

Research Note 84-81

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EARLY TRAINING ESTIMATION SYSTEM (ETES)
FINAL REPORT
APPENDIX H: USER'S GUIDE: MEDIA SELECTION PROGRAM

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<p>This report describes the research and development activities conducted under the Early Training Estimation System (ETES) development project. The Early Training Estimation System (ETES) is an integrated set of procedures and automated tools for estimating training requirements during the earliest phases of the weapon system acquisition process. The ETES has three major components; a System Description Technology (SDT), Early Training Estimation Aids and Procedures (TEAP), and Evaluative Technology. The SDT is a data base management system for storing and tracking task and training-related</p>												

data. The data in the SDT is used in the TEAP to estimate training requirements for a new system. These training requirements include estimates of task requirements, course requirements, and resource requirements as well as estimates of training costs, training efficiency, and training effectiveness. In the Evaluative Technology, the integrated impacts of training requirements are assessed, training alternatives are evaluated, tradeoff and sensitivity analyses of key parameters/are conducted, and the relationships between ETES outputs and key Army acquisition documents and processes are specified.

This report provides an overview of the components of ETES, describes the research conducted under each of the five ETES study tasks; and outlines future directions for improving ETES.

The final report and Appendixes are published as separate volumes as follows:

Final Report: ARI Research Note 84-78 (includes Appendixes A through E)

Appendix F, User's Guide: ARI Research Note 84-79

Appendix G, User's Guide, System Description Technology: ARI Research Note 84-80

Appendix H, User's Guide, Media Selection Program: ARI Research Note 84-81

Appendix I, User's Guide, Automated Resource and Cost Estimation Technique: ARI Research Note 84-82

Appendix J, User's Guide, Automated Planning and Scheduling Technique for Individual and Collective Training Plan: ARI Research Note 84-83



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PREFACE

This user's guide is part of the Early Training Estimation System (ETES). Development of the ETES was sponsored by the Army Research Institute (ARI) under contract No. MDA-903-80 C-0525. Dynamics Research Corporation (DRC) of Wilmington, Massachusetts was the contractor. The contract monitor for the project was Dr. Charles Jorgensen. The conceptual framework for the Media Selection Program was developed by Dr. Lawrence O'Brien and Ms. Donya Boylston. Ms. Rose White developed the software for the Media Selection Program.

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SECTION 1 - INTRODUCTION

1.1 OBJECTIVES

This guide provides detailed instructions for using the Media Selection Program. This program is an automated aid for (1) assigning tasks to media, and (2) determining the efficiency and effectiveness of media-task combinations. The Media Selection Program is part of the Early Training Estimation System (ETES). The Media Selection Program is designed to use input data from the ETES data base management system which is called the System Description Technology (SDT). A description of the other components of ETES is provided in The ETES User's Guide. A description of the SDT is provided in the SDT User's Guide.

1.2 POTENTIAL USERS

The Media Selection Program has been designed to be used by Army technical analysts who are directly concerned with training development for new Army Weapon Systems. The primary user organizations are expected to be: (1) the Training Development Directorates in The Army schools associated with development of new systems, (2) Program Manager's Office for new systems, particularly those individuals concerned with training development, (3) other Army organizations concerned with training development such as the TRADOC Systems Analysis Activity (TRASANA) and PM Trade, and (4) contractors who must develop training requirements for new systems. It is assumed that users are

familiar with the basic Army training development terminology and processes.

1.3 CONCEPTUAL OVERVIEW

The Media Selection Program is an automated tool for (1) assigning tasks to media and (2) calculating the efficiency and effectiveness of various task-media combinations. The media Selection Program will allow you to assign tasks to media in a manner that maximizes overall efficiency, maximizes overall effectiveness, or minimizes overall cost.¹ In addition, it would allow you to assign task to media in a manner that optimizes various combination of these variables, including an overall "utility" measure which combines either cost and efficiency or cost and effectiveness.

Efficiency, in the Media Selection Program, is determined by comparing the stimulus, response, and feedback characteristic of the tasks to the stimulus, response, and feedback characteristics of potential media. More specifically, a score is calculated which describes the match between media and tasks on these characteristics. Efficiency for each task-media combination is calculated by dividing this score by the maximum match that may be achieved for the task.

¹ The program uses a relative cost and not actual cost to measure the potential cost requirements of media. The relative cost values used in the program are listed in Appendix B.

Total efficiency for a set of tasks is the sum of the efficiency score for individual tasks.²

Effectiveness is calculated by weighting the efficiency of each task by a task criticality score. The task criticality score is a user-defined weighted combination of the eight task factors typically used in selecting tasks for training. These eight factors are task frequency, per cent members performing, per cent time performing, task delay tolerance, consequences of inadequate performance, task learning difficulty, probability of deficient performance, and time between entry and performance.

A matrix of relative cost values is stored in the program for each major media category. (See Appendix B for a listing of these cost values). In addition, a built-in set of algorithms is used to produce the utility measure which combines cost with either effectiveness or efficiency. (See Appendix A for a description of these algorithms).

1.4 PROCEDURAL OVERVIEW

The Media Selection Program is an interactive menu-driven system. This means that you do not have to know or use a computer language to run the program. Instead, you can run through the program by selecting options from a series of menus. The program will tell you what information to enter

² This concept of media efficiency was originally developed by Jorgensen (1978) and was incorporated into Training Efficiency Estimation Model (TEEM) described in Jorgensen, Kubula, and Atlas (1981).

and when to enter this information. It will tell you when you have data missing and will indicate when you have entered data that is of the wrong type or when you have entered data that is out of the acceptable range for the variable you are trying to enter.

An overview of the procedures for using the Media Selection Program is provided in Figure 1-1. To begin the procedures, you must rate each task on (1) the psychological variables to be used to assess the match between tasks and media, and (2) the variables to be used to assess task criticality (the latter is only necessary if effectiveness is being calculated). These scores must be then entered into the ETES data base management system, the System Description Technology. When this is completed you must enter the Applications Program mode in the System Description Technology, and select the Media Selection Program. Once in the Media Selection Program, you must then select criteria to be used in making Media assignments. Seven options for selecting criteria are provided: (1) efficiency, (2) effectiveness (3) relative cost, (4) cost and efficiency, (5) cost and effectiveness, (6) a utility measure, combining efficiency and cost, and (7) a utility measure combining effectiveness and cost.

Once the criteria have been selected, you must select the tasks to be included in the analysis (only tasks already in the SDT may be selected). Typically, the tasks for single course module will be selected for each analysis.

With the analysis criteria identified, the psychological variables to be used in calculating the match between tasks and media must be selected. You may select from twelve

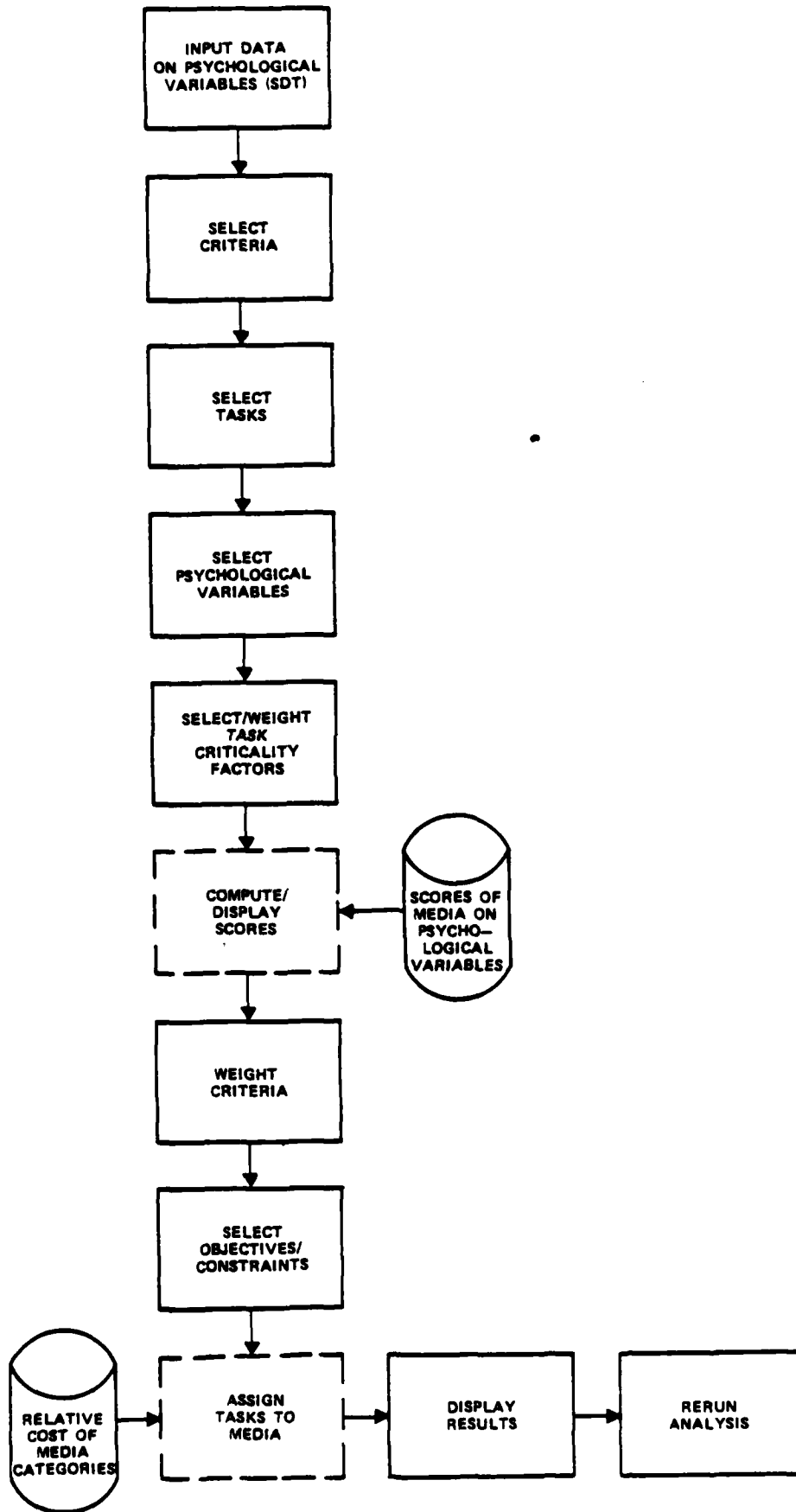


Figure 1-1 Overview of Media Selection Program

variables assessing stimulus characteristics, six variables assessing response characteristics and four variables assessing feedback characteristics.³

If you have selected a set of criteria involving effectiveness (effectiveness, cost and effectiveness, or utility with effectiveness), the weights for the component criticality variables must be entered so that a composite task criticality score can be computed. Eight variables may be used in the calculation of task criticality: (task frequency, per cent member performing, per cent time performing, task delay tolerance, consequences of inadequate performance, task learning difficulty, probability of deficient performance and time between entry and performance).

At this point, the program has all of the information needed to calculate efficiency and/or effectiveness. It will use this information to calculate the relevant measure and it will display the results.

If you have selected one of the two utility measures (combining either cost and efficiency or cost and effectiveness) you will then be required to enter the weights to be used in the computation of utility. Following this you must select the objectives and constraints to be used in assigning tasks to media. A listing of the possible combinations of objectives and constraints is displayed in Table 1-1. (More information on strategies for selecting objectives and

³ These psychological variables were taken directly from the TEEM Model (Jorgensen, Kubula, and Atlas; 1981).

Table 1-1. Possible Assignment Strategies.

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Efficiency	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Cost	Effectiveness	Cost
maximize efficiency	No constraint	Each task is assigned the medium with the greatest efficiency for that task.	X	X	X	X	X	X	X	X
	effectiveness	An assignment of all tasks to media is generated such that total efficiency is maximized and total effectiveness is greater than or equal to user-specified level of effectiveness.		X	X		X			
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."				X	X			
	cost	An assignment of all tasks to media is generated such that total efficiency is maximized and total cost is less than or equal to a user-specified level of cost.			X	X	X			
maximize effectiveness	no constraint	Each task is assigned the medium with the greatest effectiveness for that task.		X	X		X		X	
	efficiency	An assignment of all tasks to media is generated such that total effectiveness is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.		X	X		X		X	
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."					X		X	
	cost	An assignment of all tasks to media is generated such that total effectiveness is maximized and total cost is less than or equal to a user-specified level of cost.			X	X	X		X	
maximize "utility"	no constraint	Each task is assigned the medium with the greatest "utility" for that task.					X	X	X	*
	efficiency	An assignment of all tasks to media is generated such that total "utility" is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.				X	X		X	
	effectiveness	An assignment of all tasks to media is generated such that total "utility" is maximized and total effectiveness is greater than or equal to a user-specified level of efficiency.							X	
	cost	An assignment of all tasks to media is generated such that total "utility" is maximized and total cost is less than or equal to a user-specified level of efficiency.					X	X	X	

Table 1-1. Possible Assignment Strategies. (continued)

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Efficiency	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Effectiveness	Cost
minimize cost	no constraint	Each task is assigned the medium with the least relative cost.			X	X	X	X	X
	efficiency	An assignment of all tasks to media is generated such that total cost is minimized and total efficiency is greater than or equal to a user-specified level of efficiency.			X	X	X	X	*
	effectiveness	An assignment of all tasks to media is generated such that total cost is minimized and total effectiveness is greater than or equal to a user-specified level of effectiveness.				X	X	X	*
	"utility"	An assignment of all tasks to media is generated such that total cost is minimized and total "utility" is greater than or equal to a user-specified level of "utility."					X	X	

*most easily interpreted strategies

constraints is provided in Section 2.5). Once this information has been put into the computer, the program will optimally assign the tasks to training media. For instance, if you selected "maximize effectiveness" as your objective and "minimize cost" as your constraint, the program would determine the assignment of tasks to media which gives the highest overall score on effectiveness and still remains under a user-specified level of overall cost. Once the initial assignments have been examined, you may wish to examine the effects of several alternatives including changes in (1) objective, (2) constraint, (3) criteria, (4) task criticality variables, (5) psychological variables, (6) task criticality variable weights, and/or (7) utility weights.

After you have explored these alternatives, the task-media assignments from the Media Selection Program should be compared against practical factors, such as resource availability, and schedule and budget constraints and a final set of assignments should be constructed and entered into the SDT.

1.5 PRODUCTS OF MEDIA SELECTION PROGRAM

The Media Selection Program will produce two major products: (1) a listing of the efficiency, effectiveness or utility scores for each media-task combination and (2) a listing of the optimal media-task assignments. Examples of both of these products are provided in Tables 1-2, and 1-3 respectively.

Table 1-2. Example of Efficiency Score Listing

	MEDIA CATEGORIES			
<u>1</u>	<u>10</u>	<u>19</u>	<u>20</u>	<u>21</u>
Perform Preflight Insp.	60	80	70	70
Perform VFR Take-off	30	30	80	75
Complete Post-flight Report	80	60	70	70

Table 1-3. Example of Task-Media Assignment Listing

Assign PERFORM PRE-FLIGHT INSP. to AV-Mot. w/Fd (10)

Assign PERFORM VFR TAKE-OFF to Operational Equipment (20)

Assign COMPLETE POST-FLIGHT REPORT to Print w/o Fd (1)

1.6 GUIDELINES FOR USING THIS GUIDE

The remainder of this User's Guide is divided into four sections. Section 2 describes the basic operational procedures for using the Media Selection program and the hardware and software which are required to run the program, and procedures for developing the input data needed to run the program. Section 3 provides a detailed description of the menus and frames in the Media Selection Program. Section 4 contains an example application of the Media Selection Program. This example is designed to provide first-time users with some hands-on experience in using the program. No experience is required to run this application. Section 5 contains guidance on evaluating and using the results of the Media Selection Program. Appendix A provides a technical description of the Media Selection Program assignment algorithms and procedures. Appendix B provides a detailed description of the psychological variables, criticality variables, media categories and relative cost values which are used in the Media Selection Program.

SECTION 2 - BASIC OPERATIONAL PROCEDURES

This section describes basic operational procedures for using the Media Selection Program. In addition, it describes the hardware/software required to use the program and the input data which must be developed before the program can be run. This section is divided into five subsections. Section 3.1 describes the hardware required to use the program. Section 3.2 describes the software required to use the program. Section 3.3 describes procedures for using the program menus. Section 3.4 describes procedures for loading the Media Selection Program. Section 3.5 describes the input data which must be developed to run the program.

2.1 HARDWARE

To use the Media Selection Program, you must have an Apple III computer with:

- o 128K Bytes of RAM memory.
- o A video monitor. The monitor can be black and white or color. However, the program does not produce color images.
- o A 5 megabyte Profile hard disk.
- o An additional floppy disk drive (that is, over and above the disk drive built into your Apple III).

This drive is needed to make a local floppy disk copy of an SDT data base and to load the System Description Technology (SDT) software which contains the SDT data base management system and the Media Selection Program.

- o A printer. A printer is needed to get hard copy output.

If you are using the Apple for the first time, be sure to follow the APPLE III Owner's Guide for instructions on how to connect the computer, the monitor, and an extra floppy disk drive. Also, follow the manufacturer's instructions on how to connect your PROFILE hard disk to your system.

Procedures for insuring that your printer and other peripherals are properly linked to SDT software are described in the SDT User Guide.

2.2 SOFTWARE REQUIREMENTS

To use the Media Selection Program, you will need the following software:¹

- o SDT Program Diskettes. The program diskettes contain software for both the SDT and the Media Selection Program.

¹ For information on obtaining SDT software, contact Dr. Lawrence O'Brien, Dynamics Research Corporation, 7 Lopez Road, Wilmington, MA 01887.

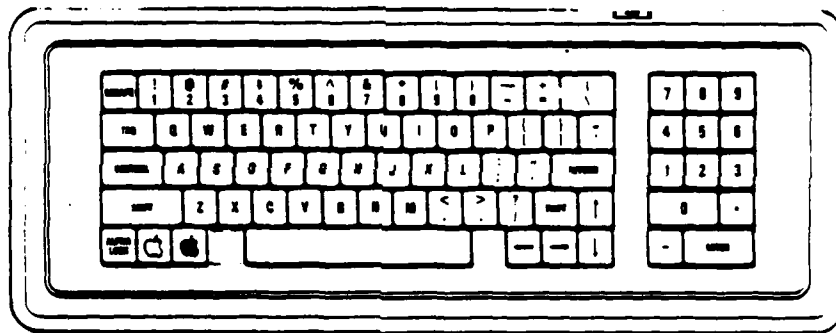


Figure 2-1. The Apple III Keyboard.

- o SDT Boot Diskette - This diskette is used to boot (that is, activate) the SDT software.

- o SDT Backup Diskette (Optional) - These backup diskettes are used to make a local copy of an SDT data base.

2.2.1 General Instructions for Handling Diskettes

To insert a diskette, open the disk drive and slip the diskette into the slot with the label facing upward as shown in Figure 2-2. The edge of the diskette with the oval cutout should enter the drive first; the edge with the label should enter face up and last. Gently push the diskette into the drive; do not bend it. Close the drive door firmly.

To remove the diskette, open the door and pull the diskette straight out of the slot. If you leave the diskette in a drive for long periods of time without use, it is a good idea to open the door so the read/write head does not rest on the diskette. NEVER REMOVE A DISKETTE WHILE THE RED LIGHT UNDER THE DOOR IS ON. This can permanently damage the diskette and is almost certain to destroy the information on it. You may be able to reuse such a diskette, but you will not be able to recover the lost data.

2.2.2 Loading Program Software

The software which contains the SDT and Media Selection programs should be stored on your PROFILE hard disk.

To load the SDT program into your hard disk use the following procedures:

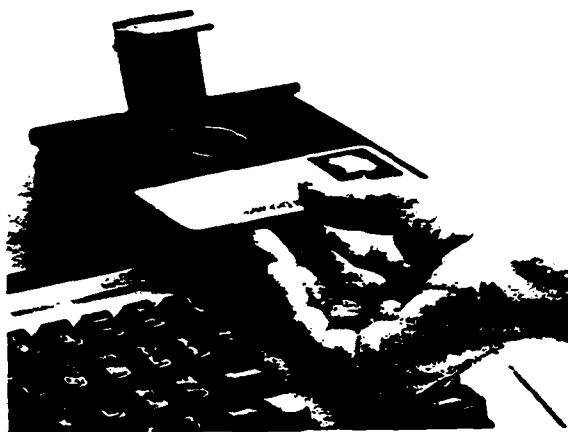


Figure 2-2. Inserting a Diskette.

- o Load the SDT Boot Disk into the built-in drive. Turn the computer off and then on again using the switch at back left of the Apple.
- o Follow the instructions which appear on the screen, and load the SDT Program Diskettes into the additional floppy disk drive.

Once the SDT Program Diskettes have been loaded into your PROFILE hard disk, you will not have to enter the SDT Program Diskettes again.

2.3 PROGRAM MENUS

Unlike many computer programs, you do not have to know a computer language to use the Media Selection Program. Instead, you can make commands and move through the program by selecting options from a series of menus. An example menu is listed in Figure 2-3.

To select a menu option, you must highlight it with the cursor and press the RETURN key. The cursor is a highlighted area on the screen, as shown in Figure 2-3.

You can move the cursor by hitting the up or down arrow keys. Moving the cursor to a menu option causes no action to take place. To select a menu option, you must move the cursor to the option and press the RETURN key.

Some menus in the program may have so many items that not all of these items will be able to be shown at the screen at

WELCOME TO
MEDIA SELECTION PROGRAM

- Return to SDT
- Continue with Program

Figure 2-3. Typical Menu

any one time (such menus will have the phrase MORE at the bottom). To see these additional items, you must scroll the menu up or down. To scroll down, move to the bottom of the menu by hitting the down arrow key. Continue to hit this key and the menu will move up showing you the additional items in the menu. You can then scroll back up by hitting the up arrow key.

2.4 LOADING THE MEDIA SELECTION PROGRAM

To run the Media Selection Program, you must do three things. First, you must load the SDT Boot Diskette into your built-in drive. Second you must load the five SDT Program Diskettes onto your PROFILE hard disk. Procedures for accomplishing these first two steps were described in Section 2.2. When you have successfully accomplished these two steps you will see the first menu of the SDT data base management system on your screen.

In the third step, you must enter the SDT program and move your way through the program to the Applications Program mode where you can select the Media Selection program and load this program into "active memory." To do this you must run through four SDT menus. On the pages which follow these four menus are listed and the specific options you must select on each menu are described. When you are finished with these four menus, the first menu or frame of the Media Selection Program will appear on the screen (This frame will say "Welcome to Media Selection Program" at the top). Details for using the menus and frames in this program are provided in Section 3.

Action 1: Examine SDT Introduction Frame

The SDT introductory frame (see Figure 2-4) will appear on the screen after you have loaded the SDT Program Diskettes and SDT Boot Diskette (see Section 2.2). The frame will describe instructions for using SDT menus. Read the instructions and use what you have learned to move to the next frame. More specifically, move the cursor up and down until you get to the option Skip to Start of Program, then hit RETURN.

Action 2: Select System

A menu will appear on the screen asking you to select the system to be examined (See Figure 2-5 for an example). Move the cursor to the system you want to work with and hit RETURN. (See the SDT User's Guide for instructions on setting up an SDT data base for your weapon system).

Action 3: Examine System Description

A description of the data base you selected will appear on the screen (see example in Figure 2-6). Read the description, then move the cursor to Continue and hit Return.

Action 4: Select SDT Mode of Operation

A menu will appear on the screen asking you to select one of the seven SDT modes of operation (see Figure 2-7). Move the cursor to Applications and hit Return.

WELCOME TO THE
SYSTEM DESCRIPTION TECHNOLOGY
(SDT)

Whenever the right arrow appears, press the up or down arrow keys on the keyboard or use the joystick until the desired menu action is highlighted. Then press the RETURN key on the keyboard or push the joystick button.

For a further explanation at any time, hold down the escape key (upper left hand corner) or toggle the auxiliary switch on the joystick. The explanation will remain on the screen for as long as the key or button is held down.

More instructions
Skip to start of program
Wait until later time

Figure 2-4. SDT Introduction (SDT-1).

SYSTEM SELECTION

Select system for this session.

- SDT Example
- ARI Example

Figure 2-5. System Selection

System Selected:

SDT EXAMPLE

DESCRIPTION GOES HERE.

UP TO 10 LINES

- ABORT SDT EXAMPLE-
CONTINUE

Figure 2-6. System Description (SDT-3).

SDT MODE SELECTION

SELECT SDT OPERATION MODE:

-EXIT SDT-	(Terminate the Program)
-AUDIT/UPDATE-	(Examine Audit Trail/Update on Honeywell at DRC)
-INPUT DATA-	(Add Tabular Data into the SDT data files)
-CORRECT DATA-	(Change Specific Attribute for a Particular Entity)
-OUTPUT DATA-	(Display or Print Existing Data)
-SAVE/RESTORE-	(Copy this system to or from diskette)
<u>-APPLICATIONS-</u>	<u>(Execute the Applications Programs)</u>
<u>-AUXILIARY-</u>	<u>(Execute Auxiliary SDT Programs)</u>

Figure 2-7. Mode Select (SDT-4).

Action 5: Select Media Selection Program

A menu will appear on the screen as asking you to select a SDT applications program (see Figure 2-8). Move the cursor to Media Selection Program and hit Return.

2.5 PREPARING INPUT DATA

Figure 2-9 outlines the steps which must be taken to prepare input data for the Media Selection Program. More details on each of these steps follow.

Select Tasks: You must select the tasks to be used in the analysis. (You can only select tasks which are already in the SDT). The best strategy is to select all of the tasks associated with a particular course module. This information may be obtained from the standard SDT output report labeled "Quasi Program of Instruction-Part 2". This report is listed under the SDT entity Courses. (See the SDT User's Guide for instructions on obtaining this report). A maximum of fifty tasks may be examined in any one application of the Media Selection Program.

Select Criteria: You may select from one of seven criteria for assessing the "goodness" of a Media task assignment (1) efficiency, (2) effectiveness, (3) cost and effectiveness, (4) cost and efficiency, (5) relative cost, (6) a utility measure combining cost and efficiency and (7) a utility measure combining cost and effectiveness.

Table 2-1 summarizes the advantages and disadvantages of each criteria. More details on the advantages and disadvantages of the different criteria are contained in the remaining portion of this discussion for inputting data.

SDT APPLICATIONS PROGRAM

Select Applications Program:

- | | |
|--|-----------------------------------|
| -Terminate Session- | (Terminate the Program) |
| -Return to SDT | (Return to the SDT Main Program) |
| <u>-Media Selection Program</u> | <u>(Perform Media Selection)</u> |
| -Resource and Cost Estimation
Technique | (Interface with VISICALC Program) |

Figure 2-8. Select Applications Program.

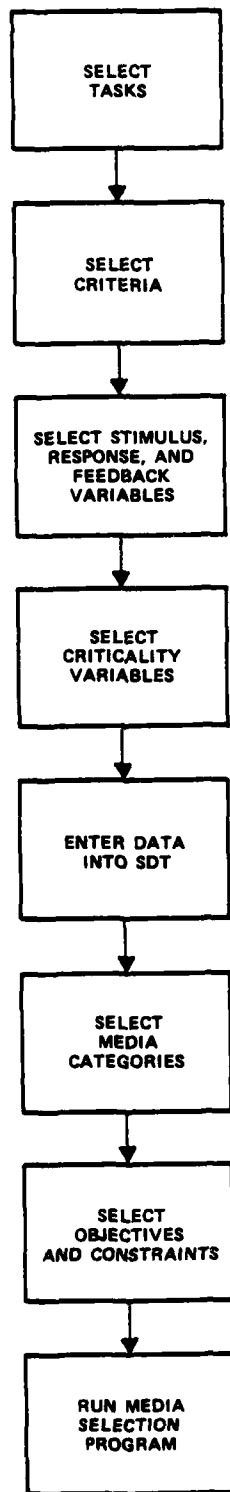


Figure 2-9 Preparing Input Data

Table 2-1. Advantages and Disadvantages of Different Criteria.

CRITERIA	ADVANTAGES	DISADVANTAGES
Efficiency	Assesses match between media and tasks	<ul style="list-style-type: none"> Does not assess cost or take into account task criticality
Effectiveness	Assesses match between media and tasks and allows you to weight tasks by their criticality	<ul style="list-style-type: none"> Does not assess cost
Relative Cost	Assesses media cost	<ul style="list-style-type: none"> Does not assess the match between tasks and media
Cost and Efficiency	Allows you the option of assessing cost or efficiency while using the other variable as a constraint	<ul style="list-style-type: none"> Does not take into account task criticality Does not provide summary measure combining cost and efficiency
Cost and Effectiveness	Allows you the option of assessing cost or effectiveness while using the other variables as a constraint	<ul style="list-style-type: none"> Does not provide summary measure combining cost and efficiency
Utility with Efficiency	Allows the use of a summary measure assessing both cost and efficiency	<ul style="list-style-type: none"> Does not take into account task criticality If constraints are used results may be difficult to interpret
Utility with Effectiveness	Allows the use of a summary measure assessing both cost and effectiveness	<ul style="list-style-type: none"> If constraints are used results may be difficult to interpret

Select Stimulus, Response, and Feedback Variables: if you have selected an option involving efficiency or effectiveness (this will include all but the cost only option), you must determine what stimulus, response and feedback variables will be used to calculate the match between Media and tasks. A listing of the stimulus response, and feedback variables in the SDT and the Media Selection Program is provided in Table 2-2.1 Definitions and descriptions of each of these variables is provided in Appendix B. Unless you have extensive experience in Media selection, it is recommended that you use all of these variables. The criteria you select should be documented in the Media Selection Program planning worksheet listed in Table 2-3.

Select Criticality Variables: Typically, there are eight potential variables which are used to determine task criticality in the Army: (1) task frequency, (2) per cent members performing, (3) per cent time performing, (4) task delay tolerance, (5) consequences of inadequate performance, (6) task frequency, (7) probability of deficient performance, and (8) time between entry and performance. Definitions for each of these variables is provided in Appendix B. During the earliest portion of the acquisition process, it is recommended that three factors--task learning difficulty, consequences of inadequate performance, and task frequency--be used to assess criticality. In later phases of the acquisition process, it is recommended that all eight variables be used to assess criticality. More detailed descriptions of strategies for assessing task criticality

1 These categories were taken directly from the TEEM model (Jorgensen, Kubala and Atlas; 1981).

Table 2-2. Psychological Variables

STIMULUS VARIABLES

MEDIUM

VISUAL FORM

VISUAL MOVEMENT

VISUAL SPECTRUM

VISUAL SCALE

VISUAL CONTRAST

AUDIO SOURCES

AUDIO STIMULI INTENSITY

STIMULI PRESENTATION

STIMULI PRESENTATION RATE

NUMBER OF CHANNELS

STIMULI DISTRIBUTION

RESPONSE VARIABLES

RESPONSE MODE

INTENSITY OF RESPONSE

RESPONSE IMPLEMENTATION

REQUIRED RESPONSE RATE

RESPONSE CHANNELS

RESPONSE DISTRIBUTION

FEEDBACK VARIABLES

FEEDBACK MEDIUM

FEEDBACK SOURCE

FEEDBACK TYPE

FEEDBACK DISTRIBUTION

Table 2-3. Media Selection Planning Worksheet (MSEL).

Date _____

Analysis _____

Criteria (Pick one)

Utility Weights

- ___ Efficiency _____
- ___ Effectiveness _____
- ___ Cost _____
- ___ Cost and Efficiency _____
- ___ Cost and Effectiveness _____
- ___ Utility with Efficiency _____
- ___ Utility with Effectiveness _____

Criticality Variables

Criticality Weights

- ___ Task Frequency _____
- ___ Per Cent Members Performing _____
- ___ Per Cent Time Performing _____
- ___ Task Delay Tolerance _____
- ___ Task Learning Difficulty _____
- ___ Probability of Deficiency Performance _____
- ___ Time Between Entry and Performance _____
- ___ Consequences of Inadequate Performance _____

	<u>Objective</u>	<u>Constraint</u>
Maximize Efficiency	_____	_____
Maximize Effectiveness	_____	_____
Minimize Cost	_____	_____
Maximize Utility	_____	_____

Table 2-3. (cont'd)

PSYCHOLOGICAL VARIABLES

STIMULUS VARIABLES

MEDIUM	_____
VISUAL FORM	_____
VISUAL MOVEMENT	_____
VISUAL SPECTRUM	_____
VISUAL SCALE	_____
VISUAL CONTRAST	_____
AUDIO CONTRAST	_____
AUDIO SOURCES	_____
AUDIO STIMULI INTENSITY	_____
STIMULI PRESENTATION	_____
STIMULI PRESENTATION RATE	_____
NUMBER OF CHANNELS	_____
STIMULI DISTRIBUTION	_____

RESPONSE VARIABLES

RESPONSE MODE	_____
INTENSITY OF RESPONSE	_____
RESPONSE IMPLEMENTATION	_____
REQUIRED RESPONSE RATE	_____
# RESPONSE CHANNELS	_____
RESPONSE DISTRIBUTION	_____

FEEDBACK VARIABLES

FEEDBACK MEDIUM	_____
FEEDBACK SOURCE	_____
FEEDBACK TYPE	_____
FEEDBACK DISTRIBUTION	_____

Table 2-3. Media Categories. (continued)

<u>CAT #</u>	<u>GROUP #</u>	<u>MEDIA CATEGORY</u>	
1	1.1	PRINT INSTRUCTIONS W/O FEEDBACK	_____
2	1.2	PRINT INSTRUCTIONS WITH ORAL FEEDBACK	_____
3	1.3	PRINT INSTRUCTION - WITH WRITTEN FEEDBACK	_____
4	1.4	PRINT - REFERENCE MATERIAL	_____
5	1.5	IMAGE PROJECTION - STILL	_____
6	2.1	PASSIVE AUDIO	_____
7	2.2	ACTIVE AUDIO	_____
8	3.1	AUDIOVISUAL - STILL WITH FEEDBACK	_____
9	3.2	AUDIOVISUAL - STILL WITHOUT FEEDBACK	_____
10	3.3	AUDIOVISUAL - MOTION WITH FEEDBACK	_____
11	3.4	AUDIOVISUAL - MOTION WITHOUT FEEDBACK	_____
12	4.1	STATIC DISPLAY WITHOUT FEEDBACK	_____
13	4.2	DYNAMIC DISPLAY WITHOUT FEEDBACK	_____
14	4.3	PHYSIOLOGICAL TRAINER - INTERNAL	_____
15	4.4	PHYSIOLOGICAL TRAINER - AUDIO	_____
16	4.5	PHYSIOLOGICAL TRAINER - VISUAL	_____
17	4.6	SYMBOLIC SIMULATION WITH FEEDBACK	_____
18	4.7	TRAINER	_____
19	4.8	SIMULATOR	_____
20	4.9	OPERATIONAL EQUIPMENT	_____
21	4.10	OPERATIONAL EQUIPMENT WITH FEEDBACK	_____
22	5.1	VISUAL COMPUTER - STILL WITH FEEDBACK	_____
23	5.2	VISUAL COMPUTER - STILL WITHOUT FEEDBACK	_____
24	5.3	VISUAL COMPUTER - MOTION WITH FEEDBACK	_____
25	5.4	VISUAL COMPUTER - MOTION WITHOUT FEEDBACK	_____
26	5.5	AUDIOVISUAL COMPUTER - STILL WITH FEEDBACK	_____
27	5.6	AUDIOVISUAL COMPUTER - STILL WITHOUT FEEDBACK	_____
28	5.7	AUDIOVISUAL COMPUTER - MOTION WITH FEEDBACK	_____
29	5.8	AUDIOVISUAL COMPUTER - MOTION WITHOUT FEEDBACK	_____
30	6.1	INSTRUCTOR	_____

are provided in The ETES User's Guide. The criteria you select should be documented in the Media Selection Program planning worksheet (see Table 2-3).

Enter Data Into SDT: Once the stimulus, response, and feedback variables and task criticality variables have been selected, each task must be scored on each of these variables and the resulting data must be entered into the SDT. Table 2-4 displays a worksheet which can be used to assist users in inputting this data into the SDT.

To enter data into the SDT, enter the INPUT mode of the SDT and select the Task entity. The psychological variables and the criticality variables are stored under the Task entity. Additional assistance can be provided by successively selecting four built-in input/output formats for data entry: (1) Training Emphasis Ratings - this format contains the seven criticality variables, (2) Stimuli (Parts 1 and 2) - this format contains the stimulus variables, (3) Responses - this format contains the response variables, (4) Feedback - this format contains the feedback variables. By selecting these formats, you can avoid the process of selecting the variables to be entered into the SDT. More details on inputting data into the SDT are provided in Section 7 of the SDT User's Guide.

Select Media Categories: After entering the task data into the SDT, you must decide what potential media categories will be considered during the assignment process. Table 2-5 lists the media categories which are available in the Media Selection Program. More detailed descriptions of each of these categories is provided in Appendix B. To select a set of media categories, start with the full set of categories

Table 2-5. Media Categories.

<u>CAT #</u>	<u>GROUP #</u>	<u>MEDIA CATEGORY</u>
1	1.1	PRINT INSTRUCTIONS W/O FEEDBACK
2	1.2	PRINT INSTRUCTIONS WITH ORAL FEEDBACK
3	1.3	PRINT INSTRUCTION - WITH WRITTEN FEEDBACK
4	1.4	PRINT - REFERENCE MATERIAL
5	1.5	IMAGE PROJECTION - STILL
6	2.1	PASSIVE AUDIO
7	2.2	ACTIVE AUDIO
8	3.1	AUDIOVISUAL - STILL WITH FEEDBACK
9	3.2	AUDIOVISUAL - STILL WITHOUT FEEDBACK
10	3.3	AUDIOVISUAL - MOTION WITH FEEDBACK
11	3.4	AUDIOVISUAL - MOTION WITHOUT FEEDBACK
12	4.1	STATIC DISPLAY WITHOUT FEEDBACK
13	4.2	DYNAMIC DISPLAY WITHOUT FEEDBACK
14	4.3	PHYSIOLOGICAL TRAINER - INTERNAL
15	4.4	PHYSIOLOGICAL TRAINER - AUDIO
16	4.5	PHYSIOLOGICAL TRAINER - VISUAL
17	4.6	SYMBOLIC SIMULATION WITH FEEDBACK
18	4.7	TRAINER
19	4.8	SIMULATOR
20	4.9	OPERATIONAL EQUIPMENT
21	4.10	OPERATIONAL EQUIPMENT WITH FEEDBACK
22	5.1	VISUAL COMPUTER - STILL WITH FEEDBACK
23	5.2	VISUAL COMPUTER - STILL WITHOUT FEEDBACK
24	5.3	VISUAL COMPUTER - MOTION WITH FEEDBACK
25	5.4	VISUAL COMPUTER - MOTION WITHOUT FEEDBACK
26	5.5	AUDIOVISUAL COMPUTER - STILL WITH FEEDBACK
27	5.6	AUDIOVISUAL COMPUTER - STILL WITHOUT FEEDBACK
28	5.7	AUDIOVISUAL COMPUTER - MOTION WITH FEEDBACK
29	5.8	AUDIOVISUAL COMPUTER - MOTION WITHOUT FEEDBACK
30	6.1	INSTRUCTOR

listed in Table 2-4 and eliminate any categories which (1) are not available at the setting where the course associated with tasks is likely to be taught, and (2) are clearly inappropriate for the particular subject area covered by the course (the latter criteria should be used with extreme caution since you may unnecessarily eliminate potential media).

Once the media categories have been selected, they should be documented in the Media Selection Program Planning Worksheet listed in Table 2-5.

Select Criticality and Utility Weights: You must decide what weights will be used in aggregating: (1) the criticality variables and (2) the components of utility (that is, cost and efficiency, or cost and effectiveness). It is recommended that you use equal weights for both of these areas.

If you (1) suspect the validity of some of the variables or (2) feel that some of the variables are less important to your particular analysis, you may want to assign these variables smaller weights. However, if you decide to do this you must compensate by increasing the weight of some of the other variables since the sum of any set of weights must be 100. The worksheet listed in Table 2-4 should be used to document the criticality weights you develop.

Select Objectives and Constraints: Table 2-6 displays the objectives and instruments that you can use to assign tasks to media, the constraints that can be used to qualify each objective and the type of assignments that will be produced by each objective-constraint combination. Examine this

Table 2-6. Possible Assignment Strategies.

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Efficiency	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Cost	Effectiveness	Cost
maximize efficiency	No constraint	Each task is assigned the medium with the greatest efficiency for that task.	X	X	X	X	X	X	X	X
	effectiveness	An assignment of all tasks to media is generated such that total efficiency is maximized and total effectiveness is greater than or equal to user-specified level of effectiveness.		X		X				
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."					X	X		
	cost	An assignment of all tasks to media is generated such that total efficiency is maximized and total cost is less than or equal to a user-specified level of cost.			X	X				*
maximize effectiveness	no constraint	Each task is assigned the medium with the greatest effectiveness for that task.		X		X			X	*
	efficiency	An assignment of all tasks to media is generated such that total effectiveness is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.		X		X				
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."						X		
	cost	An assignment of all tasks to media is generated such that total effectiveness is maximized and total cost is less than or equal to a user-specified level of cost.				X			X	*
maximize "utility"	no constraint	Each task is assigned the medium with the greatest "utility" for that task.					X	X		*
	efficiency	An assignment of all tasks to media is generated such that total "utility" is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.					X	X		
	effectiveness	An assignment of all tasks to media is generated such that total "utility" is maximized and total effectiveness is greater than or equal to a user-specified level of effectiveness.							X	
	cost	An assignment of all tasks to media is generated such that total "utility" is maximized and total cost is less than or equal to a user-specified level of efficiency.						X		

Table 2-6. Possible Assignment Strategies. (continued)

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Cost	Effectiveness	Cost
minimize cost	no constraint	Each task is assigned the medium with the least relative cost.		X		X	X	X	X
	efficiency	An assignment of all tasks to media is generated such that total cost is minimized and total efficiency is greater than or equal to a user-specified level of efficiency.		X		X	X		
	effectiveness	An assignment of all tasks to media is generated such that total cost is minimized and total effectiveness is greater than or equal to a user-specified level of effectiveness.			X		X		
	"utility"	An assignment of all tasks to media is generated such that total cost is minimized and total "utility" is greater than or equal to a user-specified level of "utility."					X		

*most easily interpreted strategies

table, determine the types of assignments you would like to produce, and select the appropriate combination of objective and constraint. The combinations that are most likely to produce meaningful and easy-to-interpret results are starred in Table 2-6. It is recommended that first-time users select one of the following combinations;

<u>OBJECTIVE</u>	<u>CONSTRAINT</u>
Maximize Efficiency	Minimize Cost
Maximize Effectiveness	Minimize Cost
Maximize "Utility"	No Constraint

You should document your selection in the Media Selection Planning Worksheet (see Table 3-5).

Table 2-6 also lists the criteria that must be selected to support each objective-constraint combination. Make sure you have selected a set of criteria which can support the type of assignment and objective-constraint combination you desire.

Run Media Selection Program: At this point, you are ready to run the program. The menus and frames for running the Media Selection program are described in Section 6. Don't forget to bring the completed Media Selection program worksheet (Table 2-3) and task data worksheets (Table 2-4) with you when you decide to run the program. Procedures for evaluating the results of the Media Selection Program are listed in Section 5.

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SECTION 3 - MENUS AND FRAMES

This section provides a detailed description of the menus and frames in the Media Selection Program. Table 3-1 describes the individual menus and frames. An overview of the logic among these menus and frames is presented in Figure 3-1. A detailed description of this logic is presented in Figure 3-2.

In the sections which follow, detailed descriptions of each individual menu or frame are provided. These descriptions list (a) the purpose of each menu, (b) the procedures for using it, (c) the frames which will follow the frame when you have completed the action required in the frame, and (d) the frame where the you will go if you select the abort option which is available in most frames. In addition, an example of each frame is provided.

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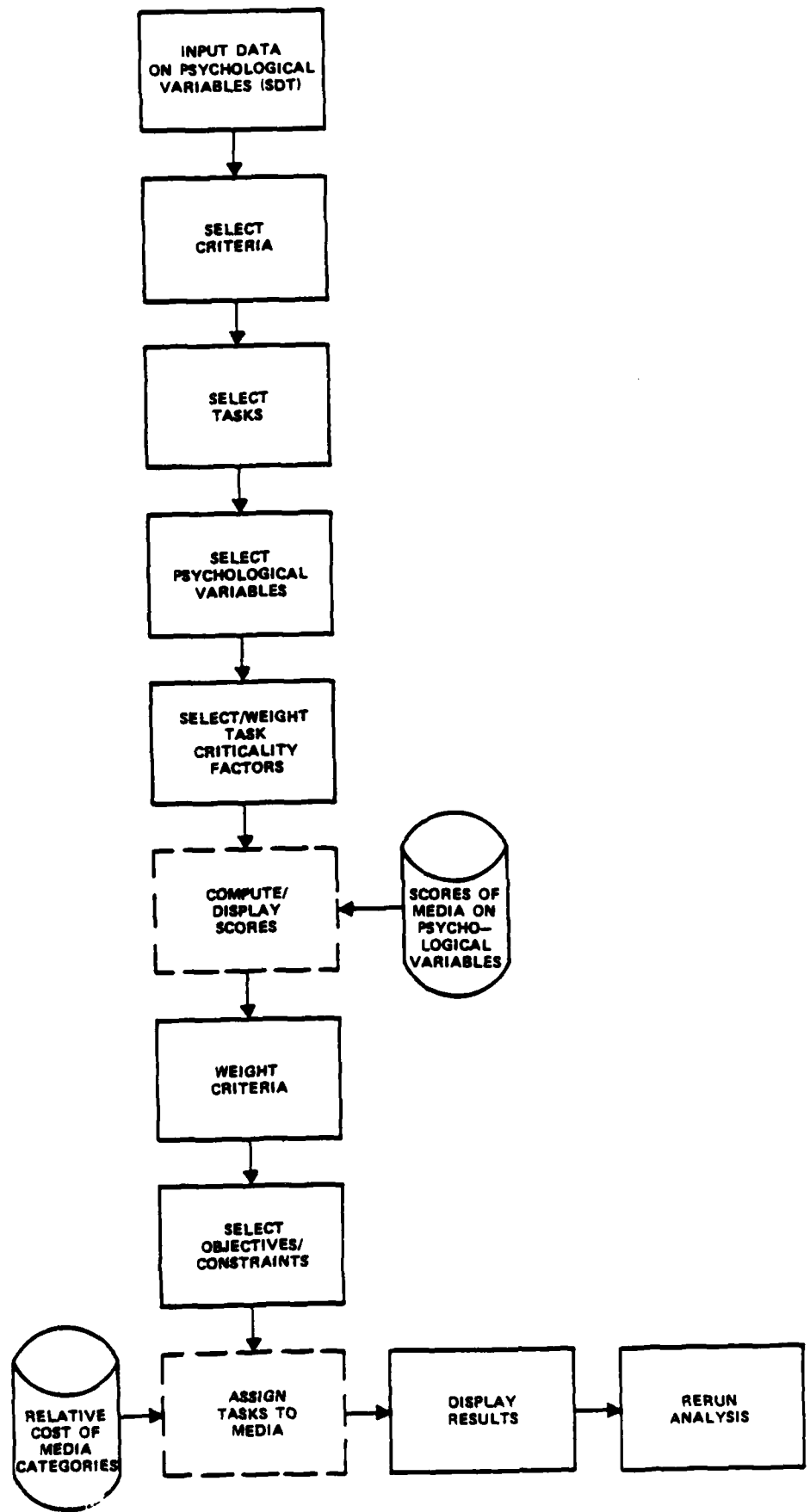


Figure 3-1 Overview of Media Selection Program

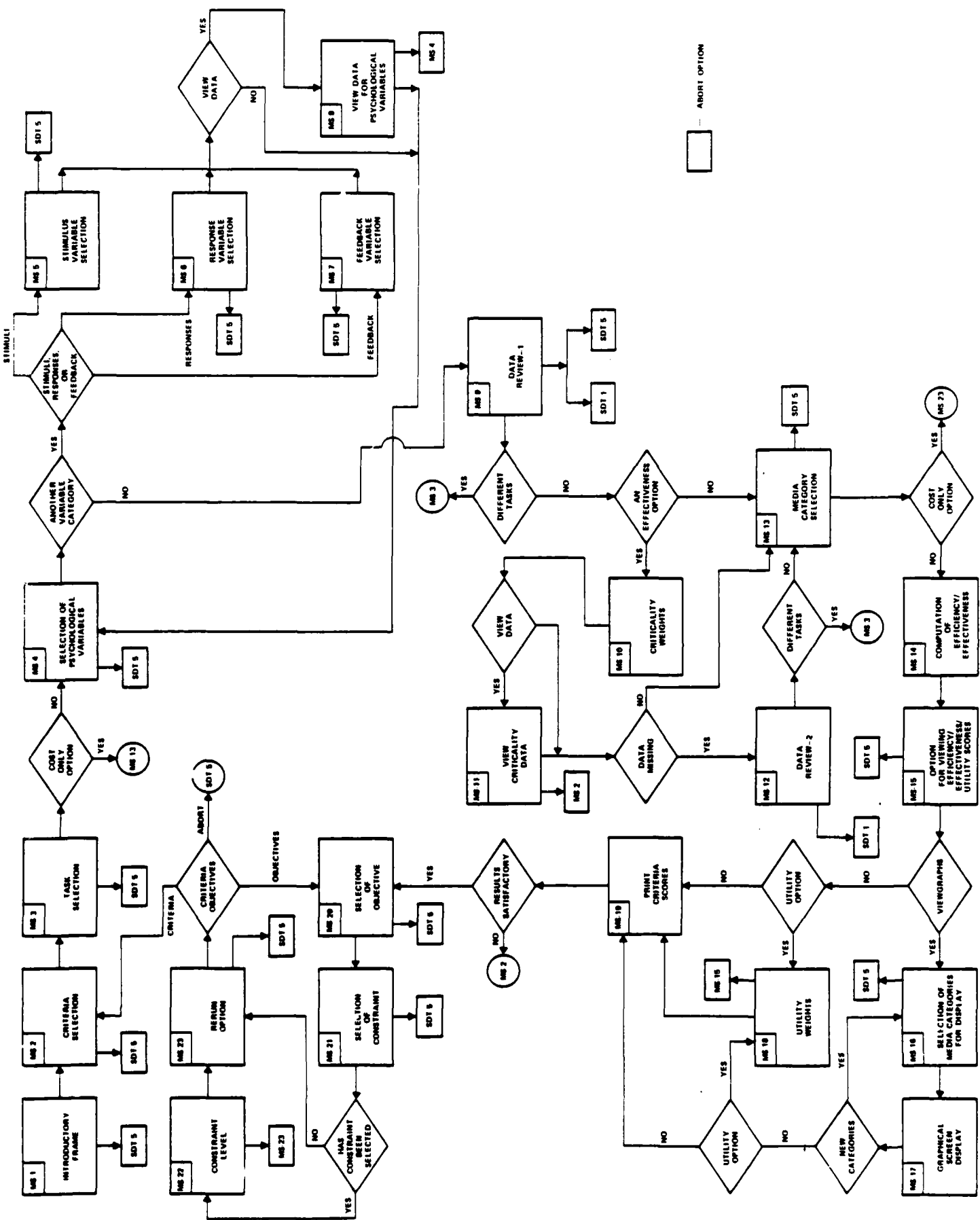


Figure 3-2. Detailed Description of Logic in Media Selection Program.

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3.1 INTRODUCTORY FRAME (MS-1)

Description. This is the first frame you will see in the Media Selection Program. The purpose of this frame is to let you know that you have successfully entered the Media Selection Program.

The frame is listed in Figure 3-3. You have the option of either returning to the SDT or continuing with the Media Selection Program. To select an option, move the cursor (that is the highlighted area) to the desired option and hit Return. (The cursor is moved by hitting the up or down arrow key.)

Abort Options

- o Exit to SDT-By selecting this option, you will return to SDT Applications Program Select (Frame SDT-5)

Follow-on Frames

- o Criteria Selection (MS-2)

WELCOME TO MEDIA SELECTION PROGRAM

- Return to SDT
- Continue

Figure 3-3. Introductory Frame (MS-1).

3.2 CRITERIA SELECTION (MS-2)

Description. This menu will allow you to select one of the seven sets of analysis criteria used in the Media Selection Program (see Figure 3-4). The seven criteria are (1) efficiency, (2) effectiveness, (3) efficiency and cost, (4) effectiveness and cost, (5) "utility" with efficiency, (6) "utility" with effectiveness, and (7) cost. Guidelines for selecting criteria are provided in Section 2.5.

To select a set of criteria, move the cursor to the desired option and hit Return.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o Task Selection (MS-3)

Select criteria for analysis.

- ABORT

Efficiency

Effectiveness

Efficiency and Cost

Effectiveness and Cost

"Utility" With Efficiency

"Utility" With Effectiveness

Cost

Figure 3-4. Criteria Selection (MS-2).

3.3 TASK SELECTION (MS-3)

Description. This menu allows you to select the tasks to be included in the analysis (see Figure 3-5). A maximum of fifty tasks may be selected. The tasks selected should be associated with a course module or other logical unit of instruction.

To select tasks, move the cursor up and down on the screen and press Return when it is on the item you want to select. To select another task move the cursor to the desired item and hit Return again. If all of the tasks do not fit on the screen (this is indicated by the phrase "more" on the bottom of the screen), you can view and select the remaining tasks by "scrolling" the screen up (see Section 2.2). When you have selected all of the tasks you desire, hit No More. You may select all tasks by moving the cursor to this option and hitting Return. The All Tasks option can be used to reverse the current status (highlighted or non-highlighted) of the tasks selected. (Thus you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted).

Select tasks for analysis.

- ABORT

- All tasks

PERFORM PREFLIGHT INSPECTION OF XXX FIGHTER AIRCRAFT

TAXI XXX FIGHTER AIRCRAFT

PERFORM A SHOREBASED VFR TAKE OFF

PERFORM A SHOREBASED VFR LANDING

OPERATE XXX HEADS-UP DISPLAY

EXECUTE FORMATION MANEUVERS

COMPLETE POST-FLIGHT REPORT

Figure 3-5. Task Selection (MS-3).

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o If you have selected the cost only option as your analysis criteria, you will go Media Category Selection (MS-13).
- o If you select any of the other criteria, you will go to Selection of Psychological Variables (MS-4).

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3.4 SELECTION OF PSYCHOLOGICAL VARIABLES (MS-4)

Description. This menu allows you to select one of the three categories of psychological variables (stimuli, responses, and feedback). This is the first step in a two-step process for selecting psychological variables. In subsequent menus you will be able to select specific variables within these three categories. Guidelines for selecting categories are provided in Section 2.5.

An example of this frame is provided in Figure 3-6. To select a category, move the category to the desired option and hit Return. If you have completed your selection of psychological variables, move the cursor to the No More option and hit Return.

The latter action will take you to the Data Review-1 Frame (MS-9) where you will have the option of selecting a different set of tasks, or exiting to the SDT mode select frame (SDT-4). (These options are designed to let you deal with any missing data identified during the selection and examination of psychological variables.)

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-On Frames

- o If you select the No More option, you will go to Data Review-1 (MS-9)

Select Psychological Variables

- ABORT
- No More
- STIMULI
- RESPONSES
- FEEDBACK

Figure 3-6. Selection of Psychological Variables (MS-4).

- o If you select the Stimuli category, you will go to Stimulus Variable Selection (MS-5)
- o If you select the Response category, you will go to Response Variable Selection (MS-6)
- o If you select the Feedback category, you will go to Feedback Variable Selection (MS-7).

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3.5 STIMULUS VARIABLE SELECTION (MS-5)

This menu allows you to select which of the twelve variables which describe stimulus characteristics will be included in the analysis (see Figure 3-7). Guidelines for selecting psychological variables are provided in Section 2.5. Until you gain experience with the program, it is recommended that you select all of the stimulus variables.

To select stimulus variables, move the cursor up and down on the screen and press Return when it is on the item you want to select. To select another variable move the cursor to the desired item and hit Return again. When you have selected all of the variables you desire, hit No More. You may select all variables by moving the cursor to this option and hitting Return. The All Attributes option can be used to reverse the current status (highlighted or non-highlighted) of all variables on the screen. Thus, you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted.

Once you have selected all of the stimuli variables you desire (this is indicated by hitting the No More Attributes option) a message will appear on the right hand side of the screen asking you if you want to view the scores of the tasks you selected in Task Selection (MS-3) on the stimulus variables you have just selected in this menu. If you hit yes, you will go to View Data for Psychological Variables (MS-8) where the scores of each task on the psychological variables will be displayed.

Psychological variable: Stimuli.

Select Attributes:

- ABORT
- All Attributes
 - MEDIUM
 - VISUAL FORM
 - VISUAL MOVEMENT
 - VISUAL SPECTRUM
 - VISUAL SCALE
 - VISUAL CONTRAST
 - AUDIO SOURCES
 - AUDIO STIMULI INTENSITY
 - STIMULI PRESENTATION
 - STIMULI PRESENTATION RATE
 - NUMBER OF CHANNELS
 - STIMULI DISTRIBUTION

Figure 3-7. Stimulus Variable Selection (MS-5).

If you hit no, the program will check for missing data for each task and indicate where data is missing by displaying the phrase Missing Data beside each stimulus variable. If there is no data missing, no such message will be displayed. As the program performs this check for each task, the name of the task will be displayed at the top of the frame. Once the program has checked for missing data you will go to Select Psychological Variables (MS-4), where you will have the option of selecting another category of psychological variables or continuing with the analysis.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o If you select the option for viewing data you will go to the View Data for Psychological Variables (MS-8).
- o If you do not select the option for viewing data you will go back to Selection of Psychological Variables (MS-4) where you can select another category of psychological variables or go on to the next step in the analysis.

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3.6 RESPONSE VARIABLE SELECTION (MS-6)

This menu allows you to select which of the six variables describing response characteristics will be included in the analysis (see Figure 3-8). Guidelines for selecting psychological variables are provided in Section 2.5. Until you gain experience with the program, it is recommended that you select all of the response variables.

To select a response variable, move the cursor up and down on the screen and press Return when it is on the item you want to select. To select another variable move the cursor to the desired item and hit Return again. When you have selected all of the variables you desire, hit No More. You may select all variables by moving the cursor to this option and hitting Return. The All Attributes option can be used to reverse the current status (highlighted or non-highlighted) of the variables selected. Thus, you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted.

Once you have selected all of the response variables you desire (this is indicated by hitting the No More Attributes option) a message will appear on the right hand side of the screen asking you if you want to view the scores of tasks you selected in Task Selection (MS-3) on the response variables you have just selected in this menu.

If you hit yes, you will go to View Data for Psychological Variables (MS-8) where the scores of each task on the psychological variables will be displayed.

Psychological variable: Responses.

Select attributes

- ABORT

- All Attributes

RESPONSE MODE

INTENSITY OF RESPONSE

RESPONSE IMPLEMENTATION

REQUIRED RESPONSE RATE

RESPONSE CHANNELS

RESPONSE DISTRIBUTION

Figure 3-8. Response Variable Selection (MS-6).

If you hit no, the program will still check for missing data for each task and indicate where data is missing by displaying the phrase Missing Data beside each response variable. If there is no missing data no such message will be displayed. As the program performs this check for each task, the name of the task will be displayed at the top of the frame.

Once the program has checked for missing data, you will go to Select Psychological Variables (MS-4), where you will have the option of selecting another category of psychological variables or continuing with the analysis.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-On Frames

- o If you select the option for viewing data you will go to View Data for Psychological Variables (MS-8).
- o If you do not select the option for viewing data you will go back to Selection of Psychological Variables (MS-4) where you can select another category of psychological variables or go on to the next step in the analysis.

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3.7 FEEDBACK VARIABLE SELECTION (MS-7)

This menu allows you to select which of the twelve variables describing feedback characteristics will be included in the analysis (see Figure 3-9). Guidelines for selecting psychological variables are provided in Section 2.5. Until you have gained experience with the program, it is recommended that you select all of the feedback variables.

To select a feedback variable, move the cursor up and down on the screen and press Return when it is on the item you want to select. To select another, move the cursor to the desired item and hit Return again. When you have selected all of the variables you desire, hit No More. You may select all variables by moving the cursor to this option and hitting Return. The All Attributes option can be used to reverse the current status (highlighted or non-highlighted) of the variables selected. Thus, you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted.

Once you have selected all of the feedback variables you desire (this is indicated by hitting the No More Attributes option) a message will appear on the right hand side of the screen asking you if you want to view the scores of tasks you selected in Task Selection (MS-3) on the feedback variables you have just selected in this menu.

If you hit yes, you will go to View Data for Psychological Variables (MS-8) where the scores of each task on the psychological variable will be displayed.

Psychological Variable: Feedback.

Select Attributes

- ABORT

- ALL ATTRIBUTES

FEEDBACK MEDIUM

FEEDBACK SOURCE

FEEDBACK TYPE

FEEDBACK DISTRIBUTION

Figure 3-9. Feedback Variable Selection (MS-7).

If you hit no, the program will still check for missing data for each task and indicate where data is missing by displaying the phrase "missing data" beside each feedback variable. If there is no data missing, no such message will be displayed. As it performs this check for each task, the name of the task will be displayed at the top of the frame.

Once the program has checked for missing data, you will go to Select Psychological Variables (MS-4), where you will have the option of selecting another category of psychological variable or continuing with the analysis.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-On Frames

- o If you select the option for viewing data you will go to View Data for Psychological Variables (MS-8).
- o If you do not select the option for viewing data, you will go to Select Psychological Variables (MS-4) where you can select another category of psychological variables or go on to the next step in the analysis.

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3.8 VIEW DATA FOR PSYCHOLOGICAL VARIABLES (MS-8)

If you have selected the option for viewing data, in the Stimulus Variable Selection (MS-S0, Response Variable Selection (MS-6), or Feedback Variable Selection (MS-7) frames, the data for the variables you have selected will appear on the screen to the right of the variables names. An example of this frame is presented in Figure 3-10. The data will begin appearing immediately after you hit the yes option for viewing data in the Stimulus Variable Selection (MS-S), Response Variable Selection (MS-6), or Feedback Variable Selection (MS-7) Frame. Data for one task will appear on the screen, then data for the next task will appear on the screen, etc. until data for all the tasks you have selected has been displayed. The title of each task will be displayed at the top of the screen. To move to the next task, you must hit Continue. If there is data missing for any of the tasks, the term Missing Data will appear on the screen beside each variable with data missing.

You can abort the viewing of data by hitting the Abort option. If you select this option, the program will still search for missing data for all of the selected tasks but individual data elements for each variable will not be displayed on the screen.

After all the data has been displayed you will go back to Select Psychological Variables (MS-4) where you will have the option of selecting another type of psychological variable, or continuing with the analysis.

Psychological Variable: Feedback for Task Remove and Replace
AN RM/Q15.

Select Attributes:

SDT VALUE:

- ABORT

- ALL ATTRIBUTES

FEEDBACK MEDIUM

VISUAL

FEEDBACK SOURCE

INTRINSIC

FEEDBACK TYPE

RESPONSE CORRECTNESS

FEEDBACK DISTRIBUTION

INDIVIDUAL

- Abort viewing these values

- Continue

Figure 3-10. View Data for Psy. Variables (MS-8).

Abort Options

- o If you select the Abort option, the program will search for missing data and then return you to Select Psychological Variable (MS-4)

Follow-On Frames

- o Select Psychological Variables (MS-4)

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3.9 DATA REVIEW-1 (MS-9)

This purpose of this frame is to allow you to deal with any missing data for psychological variables you selected and examined in Stimulus Variable Selection (MS-5), Response Variable Selection (MS-6), Feedback Variable Selection (MS-7) and View Data for Psychological Variables (MS-8).

The frame provides you with three options (1) continuing with the analysis, (2) selecting a different set of tasks, or (3) exiting the program to enter the missing data into the SDT.

If you have data missing, you should either select a new set of tasks for which you are sure there is data, or you should exit and enter the SDT where you can enter data for the tasks with data missing. Only if there is no missing data should you select the continue option. If you continue, the program will assign a value of zero to each psychological variable with missing data.

Abort Options

- o If you select the Abort option you will go back to the SDT Applications Program Select (SDT-5). If you select this option, all of your work from the current session of the Media Selection Program will be destroyed.

- o If you select the option for exiting to enter missing data into the SDT, you will go back to the SDT Introduction (SDT-1).

If you would like to pick a different set of tasks, please select the appropriate option.

-ABORT

-Continue

-Different tasks

-Exit to enter missing data into SDT

Figure 3-11. Data Review-1 (MS-9).

Follow-On Frames

- o If you have selected the Continue option and you have selected as your analysis criteria any of the options which involve effectiveness (effectiveness, cost and effectiveness or utility with effectiveness) you will go to Criticality Weights (MS-10).

- o If you have selected the continue option and have not selected a criteria which involves effectiveness you will go to Media Category Selection (MS-B).

- o If you have selected the option for choosing different tasks you will go to Task Selection (MS-3).

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3.10 CRITICALLY WEIGHTS (MS-10)

This frame allows you to enter weights for the eight variables used to assess task criticality (task frequency, percent members performing, percent time performing, task delay tolerance, consequences of inadequate performance, task learning difficulty, probability of deficient performance, and time between entry and performance).

The frame will begin by asking you whether you would like to use equal weights or not. Unless you are an experienced user, you should select the equal weights option. If you select the equal weights option, the program will assign equal weights to all eight variables and you will be asked if you want to review the scores of the tasks on the eight psychological variables.

If you select the option for inputting weights, spaces will appear in the screen for entering weights for each variable (see Figure 3-12). To enter a weight, use your keyboard to type in the weights. You must input a number between 0 and 100. The program will automatically convert your input to fractional weights. For example, if you type in 50 it will assign a weight of .50. If you make a mistake you can correct it, by moving the cursor back and retyping the information before you hit Return. You can eliminate a criticality variable from the analysis by assigning it a value of 0.

The weights you assign must sum to 100. If you assign a set of weights and they do not sum to 100, you will get an error message and the program will ask you to enter the weights again, starting with the first criticality variable

Weights for criticality variables must be between 0-100 and
sum to 100.

Please enter weight for
PER CENT PERFORMING

- - -

1 4 -

↑

THEN PRESS RETURN

(MAKE NO ENTRY TO ABORT)

Figure 3-12. Criticality Weights (MS-10).

- Percent Performing. After you have entered the weights the program will give you the option of continuing or reentering the weights. If you hit continue a message will appear on the screen asking if you would like to view the criticality data for the tasks you have selected. If you select the yes option for viewing criticality data you will go to View Criticality Data (MS-11). If you select the no option for viewing criticality data, and there is missing criticality data you will go to Data Review - 2 (MS-12). If you select the no option for viewing criticality and there is no missing data, the program will calculate criticality scores. This will be indicated by the message computing . . . please wait. After the scores are calculated you will go to Media Category Selection (MS-13)

Abort Options

- o If you make no entry for any particular criticality variable, you will go to the form for inputting data on the next criticality variable.
- o If you select the option for aborting criticality values which appears after all the weights have been entered, you will return to the form for inputting data for the first criticality variable.

Follow-on Frames

- o If you select the option for viewing the criticality data, you will go to View Criticality Data (MS-4),
- o If you do not select the option for viewing criticality data and there is missing criticality data, you will go to Data Review-2 (MS-12)

- o If you do not select the option for viewing criticality data and there is no missing criticality data, the program will calculate criticality scores and then you will go to Media Category Selection (MS-13)

3.11 VIEW CRITICALITY DATA (MS-11)

During this frame, you can view the criticality data for each of the tasks you selected. Data will be displayed for each criticality variable. An example of this frame is provided in Figure 3-13. If there is data missing, the message No Data will be displayed beside the variable with data missing. When you have completed your review of the criticality data for the first task move the cursor to Continue and hit Return. The data for the second task you have selected will appear on the screen, followed by the data for the next, etc., until the data for all tasks has been displayed.

Abort Options

- o If you abort viewing criticality values, the program will compute criticality scores. If there is no missing data, you will then go to Media Category Selection (MS-13). If there is missing data, you will go to Data Review 2 (MS-12)

Follow-on Frames

- o If there is missing data, you will go to Data Review 2 (MS-12)
- o If there is no missing data, the program will compute criticality scores and you will then go to Media Category Selection (MS-13)

REPLACE AN RM/Q15 - Criticality Values.

PER CENT PERFORMING	58
PER CENT TIME PERFORMING	3
CONSEQ. INADEQ. PERFORM.	3
TASK DELAY TOLERANCE	3
TASK LEARNING DIFFICULTY	3
PROB. OF DIFICIENT PERFORMANCE	3
TIME FROM ENTRY TO PRFRM	3

- Abort viewing criticality values
- Continue

Figure 3-13. View Criticality Data (MS-11).

3.12 DATA REVIEW -2 (MS-12)

The purpose of this frame is to allow you to deal with any missing data for the criticality variables.

The frame is displayed in Figure 3-14. The frame provides you with three options: (1) continuing with the analysis, (2) selecting a different set of tasks, or (3) exiting to enter the missing data into the SDT.

If you have data missing you should either select a new set of tasks for which you are sure there is data, or you should exit and enter the SDT to input data for the tasks you have selected.

Only if there is no missing data should you select the continue option.

Abort Options

- o Exit to enter missing data into SDT. By selecting this option you will go back to the SDT Introduction Frame (SDT-1). If you select this option all of your work from the current session of the Media Selection Program will be destroyed.

Follow-on Frames

- o If you select the option for selecting different tasks you will go to Task Selection (MS-3).

There is criticality data missing. Please select the appropriate option.

- Different Tasks
- Exit to enter missing data into SDT

Figure 3-14. Data Review-2 (MS-12).

3.13 MEDIA CATEGORY SELECTION (MS-13)

This frame allows you to select which of the twenty nine media categories hard-coded in the program will be used in the analysis. A listing of the media categories is provided in Table 3-2. The frame for selecting media categories is presented in Figure 3-15. Guidelines for selecting media categories are provided in Section 2.5. Unless you are familiar with the program, you should select all media categories.

To select media categories, move the cursor up and down on the screen and press Return when it is on the media category you want to select. To select another category move the cursor to the desired item and hit Return again. Since all of the categories do not fit on the screen (this is indicated by the phrase more on the bottom of the screen), you can view and select the remaining categories by "scrolling" the screen up (see Section 2.2). When you have selected all of the categories you desire, hit No More. You may select All categories by moving the cursor to this option and hitting Return. The All Media Categories option can be used to reverse the current status (highlighted or non-highlighted) of the categories selected. Thus, you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted.

Abort Options

- o SDT Applications Program Select (SDT-5)

Please select built-in media categories for analysis:

- ABORT
- All Media Categories
 - Prnt Ins w/o Fd
 - Prnt In w/oral Fd
 - Prnt In w/oral Fd
 - Prnt In w/writ Fd
 - Prnt - Ref Material
 - Image Proj - Still
 - Passive Audio
 - Active Audio
 - AV - Still w/Fd
 - AV - Still w/o Fd
 - AV - Motion w/o Fd
 - AV - Mot w/o Fd
 - Stat Disp w/o Fd
 - Dyn Displ w/o Fd
 - Phys Train - inter
 - Phys Train - audio
 - Phys Train - visual
- more -

Figure 3-15. Media Category Selection (M-13).

Table 3-2. Media Categories.

<u>CAT #</u>	<u>GROUP #</u>	<u>MEDIA CATEGORY</u>
1	1.1	PRINT INSTRUCTIONS W/O FEEDBACK
2	1.2	PRINT INSTRUCTIONS WITH ORAL FEEDBACK
3	1.3	PRINT INSTRUCTION - WITH WRITTEN FEEDBACK
4	1.4	PRINT - REFERENCE MATERIAL
5	1.5	IMAGE PROJECTION - STILL
6	2.1	PASSIVE AUDIO
7	2.2	ACTIVE AUDIO
8	3.1	AUDIOVISUAL - STILL WITH FEEDBACK
9	3.2	AUDIOVISUAL - STILL WITHOUT FEEDBACK
10	3.3	AUDIOVISUAL - MOTION WITH FEEDBACK
11	3.4	AUDIOVISUAL - MOTION WITHOUT FEEDBACK
12	4.1	STATIC DISPLAY WITHOUT FEEDBACK
13	4.2	DYNAMIC DISPLAY WITHOUT FEEDBACK
14	4.3	PHYSIOLOGICAL TRAINER - INTERNAL
15	4.4	PHYSIOLOGICAL TRAINER - AUDIO
16	4.5	PHYSIOLOGICAL TRAINER - VISUAL
17	4.6	SYMBOLIC SIMULATION WITH FEEDBACK
18	4.7	TRAINER
19	4.8	SIMULATOR
20	4.9	OPERATIONAL EQUIPMENT
21	4.10	OPERATIONAL EQUIPMENT WITH FEEDBACK
22	5.1	VISUAL COMPUTER - STILL WITH FEEDBACK
23	5.2	VISUAL COMPUTER - STILL WITHOUT FEEDBACK
24	5.3	VISUAL COMPUTER - MOTION WITH FEEDBACK
25	5.4	VISUAL COMPUTER - MOTION WITHOUT FEEDBACK
26	5.5	AUDIOVISUAL COMPUTER - STILL WITH FEEDBACK
27	5.6	AUDIOVISUAL COMPUTER - STILL WITHOUT FEEDBACK
28	5.7	AUDIOVISUAL COMPUTER - MOTION WITH FEEDBACK
29	5.8	AUDIOVISUAL COMPUTER - MOTION WITHOUT FEEDBACK
30	6.1	INSTRUCTOR

Follow-on Frames

- o If you have selected cost only as your analysis criterion the program now has all the information needed to make task-media assignments. The program will print out the assignments and you will go to Select Rerun Option (MS-23).

- o If you did not select the cost only criterion option, you will go to Computation of Efficiency/Effectiveness (MS-14).

3.14 COMPUTATION OF EFFICIENCY/EFFECTIVENESS (MS-14)

During this frame the message Computing-please wait will be displayed on the screen (see Figure 3-16). This message will remain on the screen until the program has calculated all efficiency and effectiveness scores.

Abort Options

None.

Follow-on Frames

- o Option for View Efficiency/Effectiveness Scores (MS-15)

Computing. . . please wait

Figure 3-16. Computation of Efficiency/Effectiveness (MS-14).

3.15 OPTION FOR VIEWING EFFICIENCY/EFFECTIVENESS SCORES (MS-15)

During this frame, you can select the option for examining a histogram of efficiency scores on your computer screen (see Figure 3-17).

To select an option, move the cursor to the desired option and hit Return.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o If you select the option for viewing graphs of efficiency scores on your computer screen you will go to Selection of Media Categories for Display (MS-16).
- o If you do not select the option for viewing efficiency scores and have not selected "utility" as an analysis criterion, you will go to Print Criteria Scores (MS-19).
- o If you do not select the option for viewing efficiency scores and you have selected "utility" as an analysis criterion, you will go to "Utility" Weights (MS-18).

Would you like to view bar graphs for efficiency scores?

- yes

- no

Figure 3-17. Option for Viewing Efficiency/
Effectiveness Scores (MS-15).

3.16 SELECTION OF MEDIA CATEGORIES FOR DISPLAY

During this frame, you can select which of the media categories will be included in the graphical displays of efficiency scores on your computer screen (see Figure 3-18). No more than ten media categories may be selected for display.

To select media categories, move the cursor up and down on the screen and press Return when it is on the item you want to select. To select another category move the cursor to the desired item and hit Return again. When you have selected all of the categories you desire, hit No More. You may select All Media Categories by moving the cursor to that option and hitting Return. The All Media Categories option can also be used to reverse the current status (highlighted or non-highlighted) of the categories selected. Thus, you can use this option to "unselect" the selected items which are highlighted on the screen or to select the items not currently highlighted.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o Graphical Screen Display (MS-15)

Please select media categories for bar graph.

- ABORT

Prnt Ins w/o Fd

Prnt Ins w/oral Fd

Prnt Ins w/writ Fd

Figure 3-18. Selection of Media Categories For Display (MS-16).

3.17 GRAPHICAL SCREEN DISPLAY (MS-17)

During this frame, graphs displaying the efficiency of each selected media category will be displayed on the computer screen. An example of one of these graphs is displayed in Figure 3-19. The efficiency scores displayed in this graphic will range from a minimum score of 1 to a maximum score of 100. After completing your examination of a graph, hit Return and bar graph for next task will appear on the screen, until graphs have been displayed for each of the tasks you selected. You may abort out of the graph displays by hitting Abort. After the last graph has been displayed, the program will ask you if you want to choose a different set of media categories. If you select this option you will return to Selection of Media Categories, For Display (MS-16). If you do not select this option you will go to Utility Weights (MS-18) or Print Criteria (MS-19).

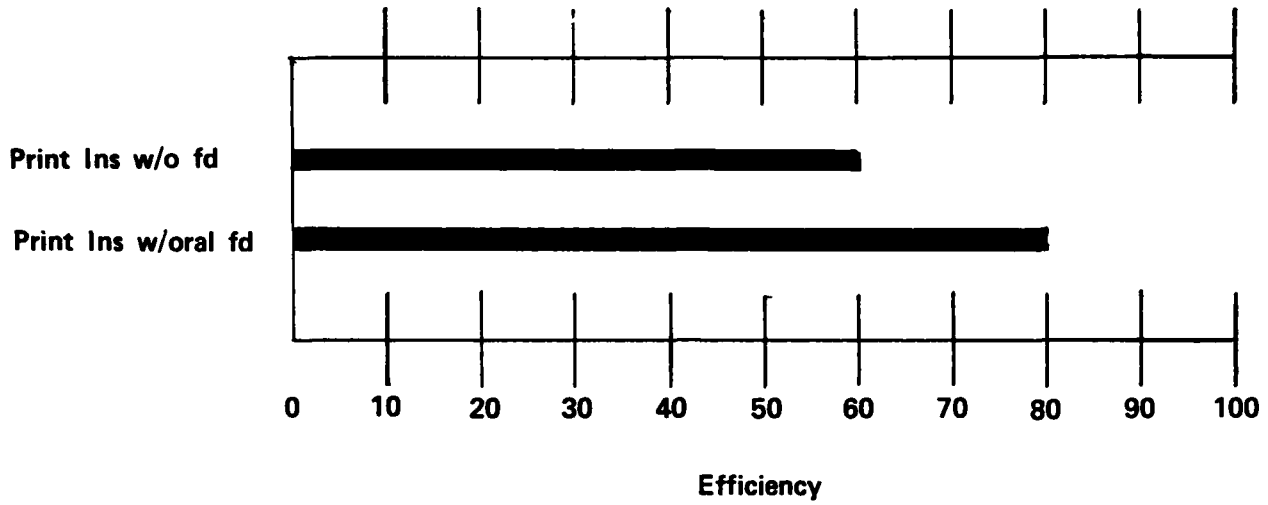
Abort Options

- o If you selected a criteria involving effectiveness you will go to Utility Weights (MS-18)
- o If you did not select a criteria involving effectiveness you will go to Print Criteria (MS-19)

Follow-on Frames

- o If you select the option for choosing new media categories you go to Selection of Media Categories For Display (MS-16).

Replace AN RM/Q15



- Abort
- Continue

Figure 3-19. Graphical Screen Display (MS-17).

- o If you did not select the option for choosing new media categories and you selected a criteria involving effectiveness you will go to Utility Weights (MS-18)

- o If you did not select the option for choosing new media categories and you did not select a criteria involving effectiveness you will go to Print Criteria (MS-19)

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3.18 "UTILITY" WEIGHTS (MS-18)

This frame allows you to input weights for the two criteria used in the construction of an overall "utility" measure (a detailed description of the algorithm used to compute "utility" is provided in Appendix A).

An example of the frame is presented in Figure 3-20. To enter a weight for a criterion, type in an integer between 0 and 100. The program will automatically convert your input to fractional weights. For example, if you type in 50 the program will assign the variable a weight of .5. If you make a mistake, you can correct it by moving the cursor back and retyping the information. (This must be done before hitting Return.) The weights must sum to 100. Until you have gained experience with the program, it is recommended that you use equal weights of 50 for both criteria.

Once you have entered the weight for the first variable, space will be provided for entering the weight for the second variable. When you have entered the second weight, the program will ask you if you want to stay with the weights you have just entered or select a new set of weights. If you select the option for choosing a new set of weights, the form for entering the first utility weight will appear on the screen. If you do not select this option, you will go to Print Criteria (MS-19).

Abort Options

- o If you select the Abort option which will appear after all the weights have been entered you will go back to the form for inputting weights on the first variable.

Weights for effectiveness and cost must be between 0-100 and
sum to 100.

Please enter weight for
Effectiveness



THEN PRESS RETURN

(MAKE NO ENTRY TO ABORT)

Figure 3-20. Utility Weights (MS-18).

Follow-on Frames

- o Print Criteria Scores (MS-19)

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3.19 PRINT CRITERIA (MS-19)

This frame will allow you to print one of the three individual analysis criteria calculated by the program (see Figure 3-21). The three options are (1) print efficiency, (2) print effectiveness (3) print "utility."

To select an option, move the cursor to the desired option and hit Return. The scores will then be printed out for that option. The Print Criteria frame will appear again giving you the option of obtaining printed output for another criterion, or leaving the print option (this is indicated by hitting No More.) An example printout is displayed in Table 3-3. Each row represents one task, and each column represents a media category. A key for interpreting the media category numbers is displayed in Table 3-4.

Once you either have selected the No More option indicating that you are finished printing criteria scores or the Continue option indicating that you want to skip the printing of scores, a message will appear on the screen asking you if the results you obtained were satisfactory. If you select the yes option, you will then go to the first frame in the task assignment process Selection of Objective, MS-20. If you select no, you will go to Criteria Selection (MS-2), where you can start your analysis over again.

Abort Option

- o None

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Table 3-3. Example Printout of Criteria Scores

	MEDIA CATEGORIES				
	<u>1</u>	<u>10</u>	<u>19</u>	<u>20</u>	<u>21</u>
Perform Preflight Insp.	60	80	70	70	70
Perform VFR Take-off	30	30	80	75	70
Complete Post-flight Report	80	60	70	70	70

Table 3-4. Media Categories.

<u>CAT</u> <u>#</u>	<u>GROUP</u> <u>#</u>	<u>MEDIA CATEGORY</u>
1	1.1	PRINT INSTRUCTIONS W/O FEEDBACK
2	1.2	PRINT INSTRUCTIONS WITH ORAL FEEDBACK
3	1.3	PRINT INSTRUCTION - WITH WRITTEN FEEDBACK
4	1.4	PRINT - REFERENCE MATERIAL
5	1.5	IMAGE PROJECTION - STILL
6	2.1	PASSIVE AUDIO
7	2.2	ACTIVE AUDIO
8	3.1	AUDIOVISUAL - STILL WITH FEEDBACK
9	3.2	AUDIOVISUAL - STILL WITHOUT FEEDBACK
10	3.3	AUDIOVISUAL - MOTION WITH FEEDBACK
11	3.4	AUDIOVISUAL - MOTION WITHOUT FEEDBACK
12	4.1	STATIC DISPLAY WITHOUT FEEDBACK
13	4.2	DYNAMIC DISPLAY WITHOUT FEEDBACK
14	4.3	PHYSIOLOGICAL TRAINER - INTERNAL
15	4.4	PHYSIOLOGICAL TRAINER - AUDIO
16	4.5	PHYSIOLOGICAL TRAINER - VISUAL
17	4.6	SYMBOLIC SIMULATION WITH FEEDBACK
18	4.7	TRAINER
19	4.8	SIMULATOR
20	4.9	OPERATIONAL EQUIPMENT
21	4.10	OPERATIONAL EQUIPMENT WITH FEEDBACK
22	5.1	VISUAL COMPUTER - STILL WITH FEEDBACK
23	5.2	VISUAL COMPUTER - STILL WITHOUT FEEDBACK
24	5.3	VISUAL COMPUTER - MOTION WITH FEEDBACK
25	5.4	VISUAL COMPUTER - MOTION WITHOUT FEEDBACK
26	5.5	AUDIOVISUAL COMPUTER - STILL WITH FEEDBACK
27	5.6	AUDIOVISUAL COMPUTER - STILL WITHOUT FEEDBACK
28	5.7	AUDIOVISUAL COMPUTER - MOTION WITH FEEDBACK
29	5.8	AUDIOVISUAL COMPUTER - MOTION WITHOUT FEEDBACK
30	6.1	INSTRUCTOR

Follow-on Frames

- o If you hit yes, indicating that your results are satisfactory you will go to Selection of Objective (MS-20).

- o If you hit no, indicating that your results are not satisfactory, the program will ask you if you want to abort to SDT Applications Program Select (SDT-5) or select different criteria. If you choose different criteria, you will go to Criteria Selection (MS-2). If you select this option, all of your work from the current session will be destroyed.

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3.20 SELECTION OF OBJECTIVE (MS-20)

This frame will allow you to select the objective which will guide the task assignment process. There are four possible objectives: (1) minimize cost, (2) maximize efficiency, (3) maximize effectiveness, and (4) maximize "utility." Table 3-5 provides guidance for selecting objectives. This table describes the types of assignments that will result from each combination of an objective and a constraint. (Constraints will be selected in the next frame.) To select an objective, examine the column labeled "assignment strategy," pick the type of assignment that meets your needs, and select the objective that matches that assignment strategy. Make sure that the objective you selected is congruent with the analysis criteria you selected. Some objectives will not be possible with certain criteria. The assignment strategies which are the most informative and easiest to interpret are stated in Table 3-5.

To select an objective move the cursor to the desired objective and hit Return.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o Selection of Constraint (MS-21).

Please select objective.

- ABORT

Minimize Cost

Maximize Efficiency

Maximize Effectiveness

Maximize Utility

Figure 3-22. Selection of Objective (MS-20).

Table 3-5. Possible Assignment Strategies.

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Efficiency	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Effectiveness	Cost
maximize efficiency	No constraint	Each task is assigned the medium with the greatest efficiency for that task.	X	X	X	X	X	X	X
	effectiveness	An assignment of all tasks to media is generated such that total efficiency is maximized and total effectiveness is greater than or equal to user-specified level of effectiveness.		X		X		X	
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."					X	X	
	cost	An assignment of all tasks to media is generated such that total efficiency is maximized and total cost is less than or equal to a user-specified level of cost.			X	X		X	
maximize effectiveness	no constraint	Each task is assigned the medium with the greatest effectiveness for that task.		X		X		X	
	efficiency	An assignment of all tasks to media is generated such that total effectiveness is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.		X		X		X	
	"utility"	An assignment of all tasks to media is generated such that total effectiveness is maximized and total "utility" is greater than or equal to a user-specified level of "utility."						X	
	cost	An assignment of all tasks to media is generated such that total effectiveness is maximized and total cost is less than or equal to a user-specified level of cost.			X	X		X	
maximize "utility"	no constraint	Each task is assigned the medium with the greatest "utility" for that task.					X	X	
	efficiency	An assignment of all tasks to media is generated such that total "utility" is maximized and total efficiency is greater than or equal to a user-specified level of efficiency.					X	X	
	effectiveness	An assignment of all tasks to media is generated such that total "utility" is maximized and total effectiveness is greater than or equal to a user-specified level of efficiency.						X	
	cost	An assignment of all tasks to media is generated such that total "utility" is maximized and total cost is less than or equal to a user-specified level of efficiency.					X	X	

Table 3-5. Possible Assignment Strategies. (continued)

OBJECTIVE	CONSTRAINT	ASSIGNMENT STRATEGY	Effectiveness	Efficiency and Cost	Effectiveness and Cost	"Utility" with Efficiency	"Utility" with Cost	Effectiveness	Cost
minimize cost	no constraint	Each task is assigned the medium with the least relative cost.		X		X	X		X
	efficiency	An assignment of all tasks to media is generated such that total cost is minimized and total efficiency is greater than or equal to a user-specified level of efficiency.		X		X			
	effectiveness	An assignment of all tasks to media is generated such that total cost is minimized and total effectiveness is greater than or equal to a user-specified level of effectiveness.			X			X	
	"utility"	An assignment of all tasks to media is generated such that total cost is minimized and total "utility" is greater than or equal to a user-specified level of "utility."					X		

*most easily interpreted strategies

3.21 SELECTION OF CONSTRAINT (MS-21)

This frame allows you to select a constraint to guide the task assignment process. To select a constraint, review the assignment strategies listed in Table 3-5, and select a constraint which is appropriate for the assignment strategy you selected during the selection of an objective in the previous frame. After you select a constraint, the program will automatically print two columns listing the scores on the objective and the constraint variables. This information will be used in the next frame to select a constraint level. (See Constraint Level, MS-21.) If you do not select a constraint, that is you select the No Constraint option, the program will automatically print the task-media assignments and you will go to Select Rerun Option (MS-23).

An example of this frame is provided in Figure 3-23. To select a constraint, move the cursor to the desired item and hit Return.

Abort Options

- o SDT Applications Program Select (SDT-5)

Follow-on Frames

- o If you select the No Constraint option you will go to Select Rerun Option (MS-23).
- o If you select a constraint, you will go to Constraint Level (MS-22).

Please select constraint

- ABORT

Restart Selection

Minimize Cost

Maximize Effectiveness

No Constraint

Figure 3-23. Constraint Selection (MS-21).

3.22 CONSTRAINT LEVEL (MS-22)

During this frame, you will be required to enter the minimum possible total score on the constraint variable that you are willing to accept (or maximum possible if you have selected minimize cost as you constraint). To select the appropriate level, you must examine the printout of scores on the objective and constraint values that was printed after your selected a constraint in the previous frame (Selection of Constraint MS-21). An example of one of these printouts is presented in Table 3-6. The printout will list the best objective value obtainable for each of a range of constraint levels. Associated with each of the constraint levels listed is an assignment set. An assignment set is a specific assignment of each task to exactly one media category. The score of the objective variable for the assignment set is determined by aggregating the scores of the individual tasks on that variable. Similarly, the score of the constraint variable for the assignment set is determined by aggregating the scores on the individual tasks for the constraint variable. The constraint levels for the assignment sets will be listed in ascending order with the assignment sets with the lowest constraint levels listed first.

To select a constraint level, you must first determine how low of a score in the constraint variable, you are willing to tolerate. (If you have selected to minimize cost as your constraint you must determine how high of a score you are willing to tolerate.) Table 3-7 provides guidelines to assist you in making this decision. If you are willing to accept a low score, select a score that is about 25% of the way between the minimum and maximum of the constraint scores

Please enter constraint level:

Numbers must be between 10 and 500

- - -

- - -



THEN PRESS RETURN

(MAKE NO ENTRY TO ABORT)

Figure 3-24. Constraint Level (MS-22).

Table 3-6. Example of Printout of
Constraint and Objective Variable Scores

OBJECTIVE: MAXIMIZE EFFICIENCY
CONSTRAINT: MINIMIZE COST

<u>CONSTRAINT LEVEL</u>	<u>OBJECTIVE VALUE</u>
50	500
60	500
70	550
80	550
90	550
100	670
110	670
120	670
130	700
140	700
150	700

Table 3-7. Guidelines for Selecting Constraint Levels.

LEVEL OF SCORE WILLING TO ACCEPT	SELECT LEVEL AT
LOW (HIGH)	25% (75%) between minimum and maximum
MODERATE	50% (50%) between minimum and maximum
HIGH (LOW)	75% (25%) between minimum and maximum

() = values to be used when using minimize cost as a constraint.

(the minimum and maximum will be listed at the top of the frame.) If you are willing to accept a moderate score on the constraint variable select a score that is about half way between these two scores. If you are willing to accept a high score, select a score that is 75% of the way between the minimum and maximum. If you have selected Minimize Cost as constraint this logic would be reversed (see Table 3-7).

When you are selecting a specific constraint level, you should examine the printout to select a constraint score which is associated with a significant jump in the score for the objective value which is close to your targeted level 25%, 50%, 75%.

To enter the constraint level, simply type it the number you have selected in the spaces provided. You must input an integer which is between the minimum and maximum constraint level.

Abort Options

- o Select Rerun Option (MS-23)

Follow-On Frames

- o Select Rerun Option (MS-23)

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3.23 SELECT RETURN OPTION (MS-23)

After you have selected the constraint level, the task-media assignment will automatically be printed. When this printing is complete, the Select Return Option (MS-23) will appear on the screen. (See Figure 3-25.) This frame will allow you the option of (1) exiting to the SDT where you can terminate your session in the computer or use the SDT data base management system, (2) selecting different criteria, or (3) selecting different objectives.

To select an option, move the cursor to the desired item and hit Return. An example of the Task-Media Assignment listing is provided in Table 3-8.

Abort Options

By selecting the Abort option, you can exit to the SDT Applications Program Select (SDT-5). If you select this option all of your work from the current session of the Media Selection Program will be destroyed.

Follow-On Frames

- o If you select the option for choosing different criteria you will go to Criteria Selection (MS-2). If you select this option all of your work from the current session of the Media Selection Program will be destroyed.

- o If you select the option for choosing a different objective you will go to Selection of Objectives (MS-20).

Select rerun option:

- Abort
- Select different criteria
- Select different objectives

Figure 3-25. Select Rerun Option (MS-23).

Table 3-8. Example of Task-Media Assignment Listing

Assign PERFORM PRE-FLIGHT INSP. to AV-Mot. w/Fd (10)

Assign PERFORM VFR TAKE-OFF to Operational Equipment (20)

Assign COMPLETE POST-FLIGHT REPORT to Print w/o Fd (1)

SECTION 4 - EXAMPLE APPLICATION

This section presents an example application of the Media Selection Program. The application is designed to provide first-time users with hands-on experience in using the program. The example will allow you to assign a set of example tasks to media in manner that will maximize training efficiency.

On the pages which follow each specific action which you must take to run through the example is described. More specifically, the frames which you will encounter during the example application are listed in sequence and the specific actions which you must take during these frames are described.

The first frame you will encounter during the example is the Introductory Frame (MS-1) to the Media Selection Program. To get to this frame you must load the SDT software, enter the Applications mode of the SDT and select the Media Selection Program. Procedures for performing these actions are described in Section 2.4.

4.1 ACTION 1: INTRODUCTION FRAME (MS-1)

After you select the Media Selection Program option in the SDT applications mode, this frame will appear on the screen. Move the cursor (or highlighted area) to the Continue with Program option and hit the Return key. (The cursor is moved by hitting the up or down arrow keys.)

WELCOME TO MEDIA SELECTION PROGRAM

- Return to SDT
- Continue

Figure 4-1. Introductory Frame (MS-1).

4.2 ACTION 2: CRITERIA SELECTION (MS-2)

This frame will allow you to select the criteria that will be used in the analysis. Move the cursor to the Efficiency option and hit Return.

4.3 ACTION 3: TASK SELECTION (MS-3)

This frame will allow you to select the tasks used in the analysis. Move the cursor to the All tasks option and hit Return. Then move the cursor to No More and hit Return.

4.4 ACTION 4: SELECTION OF PSYCHOLOGICAL VARIABLES MS-4)

This frame will allow you to select one of the three categories of psychological variables (stimuli, responses, and feedbacks). In subsequent frames, you will select specific variables within each of these three categories. (Efficiency is determined by calculating the match between tasks and media on these psychological variables).

Move the cursor to Stimuli and hit Return.

4.5 ACTION 5: STIMULUS VARIABLE SELECTION (MS-5)

This frame will allow you to select the specific stimulus variables to be included in the analyses. Move the cursor to All Attributes and hit Return. Then move the cursor to No More and hit Return.

Select criteria for analysis.

- ABORT

Efficiency

Effectiveness

Efficiency and Cost

Effectiveness and Cost

"Utility" With Efficiency

"Utility" With Effectiveness

Cost

Figure 4-2. Criteria Selection (MS-2).

Select tasks for analysis.

- ABORT

- All tasks

PERFORM PREFLIGHT INSPECTION OF XXX FIGHTER AIRCRAFT

TAXI XXX FIGHTER AIRCRAFT

PERFORM A SHOREBASED VFR TAKE OFF

PERFORM A SHOREBASED VFR LANDING

OPERATE XXX HEADS-UP DISPLAY

EXECUTE FORMATION MANEUVERS

COMPLETE POST-FLIGHT REPORT

Figure 4-3. Task Selection (MS-3).

Select Psychological Variables

- ABORT
- No More
- STIMULI
- RESPONSES
- FEEDBACK

Figure 4-4. Selection of Psychological Variables (MS-4).

Psychological variable: Stimuli.

Select Attributes:

- ABORT
- All Attributes
 - MEDIUM
 - VISUAL FORM
 - VISUAL MOVEMENT
 - VISUAL SPECTRUM
 - VISUAL SCALE
 - VISUAL CONTRAST
 - AUDIO SOURCES
 - AUDIO STIMULI INTENSITY
 - STIMULI PRESENTATION
 - STIMULI PRESENTATION RATE
 - NUMBER OF CHANNELS
 - STIMULI DISTRIBUTION

Figure 4-5. Stimulus Variable Selection (MS-5).

After you hit Return, a message will appear on the screen asking you if you would like to view the psychological variable data. Move the cursor to the No option and hit Return. The program will check for missing data. As it does so the name of each task in the example will appear at the top of the screen. (There is no data missing in this example.)

4.6 ACTION 6: SELECTION OF PSYCHOLOGICAL VARIABLES (MS-4)

You will return to the frame asking you to select another category of psychological variables. Move the cursor to Responses and hit Return.

4.7 ACTION 7: SELECTION OF RESPONSE VARIABLES (MS-6)

This frame will allow you to select response variables. Move the cursor to the All Attributes option and hit Return. Then move the cursor to No More and hit Return. A message will then appear in the screen asking you if you would like to view the response variable data. Move the cursor to No and hit Return. The program will check for missing data. As it does so the name of each task in the example will appear at the top of the screen. (There is no data missing in this example.)

4.8 ACTION 8: SELECTION OF PSYCHOLOGICAL VARIABLES (MS-6)

You will return to the frame asking you to select a category of psychological variables. Move the cursor to Feedback and hit Return.

Select Psychological Variables

ABORT

No More

Stimuli

Responses

Feedback

Figure 4-6. Selection of Psychological Variables (MS-4).

Psychological variable: Responses.

Select attributes

- ABORT

- All Attributes

RESPONSE MODE

INTENSITY OF RESPONSE

RESPONSE IMPLEMENTATION

REQUIRED RESPONSE RATE

RESPONSE CHANNELS

RESPONSE DISTRIBUTION

Figure 4-7. Response Variable Selection (MS-6).

Select Psychological Variables

- ABORT
- No More
- Stimuli
- Responses
- Feedback

Figure 4-8. Selection of Psychological Variables (MS-4).

4.9 ACTION 9: SELECTION OF FEEDBACK VARIABLES (MS-7)

This frame will allow you to select Feedback variables. Move the cursor to the All Attributes option and hit Return. Then move the cursor to No More and hit Return. A message will then appear on the screen asking you if you would like to view the feedback variable data. Move the cursor to No and hit Return. (There is no data missing in this example.)

4.10 ACTION 10: DATA REVIEW - 1 (MS-8)

This frame is designed to allow you to deal with any missing data identified during the previous frame. The frame will give you the option of selecting a new set of tasks or exiting to enter data into the SDT.

Since you have no data missing, move the cursor to Continue and hit Return.

4.11 ACTION 11: MEDIA CATEGORY SELECTION (MS-13)

This frame allows you to select the media categories to be used in the analysis. Move the cursor to Select all media categories and hit Return. Then move the cursor to No More and hit Return.

4.12 ACTION 12: COMPUTATION OF EFFICIENCY SCORES (MS-14)

During this frame, a message will appear on the screen, indicating that the program is calculating efficiency. You do not have to do anything during this frame. When the scores have been computed, you will go to the next frame.

Psychological Variable: Feedback.

Select Attributes

- ABORT

- ALL ATTRIBUTES

FEEDBACK MEDIUM

FEEDBACK SOURCE

FEEDBACK TYPE

FEEDBACK DISTRIBUTION •

Figure 4-9. Feedback Variable Selection (MS-7).

You have just reviewed psychological variables. Please select the appropriate option.

-ABORT

-Continue

-Different tasks

-Exit to enter missing data into SDT.

Figure 4-10. Data Review-1 (MS-9).

Please select built-in media categories for analysis:

- ABORT
- All Media Categories
 - Prnt Ins w/o Fd
 - Prnt In w/oral Fd
 - Prnt In w/oral Fd
 - Prnt In w/writ Fd
 - Prnt - Ref Material
 - Image Proj - Still
 - Passive Audio
 - Active Audio
 - AV - Still w/Fd
 - AV - Still w/o Fd
 - AV - Motion w/o Fd
 - AV - Mot w/o Fd
 - Stat Disp w/o Fd
 - Dyn Displ w/o Fd
 - Phys Train - inter
 - Phys Train - audio
 - Phys Train - visual
- more -

Figure 4-11. Media Category Selection (M-13).

Computing. . . please wait

Figure 4-12. Computation of Efficiency/Effectiveness (MS-14).

4.13 ACTION 13: SELECTION OPTION FOR VIEWING EFFICIENCY/
EFFECTIVENESS/"UTILITY" SCORES (MS-15)

This frame provides you with the option of viewing efficiency scores.

Move the cursor to No and hit Return.

4.14 ACTION 14: PRINT CRITERIA SCORES (MS-19)

This frame will allow you to print out the efficiency scores. Move the cursor to the Efficiency option and hit Return. The efficiency score for each media - task combination will then be printed on your printer.

4.15 ACTION 15: PRINT CRITERIA SCORES (MS-19)

Move the cursor to No More and hit Return. A message will then appear on the screen asking you if the results are satisfactory. Move the cursor to yes and hit Return.

At this point, the program will automatically print out the task-media assignments which maximize efficiency. In so doing it will assign each task to the media which produces the highest efficiency score.

After the results being printed the Rerun Option (MS-23) frame will appear on the screen giving you the option of selecting a different set of criteria and starting your analysis over again.

Would you like to view bar graphs for efficiency scores?

-Yes

-No

Figure 4-13. Option for Viewing Efficiency/
Effectiveness Scores (MS-15).

Select criteria to be printed.

-Continue

-Efficiency

Figure 4-14. Print Criteria (MS-19).

Select rerun option:

-ABORT-

-Select different criteria

-Select different objectives

Figure 4-15. Select Rerun Option (MS-23).

SECTION 5 - EVALUATING AND USING RESULTS

An overview of the process for evaluating and using the results of the Media Selection Program is presented in Figure 5-1. There are four steps in this process. In the first step, sensitivity analyses are conducted. In the second step, specific types of media within each media category are identified for each task - media category assignment. In the third step, the media assignments are reviewed with respect to a set of practical factors which may restrict media assignments. In the fourth step, the final set of media assignments are documented in the SDT.

More details on each of these four steps are provided in the sections which follow.

5.1 STEP 1 CONDUCT SENSITIVITY ANALYSES

As the first step in analyzing your results, you may want to see how robust your analyses are to changes in key analyses alternatives and parameters. The more consistent your result are over a range of reasonable alternatives and parameter values, the more likely it is that your results are correct. One of the advantages of the automated Media Selection Program is that it allows you to quickly determine the impact of these sensitivity analyses. Table 5-1 displays the different alternatives that may be explored in a sensitivity analysis. The three most likely alternatives you will want to explore are: (1) alternative criteria, (2) alternative objectives, and (3) alternative constraints.

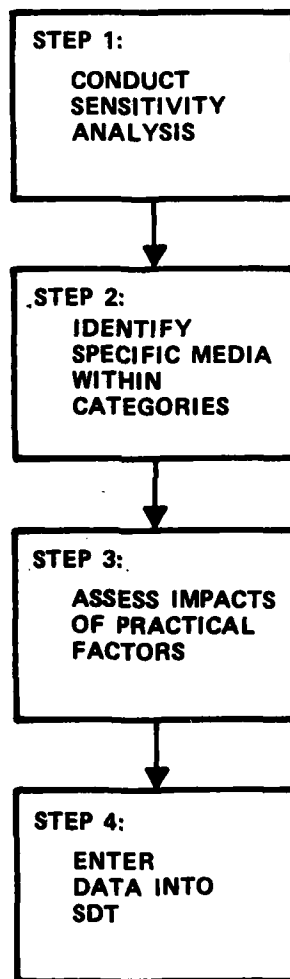


Figure 5-1 Guidelines for Evaluating and Using Results

Table 5-1. Alternatives for Sensitivity Analyses

- CRITERIA
- PSYCHOLOGICAL VARIABLES
- MEDIA CATEGORIES
- CRITICALITY VARIABLES
- OBJECTIVES
- CONSTRAINTS
- CRITICALITY WEIGHTS
- UTILITY WEIGHTS

In planning new analyses, make sure to use the Media Selection Program planning worksheet listed in Table 2-3 to document your analyses.

5.2 STEP 2: IDENTIFY SPECIFIC MEDIA WITHIN CATEGORIES

The Media Selection Program will identify the generic category of media which should be used to train a task. To develop more detailed media requirements, specific media within each of these categories must be identified. Table 5-2 displays some examples of specific media.

Media may be divided into two general groups (1) Course-Related Media - those that are developed specifically for a particular course and (2) Course-Independent Media those that are supplied by the local school and used in wide range of courses. Table 5-3 displays a worksheet which can be used to describe the specific media that is used in number of different courses. Relevant media categories within each of these two groupings are identified in Table 5-2. To identify specific media for Course-Independent Media, you must examine the specific media that is likely to be available within each media category at the school where the course will be taught. To select specific media for Course-Related Media, you must identify the most comparable existing task that was taught via the same media category and identify the specific media that was used to train that task. (Procedures for identifying comparable tasks are described in the ETES User Guide.) Specific media identified for the Simulation-Three Dimensional Media Category should be reviewed with PM TRADE since this organization is likely to have the most up-to-date listing of media in this category.

Table 5.2. Examples of Specific Media Categories. (continued)

CAT. #	GROUP	GROUP #	MEDIA CATEGORY	EXAMPLES
(1)		1.1	Print Instruction - w/o Feedback	Case study with Folders, Handouts, Textbooks
(2)	Visual only	1.2	Print Instruction - with Oral Feedback	Flash Cards
(3)		1.3	Print Instruction - with Written Feedback	Workbooks, Programmed Text
(4)		1.4	Print - Reference Material	Performance Aids, Reference Books
(5)		1.5	Image Projection - Still	Overhead Projector, Slide Projector, Microform, Filmstrip
(6)	Audio only	2.1	Passive Audio	Audio Tape, Microform with Audio, Audio Disc, Radio
(7)		2.2	Active Audio	Language Lab, Radio with Transponders, Telephone
(8)	Audiovisual	3.1	Audiovisual - Still with Feedback	Teaching Machine - Still
(9)	Two-dimensional	3.2	Audiovisual - Still w/o Feedback	Sound-slide, Filmstrip-Audio, Dial Access
(10)		3.3	Audiovisual - Motion with Feedback	Televideo, Teaching Machine - Motion
(11)		3.4	Audiovisual - Motion w/o Feedback	Motion Picture, T.V. Cartridge, T.V. - Cable, T.V. - Closed Circuit, T.V. - Non-magnetic Video Disc
(12)	Simulation	4.1	Static Display w/o Feedback	Mock-ups and Panels - Static
(13)	Three-dimensional	4.2	Dynamic Display w/o Feedback	Demonstrator, Mock-up and Panels - Dynamic
(14)		4.3	Physiological Trainer - Internal	--
(15)		4.4	Physiological Trainer - Audio	--
(16)		4.5	Physiological Trainer - Visual	--
(17)		4.6	Symbolic Simulation with Feedback	Games, Computer Simulation, Logic Trainers

Table 5.2. Examples of Specific Media Categories.

CAT. #	GROUP	GROUP #	MEDIA CATEGORY	EXAMPLES
(18)		4.7	Trainer	---
(19)		4.8	Simulator	---
(20)		4.9	Operational Equipment	---
(21)		4.10	Operational Equipment with Feedback	---
(22)	Computer	5.1	Visual Computer - Still with Feedback	---
(23)		5.2	Visual Computer - Still w/o Feedback	---
(24)		5.3	Visual Computer - Motion with Feedback	---
(25)		5.4	Visual Computer - Motion w/o Feedback	---
(26)		5.5	Audiovisual Computer - Still with Feedback	---
(27)		5.6	Audiovisual Computer - Still w/o Feedback	---
(28)		5.7	Audiovisual Computer - Motion with Feedback	---
(29)		5.8	Audiovisual Computer - Motion w/o Feedback	---
(30)	Instructor	6.1	Instructor	---

*Taken from Jorgensen, Kabala, Davis, and Atlas (1981)

Table 5-3. Worksheet for Documenting Media Assignments (MAS).

MEDIA ASSIGNMENTS

COURSE MODULE

TASKS (a) MEDIA CATEGORY (b) SPECIFIC MEDIA (c) COMPARABLE TASK/MEDIA (d)

5.3 STEP 3: ASSESS IMPACTS OF PRACTICAL FACTORS

Before making the final assignment of tasks to media, you should review these potential assignments against practical factors which may limit or in some cases prohibit making the task-media assignments produced by the Media Selection Program. More specifically, each task-media assignment must be reviewed in terms of the practical factors listed in Table 5-3. After reviewing the impacts of these factors, the final assignments of tasks to media can be made.

5.4 ENTER DATA INTO SDT

Once the final task-media assignments have been made, these assignments must be entered into the SDT data base management system. To do this you must enter the Input mode of the SDT, select the entity Media and enter the titles for all of the specific media you have identified in your analysis. While still in the Input Mode you must then select the entity Course, select the subentity Module and the attribute media, and enter the information required to link course modules to media. The worksheet listed in Table 5-4 can be used to help in entering media selections into the SDT.

Table 5-4. Practical Factors to Consider in Making
Media Assignments

1. Marginal Technical Solutions - The learning guidelines and algorithm cannot be easily carried out with the system.
2. State-of-the-Art - The system is under development at best and may not be available for practical application by the time it is required.
3. Size of the System - Some approaches are useful within large training programs. Others are suited only for small programs and therefore, may not be suited to the size program being considered.
4. Interface with Existing Program - Many new courses must be designed to fit into existing programs, which place constraints on the new courses; e.g., equipment on hand, available classrooms, scheduling practices.
5. Time to Produce System - Approaches which require long lead times for development may not be useful when scheduled ready-for-training dates do not allow a long development cycle.
6. Budget Cycle Constraints - While the application of some of the powerful training approaches, such as CAI (Computer Assisted Instruction), may result in low costs per student graduate, the initial investment is substantial. Unless these resources appear in existing budgets, the applications of these techniques to an immediate problem may not be feasible.
7. Adoption of Innovations - Instructors frequently resist innovations. If the proposed technique is significantly different from existing techniques, either adequate resources must be focused upon gaining acceptance for the innovation, or a more traditional approach must be selected.
8. Courseware Development - If the courseware is to be locally developed, skilled personnel, equipment, time, and dollars must be made available.
9. High Cost Alternatives - The projected life cycle cost of a media approach may be significantly higher than other equally useful alternatives. Reject high cost alternatives when others are available.
10. Learning Style of Trainees - If the trainee has a low reading ability or would be limited in his ability to use certain kinds of systems then reject these systems as inappropriate.
11. Other Constraints - A variety of other practical factors should be considered; e.g., command policy and existing investment in production facilities.

* Training Device Requirements and Document Guide.

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APPENDIX A - TECHNICAL DESCRIPTION OF MEDIA
SELECTION PROGRAM ALGORITHMS

A.1 COMPUTING THE SCORES

In order to produce an optimal assignment of media to tasks, some measures of the appropriateness of possible assignments must be used as criteria. The four basic measures used by the Media Selection Program are training efficiency, training effectiveness, relative cost, and "utility."

A.1.1 Training Efficiency

Training efficiency provides a measure of the match between the characteristics of a training medium and the characteristics of a task to be trained, based on the percentage of the psychological variables involved in the task which are provided by the training medium. This approach, taken from the TEEM model (Jorgenseon, Kubula, and Atlas, 1981), is detailed below. Given T tasks, M media, and P psychological variables, we make the following definitions:

$$\tau_{t,p} \equiv \begin{cases} 1 & \text{if task } t \text{ involves psychological variable } p \\ 0 & \text{otherwise} \end{cases}$$

$$\mu_{m,p} \equiv \begin{cases} 1 & \text{if medium } m \text{ involves psychological variable } p \\ 0 & \text{otherwise} \end{cases}$$

The $[\tau]$ matrix is an input from the SDT; the $[\mu]$ matrix is hard-coded in the program. From these matrices, the efficiency of each possible task-medium combination ($e_{t,m}$) is computed as follows:

- 1) A preliminary score ($ps_{t,m}$) is computed as

$$ps_{t,m} \equiv \sum_{p=1}^P \tau_{t,p} * \mu_{m,p}$$

This is equal to the number of psychological variables that task t and medium m have in common.

- 2) An ideal score (i_t) is computed for each task as

$$i_t \equiv \sum_{p=1}^P \tau_{t,p}$$

This is the number of psychological variables involved in task t , which is equal to the best score possible for any medium with task t .

- 3) Finally, the efficiency is computed as

$$e_{t,m} \equiv \left\langle \frac{ps_{t,m}}{i_t} * 100 \right\rangle$$

where " $\langle \rangle$ " denotes the greatest integer function (the computed number is rounded down to the nearest integer). Thus training efficiency is an integer between 0 and 100 (inclusive) which measures the appropriateness of a given training medium for training a given task. Training

efficiency is computed for each possible task-medium combination.

A.1.2 TRAINING EFFECTIVENESS

Training effectiveness ($\tilde{e}_{t,m}$), a weighted measure of training efficiency based on the criticality of the task, is computed as the product of efficiency and task criticality (k_t). Task criticality is a composite of eight component criticality variables: frequency, percent performing, percent time performing, task delay tolerance, consequences of inadequate performance, task learning difficulty, time from entry to performance, and probability of deficient performance. The overall criticality of a task, k_t is an integer between 1 and 7 (inclusive) where 1 represents minimum criticality and 7 represents maximum criticality (see A.1.2.1 for a detailed explanation of how the k_t are computed). Effectiveness is computed for each task-medium combination as

$$\tilde{e}_{t,m} \equiv \frac{e_{t,m} * k_t}{7}$$

Thus training effectiveness is an integer between 0 and 100 (inclusive).

A.1.2.1 Task Criticality

Overall task criticality is a composite of eight component criticality variables from the SDT (see Table B-2). Six of the eight components (frequency, percent time performing, consequences of inadequate performance, task learning difficulty, time from entry to performance, and probability of deficient performance) are scaled from 1 to 7, with a score of 7 representing maximum criticality.

One of the components, task delay tolerance, is scaled from 7 to 1, with a score of 1 representing maximum criticality. To convert this score from a 7-to-1 scale to a 1-to-7 scale, the converted score (c) is computed from the unconverted score (u) as follows:

$$c \equiv 8 - u.$$

Another of the component criticality variables, percent performing, is scaled from 0 to 100, with a score of 100 representing maximum criticality. To convert this score from a 0-to-100 scale to a 1-to-7 scale, the converted score (c) is computed from the unconverted score (u) as follows:

$$c \equiv \left\langle \frac{(u * 7) + 99}{100} \right\rangle$$

Once the component criticality scores are on the same scale, a composite criticality may be computed for each task as a weighted average of the eight components. Eight criticality variable weights (w_i) are entered by the user; each weight is between 0 and 100 (inclusive), and the sum of the eight

weights must be 100. Then the criticality of task t (k_t) is computed as

$$k_t \equiv \left\langle \frac{\sum_{i=1}^8 (\kappa_{i,t} * w_i)}{100} \right\rangle$$

where $\kappa_{i,t}$ is the criticality score of task t on the i^{th} component of criticality, and w_i is the user-specified weight for the i^{th} criticality component.

A.1.3 Relative Cost

Each of the media in the Media Selection Program is assigned a relative cost (c_m). The c_m are between 0 and 100 (inclusive) where 100 represents maximum cost. Clearly, these costs are not in actual dollars; but they are based on the dollar costs of the media.

A.1.4 "Utility"

In considering possible task-medium assignments, it is useful to combine efficiency or effectiveness with cost into one measure of the overall goodness (or "utility") of task-medium combinations. The user specifies weights (w_c and w_e) which reflect the relative importance of cost and efficiency/effectiveness; the weights must be between 0 and 100 (inclusive) and must sum to 100. Then "utility" is computed for each task-medium combination as follows:

$$u_{t,m} \equiv \frac{[w_c * (100 - c_m)] + [w_e * e_{t,m}]}{100}, \text{ or}$$

$$\tilde{u}_{t,m} \equiv \frac{[w_c * (100 - c_m)] + [w_e * \tilde{e}_{t,m}]}{100},$$

depending on whether "utility" ($u_{t,m}$) is to be based on efficiency ($e_{t,m}$) or "utility" ($\tilde{u}_{t,m}$) is to be based on effectiveness ($\tilde{e}_{t,m}$).

A.2 OPTIMIZATION

Two forms of optimization are available to the user of the Media Selection Program: unconstrained and constrained.

A.2.1 Unconstrained optimization

An unconstrained optimization will occur whenever the user selects an objective and "no constraint." For example, if the user selects "maximize efficiency" as his objective, and "no constraint," the program will return the unconstrained maximum efficiency assignment. Mathematically this problem is formulated and solved as follows.

Given T tasks and M media, and an efficiency $e_{t,m}$ for each task-medium combination, each task will have assigned to it

the medium with the greatest efficiency for that task according to the following rule:

Assign medium m to task t only if:

$$e_{t,m} > e_{t,i} \text{ for all } i \in \{1,2,\dots,M\}.$$

The rules for the other optimizations are similar to that for efficiency: To maximize effectiveness, assign medium m to task t only if

$$\tilde{e}_{t,m} > \tilde{e}_{t,i} \text{ for all } i \in \{1,2,\dots,M\}.$$

To maximize "utility" assign medium m to task t only if

$$u_{t,m} > u_{t,i} \text{ for all } i \in \{1,2,\dots,M\}.$$

To minimize relative cost, assign medium m to all tasks only if

$$c_m < c_i \text{ for all } i \in \{1,2,\dots,M\}. *$$

* Note that relative cost is task-independent.

A.2.2 Constrained Optimization

A constrained optimization will occur whenever the user selects both an objective and a constraint. The optimization is performed using a dynamic programming algorithm which specifies the optimal assignment of exactly one medium to each task for each of a discretized set of levels of the constraint. Detailed discussions of the formulation, the dynamic programming algorithm, and the output follow.

A.2.2.1 The Formulation

Assume for example that the user selects "maximize efficiency" as the objective, and "cost" as the constraint. The mathematical formulation for this option is as follows:

$$\max \sum_{t=1}^T e_{t, m_t}$$

$$\text{st } \sum_{t=1}^T c_{m_t} < c_0$$

where m_t is the medium assigned to task t . A solution must give the value of the objective function (later defined as $f_T(c_0)$) and a list of the optimal assignment $d_t = m_i$ ($i \in \{1, 2, \dots, M\}$) for each task $t = 1, 2, \dots, T$.

A.2.2.2 The Dynamic Programming Solution Approach

For T tasks and M media, there are efficiencies $(e_{t,m})$ for each task-medium combination, and costs (c_m) for each medium. The optimization must assign exactly one of the M media to each of the T tasks. For task 1 and a level of cost, z , define the set $D_1(z)$ as

$$D_1(z) \equiv \{m | c_m \leq z\}.$$

Then $D_1(z)$ is the set of media with costs not greater than z , or the set of feasible media for task 1, cost z . Define $f_1(z)$ as

$$f_1(z) \equiv \text{maximum } \{e_{1,m} | m \in D_1(z)\}.$$

Then $f_1(z)$ is the greatest attainable efficiency for an assignment of task 1 to a medium with cost not greater than z .

Next, define the set $D_2(z)$ as

$$D_2(z) \equiv \{m | D_1(z - c_m) \neq \emptyset\}.$$

where \emptyset indicates the null set.

Then $D_2(z)$ is the set of feasible media for task 2, cost z . Note that D_2 is dependent only on z , D_1 , and the c_m . Next, define $f_2(z)$ as

$$f_2(z) \equiv \text{maximum } \{e_{2,m} + f_1(z - c_m) \mid m \in D_2(z)\}.$$

Then $f_2(z)$ is the greatest attainable efficiency for an assignment of tasks 1 and 2 to media with a total cost not greater than z .

Then, in general, $D_t(z)$ is defined as

$$D_t(z) \equiv \{m \mid D_{t-1}(z - c_m) \neq \emptyset\}.$$

and $f_t(z)$ is defined as

$$f_t(z) \equiv \text{maximum } \{e_{m,t} + f_{t-1}(z - c_m) \mid m \in D_t(z)\}.$$

Again, note that D_t is dependent only on z , D_{t-1} , and the c_m .

This function, f , is a dynamic programming recursion in canonical form. In particular, $f_T(c_0)$ gives the maximum attainable efficiency for an assignment of all T tasks to training media with the total cost of the assignment not greater than c_0 . The optimal assignment of media to tasks

is then obtained by back-substitution ("unwinding") in the above equation (see A.2.2.3).

The above example gives the formulation for efficiency as an objective, and cost as a constraint. In general, given T tasks, M media, a matrix of objective values for each task-medium pair ($o_{t,m}$), and a matrix of constraint values ($s_{t,m}$) for each task-medium pair, the dynamic programming recursion may be formulated as follows:

$$\text{Let } D_1(z) \equiv \begin{cases} \{m | s_{1,m} < z\} & \text{if the constraint is cost,} \\ \{m | s_{1,m} > z\} & \text{otherwise,} \end{cases}$$

and for $t \in \{2, 3, \dots, T\}$, define $D_t(z)$ as

$$D_t(z) \equiv \{m | D_{t-1}(z - s_{t,m}) \neq \emptyset\}.$$

Then $f_1(z)$ is defined as

$$f_1(z) \equiv \text{optimum } \{o_{1,m} | m \in D_1(z)\},$$

and for $t \in \{2, 3, \dots, T\}$, $f_t(z)$ is

$$f_t(z) \equiv \text{optimum } \{o_{t,m} + f_{t-1}(z - s_{m,t}) \mid m \in D_t(z)\},$$

where "optimum" means maximum or minimum depending on the objective selected, minimum for cost and maximum otherwise.

A.2.2.2. The Algorithm

As stated earlier, the Media Selection Program determines the optimal assignment for a discretized set of 50 levels of the constraint within the range of feasible constraints. This is accomplished by execution of the following steps:

Step 1: Determine the minimum constraint level (s_{\min}) for which an assignment of any task to any medium is possible as

$$s_{\min} \equiv \min \{s_{t,m} \mid t \in \{1, 2, \dots, T\}, m \in \{1, 2, \dots, M\}\}.$$

Step 2: Determine the maximum possible constraint level (s_{\max}) as

$$s_{\max} \equiv \sum_{t=1}^T (\max \{s_{t,m} \mid m \in \{1, 2, \dots, M\}\}).$$

Step 3: Compute a step size σ as

$$\sigma \equiv \frac{s_{\max} - s_{\min}}{50}$$

Step 4: For $z \in \{s_{\min}, s_{\min} + \sigma, s_{\min} + 2\sigma, \dots, s_{\min} + 50\sigma\}$, make a table of triples $(z, f_1(z), a_1(z))$ where $a_1(z) = m$ only if $f_1(z) = o_{1,m}$. Then $a_1(z)$ is the optimal medium for task 1 with a constraint level of z .

Step 5: Perform the following for $t=2,3,\dots,T$:

For $z \in \{s_{\min}, s_{\min} + \sigma, s_{\min} + 2\sigma, \dots, s_{\min} + 50\sigma\}$, make a table of triples $(z, f_t(z), a_t(z))$. Where $a_t(z) = m$ only if $f_t(z) = o_{t,m}$.

When step 5 is complete, the table for $t=T$ contains a triple for each of 50 levels of the constraint. Each triple gives a constraint level (z), the optimum objective value attainable under the constraint ($f_t(z)$), and the optimal assignment for task T under the constraint ($a_t(z)$).

A.2.2.3 The Output

Once the optimization has been performed, the Media Selection Program prints out a part of the table generated in step 5 above for $T=t$. Table A-1 is an example of the printout. The printout shows the user how much objective value he can "get," given the associated constraint level, i.e. $f_t(z)$ vs. z . Associated with each constraint level is an assignment of all tasks to media. When the program queries the user for the constraint level for which he would like to see the assignment, the user may enter a number between s_{\min} and s_{\max} . The program then "unwinds" the tables to produce the optimal assignment for the user-specified constraint level as follows:

Table A-1. Example of Printout of
Constraint and Objective Variable Scores

OBJECTIVE: MAXIMIZE EFFICIENCY

CONSTRAINT: MINIMIZE COST

<u>CONSTRAINT LEVEL</u>	<u>OBJECTIVE VALUE</u>
50	500
60	500
70	550
80	550
90	550
100	670
110	670
120	670
130	700
140	700
150	700

Let c_0 be the constraint level entered by the user. Then task T is assigned to media $a_t(c_0)$. Define r_T to be the remaining amount of constraint after task T is assigned, or

$$r_T \equiv c_0 - s_{T, a_T}(c_0)$$

Then task T-1 is assigned to media $a_{T-1}(r_T)$. And

$$r_{T-1} \equiv r_T - s_{T-1, a_{T-1}}(r_T)$$

is the remaining amount of constraint after tasks T and T-1 have been assigned. Similarly, r_t for $t \in \{1, 2, \dots, T-1\}$ is defined as

$$r_t \equiv r_{t+1} - s_{t, a_t}(r_{t+1})$$

Then, in general, the medium to be assigned to each of the tasks $t \in \{T-1, T-2, \dots, 1\}$ is $a_t(r_{t+1}) = d_t$. These are the assignments that are printed out in Table A-2.

A.3 TECHNICAL NOTES

A.3.1 The "Utility" Function

The function used to combine cost and efficiency/effectiveness (see A.1.3) cannot legitimately be called a

Table A-2. Example of Task-Media Assignment Listing

Assign PERFORM PRE-FLIGHT INSP. to AV-Mot. w/Fd (10)

Assign PERFORM VFR TAKE-OFF to Operational Equipment (20)

Assign COMPLETE POST-FLIGHT REPORT to Print w/o Fd (1)

utility function in the vonNeumann-Morgenstern sense; no method is provided to elicit from the user the data necessary to construct a function which satisfies the axioms of utility theory. Rather, the user is provided with the most straight-forward preference curve: the straight line of expected value.

A.3.2 Accuracy of the Dynamic Programming Solution

In order to keep main memory requirements within Apple III limits, all possible constraint levels are not considered. Instead, the feasible region is represented by 50 equally-spaced constraint levels (see A.2.2.2). This means that a worst case error of up to σ_*T may be introduced into the constraint levels reported for the possible assignments (see Table A-1), the average error will be much smaller. However, this is not a severe problem, as the exact constraint level is recomputed and printed for any "unwound" assignment (see A.2.2.3).

A.3.3 Integers vs. Real Numbers n the Apple III

An Apple Pascal library unit is available to process real numbers, but it requires a great deal of main memory to run. Since the memory requirements of the Media Selection Program are quite large, the Apple library unit for real numbers cannot be used and all computations are done using integer arithmetic. Therefore all values computed using a division are subject to a relatively small truncation error.

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APPENDIX B

This appendix provides definitions for the psychological and criticality variables used in the Media Selection Program. In addition, it lists the relative cost values for each media category used in the program.

Table B-1 provides definitions for the psychological variables. Those definitions are taken directly from Jorgensen, Kubulas, and Athus (1981). Most of these definitions were derived from the TRADOC Task Analysis Handbook. Table B-2 provides definitions for the criticality variables. Table B-3 lists the relative cost values for each media category used in the program.

Table B-1. Psychological Variables *

STIMULUS VARIABLES

Medium of Stimuli Presentation

1. Visual Cues - Signals received through the sense of sight.
2. Audio Cues - Signals received through the sense of hearing.
3. Tactile Cues - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.
4. External Stimulus Motion Cues - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.
5. Internal Stimulus Motion Cues - The sensations felt by a person when he moves his arm, leg, fingers, etc.
6. Olfactile Cues - Signals received through the sense of smell.
7. Gustatile Cues - Signals received through the sense of taste.

Visual Form

8. Visual Alphanumeric - Words and/or numbers presented visually.
9. Visual Symbolic - Symbols presented graphically.
10. Visual Graphic - Two-dimensional figures, such as maps, graphs, mathematical curves, etc., presented visually.
11. Visual Pictorial - Two-dimensional images, such as photographs, drawings, etc., presented visually.
12. Visual Solid Object - A three-dimensional image or reality that is viewed from exterior perspectives.
13. Visual Environment - A three-dimensional image or reality that is viewed from inside.

Visual Movement

14. Visual Still - A static visual field, as with a still photograph, drawing or printed page.
15. Visual Limited Movement - A basically static visual field with elements that can be made to move, as with an animated transparency or simple panel with switches that move.

Table B-1. (continued)

16. Visual Full Movement - A visual field in which all elements can move, as with a motion picture, flight simulator, or operational aircraft.

17. Visual Cyclic Movement - A visual field which moves through a fixed sequence and then repeats the sequence in a repetitive manner, as with a film loop.

Visual Spectrum

18. Black and White - A visual field composed of either black or white elements, as with the printed page or line drawings.

19. Gray Scale - A visual field composed of black, white and continuous gradations of gray, as with a black and white photograph or television picture.

20. Color - A visual field composed of various segments of the visual spectrum, as with color television or motion pictures.

Visual Scale

21. Exact Scale - Actual visual field or a one-to-one replication of that field as with a full-sized mock-up, simulator, or operational system.

22. Proportional Scale - A representation of reality in other than full scale, such as a scaled model map or photograph.

Visual Contrast

23. Dim - A visual object which blends in with its background, i.e., there is a small or no luminance difference between an object and its background.

24. Bright - A visual object which is brighter than its background, i.e., there is a large luminance difference between an object and its background.

Audio Sources

25. Tonal Sound - A very limited source of sound or noise which is used, rather than speech, for signaling or warning, e.g., horns, whistles, sirens, bells, buzzers, etc.

26. Voice Sound - A limited source of sound which enables spoken words to be used as the medium of communications, but not suited to more demanding tasks, such as music or sound recognition exercises.

27. Full Sound - A source of sound that contains all the significant elements of the sound and is suited to the demanding task of sound recognition exercises.

Table B-1. (continued)

28. Ambient Sound - A complex sound environment with sounds emanating from various sources and from various directions, including background noise and task significant sounds.

Audio Stimuli Intensity

29. Weak - Audio stimuli presented to the trainee which have weak intensity.

30. Strong - Audio stimuli presented to the trainee which have strong intensity.

Stimuli Presentation

31. Static - A unitary stimuli situation, i.e., stimuli are presented to the trainee "all at once", e.g., batch presentations.

32. Dynamic-Ordered - A sequential stimuli situation, i.e., stimuli are presented to the trainee sequentially or in an ordered manner over time.

33. Dynamic-Random - A non-sequential stimuli situation, i.e., stimuli are presented to the trainee randomly over time.

Stimuli Presentation Rate

34. Slow Rate - A slow rate or speed of presentation of stimuli to the trainee, allowing the trainee a long or maximum stimulus analysis time.

35. Fast Rate - A fast rate or speed of presentation of stimuli to the trainee, allowing the trainee a short or minimum stimulus analysis time.

Number of Channels or Sources

36. Limited - A small number of sources, channels, or instruments through which stimuli are presented to the trainee.

37. Unlimited - A multiple number of sources, channels, or instruments through which stimuli are presented to the trainee.

Stimuli Distribution

38. Individual - All information is presented directly to one individual trainee.

39. Group - Information is presented to a group of trainees, allowing only indirect access to the information for an individual.

Table B-1. (continued)

RESPONSE VARIABLES

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.
2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.
3. Overt Response - Manipulative Acts - A response which the trainee expresses in an observable (manipulative) manner, such as the small movements of dials, switches, keys, or small adjustments to instruments or the large movements of levers, wheels or use of hand held tools.
4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continuously controlling a constantly changing system, e.g., steering an automobile.
5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

Intensity of Response

6. Weak - Responses made by the trainee with weak intensity.
7. Strong - Responses made by the trainee with strong intensity.

Response Implementation

8. Static - A unitary response situation, i.e., responses are made by the trainee "all at once".
9. Dynamic-Ordered - A sequential response situation, i.e., responses are made by the trainee sequentially or in an ordered manner over time.
10. Dynamic-Random - A non-sequential response situation, i.e., responses are made by the trainee randomly over time.

Table B-1. (continued)

Required Response Rate

11. Slow Rate - A slow rate or speed of trainee response, i.e., a rate which allows the trainee a long or maximum response time.
12. Fast Rate - A fast rate or speed of trainee response, i.e., a rate which allows the trainee a short or minimum response time.

Number of Response Channels

13. Limited - A limited number of sources, channels, or instruments through which required responses are made by the trainee.
14. Unlimited - An unlimited number of sources, channels, or instruments through which responses are made by the trainee.

Response Distribution

15. Individual - One individual trainee makes the required response.
16. Group - A group of trainees make the required response.

Table B-1. (continued)

FEEDBACK VARIABLES

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.
2. Aural - Feedback presented aurally by means of a display to the trainee.
3. Written Form - Feedback presented to the trainee in written form.
4. Face-to-Face Communication - Feedback presented by direct verbal means to the trainee.
5. Indirect Communication - Feedback presented by indirect verbal means, such as by intercom, telephone, or radio link.
6. Tactile - Feedback presented to the trainee through the sense of touch, including sensations related to texture, shape, size, or vibration of the skin.
7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.
8. Olfactile - Feedback presented to the trainee through the sense of smell.
9. Gustatile - Feedback presented to the trainee through the sense of taste.

Source of Feedback

10. Intrinsic F - Information or cues built into the system from which the trainee interprets feedback information.
11. Extrinsic F - Information or cues not inherent in the trainee action or system operations but is supplied by an external source.

Type of Feedback

12. Research Correctness (Rcr) - Information about the correctness or incorrectness of trainee's response, when several response alternatives are possible and the correct choice is not known to the trainee in advance. (Also known as augmented feedback.)
13. Response Correctness (Rcf) - Information provided to the trainee (or others who need to know about his performance) that he has in fact performed an operation, but does not say anything about the longer range consequences of the action taken.

Table B-1. (continued)

14. Response Consequences (Rcn) - Information about the consequences of the action taken. It confirms the response made by the trainee, and the correctness of a response can be inferred only from its consequences. May also serve to cue the trainee to perform the next response in sequence.
15. System Status (Rss) - Information about the condition of one's own or another system or the external environment, on the basis of which a trainee or team must act. Information is not necessarily (or even frequently) the immediate consequence of or follow-on to a specific trainee/team action; it may reflect system events that have been put in motion by much earlier trainee actions. Provides information that regulates trainee and system actions in the sense that when a particular status condition occurs, the trainee must often take action to maintain the integrity of his system.

Feedback Distribution

16. Individual - Feedback is presented to one individual trainee.
17. Group - Feedback is presented to a group of trainees, allowing only indirect access for an individual.

Table B-2. Criticality Variables¹

1. Frequency - The number of times the task is performed per week.
2. Percent Performing - The percentage of soldiers within an MOS who are performing the task.
3. Percent Time Performing - An estimate of percentage of the average workweek that soldiers in a given MOS spend in performing the task.
4. Task Delay Tolerance - A measure of how much delay can be tolerated between the time the need for task performance becomes evident and the time actual performance must begin. (TRADOC MPA 350-30)
5. Consequences of Inadequate Performance - The possible adverse effects, in terms of personal safety, mission success and/or damage to the system, which could result from inadequate performance of a task.
6. Task Learning Difficulty - An estimate of the time, effort, and assistance required by a student to achieve performance proficiency.
7. Time from Entry to Performance - Amount of time between job entry and task performance.
8. Probability of Deficient Performance - An estimate of the frequency that a task is performed poorly.

¹More details on obtaining values for these variables are listed in the ETES User's Guide.

Table B-3. Relative Cost Values.

<u>CAT #</u>	<u>GROUP #</u>	<u>MEDIA CATEGORY</u>	<u>RELATIVE COST</u>
1	1.1	PRINT INSTRUCTIONS W/O FEEDBACK	1
2	1.2	PRINT INSTRUCTIONS WITH ORAL FEEDBACK	1
3	1.3	PRINT INSTRUCTION - WITH WRITTEN FEEDBACK	1
4	1.4	PRINT - REFERENCE MATERIAL	5
5	1.5	IMAGE PROJECTION - STILL	1
6	2.1	PASSIVE AUDIO	1
7	2.2	ACTIVE AUDIO	4
8	3.1	AUDIOVISUAL - STILL WITH FEEDBACK	3
9	3.2	AUDIOVISUAL - STILL WITHOUT FEEDBACK	2
10	3.3	AUDIOVISUAL - MOTION WITH FEEDBACK	5
11	3.4	AUDIOVISUAL - MOTION WITHOUT FEEDBACK	4
12	4.1	STATIC DISPLAY WITHOUT FEEDBACK	1
13	4.2	DYNAMIC DISPLAY WITHOUT FEEDBACK	5
14	4.3	PHYSIOLOGICAL TRAINER - INTERNAL	50
15	4.4	PHYSIOLOGICAL TRAINER - AUDIO	37
16	4.5	PHYSIOLOGICAL TRAINER - VISUAL	37
17	4.6	SYMBOLIC SIMULATION WITH FEEDBACK	5
18	4.7	TRAINER	55
19	4.8	SIMULATOR	72
20	4.9	OPERATIONAL EQUIPMENT	82
21	4.10	OPERATIONAL EQUIPMENT WITH FEEDBACK	95
22	5.1	VISUAL COMPUTER - STILL WITH FEEDBACK	12
23	5.2	VISUAL COMPUTER - STILL WITHOUT FEEDBACK	8
24	5.3	VISUAL COMPUTER - MOTION WITH FEEDBACK	24
25	5.4	VISUAL COMPUTER - MOTION WITHOUT FEEDBACK	14
26	5.5	AUDIOVISUAL COMPUTER - STILL WITH FEEDBACK	22
27	5.6	AUDIOVISUAL COMPUTER - STILL WITHOUT FEEDBACK	18
28	5.7	AUDIOVISUAL COMPUTER - MOTION WITH FEEDBACK	34
29	5.8	AUDIOVISUAL COMPUTER - MOTION WITHOUT FEEDBACK	24
30	6.1	INSTRUCTOR	