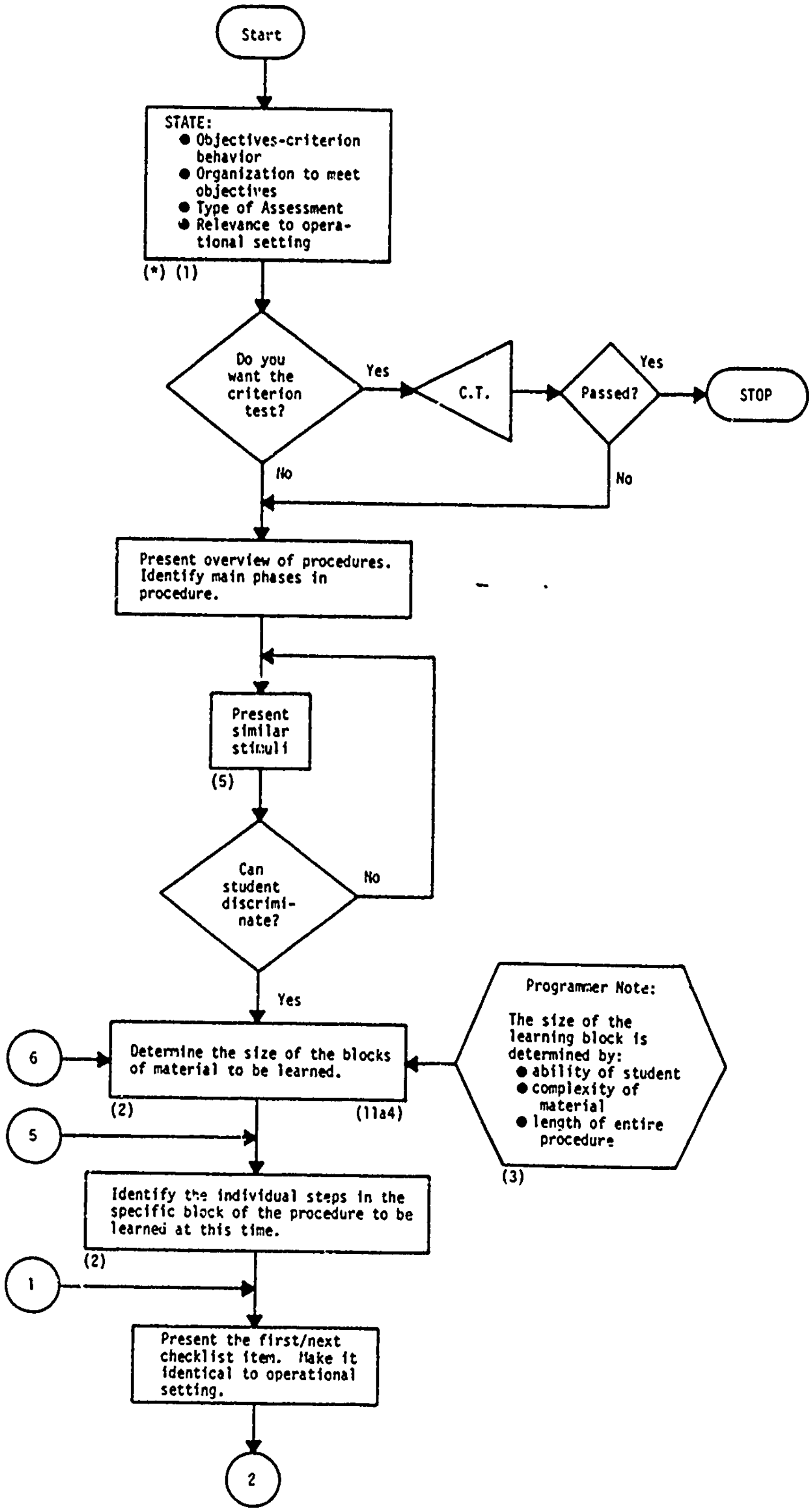
16. Arrange for slow learners to have a higher number of reinforcements of correct responses than the fast learners.

17. Maximize the realism of checklist items and their corresponding procedural responses.

18. Arrange for the student to compare the program objectives with his current status in meeting these objectives (use periodically).

19. Train the student to the operational criterion; i.e., ensure that acquisition of the procedural material will be to the level of performance required for on-the-job duties.

20. Prevent decay of recall by providing periodic refresher training for infrequently used procedures.



(*) Corresponds to the guideline number for this task.

Figure B-1. Learning Algorithm for Recalling Procedures and Positioning Movement

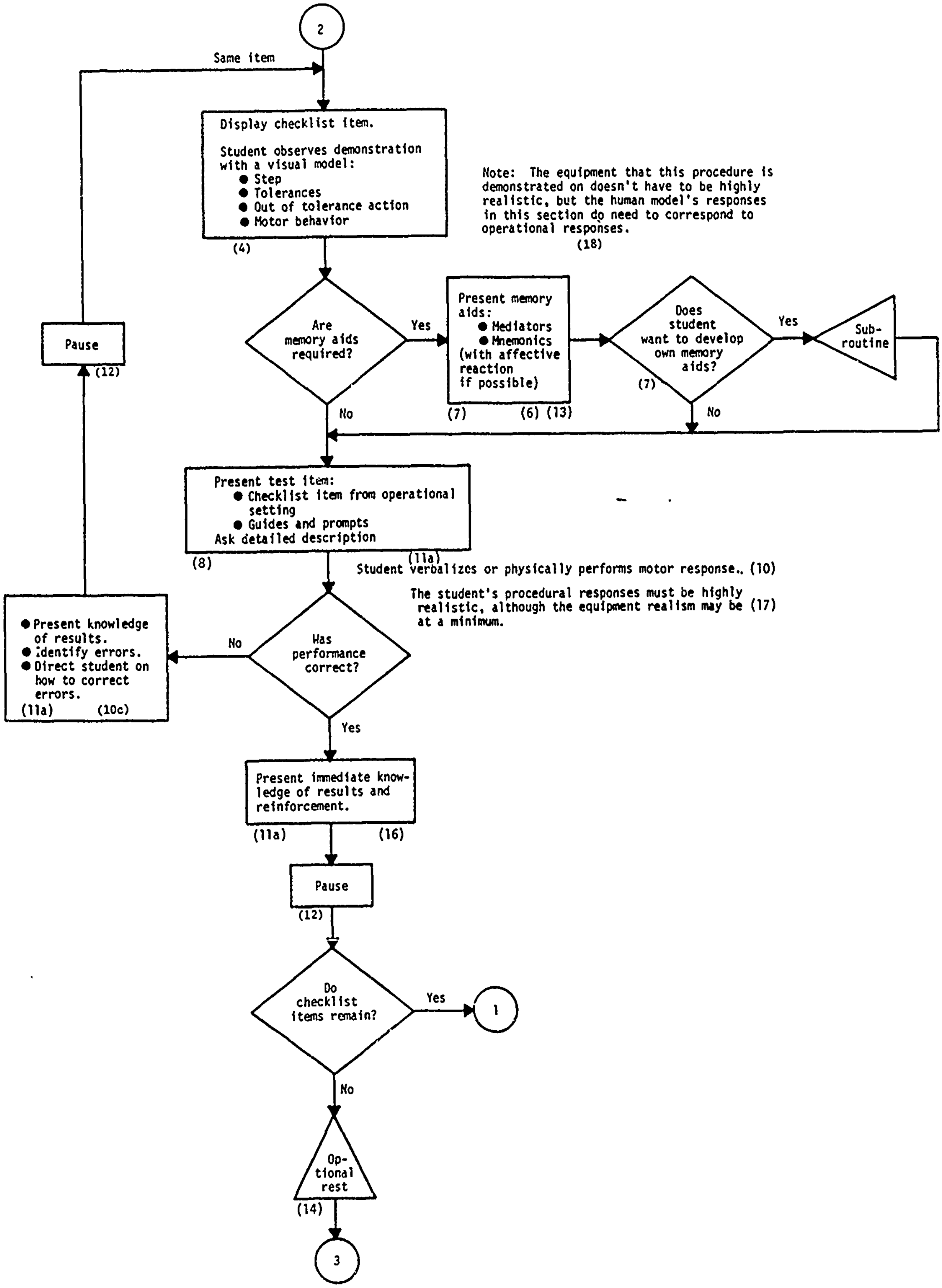


Figure B-1. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

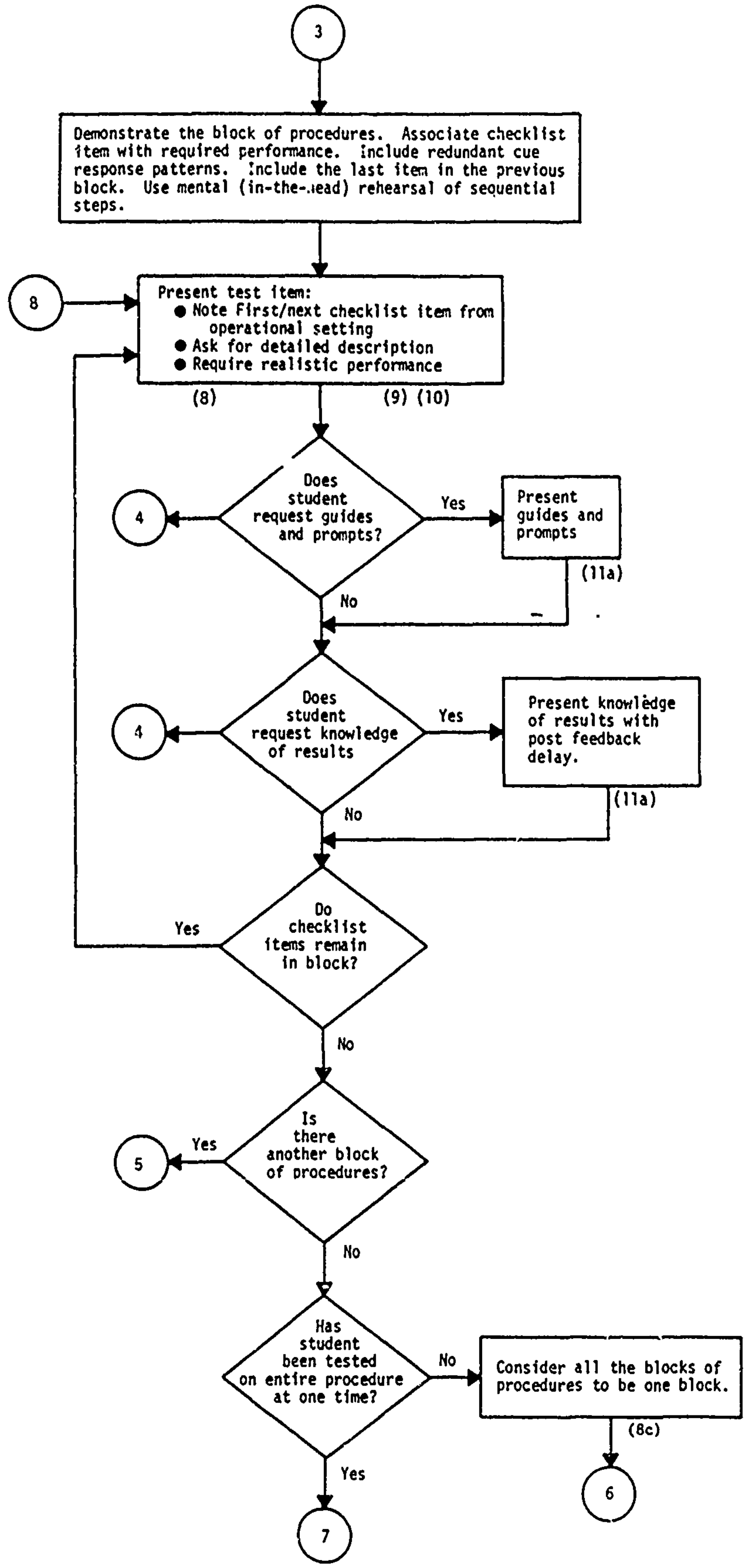


Figure B-1. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

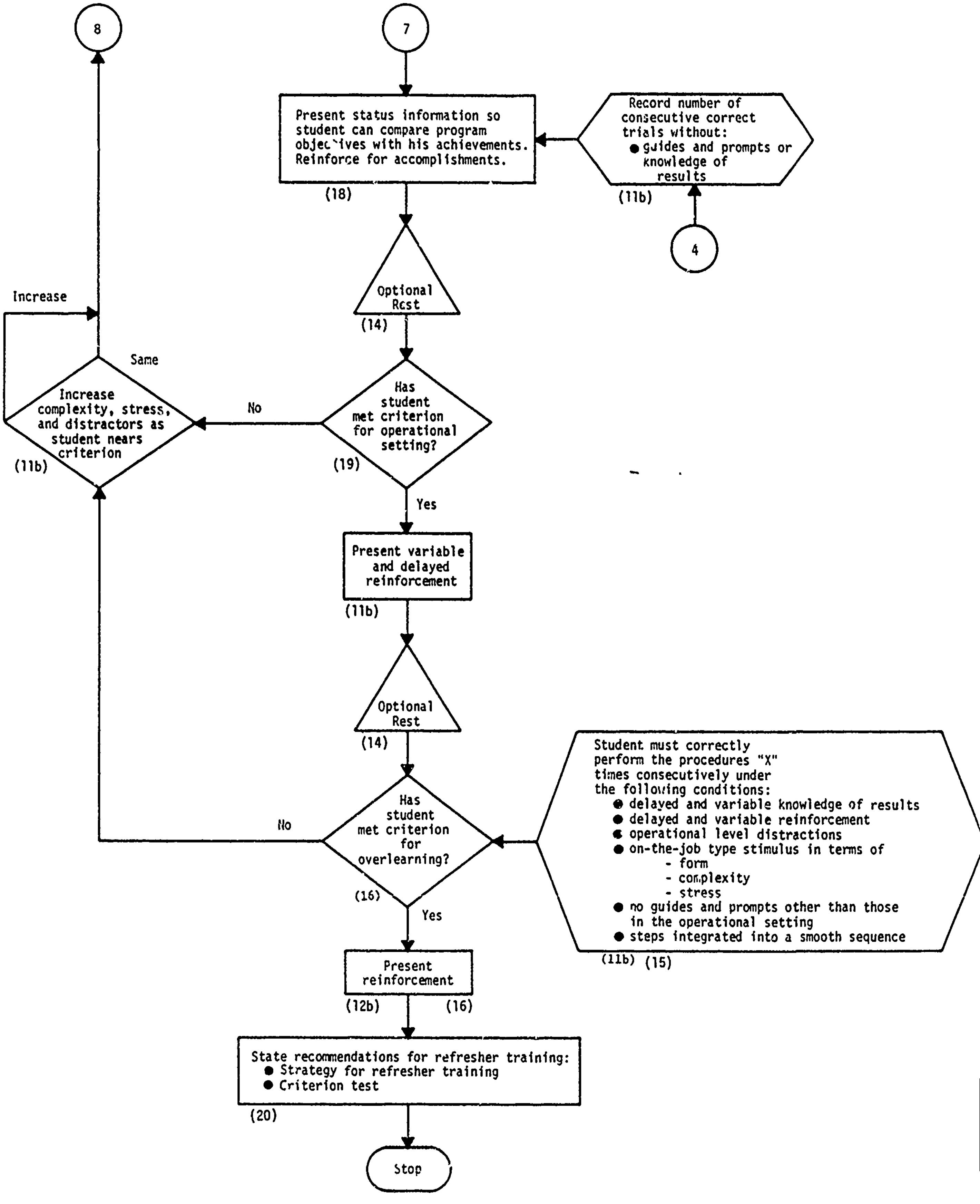


Figure B-1. Learning Algorithm for Recalling Procedures and Positioning Movement (continued)

2. VOICE COMMUNICATION

Voice communication is used here to mean a conversation between people in which standardized message formats are employed. A person has typically been overtrained in speaking and listening as a part of everyday living. Certain conversation patterns must be changed in order to communicate effectively within the military tactical environment. In this setting, messages must be brief and have a single meaning. The timing of when to pass the essential information is frequently critical. The task may be made more difficult due to the presence of background noise and other conversations on the communication circuit. Clarity of enunciation is important. Most of the guidelines are based upon general learning principles. In addition, principles identified through analysis of voice communication are used.

The following guidelines are presented for voice communication. The algorithm representing these guidelines is presented in Figure B-2.

1. Present objectives of the learning program to the student. Organize material around objectives. Relate material to the operational setting of voice communication.

2. Present brief overview of the learning program.

3. Break up the material into discrete voice communication categories that frequently occur in the job setting.

4. Identify similar cues (usually auditory) that frequently are confused in voice communication tasks and test the student to see if he can discriminate among them.

5. Point out critical cues and responses that are different from the student's habitual ("everyday") voice communication.

6. Teach the student to anticipate certain messages in a given operational setting -listen for certain words.

7. In general teach voice communication procedures and terminology using Recalling Bodies of Knowledge Guidelines, before presenting a demonstration of each specific procedure.

8. Demonstrate each voice procedure with a model performance; ensure that the student observes the critical cues and responses in the model's demonstration.

9. Require the student to practice until he demonstrates the correct performance. Have him concentrate his practice on the parts he finds difficult.

10. Give specific knowledge of results with each performance of the student; reinforce correct segments of performance.

11. Provide rest periods at intervals within the training period.

12. Increase distractors and stress conditions equal to that in the operational setting during the later stages of voice communication training.

13. Practice voice communication procedures to the same skill level that will be required in the operational setting.

14. Require student to overlearn correct voice communication procedures so that he can perform them correctly in a distracting, stressful environment.

15. Reinforce the student for meeting the overlearning and operational performance criteria.

16. Ensure periodic refresher training where it is indicated by the performance of the person on the job.

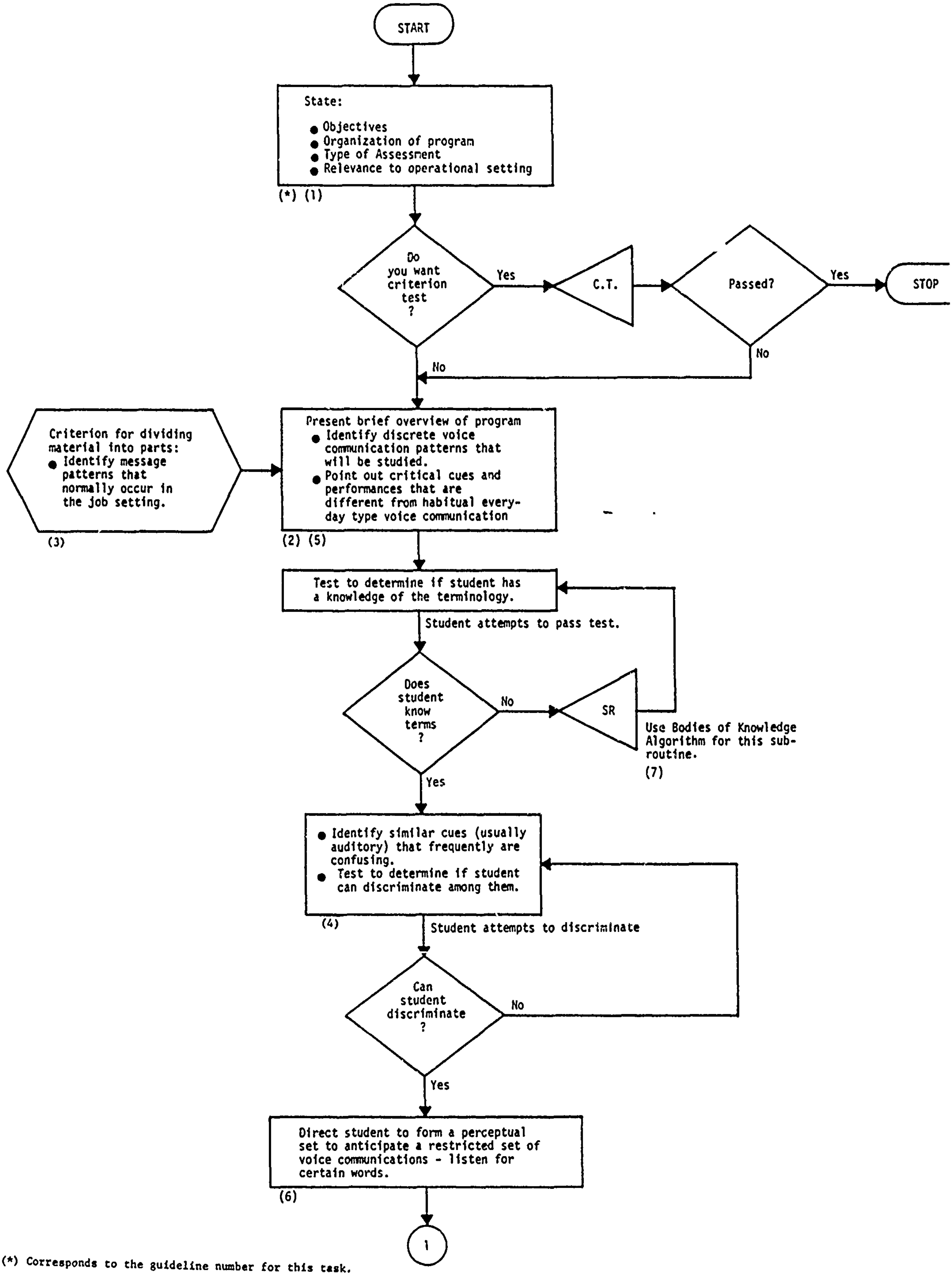


Figure B-2. Learning Algorithm for Voice Communicating

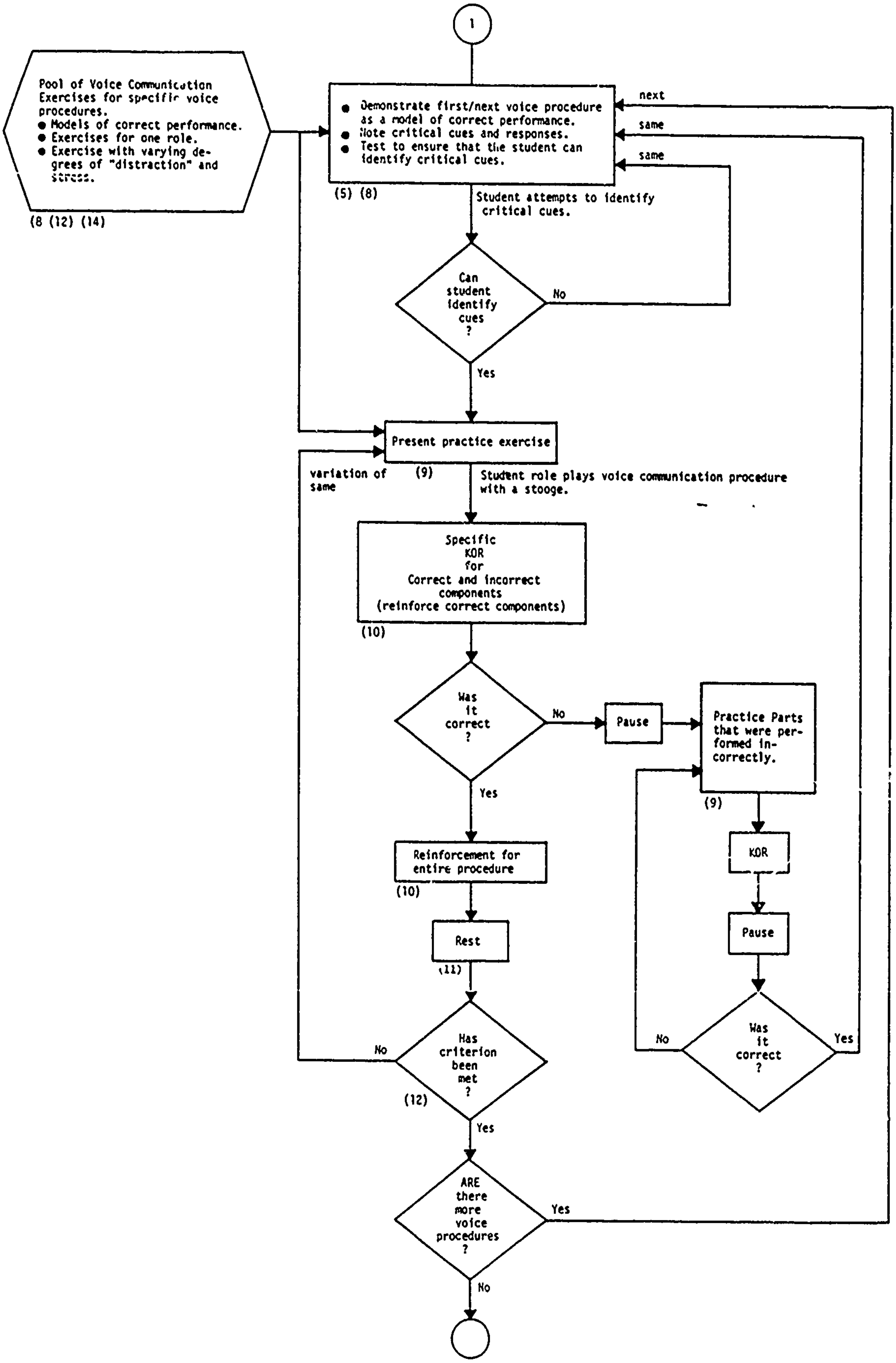


Figure B-2. Learning Algorithm for Voice Communicating (continued)

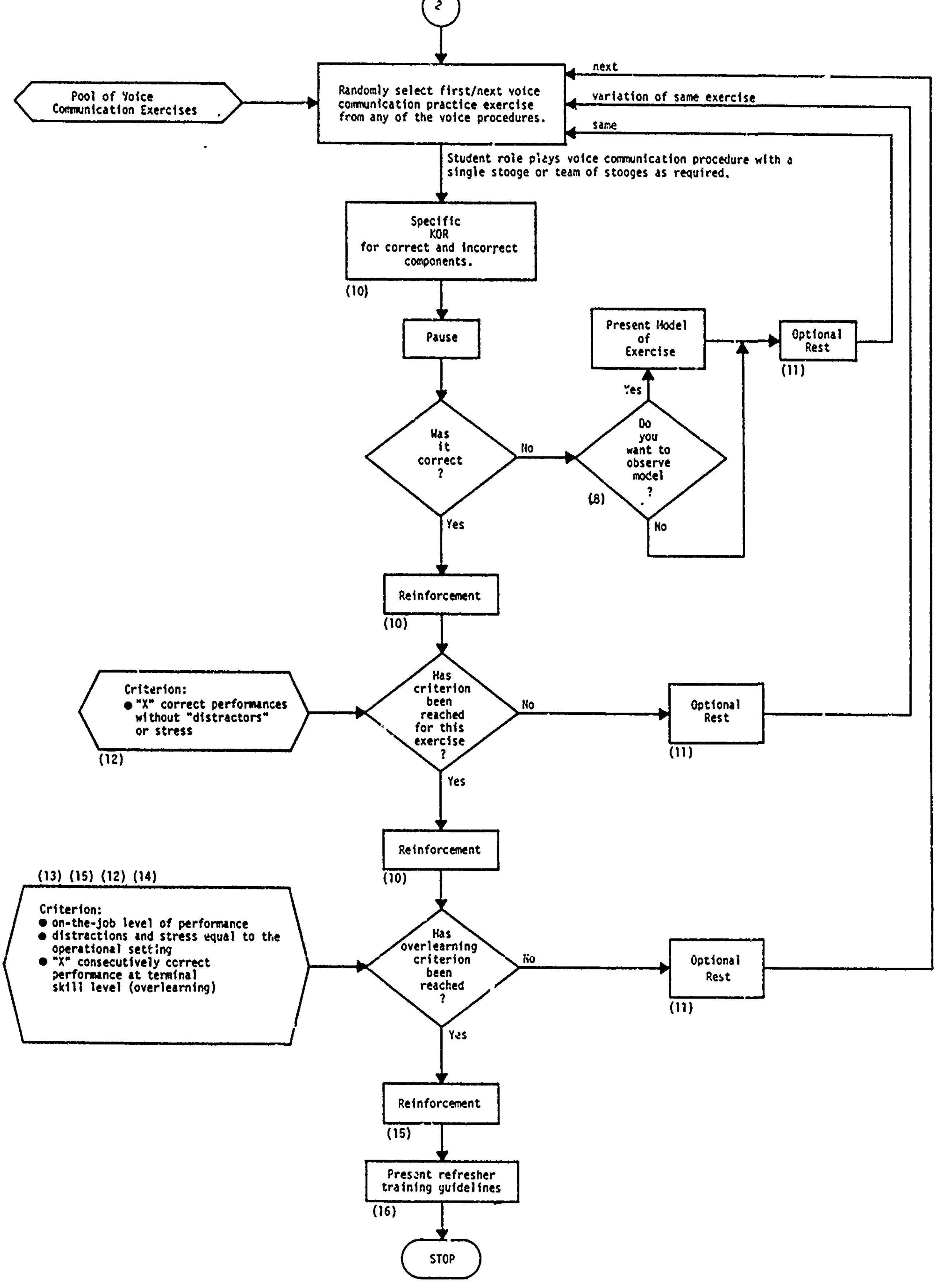


Figure B-2. Learning Algorithm for Voice Communicating (continued)

3. MAKING DECISIONS

Decision-making is defined here as the application of a specific decision model, thought to be useful in diagnosing equipment malfunctions, in choosing tactics in Fleet operations, and in planning where several alternatives must be considered, each with an unknown probability of success. The decision model combines the following factors: perception of the problems, identification of alternative solutions, evaluation of these alternatives and selection of the apparent best solutions. Therefore, the guidelines and algorithm presented here support learning to use this decision model.

The decision-making guidelines presented here are based upon the most contemporary practices in existing decision-making training programs.

The following guidelines apply to decision-making training. The algorithm representing these guidelines is presented in Figure B-3.

1. Ensure that the student acquires the knowledge required to:
    a. identify the problem

    b. generate reasonable solutions

    c. evaluate these solutions

2. Decrease student anxiety to a low level, particularly in the early stages of training, where student anxiety is high and where complex decisions are to be made.

3. Give the student examples of these two types of actions, which are to be avoided when making a decision:

    a. The tendency to make a "favorite" decision or use a "favorite" solution regardless of the real nature the problem.

    b. The tendency to generalize problems or view several types of problems as if they were all the same when, in fact, they are quite different.

Give examples of these undersirable responses in decision making.

4. Teach a decision-making strategy; the following strategy is suggested:

    a. Upon becoming aware of the problem, define it.

    b. Be alert for the availability of relevant information and collect such data.

c. Develop alternative solutions.

(1) State alternative solutions

(2) Combine alternative solutions

(3) Compare alternative solutions

d. Evaluate alternative solutions.

(1) List the probable consequences of each alternative solution

(2) Rank each alternative solution according to desirability of consequences

e. Choose course of action based on a desired solution.

f. Execute the chosen course of action.

5. Vary the setting of the significant cues of the decision-making learning task. Provide both basic and advanced problems to be solved with a wide range of problem difficulty at each level of training for the operational tasks.

6. Ensure the overlearning of decision-making skills in later stages of training if the student will be required to perform under stress in the real world.

7. Toward the end of training present the student with a realistic data load (i.e., realistic amount of significant data) plus operational distractors in real time.

8. Provide the student with access to potentially relevant data during practice. In the final stage of training, the data available to him should be limited to that expected in the real-world situations in which he will be working.

9. Provide the student with answers to the following five questions after his decisions in practice problems. These answers serve as knowledge of results (KOR).

a. Predictability? (Were problems mistakenly viewed as if they were all the same in reaching solutions?)

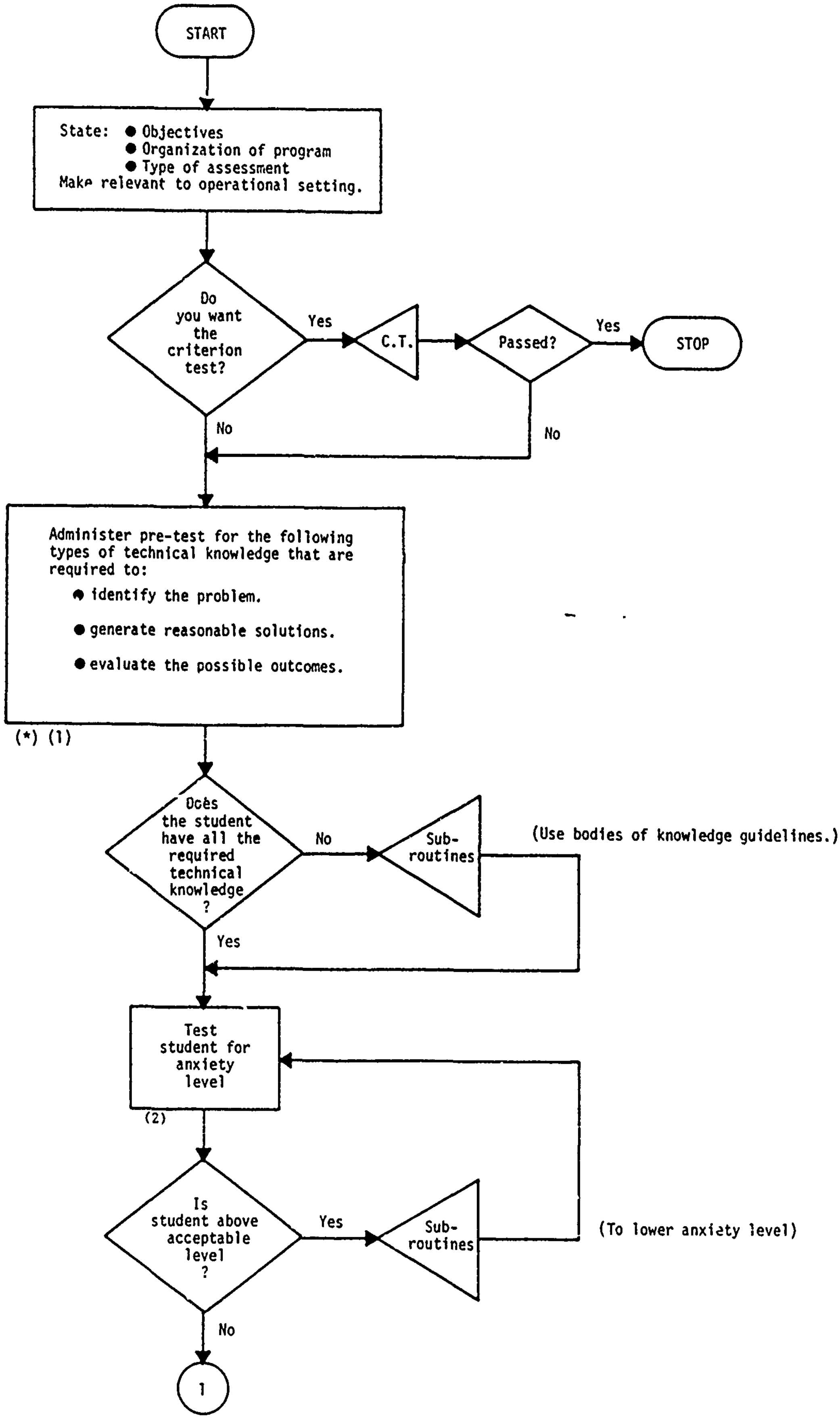
b. Persistence? (Was use made of a "favorite" solution when it was inappropriate?)

c. Timeliness? (Was this the appropriate time to execute this particular decision?)

d. Completeness? (Was all of the available information considered?)

e. Consistency? (Was the solution compatible and relevant to the available information?)

Give KOR with respect to these above five criteria each time the student makes a decision and, if possible, provide the simulated consequences of the decision as compared to alternative solutions.



* (X) Corresponds to guideline number for this task

Figure B-3. Learning Algorithm for Making Decisions

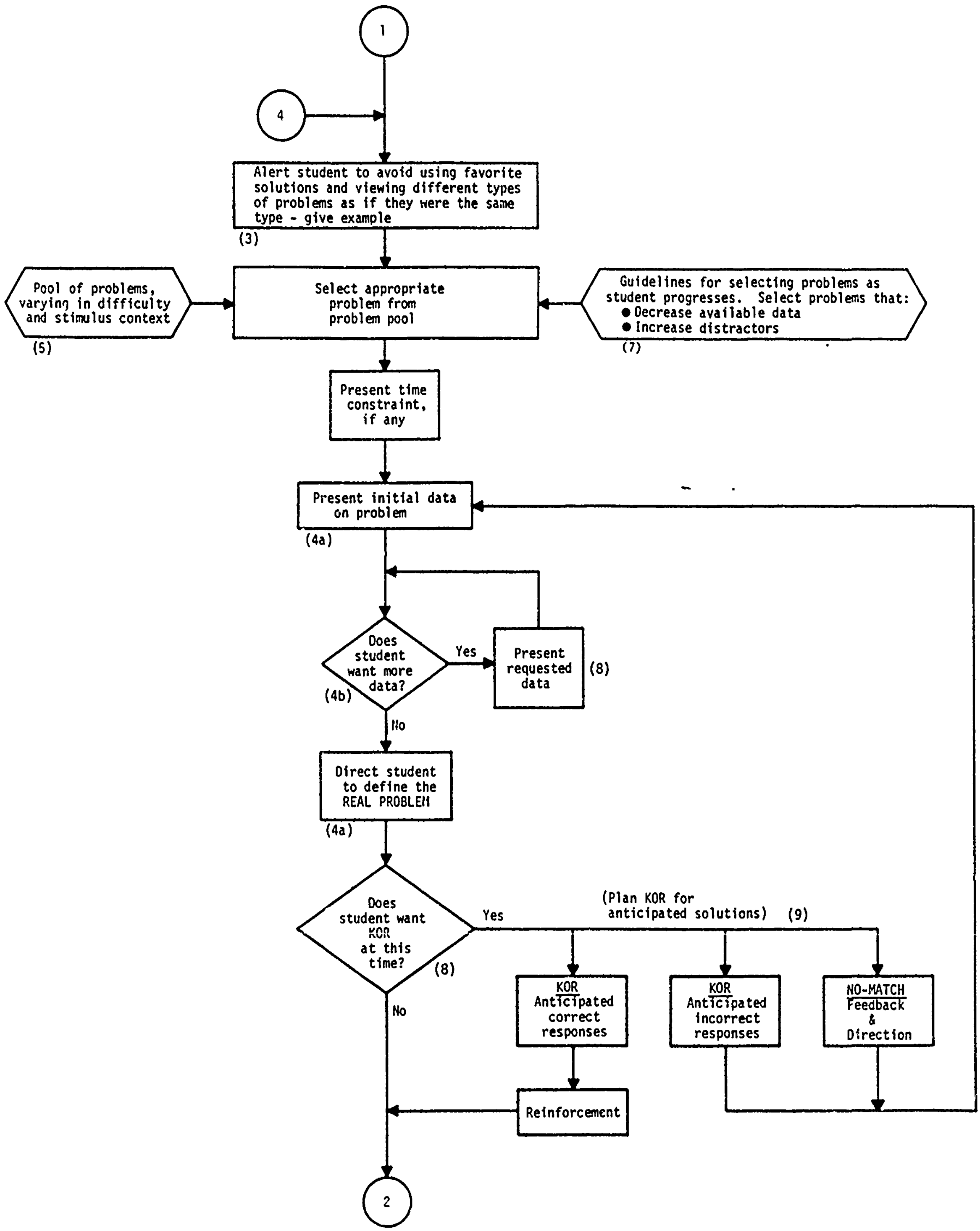


Figure B-3. Learning Algorithm for Making Decisions (continued)

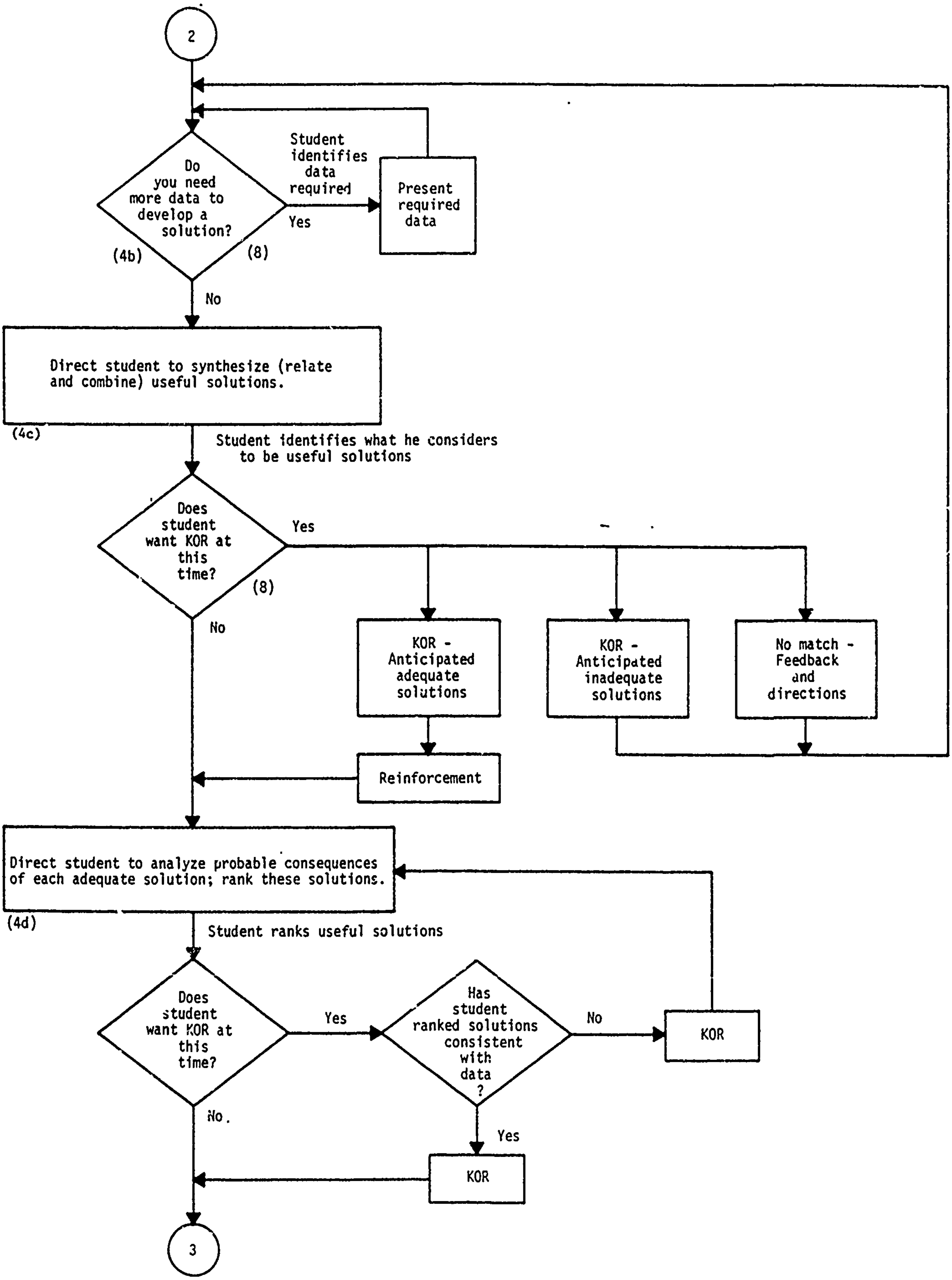


Figure B-3. Learning Algorithm for Making Decisions (continued)

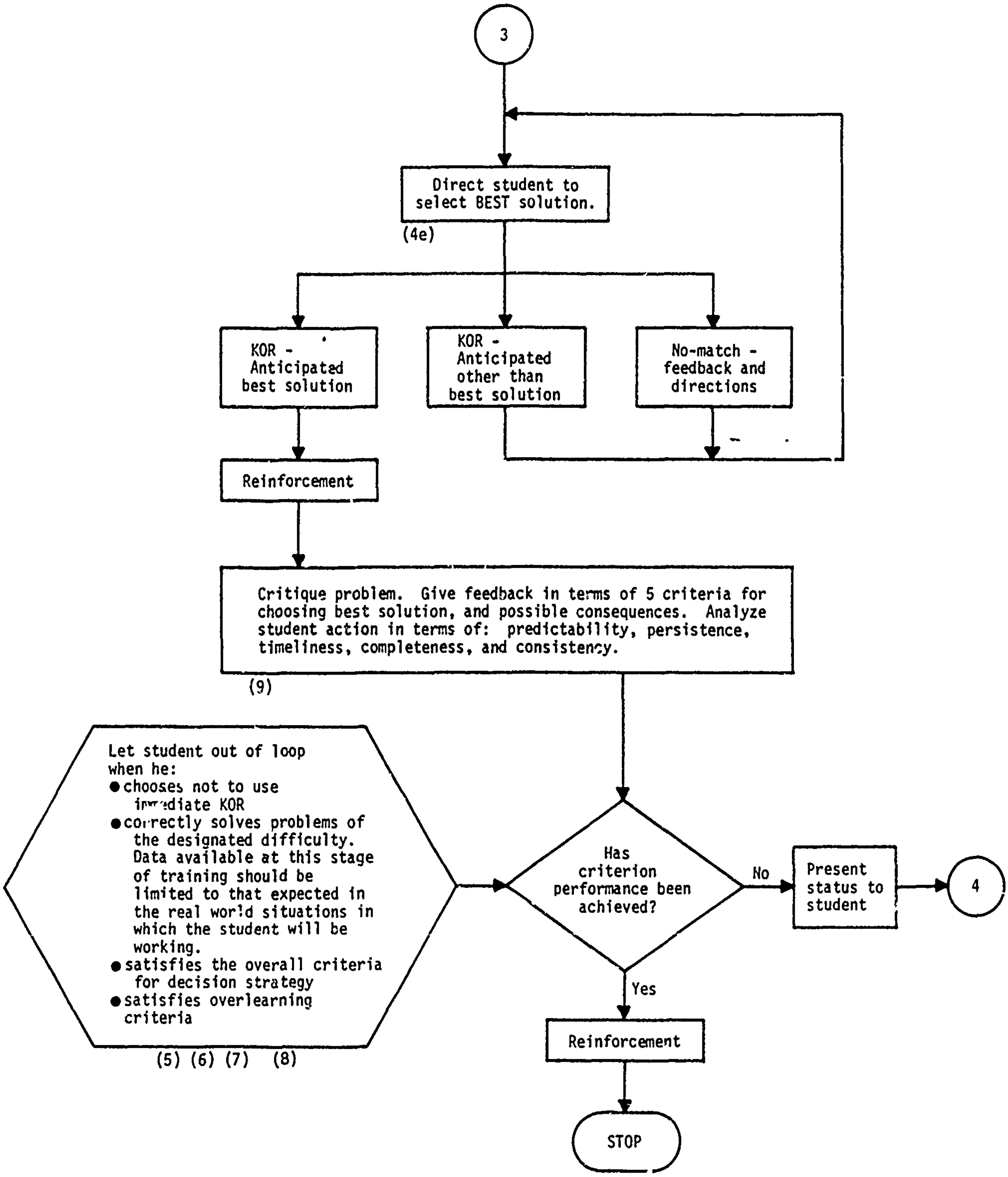


Figure B-3. Learning Algorithm for Making Decisions (continued)

4. GUIDING AND STEERING, CONTINUOUS MOVEMENT

This type of task concerns continuous physical response to a constantly moving visual reference. Frequently it involves controlling the path of a moving vehicle. Examples include maneuvering an automobile down a road, visually aiming weapons during air-to-air combat, holding a ship on course using a gyro compass. Many military jobs involve this type of behavior. Because of the high cost of vehicle control training performed on the operational systems, how best to train this type of behavior has been carefully studied. Proprioceptive stimulation arising in the muscles, tendons, and joints is normally present and is one of the primary sources of information used in controlling the force, extent, and duration of a movement. Perceptual discrimination skills are involved, including the detection of relevant cues (via sight, hearing, touch, etc.). Models of correct behavior are usually used in the training of this task. They serve as guides and criteria against which to evaluate one's own behavior. These models include rules, self-directions, and cues of adequate performance. As the student's skill increases in continuous movement tasks, a high degree of internal control is developed; i.e., the routine tasks are performed smoothly with little conscious effort, and unconscious control governs increasingly larger blocks of behavior.

The following guidelines have been defined for training continuous movement tasks. The algorithm representing these guidelines is presented in Figure B-4.

1. State clearly the criterion behavior or objective to be achieved. Relate the objective to the student's future real-world assignments. Provide him with an overview of desired movements.

2. Break the task up into appropriate parts. (Use as criteria to determine the size of these parts: learning ability, complexity, and length of task.)

3. Ensure that the critical external cues are realistic and available to the student continually during the performance of the task, particularly during the latter part of the training.

4. Provide training to scan by specific training of eye movement, and where to focus for scanning.

5. Ensure a high degree of realism in the operator's response in training for continuous controlling tasks.

6. Demonstrate the desired task performance with a model.

7. Provide for extensive practice to achieve skilled performance. Practice should contain (a) understanding skill objectives, (b) observing skilled performances,

(c) practicing the task, (d) obtaining knowledge of results (KOR), and (e) scheduling periodic rest intervals.

8. Provide reinforcement contingent upon characteristics of the student's response so that by a process of "successive approximations" the final desired proficiency (within accetable tolerances) is produced.

9. Give KOR concerning discrete segments of student performance, especially during early stages of learning.

10. Give positive reinforcement after correct student performance; initially, immediately after each discrete segment of performance; toward the end of training, after each maneuver or complete operation.

11. Practice on specific components when learning a complex task, as opposed to practicing on the entire task at once.

12. Practice under the varied conditions that will exist in the operational setting, if possible.

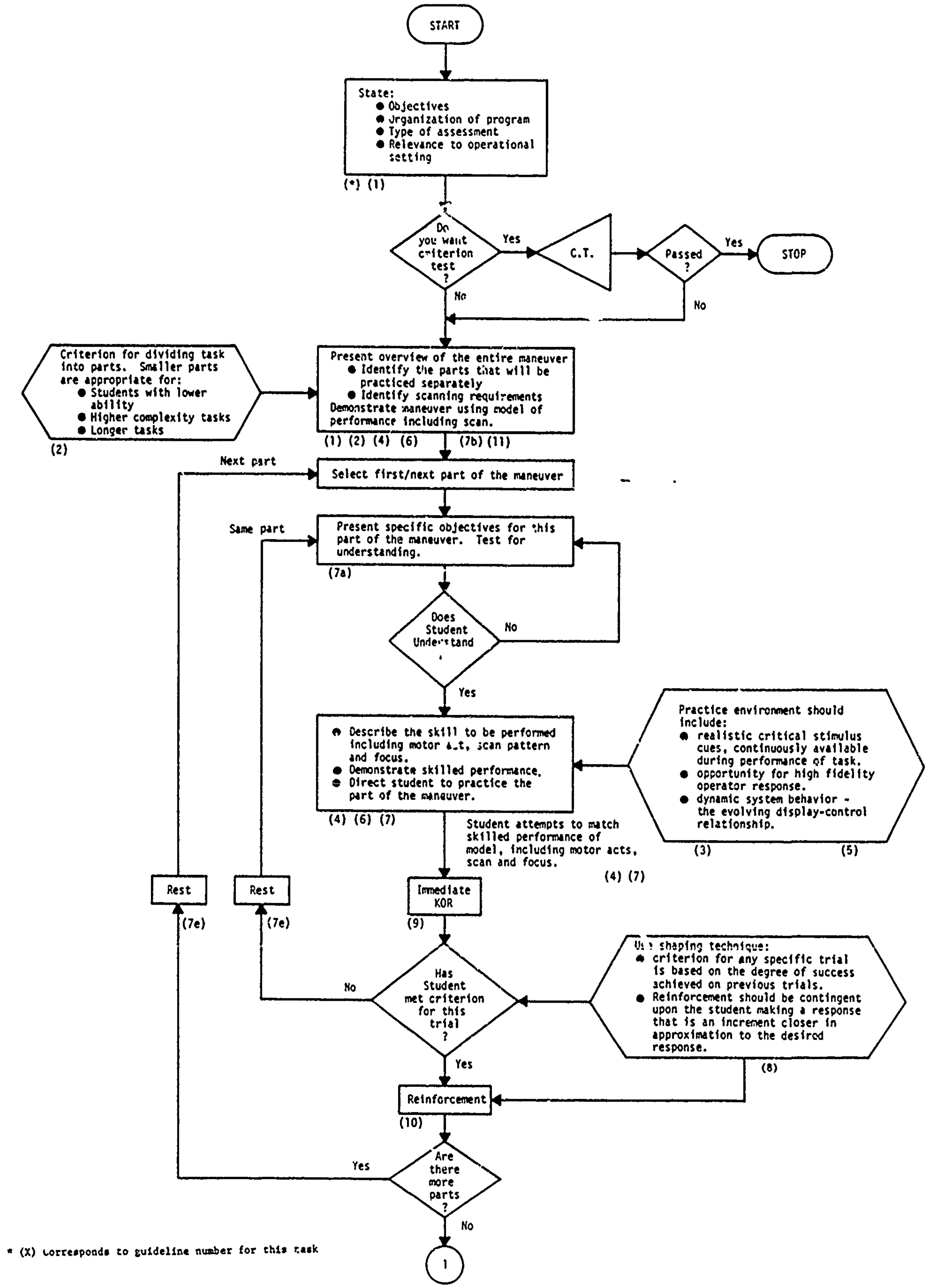


Figure B-4. Learning Algorithm for Guiding and Steering, Continuous Movement

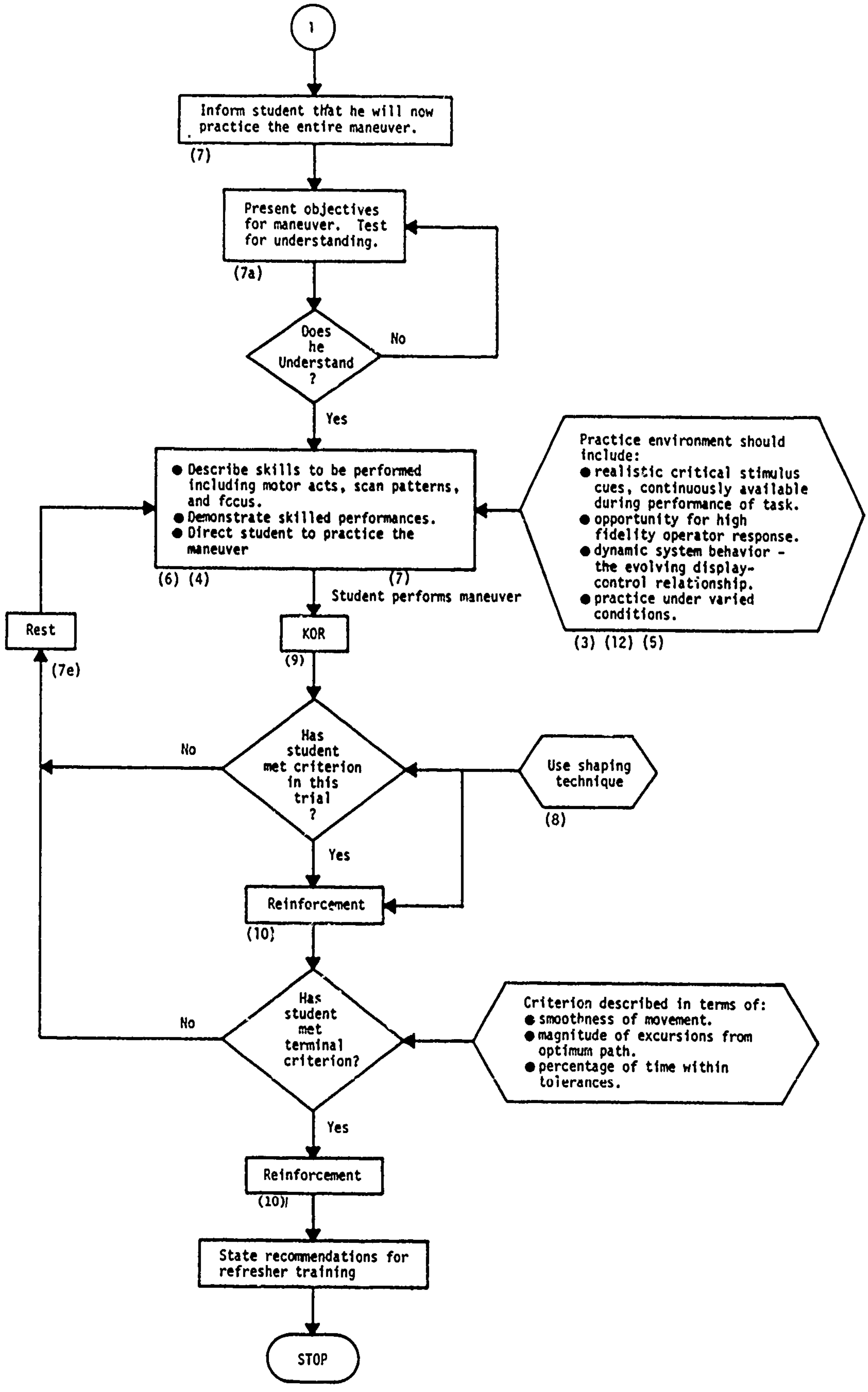


Figure B-4. Learning Algorithm for Guiding and Steering, Continuous Movement (continued)

APPENDIX C

DT Tasks in TECEP Learning Categories

Table C-1

Driver Tasks Which Belong Exclusively to the "Procedures" Learning Category

Procedure Program	Name of Procedure
1	Systems Introduction
	Procedure 1, Warning and Caution Lights
	Procedure 2, Hull Circuit Breakers
	Procedure 3, Fuel Systems
	Procedure 4, Exterior Lights
	Procedure 5, Personnel Heater
2	Systems Introduction, II
	Procedure 7, Transmission Shift Control
	Procedure 8, Brake Controls
	Procedure 9, Steering/Throttle Control
	Procedure 10, Night Vision Viewer
3	Engine Start Malfunctions
	Procedure 12, Starting the Engine
	Procedure 14, Engine Shutdown
	Procedure 15, Power Down Hull
5	Engine Start Malfunctions
	Procedure 41, Engine Will Not Crank
	Procedure 42, Engine Cranks But Will Not Start
	Procedure 43, Engine Cranks But Aborts Start
	Procedure 44, Engine Starts Then Shuts Down
8	Procedure 65, Low Fuel Level
Driving Program	
22	Malfunction 18, Low Fuel Level

Table C-2

Driver Tasks Classified Under Both the "Procedures" and "Voice Communication" Learning Categories (Continued)

Procedure Program	Name of Procedure
9	Miscellaneous Warning/Caution Lights
	Procedure 60 Engine Gas Overtemp
	Procedure 61 Low Battery Charge
	Procedure 62 Clogged Filters
	Procedure 63 Master Panel Circuit Breaker
	Procedure 64 Maintenance Monitor Circuit Breaker
10	Miscellaneous Fuel Pump Malfunctions
	Procedure 66 Right Fuel Pump Failure
	Procedure 67 Transfer Pump Failure
	Procedure 68 Left Fuel Pump Circuit Breaker
11	Emergency Procedures 1
	Procedure 81 Engine Failure
	Procedure 82 Steering Failure
	Procedure 83 Throttle Failure
12	Emergency Procedures 2
	Procedure 86 Loss of Vehicle Track
	Procedure 87 Cable Disconnect
	Procedure 89 Hydraulic Pump Failure
Driving Program	
21	Procedure 21 Placing the Tank in Motion
	Procedure 9 Clogged Air Filter
	Procedure 8 Fuel Control Faulty
	Procedure 19 Transmission Gear Shift Control
22	Malfunction 12 Engine Oil Temperature High
	Procedure 32 Fording Deep Water
	Procedure 23 Driving Over Obstacle
23	Procedure 24 Driving Over Ditch
	Malfunction 20 Master Panel Circuit Breaker Pops
	Malfunction 5 Right Fuel Pump Failure
	Malfunction 10 Engine Compartment Fire, Automatic
	Malfunction 4 Engine Failure

Table C-2
Driver Tasks Classified Under Both the "Procedures"
and "Voice Communication" Learning Categories (Continued)

Procedure Program	Name of Procedure
24	Driving Program 24 Audio Instruction Script
	Procedure 25 Smoke Generator
	Malfunction 16 Engine Gas Overtemp
	Malfunction 13 Engine Oil Pressure Low
25	Driving Program 25 Audio Instructions Script
	Malfunction 14 Transmission Oil Temperature High
	Malfunction 15 Transmission Oil Pressure Low
	Malfunction 11 Automatic Crew Compartment Fire Extinguisher
26	Driving Program 26 Audio Instructions Script
	Malfunction 21 Maintenance Monitor Circuit Breaker Pops
	Malfunction 7 Thrown Left Track
27	Driving Program 27 Audio Instructions Script
	Malfuntion 1 Throttle Failure
	Malfunction 2 Steering Failure

Table C-3
Driver Tasks That Are Classified Simultaneously Under "Procedures," "Voice Communication" and "Decision-Making" Categories.

Procedure Program	Name of Procedure
9	Miscellaneous Warning/Caution Lights Procedure 59 Engine Overspeed
11	Emergency Procedures 1 Procedure 83 Brake Failure
12	Emergency Procedures 2 Procedure 85 Alternator Failure
Driving Program	
22	Malfunction 3 Brake Failure
25	Malfunction 6 Alternator Failure
27	Malfunction 17 Engine Overspeed

Table C-4
Continuous Movement Tasks in Driving Programs

Program Number	Continuous Movement Tasks
21	Basic maneuvering
	Move out down the road at 15 MPH
	Accelerate to 25 MPH
	Stop and pivot 180°
	Drive back down the road
	Turn left onto side road
22	Proceed down a hard-surfaced road in convoy with service lights on
	Proceed down a hard-surfaced road in convoy with service lights on
	Proceed along river bank following set of tracks
	Ford shallow stream
	Cross obstacle
	Add power and move up the hill
23	Drive up and down a small, steep hill
	Proceed onto a gravel road
	Follow trail down hill and across narrow washout
	Proceed up hill through a grove of trees, then down hill
	Drive along rough trail
	Drive on hardtop road
24	Move out at 10 MPH down a rough dirt trail
	Move out down the trail; up a hill, turn
	Move out down the trail; turn
	Move out down the trail; stop, back up, turn
26	Move out down the hill and over a narrow bridge
	Turn left onto a rough trail
	Proceed along the side of a stream
	Enter water and drive down center of stream
	Move out up the steep muddy trail to top of hill
	Cross AVLB
	Climb an obstacle
27	Move out at 45 MPH down hardtop road
	Slow down and turn left onto obstacle course
	Proceed through a narrow space between two buses
	Follow dirt trail
	Move out down the back side of obstacle course
	Proceed slowly along rough trails and over steep terrain