ARI Research Note 91-04

AD-A229 811

Optimization of Simulation-Based Training Systems: User's Guide

Elizabeth L. Gilligan, B. Leon Elder,
and Paul J. Sticha

Human Resources Research Organization

for

Contracting Officer's Representative
Michael J. Singer

PM TRADE Field Unit at Orlando, Florida
Stephen L. Goldberg, Chief

Training Research Laboratory
Jack H. Hiller, Director

October 1990

United States Army
Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Research accomplished under contract
for the Department of the Army

Human Resources Research Organization

Technical review by

Jean L. Dyer
Donald R. Lampton

NOTICES

DISTRIBUTION: This report has been cleared for release to the Defense Technical Information Center (DTIC) to comply with regulatory requirements. It has been given no primary distribution other than to DTIC and will be available only through DTIC or the National Technical Information Service (NTIS).

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The views, opinions, and findings in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other authorized documents.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY -- 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE --	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) --	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARI Research Note 91-04
6a. NAME OF PERFORMING ORGANIZATION Human Resources Research Organization 6b. OFFICE SYMBOL (If applicable) --	7a. NAME OF MONITORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences
6c. ADDRESS (City, State, and ZIP Code) 1100 South Washington Street Alexandria, VA 22314-4490	7b. ADDRESS (City, State, and ZIP Code) U.S. Naval Training System Center 12350 Research Parkway Orlando, FL 32826-2376
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences 8b. OFFICE SYMBOL (If applicable) PERI-I	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-85-C-0169
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 63744A PROJECT NO. 795 TASK NO. 345 WORK UNIT ACCESSION NO. C1

11. TITLE (Include Security Classification)
Optimization of Simulation-Based Training Systems: User's Guide

12. PERSONAL AUTHOR(S)
Gilligan, Elizabeth L.; Elder, B. Leon; and Sticha, Paul J.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 85/01 TO 88/12	1990, October	129

16. SUPPLEMENTARY NOTATION
--

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Training system optimization; Fidelity; Training system model; Instructional features; Medium Selection; Training resource allocation

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This guide provides an overview of the Optimization of Simulation-Based Training Systems (OSBATS) model and prototype software as applied to an artificial but realistic problem related to Army Aviation training. OSBATS was developed to aid in the design and evaluation of training devices that meet training requirements at the minimum cost or maximum training effectiveness. The goals of this guide are (a) to illustrate the kinds of solutions to training-system design problems that OSBATS can provide, (b) to demonstrate the ways in which the model components interact to produce solutions, (c) to describe the operation of the prototype OSBATS software and rule bases, and (d) to illustrate how an OSBATS-like model could support the decisionmaking process. The guide describes the operation of the OSBATS software, concentrating on how the results of different calculations can be integrated to support the concept-formulation process and provides the information required to familiarize the user with the installation of the software, the software functions, and the operation of the rule bases.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Michael J. Singer	22b. TELEPHONE (Include Area Code) (407) 380-4387 22c. OFFICE SYMBOL PERI-IF

DD Form 1473, JUN 86 — Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

FOREWORD

In some cases, the cost of training devices and simulators has exceeded the cost of the operational equipment they service. The capabilities for simulating reality are increasing on an annual basis. To meet cost and training efficiency objectives, the military must determine how much simulation is sufficient for the stated learning objectives. Behavioral and analytical techniques that can quickly project or predict how much simulation and training is required are lacking. At the same time, information on the cost-effective use of training equipment in courses of instruction is sparse. The development of models, databases, and techniques addressing these problems is the first step toward providing integrated behavioral and engineering decisions in designing, fielding, and using advanced training technology. The potential effect on the Army is to reduce the cost of training equipment while increasing the equipment's instructional effectiveness.

In response to these concerns and problems, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM TRADE) have joined efforts (MOU of Technical Coordination, May 1983; MOU Establishing the ARI Orlando Field Unit, March 1985; Expanded MOU, July 1986). PM TRADE has maintained partnership in all aspects of the development of the models, databases, and analytical techniques for the project. The prototype software was delivered to ARI and PM TRADE in December 1988, and has been disseminated to interested parties at Fort Rucker, the Army Training Support Command, and the Systems Training Directorate at the Training and Doctrine Command. This document provides guidance on the operation of that prototype. The prototype has also been provided, at their request, to the Naval Training Systems Center Human Factors Research Group, the Air Force Aeronautical Systems Division, the Air Force Human Research Laboratory at Williams Air Force Base, and National Aeronautics and Space Administration Ames Research Center. The models and techniques developed in this effort are expected to provide the basis for useful aids supporting the integration of behavioral and engineerering data, knowledge, and expertise in training equipment design in the future.

OPTIMIZATION OF SIMULATION-BASED TRAINING SYSTEMS: USER'S GUIDE

CONTENTS

	Page
INTRODUCTION	1
Summary of OSBATS Modeling Tools.	2
Description of the Example Problem.	4
Analysis Overview	7
HARDWARE REQUIREMENTS AND SOFTWARE INSTALLATION.	9
Hardware Requirements	9
Software Installation	9
GENERAL FEATURES OF THE SOFTWARE	15
Software Conventions.	15
General Procedures.	17
SIMULATION CONFIGURATION	25
Starting the Simulation Configuration Module.	25
Display Results	25
INSTRUCTIONAL FEATURE SELECTION MODULE	41
Prerequisites for This Module	42
Starting the Instructional Features Module.	43
Editing the Task Set.	43
Editing the Instructional Feature Set	45
Calculation and Display of Results.	46
Saving Changes and Exiting the Module	61
FIDELITY OPTIMIZATION MODULE	63
Prerequisites for This Module	63
Starting the Fidelity Optimization Module	66
Including Instructional Features.	66
Editing the Task Set.	67
Constraining Fidelity Dimensions.	67
Display Results	69
Saving Changes and Exiting the Module	85

Page

TRAINING-DEVICE SELECTION MODULE 87

Prerequisites for This Section. 88
Starting the Training-Device Selection Module 88
Editing the Task Set. 89
Training-Device Selection 90
Display Results 92
Saving Changes and Exiting the Module 107

RESOURCE ALLOCATION MODULE 109

Prerequisites for This Section. 109
Starting the Resource Allocation Module 109
Selecting the Problem 111
Optimizing Allocation and Viewing Overall Results . . . 112
Editing Constraints 113
Obtaining Revised Results 115

SUMMARY OF EXAMPLE PROBLEM 123

REFERENCES 125

APPENDIX A. HOW TO USE THE RULE BASES A-1

LIST OF TABLES

Table 1. Tasks selected for example problem 6

2. Current OSBATS instructional features. 41

3. Dimensions and levels considered by the fidelity optimization module 64

4. Training devices evaluated by the training-device selection module. 87

LIST OF FIGURES

Figure 1. OSBATS introductory screen. 17

2. The instructional feature rulebase screen. 18

3. Fidelity rulebase screen. 19

			Page
Figure	4.	Task cluster library.	20
	5.	Task cluster library.	21
	6.	Module selection menu	22
	7.	Task selection screen	23
	8.	Simulation configuration module main menu . .	25
	9.	Graphical summary screen.	26
	10.	Tabular summary screen.	29
	11.	The full mission screen	31
	12.	Individual task data screen	32
	13.	Graphical summary screen.	34
	13a.	Adjusted task complexity weighting on the graphical summary screen.	35
	14.	The sensitivity analysis screen	36
	15.	The tabular summary screen after weight adjustments	37
	16.	Simulation configuration save results screen.	39
	17.	Updated task cluster library screen	42
	18.	Instructional feature menu screen	43
	19.	Task inclusion/exclusion screen	44
	20.	Instructional feature selection screen. . . .	46
	21.	Instructional feature selection summary display screen.	47
	22.	Instructional feature selection summary display screen with task weights excluded.	49

		Page
Figure 23.	Instructional features selection summary display screen with feature weights excluded.	50
24.	Task to instructional feature assignment screen.	51
25.	Task to instructional feature assignment summary screen.	52
26.	Instructional features by task trained screen.	53
27.	Instructional features by task trained summary screen.	54
28.	Instructional feature benefit-to-cost bar graph screen.	55
29.	Instructional feature cumulative B/C graph screen.	56
30.	Initial included instructional feature window.	58
31.	Adjusted instructional feature selection window, after second selection.	58
32.	Adjusted instructional feature selection window, after third package	59
33.	Adjusted instructional feature selection window, after the fourth package.	60
34.	Adjusted instructional feature selection window, after the fifth package	61
35.	Fidelity optimization menu screen	66
36.	Instructional feature package selection screen.	66
37.	Fidelity dimension constraint screen.	68
38.	Dimension level description window-- seat motion	68

		Page
Figure 39.	Fidelity optimization results graphical display screen.	69
40.	Fidelity optimization matrix display--benefit/cost screen	70
41.	Fidelity optimization matrix display--description screen.	71
42.	Fidelity optimization matrix display--cost screen	72
43.	Fidelity optimization matrix display--benefit screen.	73
44.	Fidelity optimization matrix display--percent of cost screen.	75
45.	Fidelity optimization matrix display--percent of benefit screen	76
46.	Fidelity optimization results graphical display screen--7 million dollar package. . .	77
47.	Fidelity optimization package display screen--5.4 million dollar package.	78
48.	Fidelity optimization package display screen--7.8 million dollar package.	79
49.	Dimension level description window--visual resolution	80
50.	Fidelity optimization package display screen--7 million dollar cost constraint. . .	81
51.	Fidelity optimization package display screen--3 million dollar cost constraint. . .	82
52.	Fidelity optimization user defined package display screen.	83
53.	Fidelity optimization user defined package--7 million dollar package	84
54.	Training device selection menu screen	89

Page

Figure 55. Initial training device selection screen. 90

56. Adjusted training device selection screen. 91

57. Training device selection overall results display screen. 92

58. Training device selection screen with "seven-mill" included 93

59. Training device selection overall results display screen with "seven-mill" device added. 94

60. Training device selection screen with "three-mill" included 95

61. Training device selection overall results display screen with "three-mill" device added. 96

62. Training device selection, devices and training times by task screen 97

63. Training device selection screen with "weapon system trainer" included. 99

64. Training device selection overall results display screen with "weapon system trainer" device added. 100

65. Training device selection overall results display after reiteration 101

66. Training device selection graphical comparison screen 103

67. Training device selection individual task data screen 104

68. Training device selection individual task graph screen. 105

69. Training device selection device data display screen. 106

Page

Figure 70. Resource allocation selection module menu screen 110

71. Resource allocation problem selection menu screen 111

72. Resource allocation overall results display screen. 112

73. Resource allocation overall device and individual task constraints screen. 113

74. Resource allocation overall device and individual task constraints after adjustment. 114

75. Resource allocation optimize allocation window. 115

76. Resource allocation overall results display screen after constraints. 116

77. Resource allocation graphical comparison screen 117

78. Resource allocation devices and training times by task screen 118

79. Resource allocation individual task data screen 119

80. Resource allocation individual task graph screen. 120

OPTIMIZATION OF SIMULATION-BASED TRAINING SYSTEMS: USER'S GUIDE

Introduction

This guide describes an example session using the prototype software package that implements the model for the Optimization of Simulation-Based Training Systems (OSBATS). The OSBATS model (Sticha, Blacksten, Buede, Singer, Gilligan, Mumaw, and Morrison, 1990) describes an integrated decision-making process for the design of training systems. The OSBATS model evaluates different training strategies (that is, part-task training strategy, full-mission simulator, or actual equipment training), alternative training-device designs that differ in their fidelity and instructional features, and specific allocations of training time to training devices. The OSBATS software consists of five tools that should aid the training-system designer in the design process.

The goal of this guide is twofold: (a) to illustrate the kinds of solutions to training-system design problems provided by the OSBATS model and the ways that the model components interact to produce these solutions, and (b) to describe the operation of the OSBATS software and illustrate how the software modules can support the tradeoff process. To this effect, this guide presents the OSBATS model and software in the context of an application to an artificial but realistic problem related to Army Aviation training. The example used should provide further contextual information to help the reader understand the operation and use of the system. The guide does not describe calculations used by the system. Rather, it concentrates on how the results of different calculations can be integrated to provide overall support to the concept-formulation process. The results presented in this guide were actually calculated by the OSBATS software. The reader may use the instructions contained in this guide to reproduce the results described here using the data that are supplied with the OSBATS software. Documentation on calculations used by this software is presented by Sticha et al. (1990).

The guide describes the majority of OSBATS functions. In producing this guide, we have tried to be as comprehensive as possible while focusing on a single problem. However, the guide is not a complete reference manual for the OSBATS software. It was written to illustrate both process and procedures to individuals who may be examining or evaluating the software. The information presented in this guide should be viewed as a complement to information that would normally appear in a reference manual.

This introduction continues with a description of the OSBATS software that briefly presents the five modules. Then the sample problem that will be used as the basis of the guide is described. The sample problem is based on an existing training system, the AH-1 Airman Qualification Course (AQC). That section briefly describes the requirements that are considered in the problem, and how data were obtained. The section continues with an overview of the sample analysis. The example problem provides a minimal analysis that illustrates the use of all modules.

Following the introduction, the user is guided through the operation of each of the modules. Finally, a summary of the overall results of the example analysis and a description of their implications to this hypothetical problem is presented.

Summary of OSBATS Modeling Tools

The OSBATS model is designed to be a flexible set of tools that can be tailored to the needs of the problem and the preferences and requirements of the user. The concept for the design of OSBATS software is based in an analytical approach to the concept-formulation problem. This guide describes the five modeling tools implemented in the prototype software. The individual modules are described in the following subsections.

Simulation Configuration Module. The tool for simulation configuration examines task characteristics to determine both the need for and the cost-effectiveness of training on general classes of simulators as compared to training on actual equipment. Three classes of training devices are generated by the tool: (a) a full-mission simulator (FMS), which simulates many or all of the subsystems of the actual equipment, (b) one or more part-mission simulators (PMS), which simulate selected equipment subsystems, and (c) actual equipment (AE).

The evaluation conducted by this module examines device-unique capabilities, such as training in unsafe situations, along with cost savings to establish the value of training with some sort of training device. In addition, the task cue and response requirements are used to estimate the development cost that would be required to achieve the necessary fidelity for a simulator that would train the task to criteria. Using those assessed costs and benefits, the model sorts the tasks into three clusters:

1. Those tasks that should be trained on actual equipment because the benefits of simulation do not justify the expense required to develop an effective training device.

2. Those tasks for which training in a simulated environment is cost-effective, and which have limited cue and response requirements so that they require only a PMS.

3. Those tasks for which training in a simulated environment is cost-effective, and which require an FMS, because they require a high-fidelity representation of the environment on several dimensions.

Instructional Feature Selection Module. In OSBATS instructional features are considered to be elements of training devices that can improve training efficiency on individual tasks. That is, instructional features reduce the time or cost required to achieve a given performance level on a training device. They do not affect the ultimate level of actual-equipment performance that can be reached by using a training device. The number of tasks aided by each instructional feature forms the basis of an index of benefit for the feature. The analysis proceeds by comparing the benefit to the cost of incorporating each instructional feature into the training device. The analysis then orders the features according to the ratio of benefit to cost. This order specifies the optimal selection of features as a function of the total budget for instructional features. The appropriate budget for instructional features, given a total training-device budget, is determined in the Fidelity Optimization Module.

Fidelity Optimization Module. This module addresses the problem of how much should be invested in the sophistication of a training device. The module allows the consideration of several dimensions of fidelity, comparing task cue and response requirements for the fidelity dimensions with the cost of meeting these requirements. The incremental benefit/cost ratios order the dimension levels for which increased fidelity is justified by increased training effectiveness. The output of this module is a set of possible training-device configurations applicable to the task set, each of which offers the greatest effectiveness for its cost.

Training-Device Selection Module. This tool applies a gross cost-effectiveness analysis to aid the selection of training devices that meet training requirements for all tasks at the minimum cost. The model considers (a) the fidelity of each training device compared to the cue and response requirements of the tasks to be trained, (b) the instructional features present in each training device, and (c) the level of training conducted on each training device. The model recommends the optimal assignment of training devices to tasks, including (1) the devices that should be used to train each task, (2) the level of training at which each device should be employed, (3) the life-cycle cost of training, and (4) the level of performance expected.

Resource Allocation Module. This module provides a detailed allocation of training resources to the training devices selected with the aid of the other tools. The objective of this module is to minimize the cost of meeting training requirements. The actual cost measure minimized is the pro rata per-student total training-system life-cycle cost incurred in training a student to criterion performance. The resources allocated refer to student training time at each stage of a course.

The Resource Allocation Module generalizes the Training-Device Selection Module in two ways: (a) It accounts for the discontinuities in the cost function that arise from the procurement of individual training devices, and (b) it allows the user to specify constraints on the total time a particular training device (or actual equipment) may be used, and on the minimum performance level at which a training device may be employed.

Description of the Example Problem

The operation of the OSBATS software is illustrated using an example based on the AH-1 AQC. The AH-1 AQC is a training course designed to qualify aviators to fly the AH-1 helicopter -- one of two attack helicopters presently in the Army's aircraft inventory. The AH-1 AQC is an Institutional training course, taught only at the U.S. Army Aviation Center, Fort Rucker, Alabama. During the 6.4 weeks normally required complete the course, students receive 33 hours of flight instruction in the aircraft, 3 hours of instruction in the AH-1 Flight and Weapons Simulator (AH1FWS), and academic instruction on aircraft systems, emergency procedures, and tactics. Although some Army aviators enter the AH-1 AQC immediately after completing Initial Entry Rotary Wing (IERW) training, it is more common for aviators to enter AQC training after completing one or more flying duty assignments in another aircraft. In either case, all aviators will have been trained and become qualified in two or more other aircraft prior to entering the AH-1 AQC.

Input Requirements. The procedures used to develop and collect the data on the AH-1 AQC were described in detail by Sticha, et. al. (1990). In general, the categories of data that were collected included the following classes of information:

- a comprehensive list of AH-1 AQC training tasks,
- estimates of AQC students' pre- and post-training skill level on each training task,
- ratings of the extent to which safety and training efficiency considerations would favor training in a simulated environment,
- estimates, by task and simulator component, of the flight simulator fidelity required to achieve effective training,
- estimates of the amount of time and number of practice iterations required to master each training task in the aircraft,
- ratings of the extent to which several specific information-processing activities are required to perform each task, and

- definition of a family of generic training devices and judgments about the AH-1 AQC tasks that can be trained in each device.

The data that are used in this analysis are shown in Appendix A of Optimization of Simulation-Based Training Systems: Model Description, Implementation and Evaluation (Sticha, et. al., 1990). The following paragraphs provide a brief discussion of the tasks and training devices that were used in the analysis.

<u>AH-1 training tasks</u>. A review of the task manuals resulted in a list of 188 individual tasks that AH-1 aviators must learn to perform. This list includes 125 tasks that are trained during the AH-1 AQC (Institutional training) and 63 tasks that are trained only after an AH-1 aviator has been assigned to an operational field unit (Continuation training). Thirty-eight tasks were selected from those trained in the AH-1 AQC to form the basis of the example problem (See Table 1). These tasks were chosen to satisfy the following conditions: (a) all tasks were actually trained in the AQC, rather than in continuation training, (b) tasks represented a variety of skills, such as normal flight, malfunction procedures, and attack mission tasks, (c) tasks appeared to have a variety of cue and response requirements, from low to high fidelity, and (d) tasks could not be trained to standard using academic training only. The tasks that were chosen are enumerated in Table 1. The table lists the number of the task in the Aircrew Training Manual (ATM), the task name, and an abbreviated name used to refer to the task later in the analysis.

SMEs on staff were also consulted to obtain the task data required by the OSBATS prototype. As mentioned above, a detailed breakout of the data used is provided in Sticha, et. al. (in publication). In brief, the task data includes: task learning points, task simulation evaluation factors, estimates of task training hours & costs (on actual equipment), task information processing characteristics, and task cue and response information (drawn from task activity descriptions and used by the fidelity rule base). The data for the prototype is not stored in a database, but is held in a series of ascii files in an OSBATS subdirectory.

<u>Family of training devices</u>. One of the primary functions of the OSBATS model is to aid in defining the most cost-effective set of training devices for a training system. To evaluate the models' utility for this purpose, it was necessary to define a family of potential training devices that covers a wide range of cost and training functions and to make a subjective assessment of the tasks that can be trained in each of the devices. Working in concert, the SMEs developed descriptions of five training devices that they judged to have potential value for training aviators attending the AH-1 AQC: a Cockpit Procedural Trainer, a

Table 1. Tasks Selected for Example Problem

Task Num.	Task Name Abbreviation	Task Name
1003	T/O_CHECKS	Start, Runup, Takeoff Checks
1004	HOVER_PWR_CK	Hover Power Checks
1005	HOVER_FLT	Hovering Flight
1006	NORMAL_T/O	Normal Takeoff
1007	S/MAX_P_T/O	Maximum Performance Takeoff
1008	DECEL_ACCEL	Deceleration/Acceleration
1009	TRFC_PTRN	Traffic Pattern Flight
1012	DOPPLER_NAV	Doppler Navigation
1013	PRE_LNDG_CK	Before Landing Checks
1014	VMC_APPROACH	VMC Approach
1015	SHLW_APPR	Shallow Approach/Landing
1016	CONFIND_OPN	Confined Area Operations
1018	TERR_FLT_T/O	Terrain Flight Takeoff
1019	TERRAIN_FLT	Terrain Flight
1021	NOE_DECEL	Nap-of-the-Earth Deceleration
1022	TRN_FLT_APP	Terrain Flight Approach
1024	HVR_AUTOROT	Hovering Autorotation
1026	SIM_ENG_FAIL	Simulated Engine Failure
1028	MAN_THROTTLE	Manual Throttle Operation
1029	NO_SCAS/SAS	SCAS Off Flight
1039	MSKG/UNMSKG	Masking and Unmasking
1042	MOVE_TECH	Techniques of Movement
1048	PIN/RDG_OPN	Pinnacle/Ridgeline Operation
1054	OP_RMS	Operate Rocket Mgmt. System
1055	WPNS_PROC	Weapons Cockpit Procedure
1056	OP_TURRET	Operate 197 Turret System
1057	OP_FFAR_ROC	Operate 2.75" FFAR Launcher
1058	OP_TOW_MSL	Operate TOW Missile System
1061	NOE_FIRING	Terrain Flight Firing Techs.
2000	STD_AUTOROT	Standard Autorotation
2003	S/A_TRQ_MAL	Simulated Antitorque Malfunc.
2004	L-A,H-S_AR	Lo Level Hi Speed Autorotation
3008	DROOP_CMP_FL	Droop Compensator Failure
3010	TAIL_ROT_FL	Tail Rotor Failure at a Hover
3011	MAST_BUMPING	Mast Bumping
3025	THROTTLE_FL	Emergency Shutdown--Throttle
3030	LNDG/TREES	Landing in Trees
3033	SCAS_FAILURE	SCAS Failure

Doppler Navigation Trainer, an Instrument (IMC) Flight Trainer, a Weapon Systems Trainer, and a Flight and Weapons Simulator. The Flight and Weapons Simulator is the only one of the five devices that has been developed for the AH-1 aircraft, although similar devices have been developed for other types of rotary wing aircraft. The assumed design of each training device was specified by developing tables that show:

- the type of cockpit displays,
- the type of engine instruments (if any),
- the type of cockpit controls,
- the type of motion systems (if any),
- the type of extra-cockpit visual systems (if any),
- the type of aerodynamic models (if any), and
- the type of noise simulated (if any).

Once the generic design characteristics of the family of training devices had been specified, the SMEs proceeded through the master task list (described above) and identified the tasks that they judged could be trained effectively in each device. That information was used to develop fidelity and instructional feature descriptions of the (mock and actual) training devices used for tradeoff analyses, and provide task data for the fidelity rules for OSBATS operations.

Analysis Overview

The concept of operation for the OSBATS Model is based on the iterative use of the five model tools to make recommendations regarding the definition of task clusters, the design of training devices for individual clusters, and the allocation of training resources among training devices. This iterative concept of use reflects the interactions inherent in the training-concept development, training-device design, and resource allocation components of the training-system design process. Both the subset of tools that are used and the order in which they are used may vary depending on the requirements of the problem and the preferences of the user.

For the purposes of this example, however, the guide provides a demonstration of the tools in the following order:

1. The Simulation Configuration Module defines clusters of tasks for actual equipment (AE), a full-mission simulator (FMS), and part-mission simulators (PMSs).

2. The Instructional Feature Module focuses on the FMS tasks defined by the Simulator Configuration Module and identifies

those instructional features that produce the greatest improvement in training efficiency given their development cost.

3. The Fidelity Optimization Module identifies the areas in which investment in additional fidelity would be cost efficient, for the FMS tasks. The module incorporates the results of the Instructional Feature Module to produce two candidate FMS designs at different development cost levels.

4. The Training-Device Selection Module evaluates training systems with each of the two candidate devices generated by the Fidelity Optimization Module. For each of these devices, the Training-Device Selection Module determines the minimum cost to meet the training requirements.

5. The Resource Allocation Module determines the minimum cost to meet training requirements using the best training device determined by the Training-Device Selection Module. The Resource Allocation Module takes into account hypothetical constraints on the number of training devices that may be obtained.

In the description of the OSBATS model, alternative approaches that could be taken to the application of the OSBATS model, opportunities for iteration of the model, and ways the model could be used to refine the solution that is obtained in the analysis are noted.

The following chapters describe each of the modules in turn, and illustrate the kind of data that are considered in each analysis, the procedures by which data are combined to produce a recommendation, and the particular recommendations that are made by each module. The procedures are described at a general level. The reader who wishes a more detailed understanding of the procedures should return to the formal model description (Sticha et al., 1990). The goal of this guide is to provide a hands-on demonstration of the model; thus, it concentrates on the types of recommendations produced by the model, how user judgment is incorporated into model results, and how the results may be used to develop and evaluate training-system designs.

The scheme for presentation of the OSBATS model uses three methods. First, the guide depicts a facsimile of the material presented on the screen. This provides verification that the user is at the appropriate place in the example. Next, a description of what is being viewed on the screen is presented in text. Also, additional information about what is being viewed helps the user understand what is being presented by the model. The third method is a series of "Action:" statements which detail the actions the user can make to progress through the model.

Hardware Requirements and Software Installation

Hardware Requirements

The OSBATS software runs on an IBM PC/AT, Zenith 248 or compatible with 640K of memory, and a 10 megabyte hard disk. In addition, the following features are required:

1. an enhanced graphics adapter (EGA) and monitor

2. a 80287 numeric coprocessor

3. A Microsoft compatible mouse, with mouse driver installed and activated. One of the following two situations should exist on your system (where "/1" represents the port):

   a. The file MSMOUSE.COM is in the root directory. The line "MSMOUSE /1" is in the autoexec.bat file.

   or

   b. The file MSMOUSE.SYS is in the root directory. The line "DEVICE=MSMOUSE.SYS /1" is in the autoexec.bat file.

4. the PRINT.COM file is installed in a directory specified on the path.

The OSBATS software is not compatible with the ansi.sys driver. Consequently, be sure that the ansi.sys driver is **not** on your system. If it is, you must remove it from the config.sys file and restart your system. To determine if the ansi.sys driver is on your system examine the file called CONFIG.SYS. If the file listing includes the line "DEVICE=ANSI.SYS" then you must use a text editor to remove this line from the file. Save the edited file and reboot the system.

The software includes the file EXSYS.EXE, which is the proprietary product of Exsys, Inc. This file is found on the RULES DISK in the OSBATS package. You may install this file on your hard disk, and use it freely to run the two OSBATS rule bases. However, you may not copy the file or distribute it to others. If you wish to distribute the EXSYS.EXE file, you must purchase an EXSYS runtime license from Exsys, Inc.

After verifying that your hardware system has the necessary components, proceed to the Software Installation Procedure.

Software Installation

This section describes how to install the current version of OSBATS. There are two parts to the installation procedure, the program installation and the data files installation. You will be asked in Step 4 whether you want to install the program software and the data files or just the data files. You should install the program software and the data files if you have not previously installed the current version of OSBATS on your system (Follow steps 1-19). After you have used the current version of OSBATS you may want to restore the original data files delivered with the software. In this case you would choose to install only data files (Follow steps 1-4 and Step 14).

OSBATS is delivered with two sets of data: one data set is for 125 AH-1 tasks and one data set is for the sample problem in the user guide. The latter set consists of 38 of the original 125 tasks. You will be asked in Step 14 which set of data you want to install. If you are not familiar with the OSBATS software you should install the data used in the sample problem and then work through the user guide. After you have developed a familiarity with the software you will want to install the data for all AH-1 tasks.

If you have OSBATS already installed on your system, the Install program will erase the old software files before installing the new files. Steps 6 - 11 guide the user through the erasing of the files. If you do not already have the software on your system you will skip steps 6 - 11.

1. Choose the hard disk drive in which you wish to install OSBATS. The program will create the required directories.

Note: During this installation procedure, the hard disk drive in which OSBATS is installed is referred to as Drive C. However, you may install OSBATS on any hard disk drive.

---

2. Locate the disk labeled Program Disk 1 and put it in Drive A. Type the following commands.

   A:
   INSTALL C

3. The Install program will display a message, "OSBATS software and data files will be installed on Drive C:." If the target drive is incorrect or missing, terminate the install program by holding down the "Ctrl" key and typing **C**. Type **Y** in response to the prompt. If the target drive is correct, then type any key to procede.

4. The Install program will display this message:

   "Please type one of the following letters:

P   if you want to install both OSBATS program files and data files.

D   if you want to install OSBATS data files only."

When you are initially installing the software you will want to install the program and the data files (P). After you have used the software you may want to restore the original data that came with the software. In this case you would install only data files (D).

Installation of the Program

---

5. If you chose to install both OSBATS program files and data files the Install program will display this message:

   "The Install program will now erase existing files on OSBATS directories.

   1) If you HAVE NOT previously installed OSBATS, no files will be erased.

   2) If you HAVE installed OSBATS, and want to SAVE existing task clusters, training device definitions, or program trace files, answer "NO" when the program prompts you with "Are you sure?"

   3) If you HAVE installed OSBATS, and want to ERASE existing output files, answer "YES" to all prompts.

   Strike a key when ready . . ."

   Strike any key to continue.

If you DO NOT have a previously installed version of OSBATS on your system, stop here and continue at step 12.

If you DO have a previous version of OSBATS installed on your system, many or all of the following six steps will be carried out, depending on which files exist on your system.

---

6. The following message will be displayed: "Erasing existing task cluster library . . . Are you sure? (Y/N)"

   If you wish to save any task clusters developed with the old version of OSBATS (besides the Default cluster), type **N**; otherwise, type **Y**. Press <ENTER>.

7. The following message will be displayed: "Erasing existing program and trace files . . . Are you sure? (Y/N)"

   If you wish to save a program trace or user comment, type **N**; otherwise, type **Y**. Press <ENTER>.

8. The following message will be displayed: "Erasing existing rule files . . . Are you sure? (Y/N)"

   Type **Y**. Press <ENTER>.

9. The following message will be displayed: "Erasing existing data and device files . . . Are you sure? (Y/N)"

   If you wish to save training device definitions, type **N**; otherwise, type **Y**. Press <ENTER>.

10. The following message will be displayed: "Erasing existing default task cluster mark files . . . Are you sure? (Y/N)"

    Type **Y**. Press <ENTER>.

11. The following message will be displayed: "Erasing existing help files . . . Are you sure? (Y/N)"

    Type **Y**. Press <ENTER>.

12. The next prompt will read, "Insert Program Disk 1 in Drive A: Strike a key when ready..." Program Disk 1 should already be in Drive A. Verify this and then press a key to continue.

13. When you receive the prompt to Insert Program Disk 2 in Drive A, do so and press any key to continue. Repeat this step for the Rules Disk.

Installation of Data Files

---

14. The Install program will display the following:

    "Please type one of the following letters to indicate which data base to install

    A   if you want to install data for all AH-1 tasks

    S   if you want to install the data for the sample problem in the user guide."

    You should first install the data for the sample problem (S) initially and familiarize yourself with the OSBATS software using this guide. When you are familiar the software you can reinstall the data files and include data for all AH-1 tasks (A). When you have made your selection the program will instruct you to insert the Data Disk in Drive A and strike a key.

15. You have now installed OSBATS on your computer. Place the original disks in a safe place. Type the command

    CD /OSBATS/CODE
    DIR

    and verify that the following files were copied correctly into this directory:

OSBATS.EXE	OSBATS.CFG	RA.EXE
DRIVER.EXE	G.EXE	DF.DCT
GO.BAT	FONT.TBL	

16. Continue to verify that the directories contain all the necessary files. Type

    CD \OSBATS\RULES
    DIR

    Verify that this directory contains the following files:

INSTFEAT.RUL	FIDELITY.CF1	INSTFEAT.OUT	INSTFEAT.DAT
INSTFEAT.TXT	EXSYS.EXE	INSTFEAT.CFG	FIDELITY.DAT
INSTFEAT.BLD	FID_RULE.BAT	EX1.HLP	
INSTFEAT.RUN	FID_RULE.TXT	EX2.HLP	
INSTFEAT.CF1	REPLY.COM	EX3.HLP	
FIDELITY.RUL	IF_RULE.BAT	EX4.HLP	
FIDELITY.TXT	IF_RULE.TXT	EX5.HLP	
FIDELITY.BLD	FIDELITY.OUT	EX6.HLP	
FIDELITY.RUN	FIDELITY.CFG	INST.TXT	

17. Type

    CD \OSBATS\DATA
    DIR

    Verify that this directory contains the following files:

TASKDATA.INP	DEV_NAME.INP	LONGIF.INP
TECH.INP	SIMDET.INP	LPOINTS.INP
DEVFID.INP	IF_NAME.INP	LONGDISC.INP
EQPHRS.INP	DIMDESC.INP	LONGDEV.INP
DEV_CST.INP	SENVARS.INP	DEV_IF.INP
FDIMENS.INP	DIMTEXT.INP	MINMAX.INP

    The file CUERSP.INP may also be present.

18. Type

CD \OSBATS\DEFAULT
DIR

Verify that this directory contains the following files:

TASKMARK.INP	DEVMARKS.INP	FIDMARKS.INP
BENMARKS.INP	IFMARKS.INP	

19. Type

CD \OSBATS\HELP
DIR

Verify that this directory contains the following files:

F_INCLUD.HLP	R_INDIV.HLP	T_TASKGR.HLP
R_BYTASK.HLP	S_INDIV.HLP	FMTRX1.HLP
I_FEATUR.HLP	T_BYTASK.HLP	T_SUMMRY.HLP
F_UDFP.HLP	FMTRX2.HLP	F_PACKAG.HLP
I_RESULT.HLP	S_ANALYS.HLP	R_TASKGR.HLP
T_DEVDAT.HLP	FMTRX3.HLP	I_GRPH1.HLP
R_SUMMRY.HLP	T_TASK.HLP	S_GRAPH.HLP
R_PROBLM.HLP	R_SUMGR.HLP	I_GRPH2.HLP
I_GRPH3.HLP	R_CONSTR.HLP	I_GRPH4.HLP
I_LISTS.HLP	T_DEVICE.HLP	F_CONSTR.HLP
F_GRAPH.HLP	S_TAB.HLP	T_SUMGR.HLP
T_INDIV.HLP	FMTRX4.HLP	FMTRX5.HLP
FMTRX6.HLP		

END OF INSTALLATION PROCEDURE

General Features of the Software

This section describes the general procedures used to operate the OSBATS software and display conventions. Conventions include screen layout, coloring conventions and system features. The general procedures described in this section are used to start the software, to select the task cluster that will be analyzed and to begin any of the five analysis modules.

Software Conventions

User interaction. Colors on the screen have meanings. An area with a yellow background color generally shows what part of the screen is "active". Placing the cursor within a yellow area and clicking the left button on the mouse causes the model to perform an action related to the information within the yellow area. Yellow labels and numbers show the current information in use by the model. Some labels toggle from yellow to black. When the label has a yellow background with black print, it is available for selection. When the label is black with yellow print it is not available. The color red usually denotes labels or numbers subject to deletion or temporary elimination from the model.

The mouse is used to move the cursor on the screen and the left button of the mouse is used to interact with the model. The cursor is represented on the screen by a small arrow. With one exception, the selection procedure is to place the arrow on the desired selection and click the mouse. The exception occurs in the Simulation Configuration module, on the Graphical Display screen. Here, the cursor is represented by a large arrow. Because of the graphics involved in this display, the selection procedure is to point to the desired selection with the arrow and click the mouse.

Words and numbers input by the user in response to screen prompts are entered through use of the keyboard. All keyboard entries are completed by pressing ENTER.

Screen format. A common format has been used to display results of all analyses. In this format the screen is divided into three sections. The top five lines have a blue background and contain model status information, such as the current task cluster, and the status of certain weights. The bottom seven lines also have a blue background but contain a menu of options available to the user. The middle section of the screen, comprising 31 lines, presents the table or graph describing the results.

User-comment feature. The User-comment feature is available for recording notes and comments as OSBATS is running. These comments are saved in files for review after you exit OSBATS. To use this feature, select "COMMENT" or "USER COMMENT" from the menu at the bottom of any data display or graph. A blank screen providing space for comments will appear. Use the keyboard to type comments. You can use the backspace key to correct errors. Press <ESC> to exit the screen and save your comments. Press <DEL> to exit the screen without saving your comments. Comments are numbered by the system in the order they are made.

When you exit OSBATS you will find a file called TRACE.OUT located in the OSBATS\CODE directory. This file is a record of the most recent OSBATS run. It contains a list of each OSBATS display that was viewed and the number of the comment or comments made while viewing that display. Comments are stored in separate files in the same directory under the filename CMMNT_.OUT, where the underscore (_) is replaced with the number of the comment.

Help feature. A help option is available for any data display or graph. You may select "HELP" from the menu at the bottom of the screen. The help screen will explain the information that is included in the display and list the options that are available from that display.

Print screen. Any data display or graph can be printed for later reference. Select the "PRINT" option from the menu at the bottom of the screen. The entire screen except for the menu at the bottom will be printed.

Save Screen/Toggle Screen feature. When a family of training devices is being investigated in the Training-Device Selection Module, it is convenient to save the training cost and training time information pertaining to the specific selection of devices. The information can then be compared to a different set of training devices used to train the same task cluster. This is accomplished by selecting "SAVE SCR" from the bottom of the Overall Result Display screen in the Training-Device Selection Module. You can exit the Display Results section and make changes to the set of training devices. When you return to the Overall Result Display you can use the "TOGGLE SCR" option to compare your previous results to your new results.

The same process applies to the Resource Allocation module. You may save training cost and training time information for a specific set of training devices using a certain set of constraints. If you want to change the constraints and compare the new results to the previous results, select "SAVE SCR" from the menu. You can exit the Optimize Allocation section of the Resource Allocation module and adjust the constraints. When you return to the Optimize Allocation section you can use the "TOGGLE SCR" option to compare the new results to the previous results.

The "SAVE SCR"/"TOGGLE SCR" feature is restricted to the Training-Device Selection and the Resource Allocation Modules.

Though it appears as an option on the menu at the bottom of most displays, it can only be used within the stated modules on the display called Overall Result Display. When this feature is available for selection the background color of the option will be yellow. Normally, the color of the "SAVE SCR" and "TOGGLE SCR" options is black, indicating that they are not active.

General Procedures

Getting started. If the OSBATS Model and the sample problem data base are resident in the computer, the computer system is operational (a computer prompt is available), and the drive that contains the OSBATS software is the current drive, you are ready to begin the sample problem. First perform the following action.

Action: To locate the OSBATS directory, type **CD \OSBATS\CODE** and press **ENTER**. To call up the program, type **GO** and press **ENTER**.

The Title screen will appear as shown in Figure 1.

O S B A T S

Optimization of Simulation-Based Training Systems
Version 1.1
October 31, 1988

Developed For

The U.S. Army Research Institute for the
Behavioral and Social Sciences

Project Manager for Training Devices
Contract #MDA903-85-C-0169

The Naval Training Center
Orlando, Florida

Developed by
Human Resources Research Organization (HumRRO)
PAR Government Systems Corporation
Anacapa Sciences

To Begin, Click Mouse

Figure 1. OSBATS Introductory Screen.

Action: Press the **Left Button** on the mouse.

If you are running this version of OSBATS for the first time, the rule bases will now automatically generate data for the system. The screen will flash "working" at the center of the screen. The following section, entitled Using the Rule Bases, will not apply in this case. However, you should read the section and then continue with the sample problem.

If you have previously run this version of OSBATS, a screen will appear presenting the options for recalculating the data. The screen for Instructional Features Rule Base options should appear as shown in Figure 2.

```
   The Instructional Features Appropriateness Data
has already been calculated.

Your Options:

 1  Recalculate Data Using Instructional Features Rule Base
 2  Run OSBATS Using Current Values
```

Figure 2. The Instructional Feature RuleBase Screen.

Using the rule bases. In order to obtain results with the OSBATS software that are identical to the results printed in the following sections of this guide, the rule bases must use the sample data files supplied with the software. If you have not modified these data since receiving the OSBATS software, proceed with this guide. If you have changed the data for either of the rule bases, reinstall the original rule base data files before proceeding. See the section entitled Software Installation for instructions on re-installing the sample data files.

The rule bases currently operate only on those tasks in the AH-1 AQC. If you have data available on the appropriate instructional features for the AH-1 AQC tasks you may wish to run the Instructional Features Rule Base with your data. Appendix A describes the procedure for using the rule bases outside the model. To Recalculate Data Using the Instructional Features Rule Base, you would place the cursor on the number **1** and press the left mouse button. The rule base calculations would then begin. Do not recalculate data before doing the sample problem demonstrated in this manual.

Action: Select the number **2** to Run OSBATS Using Current Values.

The screen with Fidelity Optimization Features Rule Base options should appear as shown in Figure 3.

```
   The Instructional Features Appropriateness Data
has already been calculated.

Your Options:

 1  Recalculate Data Using Instructional Features Rule Base
 2  Run OSBATS Using Current Values

    The Fidelity Optimization Features Appropriateness Data
has already been calculated.

Your Options:

 1  Recalculate Data Using Fidelity Optimization Features
    Rule Base
 2  Run OSBATS Using Current Values
```

Figure 3. Fidelity RuleBase Screen.

If you have fidelity requirement data specific to the AH-1 AQC tasks, you may wish to run the Fidelity Optimization Features Rule Base with your data. Otherwise, a file will supply data comparable to the results of the rule base.

To Recalculate Data Using the Fidelity Optimization Features Rule Base, you would place the cursor on the number **1** and press the left mouse button. The rule base would then begin. Do not recalculate the Fidelity Optimization Features Appropriateness Data if you wish to continue with this demonstration.

Action: Select the number **2** with the mouse to Run OSBATS Using Current Values.

The Task Cluster Selection Library will appear (see Figure 4). The remainder of this section describes the general procedures involved in using the Task Cluster Library, the Module Selection Menu, and the Task Inclusion/Exclusion screen. These procedures will be described again in the guide when they are used.

Selecting the task cluster. The Task Cluster Library appears after the display of rule base options. It may also be activated from the Module Selection Menu, where it is denoted as the Task Cluster Selection Menu. The Task Cluster Library should be displayed on the screen, as in Figure 4.

TASK CLUSTER LIBRARY			
Del	Name	Description	Date
1	default	The Complete Task Set	Friday July 27, 1988
Select library by clicking mouse on number Delete by clicking in Red area to left			

Figure 4. Task Cluster Library.

The Task Cluster Library lists the task clusters available to the model. Task clusters are user-defined except for the DEFAULT task cluster, which consists of all the tasks in the current data set. The current data set should be the sample data set (see the Installation procedure).

The number of task clusters available will depend on whether any have been saved by previous users. In this sample problem you will create and save three new task clusters. Initially, however, you will select to use the default task cluster. You **must** select a task cluster in order to continue, and new sessions with OSBATS should <u>always</u> be started with the default cluster.

<u>Action</u>: Use the mouse to place the cursor on the number "**1**" next to "default" and click the mouse.

The system will require 1 - 2 minutes to read in all of the data and perform the system calculations. A thermometer will appear as shown below. The bar will proceed across the screen in uneven jumps, from start to end.

Loading Data

Start End

When the thermometer has reached "End", the Module Selection Menu will appear on the screen. If you are doing the demonstration, you should read the rest of this section, but these procedures will be covered later during the demonstration.

If the system has been used to generate subsets of the default task set, the Task Cluster Library will appear more like the one depicted in Figure 5.

TASK CLUSTER LIBRARY

Del		Name	Description	Date
	1	default	The Default Task Set	Fri Jul 27
	2	fms1	The Full Mission Trainer Cluster	Tue Apr 19
	3	pms1	The Part Mission Trainer Cluster	Tue Apr 19
	4	ae1	The Actual Equipment Cluster	Tue Apr 19

Select library by clicking mouse on number
Delete by clicking in Red area to left

Figure 5. Task Cluster Library.

The Task Cluster Library is used to select a cluster of tasks for analysis by the system. The task cluster labeled "default" will always contain all the tasks included in the data files. Other task clusters are subsets of the default task cluster and are created by the user in the Simulation Congiguration or other modules.

To **SELECT** a task cluster, position the cursor so that it covers the number (highlighted in yellow) adjacent to the task cluster. Then press the left mouse button. The Module Selection Menu will appear.

To **DELETE** a task cluster which you no longer need, position the cursor so that it covers the red section adjacent to the task cluster. Then press the left mouse button. A message will be displayed asking you if you want to delete the task cluster. Type <Y> for yes or <N> for no and press <ENTER>.

Beginning the modules. When a task cluster has been selected, the Module Selection Menu is displayed. This Menu is used to access each of the five modules and the Task Cluster Selection Menu, or to exit the OSBATS program. The Module Selection Menu is also displayed whenever you exit one of the five OSBATS modules. Modules may be accessed in any order, depending on the needs of the problem. However, the Resource Allocation module is meaningful only after a training device package has been designed in the Training Device Selection module. Similarly, the Training Device Selection module is only relevant after one or more proposed training devices have been developed by using the Instructional Features and Fidelity Optimization modules. The Module Selection Menu is depicted in Figure 6.

To go to the Task Cluster Selection Menu, start a module, or exit the program, position the cursor so that it covers the desired option. Then press the left mouse button.

OSBATS Module Selection Menu Current Task Cluster: default
Task Cluster Selection Menu Simulation Configuration Instructional Features Fidelity Optimizaticn Training Device Selection Resource Allocation Quit

Figure 6. Module Selection Menu.

Editing task clusters. The Task Inclusion/Exclusion screen (see Figure 7) allows you to alter the task cluster used in a module by adding or deleting tasks. This capability is available in the Instructional Feature Selection, Fidelity Optimization, and Training-Device Selection Modules. It may be accessed from the menus for these modules by positioning the cursor so that it covers the option "Examine/Edit Task Set" and then pressing the left mouse button. The Task Inclusion/Exclusion screen will then be displayed.

The Task Inclusion/Exclusion screen allows you to select which tasks will be analyzed in the module. The tasks considered in the analysis are listed on the left side of the screen. The tasks on the right side of the screen will not be considered in the analysis.

You may use the mouse to move the tasks from one side of the screen to the other as follows:

TO **INCLUDE** A TASK in the analysis, use the mouse to position the cursor over the name of a task on the right side of the screen and press the left mouse button. The task name will move to the left side of the screen.

TO **EXCLUDE** A TASK from the analysis, position the cursor over the name of a task on the left side of the screen and press the left mouse button.

Tasks may be listed on more than one screen. To move from one screen to the other, select NEXT PAGE or PREVIOUS PAGE.

```
                    Current Task Cluster : fms
                     Task Inclusion/Exclusion
--------------------------------------------------------------
  Included Tasks                              Excluded Tasks
----------------------------       ---------------------------
1003 Start, Runup, Takeoff..
1004 Hover Power Checks
1005 Hovering Flight
1006 Normal Takeoff
1007 Maximum Performance...
1008 Deceleration/Accel
1009 Traffic Pattern Flight
 .
 .
 .
2000 Standard Autorotation
2003 Simulated AntiTorque
----------------------------       ---------------------------
   Next Page                                User Comment
 Previous Page                                  Help
                                             Main Menu
```

Figure 7. Task Selection Screen.

Simulation Configuration

Starting the Simulation Configuration Module

The Module Selection Menu should be displayed, as depicted in Figure 6. This is the main Module Selection Menu used to access the Task Cluster Selection Menu and each of the five modules. These modules may be accessed in any order. However, for the example problem presented in this guide the modules will be demonstrated in the order shown in the Module Selection Menu.

Action: Select **Simulation Configuration** and click the mouse.

A message, "One Moment Please," will appear on the screen. The first screen in the Simulation Configuration module is the Simulation Configuration Menu (Figure 8).

Current Task Cluster: default Simulation Configuration Menu
Display Results Save Results Module Selection Menu

Figure 8. Simulation Configuration Module Main Menu.

Display Results

Graphical summary. Selecting Display Results from the Simulation Configuration Menu causes the Graphical Summary Screen to appear, as shown in Figure 9.

Action: Select **Display Results** and click the mouse.

This graph illustrates the partitioning of the default task set into task clusters according to the need for and the cost-effectiveness of training on general classes of simulators as compared to training on actual equipment. Each asterisk on the graph represents a task. When two tasks occupy the same point on the graph the point is represented by a '2'. The following is a brief description of each task cluster:

1. Tasks that should be trained on a full mission simulator (FMS) representing most of the actual equipment subsystems are indicated by white asterisks,

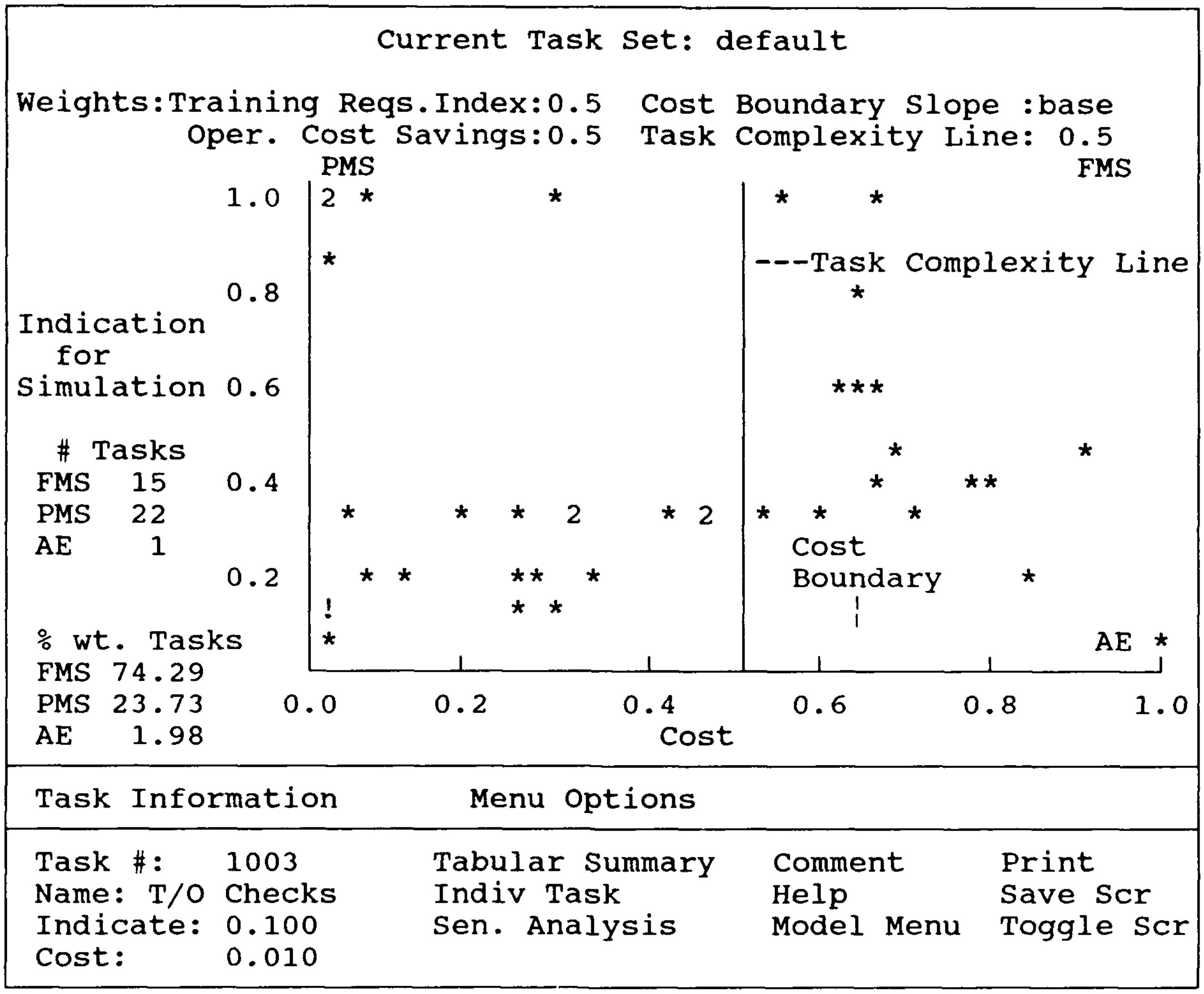


Figure 9. Graphical Summary Screen.

2. Tasks that should be trained on one or more part-mission simulators (PMSs) representing selected subsystems or representing actual equipment at a low level of fidelity are indicated by green asterisks, and

3. Tasks that should be trained on actual equipment (AE) are indicated by yellow asterisks and are boldfaced on the illustration above.

The module results are based on two scales, indication for simulation (y axis) and simulator development cost (x axis). The indication for simulation for a task is calculated from the requirements for training the task and the potential operating-cost savings associated with simulator training. The simulator development cost is determined from the task cue and response requirements. Both scales are normalized on the graph.

The training requirements index and the operating-cost savings index each receive a relative weight in the calculation of the indication for simulation. The user may adjust the weights to place greater importance on one of the indices. For example, if the user decides that tasks with low cost savings should be trained on actual equipment, he would raise the weight of the operating-cost savings index. When the weight of this index is high in comparison to the weight of the training requirements index, the cost savings plays a larger role in determining the task clusters. Therefore, tasks with low cost savings would have a low indication for simulation and would likely be assigned to the AE task cluster.

The three task clusters are separated by two boundaries. The cost boundary separates the region containing tasks in the AE task cluster and from the region containing tasks in the FMS and PMS task clusters. This boundary is determined by equating the total operating-cost savings over the equipment life-cycle that could be obtained using a baseline training device with the development cost. The user may adjust the slope of the cost boundary from 40% below the base value to 40% above the base value.

The task complexity line separates the tasks recommended for training on a part-mission simulator from the tasks recommended for training on a full mission simulator. This boundary is set by the user, although the default value is 0.5 on the cost scale.

The Task Information box, located in the lower left-hand corner of the screen, corresponds to the task represented on the graph by an exclamation point. Originally, information about the lowest numbered task, task 1003, is presented in the box. To obtain this information about a different task on the graph, point to the asterisk representing that task with the cursor (arrowhead) and click the mouse. If the task is represented by a '2' then point to the '2' with the cursor and click the mouse. At the first mouse click, information for one of the two tasks at that point will be displayed in the Task Information box. The second time the mouse is clicked, information for the other task will be displayed.

Action: Point the cursor (arrowhead) to the asterisk in the bottom left-hand corner of the graph (near the origin). Click the mouse.

The asterisk is now an exclamation point. Information for task 1013, Before Landing Checks, will appear in the Task Information box. Its normalized cost is 0.000 and its normalized indication for simulation is 0.006.

Action: Point the cursor (arrowhead) to the asterisk directly above the asterisk representing task 1013. Click the mouse.

The information for task 1003 is again presented in the Task Information box.

Examine the ordering of tasks on the graph with respect to cost and indication for simulation. You may be able to verify which tasks have a high indication for simulation and which have a high cost from your general knowledge of the training domain. However, more detailed information is available if it is needed, to provide a general verification of the cost and indication-for-simulation scales. This additional information will be presented later.

The cost of simulation is derived from the cue and response requirements of the tasks. The tasks with the highest cost, tasks 1012, 1042 and 3033, require either a sophisticated visual system, a sophisticated motion platform or a large data base to adequately train navigation and movement techniques. The tasks with the lowest cost, 1003, 1013, 1055, 3011 and 3025, are generally procedural, and could be trained on a cockpit procedures trainer with low fidelity. These tasks may be verified by selecting them as described above and examining their description in the Task Information box.

The module indicates that six tasks require simulation. Examination of these tasks, 1061, 3008, 3010, 3011, 3025 and 3030, indicates that this result is reasonable; the tasks involve serious malfunctions (droop compensator failure and tail rotor failure), require use of expensive ammunition or large training areas (terrain flight firing techniques) or involve dangerous emergency procedures (landing in trees). A task that requires simulation is assigned a value of 1.0 on the indication for simulation scale, regardless of the values of the training requirements and operating-cost savings weights.

The assignment of the lowest values of the indication for simulation to tasks 1012 and 1013 also seems reasonable. Task 1012, Doppler Navigation, is trained to a large extent in the classroom. Task 1013, Before Landing Checks, is procedural.

Tabular summary. The tabular summary display lists the tasks assigned to each of the three clusters (see Figure 10). This display is referred to in order to determine in which task cluster a particular task is located based on the ongoing analysis.

Action: Select **Tabular Summary** from the menu by pointing to it with the cursor and clicking the mouse.

Current Task Cluster: default

Weights:Training Reqs. Index:0.5   Cost Boundary Slope :base
Oper. Cost Savings :0.5   Task Complexity Line: 0.5

Cluster	# of Tasks	% of Task Weights
Actual Equipment	1	1.98
Part Mission Simulator	22	23.73
Full Mission Simulator	15	74.29

Task Set Lists

Actual Equipment		Part Mission Simltr		Full Mission Simltr	
1012	DOPPLER_NAV	1003	T/O_CHECKS	1015	SHLW_APPR
		1004	HOVER_PWR_CK	1016	CONFIND_OPN
		1005	HOVER_FLT	1019	TERRAIN_FLT
		1006	NORMAL_T/O	1042	MOVE_TECH
		1007	S/MAX_P_T/O	1048	PIN/RDG_OPN
		1008	DECEL_ACCEL	1054	OP_RMS
		1009	TRFC_PTRN	1056	OP_TURRET
		1013	PRE_LNDG_CK	1057	OP_FFAR_ROC
		1014	VMC_APPROACH	1058	OP_TOW_MSL
		1018	TERR_FLT_T/O	1061	NOE_FIRING
		1021	NOE_DECEL	2000	STD_AUTOROT
		1022	TRN_FLT_APP	2003	S/A_TRQ_MAL
		1024	HVR_AUTOROT	2004	L-A,H-S_AR
		1026	SIM_ENG_FAIL	3010	TAIL_ROT_FL
		1028	MAN_THROTTLE	3033	SCAS_FAILURE
		1029	NO_SCAS/SAS		
		1039	MSKG/UNMSKG		
		1055	WPNS_PROC		
		3008	DROOP_CMP_FL		
		3011	MAST_BUMPING		
		3025	THROTTLE_FL		
		3030	LNDG/TREES		
		UP	DOWN		

Full-Mission	Indiv. Task	Comment	Print
Part-Mission	Graphical Summary	Help	Save Scr
Actual Equip.	Sen. Analysis	Model Menu	Toggle Scr

Figure 10. Tabular Summary Screen.

This screen is a summary of the recommendations of the Simulation Configuration Module. In this example, the model recommends that 15 of the 38 tasks be trained on a full-mission simulator, 22 tasks be trained on part-mission simulators, and 1 task be trained on actual equipment (see Figure 10). These recommendations are based on the following assumptions:

1. The training requirements index and operating-cost savings index are weighted equally to determine the indication for simulation, and the overall measure of simulation benefit.

2. The slope of the cost boundary, which separates AE tasks from PMS or FMS tasks, is at its "base" level.

3. The task complexity line, the boundary between the FMS tasks and the PMS tasks, is set to 0.5.

Notice that the words "UP" and "DOWN" appear at the bottom of the Part-Mission Simulator column in the representation. Occasionally, there may be too many tasks in a single category to fit on the screen. In this case the display will comprise more than one screen. The UP and DOWN options will appear for the user to select in order to view the remaining tasks. Because there are currently 22 tasks in the PMS category, all the tasks should fit on one screen and the UP and DOWN options are not present on your computer display.

On the menu at the bottom of the screen are the options "Full-Mission," "Part-Mission," and "Actual Equip" (see Figure 10). Selecting any one of these options will allow you to view the tasks in that cluster with the normalized results that determine their coordinates on the graphical display.

<u>**Action:**</u> Select **Full-Mission** from the menu by positioning the cursor over the selection and clicking the mouse.

Figure 11 illustrates the information that should be present on the screen at this point.

On the left side of the screen are listed the tasks in the FMS cluster. On the right side of the screen are listed the normalized cost and normalized indication for simulation of each task. For example, task 1061, Terrain Flight Firing Techniques, has a normalized cost of 0.61 and a normalized indication for simulation of 1.00, indicating that training on a simulator is necessary for safety or special effects. Because all the tasks listed belong to the fms task cluster their normalized costs are high.

In order to exit this screen, perform the following action. This is the normal practice when examining the lowest level screens in the OSBATS software. (A low level screen is a screen that does not branch to provide further information or analysis.)

<u>**Action:**</u> Select **Return** from the menu at the bottom of the screen to return to the Tabular Summary display.

Full Mission Simulator Tasks		Normalized Results Cost	Ind. for Sim.
1015	Shallow Approach/Landing	0.53	0.32
1016	Confined Area Operations	0.74	0.30
1019	Terrain Flight	0.59	0.30
1042	Techniques of Movement	0.92	0.40
1048	Pinnacle/Ridgeline Operation	0.72	0.40
1054	Operate Rocket Mgmt. System	0.67	0.54
1056	Operate 197 Turret System	0.68	0.52
1057	Operate 2.75" FFAR Launcher	0.67	0.82
1058	Operate TOW Missile System	0.64	0.51
1061	Terrain Flight Firing Tech.	0.68	1.00
2000	Standard Autorotation	0.78	0.35
2003	Simulated Antitorque Malfunc.	0.80	0.36
2004	Lo Level Hi Speed Autorotation	0.69	0.37
3010	Tail Rotor Failure at a Hover	0.57	1.00
3033	SCAS Failure	0.86	0.15

Figure 11. The Full Mission Screen.

You may wish to examine the data that the results of this module are based upon. In order to do this, perform the following action.

<u>Action</u>: Select **Indiv Task** from the menu at the bottom of the screen and click the mouse.

The Individual Task screen will appear, and should be similar to Figure 12.

<u>Individual task data</u>. The Individual Task screen should appear as shown in Figure 12. Individual Task Data tables show the intermediate results that underlie the overall module results. The relative cost of simulator development (plotted along the x axis on the graphical summary screen) reflects the cue and response requirements of the task. The indication for simulation (the y axis on the graphical summary screen) is equal to the training requirement index multiplied by its weight plus the operating-cost savings index multiplied by its weight. These data are given for each task and can be viewed by selecting Next Task or Previous Task from the menu at the bottom of the screen.

```
                  Current Task Set: default

Weights:Training Reqs. Index:0.5   Cost Boundary Slope :base
         Oper. Cost Savings :0.5   Task Complexity Line: 0.5

    Task #: 1003                   Name: Start, Runup, Takeoff Ch
    Relative Cost  0.01            Indication for Simulation 0.10

Cue & Resp.Dim  Rqmt.   Cost   Factor                Value  Wt.

Visual_Resol.   0.00    0.00   Training Rqmt. Index   0.20 0.50
Visual_Content  0.00    0.00
Visual_Texture  0.00    0.00     Absolute Requirement  no
Visual_Front    0.00    0.00     Special Conditions   0 of 3
Visual_Side     0.00    0.00     Training Effects     1 of 2
Point_Effects   0.00    0.00
Area_Effects    0.00    0.00
Platform_Mot.   0.00    0.00
Seat_Motion     0.00    0.00
Sound_Effects   0.54   96.26
Map_Size        0.00    0.00   Ops Cost Saving Index  0.00 0.50
                                  Ops Cost Savings  $     0/stud
  Total Cost           96.26      AE Hours Saved      0.00
                                  Device Hours Used   0.00

 Next Task       Tabular Summary     Comment        Print
 Previous Task   Graphical Summary   Help           Save Scr
                 Sen. Analysis       Model Menu     Toggle Scr
```

Figure 12. Individual Task Data Screen.

Action: By selecting **Next Task** and **Previous Task** from the menu, the data for the individual tasks may be inspected, including the operating-cost savings information.

For most of the tasks there is essentially no cost savings associated with simulator training, though there may be a moderate value for the indication for simulation. The exceptions to this are tasks 1055, 1057 and 1061, which have a high cost savings. In light of these data, you might make one of following judgments.

1. The moderate value of the indication for simulation for many of the tasks may lead to acceptance of the initial result of the module, that most of the tasks be trained in a simulator.

2. If it is decided that tasks with low cost savings should be trained on actual equipment, the weight given to the operating-cost savings index in the determination of the

indication for simulation can be raised, to make cost savings a more important consideration in the module.

3. It may determined that for tasks with low cost savings the training requirements justify simulator training. Then the weight given to the training requirements index in the determination of the indication for simulation can be raised to make the cost savings a less important consideration in the module.

4. By examining other tasks, it may may be determined that the model has underestimated the cost savings that would actually occur. In this case, the slope of the cost boundary can be adjusted downward in proportion to the degree to which cost savings were underestimated, thereby including more tasks in the FMS task cluster.

Suppose the second judgment is made, to increase the operating-cost savings index (OCS).

Action: Select **Graphical Summary** from the menu at the bottom of the screen and click the mouse.

The Graphical Summary display will appear on the screen and appear as depicted in Figure 13.

Case 2 presumes that tasks with low cost savings should be trained on actual equipment. Because it may be that the training requirements index is overrated in the calculation of the indication for simulation, the relative weight of the operating-cost savings index is increased.

Action: Point the cursor to the number in the yellow box labeled "Weights: Operating Cost Savings" and continue to click the mouse until the weight for operating-cost savings has increased from 0.5 to 0.9.

The weight for the Training Requirements Index should simultaneously decrease to 0.1. NOTE: With each click of the mouse the graphical summary screen must be repainted. Click the mouse once and wait until the screen is entirely repainted before clicking the mouse again. The changes in the graph indicate that several tasks are assigned to new task clusters, as shown in Figure 13.

The graph shows that the value of the indication for simulation for most of the tasks has decreased. In addition, four new tasks have been added to the actual equipment task cluster, three from the FMS cluster and one from the PMS cluster. You may wish to refer to the Individual Task data tables to observe the new values of the indication for simulation for many of the tasks.

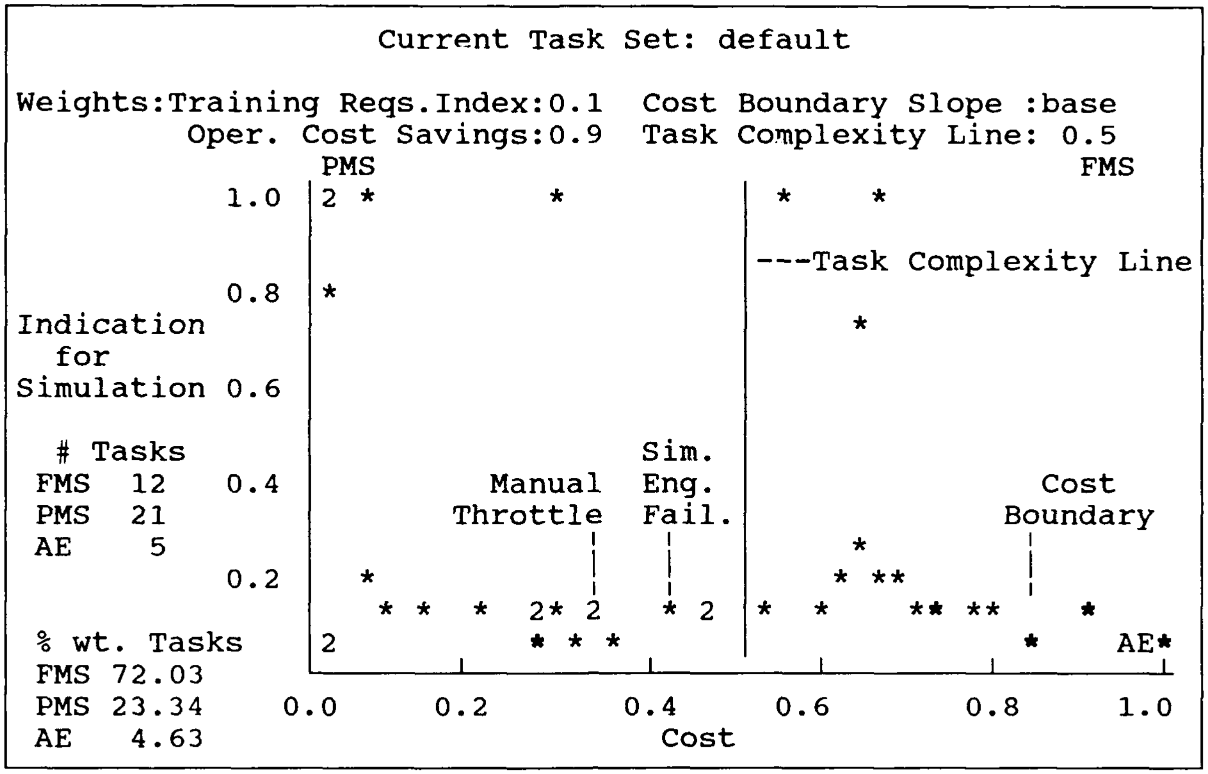


Figure 13. Graphical Summary Screen.

Now examine the task complexity line, which separates the PMS from the FMS task clusters. That investigation will proceed by examining tasks near the task complexity boundary to determine whether they appear to be in the correct task cluster.

Locate the two tasks, Manual Throttle Operation (MAN THROTTLE) and Simulated Engine Failure (SIM_ENG_FAIL), which are assigned to the FMS task cluster. (These tasks are labeled in the screen representation in Figure 12.)

Suppose you think that Simulated Engine Failure might be trained better in an FMS rather than in a PMS because it requires many systems. However, you think that Manual Throttle Operation should be trained on fairly specialized trainers (PMSs). You decide to adjust the task complexity line to the left to include the task Simulated Engine Failure in the FMS task cluster but leave Manual Throttle Operation in the PMS task cluster.

Action: Point with the cursor to the yellow box labeled Task Complexity Line (in the upper right corner of the screen) and click the mouse until the location of the line is changed from 0.5 to 0.4.

NOTE: Because the value of the task complexity line can only be changed in one direction you will have to increase the value from 0.5 to 0.9 and then increase the value from 0.1 to 0.4. Each time you click the mouse you should wait for the screen to repaint before clicking again. (If you accidentally increase the Cost Boundary Slope continue to select the Slope until it has returned to the "base" value.)

Notice that three tasks, Simulated Engine Failure, VMC Approach (1014) and Terrain Flight Approach (1022), moved from the PMS task cluster to the FMS task cluster (see Figure 13a). The task, Manual Throttle Operation, remains in the PMS task cluster.

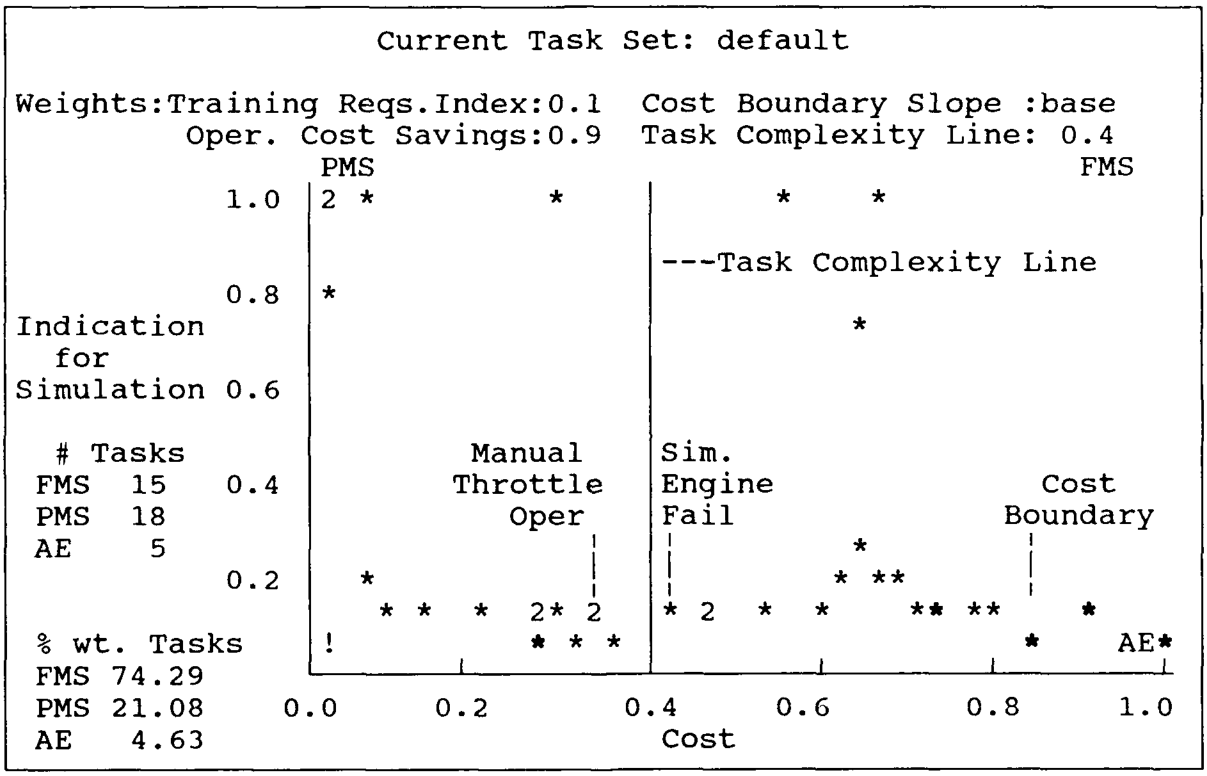


Figure 13a. Adjusted Task Complexity weighting on the Graphical Summary Screen.

In addition to changing the location of the task complexity line and changing the relative weights of the training requirements index and the operating-cost savings index, the user can adjust the cost boundary slope. To assist the user in adjusting the cost boundary slope there is a display called Sensitivity Analysis.

Action: Select **Sen. Analysis** from the menu by pointing to it with the cursor and clicking the mouse.

Sensitivity analysis. The sensitivity analysis allows you to examine the effect of changing the cost-boundary slope over a range of values (see Figure 14). Computation of the cost boundary uses operating cost-savings data, the life cycle of the simulator and the weight given the operating-cost savings index. The major assumption made in the calculation is that when a given task has no requirements for simulation, the decision to use a simulator is based solely on economics. The cost boundary essentially strikes a balance between the development cost of a simulator and the cost savings associated with simulator training. Tasks above the boundary qualify for simulator training; tasks below the line do not. The user is able to make adjustments to the slope due to the uncertainty in the actual cost savings. In this analysis, the cost-boundary slope is varied from 40% below to 40% above its nominal value.

```
                    Current Task Set:  default
Weights:Training Reqs. Index:0.9   Cost Boundary Slope : base
        Oper. Cost Savings :0.1    Task Complexity Line:  0.4

         Sensitivity Analysis on Tasks, and Task Weights
 38-|-                             100%-|-
  . |                                   |
  . |                                   |
    |                                   |
    |                               75%-|-  *  *
  . |                                   |         *   *
  . |                                   |                *
 19-|-  *  *                            |
    |   *  *   *   *   *           50%-|-
 15-|-         *                        |
    |              *                    |
 12-|-                 *                |
    |              *               25%-|-  *  *   *   *
  8-|-         *                        |                *
    |                                   |                *
  4-|-  *  *                            |   *  *   *   *
    |______________________             |______________________
  -40 -20 base +20 +40                 -40 -20 base +20 +40
```

	Number of Tasks						Percentage of Tasks				
	-40	-20	base	+20	+40		-40	-20	base	+20	+40
FMS	17	17	15	13	11	FMS	75	75	74	71	68
PMS	19	19	18	18	17	PMS	21	21	21	21	20
AE	2	2	5	7	10	AE	2	2	4	7	10

Figure 14. The Sensitivity Analysis Screen.

The tables and graphs on this screen indicate that as the cost boundary is increased from -40% of its base value to 40% of its base value, the number of tasks in the actual equipment task cluster increases. If the user thinks that the cost-savings associated with simulator training does not sufficiently offset the cost required to develop the simulator the cost boundary might be raised to +40%. This would have the effect of increasing the number of tasks in the actual equipment task cluster.

Before saving the results of the Simulation Configuration module you should verify that the FMS task cluster contains the correct tasks, and should appear as in Figure 15.

Action: Select **Tabular Summary** from the menu at the bottom of the screen using the mouse.

```
                    Current Task Cluster: default

Weights:Training Reqs. Index:0.1   Cost Boundary Slope :base
         Oper. Cost Savings :0.9   Task Complexity Line: 0.4

Cluster                        # of Tasks     % of Task Weights
Actual Equipment                   5                4.63
Part Mission Simulator            18               21.08
Full Mission Simulator            15               74.29

                              Task Set Lists
Actual Equipment      Part Mission Simltr   Full Mission Simltr
-------------------------------------------------------------
1004  HOVER_PWR_CK    1003  T/O_CHECKS      1014  VMC_APPROACH
1012  DOPPLER_NAV     1005  HOVER_FLT       1015  SHLW_APPR
1016  CONFIND_OPN     1006  NORMAL_T/O      1019  TERRAIN_FLT
1042  MOVE_TECH       1007  S/MAX_P_T/O     1022  TRN_FLT_APP
3033  SCAS_FAILURE    1008  DECEL_ACCEL     1026  SIM_ENG_FAIL
                      1009  TRFC_PTRN       1048  PIN/RDG_OPN
                      1013  PRE_LNDG_CK     1054  OP_RMS
                      1018  TERR_FLT_T/O    1056  OP_TURRET
                      1021  NOE_DECEL       1057  OP_FFAR_ROC
                      1024  HVR_AUTOROT     1058  OP_TOW_MSL
                      1028  MAN_THROTTLE    1061  NOE_FIRING
                      1029  NO_SCAS/SAS     2000  STD_AUTOROT
                      1039  MSKG/UNMSKG     2003  S/A_TRQ_MAL
                      1055  WPNS_PROC       2004  L-A,H-S_AR
                      3008  DROOP_CMP_FL    3010  TAIL_ROT_FL
                      3011  MAST_BUMPING
                      3025  THROTTLE_FL
                      3030  LNDG/TREES
```

Figure 15. The Tabular Summary Screen after weight adjustments.

If the task clusters on the screen in front of you do not appear as they are shown above then check the settings at the top of the screen. Verify that the Training Requirements Index is 0.1; the Operating-Cost Savings Index is 0.9; the Cost Boundary Slope is at "base" level; and the Task Complexity Line is 0.4. If any of these settings is incorrect you can adjust it from this screen.

Suppose you are satisfied with the task clusters as shown above. You will save these task clusters, created with the task complexity line equal to 0.4 and the operating-cost savings weight equal to 0.9, to use in the remaining modules.

Action: When you have finished examining all the screens in the Simulation Configuration Display Results, select **Model Menu** from the menu at the bottom of the screen.

This should return you to the Simulation Configuration Menu, as depicted in Figure 8.

Save Results

When you have completed the examination of the results of the Simulation Configuration Module, the new cluster definitions (clusters named FMS, PMS and AE) should be saved so they can be used in later modules. The new clusters form the requirements for the design of training devices, and will be used in the Instructional Feature Selection Module and in the Fidelity Optimization Module.

Action: Select **Save Results** and click the mouse.

A screen will appear giving you the options to save or delete the newly-defined task clusters (see Figure 16).

This screen allows you to verify the current settings and to to save the task clusters you have created in this module.

Action: Select the **Save Clusters** and click the mouse.

Action: Select **Module Selection Menu** to return to the Module Selection Menu.

The Simulation Configuration Model results produce three task lists, or clusters, which can be grouped under the following titles:

- A Full-Mission Simulator cluster
- A Part-Mission Simulator cluster
- An Actual Equipment cluster

Each cluster contains tasks which would be trained on a full-mission simulator, a part-mission simulator or on the actual equipment.

The parameters of the current set are

- Training Requirements Weight	0.10
- Operating Cost Savings Weight	0.90
- Task Complexity Line Weight	0.40
- Slope of Cost Boundary Line	Base

Saving these clusters allows the user to examine further any of the task clusters, in one of the other Models

Save Clusters
Delete Clusters

Figure 16. Simulation Configuration Save Results Screen.

Instructional Feature Selection Module

The Instructional Feature Selection Module begins the training-device design process. The training-device design process is conducted for each training device that is incorporated into the training system. Any task cluster may form the task requirements for a training device. You may use any of the task clusters produced by the Simulation Configuration Module to start the training-device design process, or you may define a cluster on which to apply the Instructional Feature Selection Module. The Instructional Feature Selection Module uses a set of rules, which have been developed through research, to compute the benefit on a task-by-task basis for each available feature. The feature benefits are compared to their respective costs and a benefit-to-cost priority list of features is developed. This priority list can then be incorporated into the Fidelity Optimization Module so that the instructional features can be prioritized with training-device fidelity options.

The instructional features evaluated by the Instructional Feature Selection Module are shown in Table 2.

Table 2. Current OSBATS Instructional Features

Instructional Feature	Abbreviation
Automated Performance Measurement	perfmeas
Performance Indicators	perf ind
Procedure Monitoring	prof mod
Automated Performance Alerts	perfalrt
Augmented Feedback	aug fdbk
Augmented Cues	aug cues
Record/Playback	rec/play
Total System Freeze	sys frez
Remote Graphics Replay	graph rp
Initial Conditions	init cnd
Scenario Control	scen ctl
Crash Override	crash ov
Reset/Reposition	reset/re
Parameter Freeze	parm frz
Flight System Freeze	flt frez
Positional Freeze	pos frez
Real-Time Simulation Variables Control	realtime
Automated Simulator Demonstration	autodemo
Adjunct CAI	adjn cai
Automated Adaptive Training	adaptive
Automated Cueing and Coaching	coaching

In this example, the 21 candidate instructional features will be evaluated in terms of how well they can be applied in a training device to train the fms task cluster produced by the Simulation Configuration Module. The results of this module will order the candidate instructional features from most to least useful according to the ratio of benefit to development cost. You can then select several instructional features that will be investigated further in the Fidelity Optimization Module.

Prerequisites for This Module

Before proceeding with this section of the guide, be sure you have created the fms task cluster described in the previous section, Simulation Configuration. Refer to the chapter entitled Simulation Configuration Module for instructions on how to create this task cluster.

The Module Selection Menu should be displayed on the screen and appear as in Figure 6 in the first chapter. The Instructional Features Module is demonstrated using the fms task cluster you developed in the Simulation Configuration Module. You must change the current task cluster from "default" to "fms1" with the following actions:

Action: Select **Task Cluster Selection Menu** and click the mouse.

The Task Cluster Library should be displayed and appear something like Figure 17.

When you created and saved task clusters in the Simulation Configuration module they were given the names fms#, pms# and ae#, where the number sign (#) represents a number. We will assume that the clusters you created in the Simulation Configuration chapter are called fms1, pms1 and ae1.

TASK CLUSTER LIBRARY

Del		Name	Description	Date
	1	default	The Complete Task Set	Fri Jul 27
	2	fms1	The Full Mission Trainer Cluster	Tue Aug 16
	3	pms1	The Part Mission Trainer Cluster	Tue Aug 16
	4	ae1	The Actual Equipment Cluster	Tue Aug 16

Select library by clicking mouse on number
Delete by clicking in Red area to left

Figure 17. Updated Task Cluster Library Screen.

NOTE: If the software has been used prior to doing this sample problem there will likely be several entries in the Task Cluster Library. If you already had clusters with the names fms1, pms1 and ae1 saved in your library when you did the Simulation Configuration chapter then the clusters you created will obviously be numbered differently. You should be able to identify the clusters you created by their date. Each time you are asked to select fms1 in this guide you should select the corresponding cluster in your Library. Simply ignore clusters other than the ones you created while using this guide until you have completed the sample problem.

Action: Select **fms1** from the Task Cluster Library by placing the cursor on the number highlighted in yellow next to "fms1" and click the mouse. The Module Selection Menu should appear.

Starting the Instructional Features Module

Action: Select **Instructional Features** from the Module Selection Menu.

The Instructional Features Menu should appear (see Figure 18).

Current Task Structure :fms1 Instructional Features Menu
Examine/Edit Task Set Examine/Edit Inst. Feat Set Display Results Save Changes Module Selection Menu

Figure 18. Instructional Feature Menu Screen.

The Instructional Features Menu presents the four functions of the module. Each function can be selected, not necessarily in the order presented, by placing the cursor on the name and clicking the mouse.

Editing the Task Set

Action: Select **Examine/Edit Task Set** from the Instructional Features menu and click mouse.

The Task Inclusion/Exclusion screen should be displayed, and list the tasks in the same manner as shown in Figure 19. The

Examine/Edit Task Set section will allow you to alter the task cluster used in this module by adding or deleting tasks.

Current Task Cluster : fms1
Task Inclusion/Exclusion

Included Tasks	Excluded Tasks
	1003 Start, Runup, Takeoff Ch
	1004 Hover Power Checks
	1005 Hovering Flight
	1006 Normal Takeoff
	1007 Maximum Performance Take
	1008 Deceleration/Acceleration
	1009 Traffic Pattern Flight
	1012 Doppler Navigation
	1013 Before Landing Checks
1014 VMC Approach	
1015 Shallow Approach/Land	
	1016 Confined Area Operations
	1018 Terrain Flight Takeoff
1019 Terrain Flight	
	1021 Nap-of-the-Earth Decel
1022 Terrain Flight Approach	
	1024 Hovering Autorotation
1026 Simulated Engine Fail	
	1028 Manual Throttle Operation
	1029 SCAS Off Flight
	1039 Masking and Unmasking
	1042 Techniques of Movement
1048 Pinnacle/Ridgeline Op	
1054 Operate Rocket Mgmt	
	1055 Weapons Cockpit Procedure
1056 Operate 197 Turret	
1057 Operate 2.75" FFAR	
1058 Operate TOW Missile	
1061 Terrain Flight Firing	
2000 Standard Autorotation	
2003 Simulated Antitorque	

Next Page
Previous Page

User Comment
Help
Main Menu

Figure 19. Task Inclusion/Exclusion Screen.

This screen allows you to select which tasks will be analyzed in determining the optimal instructional features. The tasks considered in the analysis are listed on the left side of the screen. The tasks on the right side of the screen will not be considered in the analysis. Use the mouse to move the tasks from one side of the screen to the other as follows:

TO INCLUDE A TASK in the analysis, use the mouse to position the cursor over the name of a task on the right side of the screen and press the left mouse button. The task name will move to the left side of the screen.

TO EXCLUDE A TASK from the analysis, position the cursor over the name of a task on the left side of the screen and press the left mouse button.

Tasks may be listed on more than one screen. To scroll to the bottom of the list select NEXT PAGE. To scroll to the top of the list select PREVIOUS PAGE.

In this example, we have selected the fms task cluster developed in the Simulation Configuration module to use in the Instructional Features module, as indicated at the top of the screen. The following tasks should appear on the left (INCLUDED) side of the screen:

1014, 1015, 1019, 1022, 1026, 1048, 1054, 1056,
1057, 1058, 1061, 2000, 2003, 2004, 3010

These tasks belong to the fms1 task cluster and therefore will be used in this analysis.

Action: When you have verified the task selection, select **Main Menu** from the menu at the bottom of the screen.

This action returns to the Instructional Features Menu (see Figure 18).

Editing the Instructional Feature Set

Action: Select **Examine/Edit Inst. Feat Set** from the Instructional Features Menu.

The Instructional Feature Selection screen should be displayed, appearing as depicted in Figure 20. The Examine/Edit Instructional Feature Set section will allow selection of the instructional features to be included in the analysis. The currently available 21 instructional features are listed. Two columns appear on this screen, Included Instructional Features and Excluded Instructional Features. To move a feature from one column to the other, place the cursor on the feature and press the left mouse button. This will determine which features are included in the analysis.

Current Task Cluster : fms1
Instructional Feature Selection

Included Instructional Feat's	Excluded Instructional Feat's
Automated Performance Meas... Performance Indicators Procedure Monitoring Automated Performance Alerts Augmented Feedback . . . Automated Simulator Demo... Adjunct CAI Automated Adaptive Training Automated Cueing and Coaching	

User Comment
Help
Main Menu

Figure 20. Instructional Feature Selection Screen.

In this example, we will use all the instructional features. You should verify that all features are listed on the left side of the screen.

Action: When you have verified that all of the instructional features are on the left side, select **Main Menu**.

This will return to the Instructional Features Menu (see Figure 18).

Calculation and Display of Results

The Display Results section of the module will use the fms task cluster to calculate which instructional features offer the most benefit per cost for training the specified tasks. This module contains several different screens for viewing.

Action: Select **Display Results** from the Instructional Features Menu to view the results of the module.

The results table, entitled Summary Display, will be displayed as shown in Figure 21.

The results table. The initial recommendations of the Instructional Feature Selection Module are summarized in the Summary Display.

Current Task Cluster : fms1
Summary Display

Feature Wts Included | Task Wts Included

Instructional Features	Tasks Wts.	Ben. Wt.	Benefit	Norm. Ben.	Cost (000's)	Norm. Cost	B/C
Reset/Reposi...	89	4.63	4.16	0.11	30	0.01	7.39
Total System	89	3.10	2.78	0.07	24	0.01	6.17
Crash Overri	49	4.77	2.38	0.06	29	0.01	4.37
Flight Syste	41	3.80	1.58	0.04	35	0.02	2.40
Initial Cond	99	4.30	4.30	0.11	98	0.05	2.34
Procedure Mo	92	3.40	3.16	0.08	74	0.04	2.27
Positional F	41	3.30	1.37	0.03	35	0.02	2.08
Parameter Fr	41	2.95	1.22	0.03	35	0.02	1.86
Scenario Con	99	4.40	4.40	0.11	155	0.07	1.51
Real-Time Si	99	3.70	3.70	0.09	137	0.07	1.44
Remote Graph	75	2.70	2.03	0.05	76	0.04	1.42
Automated Si	41	2.16	0.90	0.02	54	0.03	0.88
Record/Playb	89	1.42	1.27	0.03	92	0.04	0.74
Automated Pe	99	1.40	1.40	0.04	215	0.10	0.35

Next Page	Graph Displays	Comment	Print
Previous Page	Assignment Lists	Help	Save Scr
		Model Menu	Toggle Scr

Figure 21. Instructional Features Selection Summary Display Screen.

The results indicate that the first three instructional features, which have the highest benefit-to-cost ratio, offer significant increase in training efficiency considering their cost, the next ten features offer considerably less benefit, and the eight remaining instructional features offer very little or no benefit. The results table may comprise two screens. To scroll to the bottom of the table select NEXT PAGE from the menu at the bottom of the screen. Select PREVIOUS PAGE to return to the top of the table.

The cost of each instructional feature represents development cost and is taken directly from the data base. The benefit, on the other hand, is calculated from the number of tasks for which that instructional feature was estimated to improve training efficiency.

The overall instructional feature benefit is related to the number of tasks for which the instructional feature is appropriate. However, all tasks do not receive equal weight in determining benefit. Tasks that require more training receive a higher weight in the benefit calculation. The task weights are based on the total cost of training the tasks to criterion using actual equipment. In addition, empirical research has indicated that some instructional features are used by instructors more often than others even though they may be equally appropriate. For this reason the weighted average benefit calculated by the model is moderated by a benefit weight that depends only on the instructional feature. Examination of the task weights and feature weights can give an indication of the rationale behind the benefit values. The benefit weight for each instructional feature is shown in the results table, in the second numerical column.

There are conditions in which you may feel that it is inappropriate to use task weights or feature weights. For example, if the goal of a training device is to provide familiarization training on a variety of tasks then the task weights, which are based on training tasks to criterion, may not be appropriate. In this case, an unweighted average of tasks may more accurately represent the benefit of an instructional feature. Similarly, since the feature weights are essentially a measure of instructor bias, they may be counteracted by training, familiarization with the instructional feature, or motivational incentives. Thus, you may feel that these biases should not be considered in determining instructional feature benefit.

<u>Action</u>: Place the cursor in the yellow area labeled **Task Wts Included** and click the mouse.

The yellow area should now be labeled "Excluded" and the data in the table will be altered, as shown in Figure 22. Excluding the task weights is the same as considering all task weights to be 1. Therefore, the Tasks Wts. column indicates the number of tasks that can be trained with each feature. Notice that the feature named Crash Override jumps from third to first in the order. Examination of which features are assigned to each task gives an indication as to why this change occurs. (You will view the assignment of instructional features to tasks later when you select Assignment Lists.) The Tasks Wts. column shows that there are 10 tasks for which Crash Override is appropriate, while there are 8 for Reset/Reposition and 7 for Total System Freeze. However, the tasks assigned to Crash Override involve less training to reach criterion. Reset/Reposition and Total System Freeze, on the other hand, are appropriate for the difficult weapons tasks that require more training. When task weights are included these latter features have the highest benefits. Given this comparison, you would probably accept the original solution, because the simulator you are designing would be expected to take a substantial amount of the training load for the weapons tasks.

Current Task Cluster : fms1
Summary Display

Feature Wts Included | Task Wts Excluded

Instructional Features	Tasks Wts.	Ben. Wt.	Benefit	Norm. Ben.	Cost (000's)	Norm. Cost	B/C
Crash Overri...	10	4.77	47.70	0.10	29	0.01	7.54
Reset/Reposi	8	4.63	37.04	0.08	30	0.01	5.66
Total System	7	3.10	21.70	0.05	24	0.01	4.14
Initial Cond	15	4.30	64.50	0.14	98	0.05	3.02
Procedure Mo	10	3.40	34.00	0.07	74	0.04	2.11
Scenario Con	15	4.40	66.00	0.14	155	0.07	1.95
Real-Time Si	15	3.70	55.50	0.12	137	0.07	1.86
Flight Syste	3	3.80	11.40	0.02	35	0.02	1.49
Positional F	3	3.30	9.90	0.02	35	0.02	1.30
Parameter Fr	3	2.95	8.85	0.02	35	0.02	1.16
Remote Graph	5	2.70	13.50	0.03	76	0.04	0.81

Figure 22. Instructional Feature Selection Summary Display Screen with Task Weights Excluded.

Action: Place the cursor in the yellow area labeled **Task Wts Excluded** and click the mouse to recover your original results.

The yellow area should now be labeled "Included".

Action: Place the cursor in the yellow area labeled **Feature Wts Included** and click the mouse.

The yellow area should now be labeled "Excluded". Data in the table will be altered, as shown in Figure 23.

When the feature weights are set equal to each other, the feature Total System Freeze moves from second on the list to first. Examination of the original feature weights, found in the results table shown on pg. 50, indicates why this result occurs. In the original calculations, the feature Reset/Reposition was judged by instructors to be very useful, and consequently was assigned a high benefit weight. Total System Freeze, on the other hand, was judged less likely to be used, and received a weight approximately two-thirds that of Reset/Reposition. Therefore, Total System Freeze received a lower overall benefit than it otherwise would have received without the feature weights. When feature weights are excluded, Total System Freeze has a relatively higher benefit-to-cost ratio than Reset/Reposition because it is less expensive.

Current Task Cluster : fms1
Summary Display

Feature Wts Excluded — Task Wts Included

Instructional Features	Tasks Wts.	Ben. Wt.	Benefit	Norm. Ben.	Cost (000's)	Norm. Cost	B/C
Total System...	89	1.0	0.90	0.06	24	0.01	5.68
Reset/Reposi	89	1.0	0.90	0.07	30	0.01	4.55
Crash Overri	49	1.0	0.50	0.04	29	0.01	2.61
Procedure Mo	92	1.0	0.93	0.07	74	0.04	1.91
Positional F	41	1.0	0.41	0.03	35	0.02	1.80
Parameter Fr	41	1.0	0.41	0.03	35	0.02	1.80
Flight Syste	41	1.0	0.41	0.03	35	0.02	1.80
Initial Cond	99	1.0	1.00	0.07	98	0.05	1.55
Remote Graph	75	1.0	0.75	0.05	76	0.04	1.50
Record/Playb	89	1.0	0.90	0.06	92	0.04	1.48
Automated Si	41	1.0	0.41	0.03	54	0.03	1.17

Figure 23. Instructional Features Selection Summary Display Screen with Feature Weights Excluded.

<u>**Action**</u>: Select **Feature Wts Excluded** from the menu. The yellow area should now be labeled "Included".

This should restore the original results, as displayed in Figure 21.

<u>The assignment lists</u>. The Task-Instructional Feature Assignment Lists indicate which instructional features are appropriate for the training of each task.

<u>**Action**</u>: Select **Assignment Lists** from the menu at the bottom of the screen.

A screen entitled Tasks -- IF's Used in Training will appear, configured as in Figure 24.

The Instructional Feature Module assigns features to tasks according to a set of rules that make assignments depending on basic task information-processing variables. There is a Task -- IF display for each task in the task cluster being evaluated. Tasks are in numerical order.

To determine which instructional features are used to train a particular task, select NEXT TASK or PREVIOUS TASK until you find the display for the task of interest. The list of features may require more than one screen, in which case the options "UP"

```
                    Current Task Cluster : fms1
                    Tasks -- IF's Used in Training
Feature Wts  Included                        Task Wts  Included
----------------------------------------------------------------
Task                1014   VMC Approach

IFs used in training Task   Number   5

Automated Performance Measurement          1.4
Initial Conditions                         4.3
Scenario Control                           4.4
Real-Time Simulation Variables Control     3.7
Automated Adaptive Training                1.6


Select Mode
 1  Examine Tasks
 2  Examine Features
----------------------------------------------------------------
  Next Task          Results Tables     Comment      Print
  Previous Task      Graph Displays     Help         Save Scr
  All Tasks                             Model Menu   Toggle Scr
```

Figure 24. Task to Instructional Feature Assignment Screen.

and "DOWN" will appear. Select DOWN to scroll to the bottom of the list. Select UP to scroll to the top of the list.

For a comprehensive view of all of the tasks and the number of instructional features appropriate to each, select ALL TASKS from the menu at the bottom of the screen.

Action: Select **All Tasks** with the cursor and click the mouse.

A screen will appear with a list of tasks, as shown in Figure 25.

On the left side of the screen are listed the task number and task name. To the right of each task name is the number of instructional features appropriate to the training of the task. The task that is highlighted in yellow is the "current task". When you select RETURN, the Task -- IF display for the current task will appear. To change the current task, place the cursor on another task name and click the mouse.

Current Task Cluster : fmsl
Tasks -- IF's Used in Training

Feature Wts | Included | Task Wts | Included

Tasks and the Number of IF's Used in Training

ATM	Name	#
1014	**VMC Approach**	**5**
1015	Shallow Approach/Landing	6
1019	Terrain Flight	6
1022	Terrain Flight Approach	6
1026	Simul. Engine Fail. -Altitud	7
1048	Pinnacle/Ridgeline Operation	6
1054	Operate Rocket Mgmt. System	12
1056	Operate 197 Turret System	12
1057	Operate 2.75" FFAR Launcher	12
1058	Operate TOW Missile System	12
1061	Terrain Flight Firing Techs.	18
2000	Standard Autorotation	7
2003	Simulated Antitorque Malfunc	16
2004	Lo Level Hi Speed Autorotati	17
3010	Tail Rotor Failure at a Hove	11

Return

Figure 25. Task to Instructional Feature Assignment Summary Screen.

<u>**Action**</u>: Select **Return** to return to the Task -- IF displays.

<u>**Action**</u>: Select **Examine Features** from the lower left corner of the screen by placing the cursor on the yellow area containing the number **2** and clicking the mouse.

A screen entitled Instructional Features -- Task Trained will appear, as shown in Figure 26.

This display contains a list of the tasks trained with the current instructional feature and the task weights. Tasks that require more training receive a higher weight. For example, Terrain Flight Firing Techniques has a weight of 36.68, which indicates that this task requires more training than other tasks. Features that are appropriate to this task have a larger benefit due to this task's relatively high weight. Examination of the task weights and feature weights can aid understanding of the rationale behind the calculation of benefit values.

```
                  Current Task Cluster : fms1
            Instructional Features -- Task Trained by
Feature Wts  Included                       Task Wts  Included
--------------------------------------------------------------
Instructional Feature      Automated Performance Measurement

Tasks trained by IF  ( of 15 )  Number 15       Weight 100.0

1014  VMC Approach                          1.90
1015  Shallow Approach/Landing              1.90
1019  Terrain Flight                        1.01
 .                                           .
 .                                           .
2003  Simulated Antitorque Malfunction      2.41
2004  Lo Level Hi Speed Autorotation        2.41
3010  Tail Rotor Failure at a Hover         0.12

Select Mode
 1  Examine Tasks
 2  Examine Features
--------------------------------------------------------------
   Next Feature       Results Tables     Comment     Print
   Prev. Feature      Graph Displays     Help        Save Scr
   All Features                          Model Menu  Toggle Scr
```

Figure 26. Instructional Features by Task Trained Screen.

There is an Instructional Features -- Task (IF -- Task) screen for each feature selected to be evaluated in the Instructional Features module. Features are not in alphabetical order. To find out which tasks are trained on a particular feature, select NEXT FEATURE or PREVIOUS FEATURE until you locate the display for that feature. The list of tasks may require more than one screen. Select DOWN with the cursor to scroll to the bottom of the list. Select UP to scroll to the top of the list.

For a comprehensive view of all of the features, the number of tasks trained with each, and the percentage of task weights associated with each, select ALL FEATURES from the menu at the bottom of the screen.

<u>Action</u>: Select **All Features** with the cursor and click the mouse.

A screen will appear with a list of features, as shown in Figure 27. This display is a list of each instructional feature being evaluated in this module. Associated with each feature is the number of tasks trained with that feature and the percentage

Current Task Cluster : fmsl Instructional Features -- Task Trained by Feature Wts Included	Task Wts Included	
Instructional Feature	Tasks Trnd.	% Wts of Tasks
Automated Performance Measurement	15	99
Performance Indicators	0	0
Procedures Monitoring	10	92
Automated Performance Alerts	0	0
Augmented Feedback	1	9
Augmented Cues	2	39
Record/Playback	7	89
Total System Freeze	7	89
Remote Graphics Replay	5	75
Initial Conditions	15	99
.	.	.
.	.	.
Automated Cueing & Coaching	8	89

Figure 27. Instructional Features by Task Trained Summary Screen.

of the total task weight those tasks carry. The column labeled "Tasks Trnd." contains the same numbers as the column labeled "Tasks Wts," found in the Summary Display when the task weights are excluded. The column labeled "% Wts of Tasks" contains the same numbers as the column labeled "Tasks Wts," found in the results table when task weights are included.

The feature highlighted in yellow is the "current feature." When you select RETURN, the IF -- Task display for this feature will appear. To change the "current feature," place the cursor on another feature and click the mouse.

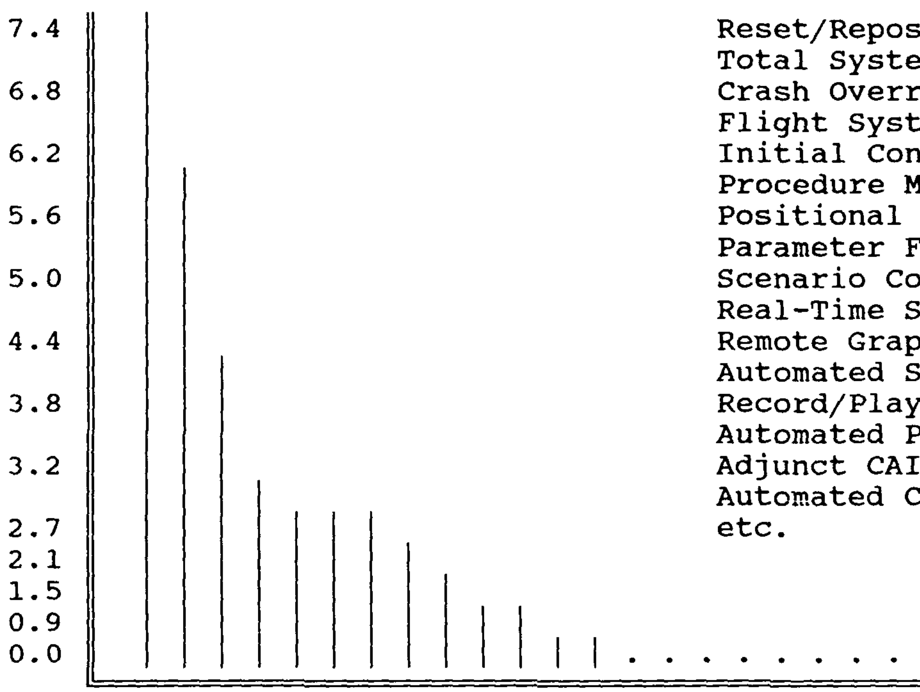
Action: Select **Return** to return to the IF -- Task displays.

Action: Select **Graph Displays** from the menu at the bottom of the screen to view the Instructional Feature module results in graphic form.

The graph displays. This section of the Instructional Features Module contains three bar graphs, (a) a graph of the benefit-to-cost ratio for each instructional feature, (b) a graph of the benefit for each instructional feature, (c) a graph of the cost for each instructional feature, and one line graph. The first graph that appears is the Benefit / Cost Graph, as illustrated in Figure 28.

Current Task Cluster : fms1
Benefit / Cost Graph

Feature Wts Included   Task Wts Included



Reset/Reposition	7.4
Total System Free	6.2
Crash Override	4.4
Flight System Fre	2.4
Initial Condition	2.3
Procedure Monitor	2.3
Positional Freeze	2.1
Parameter Freeze	1.9
Scenario Control	1.5
Real-Time Simulat	1.4
Remote Graphics R	1.4
Automated Simulat	0.9
Record/Playback	0.7
Automated Perform	0.3
Adjunct CAI	0.3
Automated Cueing	0.3
etc.	

1 Benefit/Cost Graph		Comment	Print
2 Benefit Graph	Results Table	Help	Save Scr
3 Cost Graph	Assignment Lists	Model Menu	Toggle Scr
4 Cumulative B/C Graph			

Figure 28. Instructional Feature Benefit-to-Cost Bar Graph Screen.

This graph allows the user to scan the results of the module quickly and to assess the features with the highest benefit-to-cost ratios for the current task cluster. The legend shows how the Instructional Features are color coded and gives the benefit-to-cost ratio of each feature.

To select another graph, place the cursor on the number next to the desired graph and click the mouse. More detailed information on the costs of optimal packages is available to the user on the Cumulative B/C Graph (see Figure 29).

<u>**Action**</u>: Select **Cumulative B/C Graph** from the menu at the bottom of the screen by selecting the number **4**.

Line graph and saving results. The Line Graph is a graph of cumulative optimal benefit-to-cost packages of instructional features.

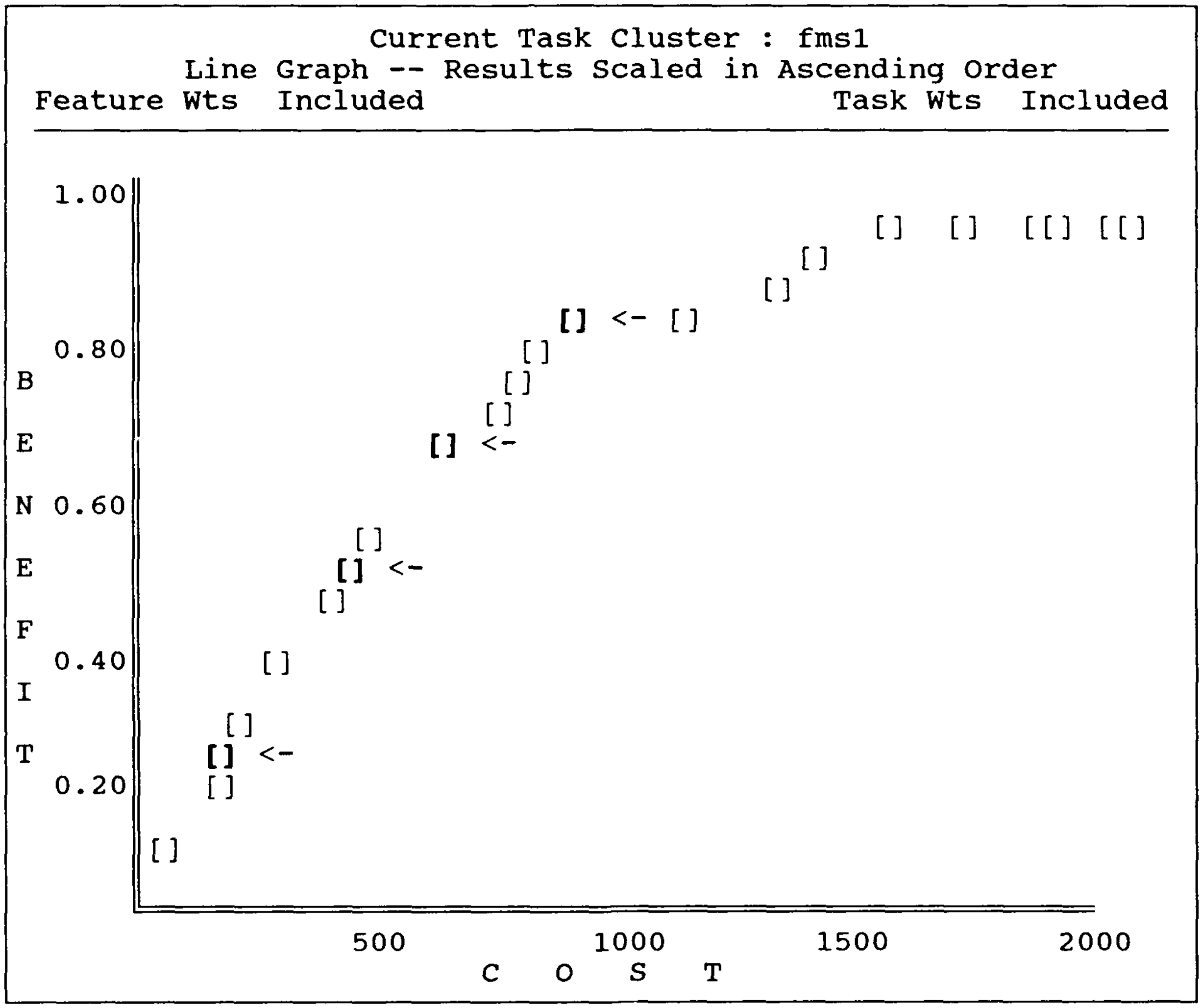


Figure 29. Instructional Feature Cumulative B/C Graph Screen.

The Cumulative Graph shows graphically the cost and normalized benefit of optimal packages of instructional features. The first non-zero point on the figure represents the cost and normalized benefit of the instructional feature with the highest benefit-to-cost ratio. In this example, the first point represents the feature Reset/Reposition. The second point represents the cumulative cost and benefit of the two features having the highest benefit-to-cost ratios, and so forth. The final point represents the cumulative cost and benefit of a package containing all the instructional features. These packages are the optimal combinations of features at a given cost.

The optimal package of instructional features can be determined from this graph as a function of the budget for instructional features. For example, if the budget for instructional features were $150K then the model would recommend incorporating four instructional features in the training device: Flight System Freeze, Crash Override, Total System Freeze, and Reset/Reposition. Of course, usually there will not be a budget designated for instructional features. In that case, you might choose several optimal packages of instructional features for evaluation in the Fidelity Optimization Module.

Any point on the graph can be saved for use in later modules as the minimum level of instructional features you will accept on the device you are designing. Points including the minimal features plus additional instructional features can be considered as higher-cost options in the device design.

Suppose that you accept the solution with both task weights and feature weights included. You also wish to choose a range of instructional features to be included in the Fidelity Optimization Module. Assume for this example that the minimum level that you will consider includes the first three instructional features, Reset/Reposition, Total System Freeze and Crash Override ($83K). Suppose you are also willing to consider the optional addition of other features to the minimum package. As a second level, you will consider the first three features plus Flight System Freeze, Initial Conditions, Procedure Monitoring and Positional Freeze ($325K). The third level includes the first and second levels plus Parameter Freeze and Scenario Control ($515K). The highest level of instructional features you will consider is the cumulative package including the first three packages and Real-time Simulation Variables Control, Remote Graphics Replay, Automated Simulation Demonstration and Record/Playback ($874K). These four options (the minimum option plus the three cumulative options) will then be incorporated in the Fidelity Optimization Module to obtain an overall training-device design.

For more information about a particular point on this graph, select the point of interest with the cursor and click the mouse. A window will appear on the screen containing information about the package represented by the point. You will now save four packages for use in designing a training device. These points are highlighted on the screen representation on pg. 59 and have arrows pointing towards them. In general, you may save a maximum of seven packages.

Action: Use the mouse to select the lowest point on the graph, which represents the feature with the highest benefit-to-cost ratio, Reset/Reposition.

Examine the data in the window that appears, it should look something like Figure 30.

```
  Included IF's
Reset/Reposition

Norm. Benefit = 0.11
Norm. Cost    = 0.01
Total Benefit = 0.11
Total Cost    =   30
```

Figure 30. Initial Included Instructional Feature Window.

One instructional feature is included in this package. The Normalized Benefit and Normalized Cost refer to the current feature, Reset/Reposition, the feature with the highest benefit-to-cost ratio. The Total Benefit and Total Cost reflect the cumulative benefit and cost of the current feature plus any features with higher benefit-to-cost ratios, of which there none. In this case the Total Cost is $30,000, the cost of Reset/Reposition. Assume that this package does not meet your minimum specifications so do NOT select SAVE.

Action: Use the mouse to select the third point (light blue), as indicated by an arrow on Figure 29.

When you select this package the Instructional Feature Selection Window will appear as shown in Figure 31.

```
  Included IF's
Crash Override
Total System Freeze
Reset/Reposition

Norm. Benefit = 0.06
Norm. Cost    = 0.01
Total Benefit = 0.24
Total Cost    =   83
```

Figure 31. Adjusted Instructional Feature Selection Window, after Second Selection.

Examine the data shown. The normalized benefit of Crash Override, the feature with the third highest benefit-to-cost ratio, is 0.06 and the normalized cost is 0.01. The total cost for the three instructional features included in this package is $83,000. Their total benefit is 0.24.

Action: Save this package by placing the cursor on **SAVE** and clicking the mouse.

A red window will appear in the middle of the graph with the prompt "Save as:". Use the keyboard to type in the name "IF1" (without the quotes). In general, package names should have a maximum of 12 characters and no spaces. Press the **ENTER** key when finished. The current package is saved as "IF1." An indication that the name has been accepted the message, "Saved as IF1" will be displayed.

Action: Use the mouse to select the seventh point (gray), as indicated by an arrow on Figure 29.

When you select this package the Instructional Feature Selection Window will appear as shown in Figure 32.

```
  Included IF's
Positional Freeze
Procedure Monitoring
Initial Conditions
Flight System Freeze
Crash Override
Total System Freeze
Reset/Reposition

Norm. Benefit = 0.03
Norm. Cost    = 0.02
Total Benefit = 0.50
Total Cost    =  325
```

Figure 32. Adjusted Instructional Feature Selection Window, after Third Package.

The data shown indicate that the normalized benefit of the Positional Freeze feature is 0.03 and the normalized cost is 0.02. The total cost for the seven instructional features included in this package is $325,000. Their total benefit is 0.50.

Action: Use the mouse to save this package by selecting **SAVE**.

Only the first SAVE requires you to enter a package name. When you save the remaining packages, the message "Saved as part of IF1" will appear on the screen.

Action: Use the mouse to select the ninth point (green), as indicated by an arrow on Figure 29.

When you select this package a window will appear as shown in Figure 33.

```
  Included IF's
Scenario Control
Parameter Freeze
Positional Freeze
Procedure Monitoring
Initial Conditions
Flight System Freeze
Crash Override
Total System Freeze
Reset/Reposition

Norm. Benefit = 0.11
Norm. Cost    = 0.07
Total Benefit = 0.64
Total Cost    =  515
```

Figure 33. Adjusted Instructional Feature Selection Window, after the Fourth Package.

The data shown indicate that the normalized benefit of the Scenario Control feature is 0.11 and the normalized cost is 0.07. The total cost for the nine instructional features included in this package is $515,000. Their total benefit is 0.64.

Action: Use the mouse to save this package.

Remember, only the first SAVE requires you to enter a package name. The message indicating that the package has been saved will again be displayed (see above).

Action: Use the mouse to select the thirteenth point (brown), as indicated by an arrow on Figure 29.

When you select this package data will appear as shown in Figure 34. The data indicate that the normalized benefit of the Record/Playback feature is 0.03 and the normalized cost is 0.04. The total cost for the thirteen instructional features included in this package is $874,000. Their total benefit is 0.84.

Action: Use the mouse to save this package.

```
  Included IF's
Record/Playback
Automated Simulator D
Remore Graphics Repl
Real-Time Simulation
Scenario Control
Parameter Freeze
Positional Freeze
Procedure Monitoring
Initail Conditions
Flight System Freeze
Crash Override
Total System Freeze
Reset/Reposition

Norm. Benefit = 0.03
Norm. Cost    = 0.04
Total Benefit = 0.84
Total Cost    =  874
```

Figure 34. Adjusted Instructional Feature Selection Window, after the Fifth Package.

Again, remember that only the first SAVE requires you to enter a package name. The "Saved as part of IF1" message will confirm the saved package.

<u>**Action**</u>: When you have completed examining the Cumulative B/C Graph and any other displays listed in the menu at the bottom of the screen, select **Model Menu** to return to the Instructional Features Menu (see Figure 18).

<u>Saving Changes and Exiting Module</u>

The last function of the Instructional Features Module, **SAVE** CHANGES, allows the user to save any changes made in the task cluster and instructional features set within the Instructional Features module. If you had made changes to the task cluster or instructional features set and wanted to save these changes, you would select SAVE CHANGES. You would then be asked to enter an eight-character alphanumeric name to represent the new task set and instructional feature set. You can access new data sets in the Task Cluster Library just as you selected to use the fms1 task cluster. If you had made changes to the task cluster or instructional feature set and did not select the SAVE CHANGES function, the program would remind you to save these changes with a SAVE option when you selected MODULE SELECTION MENU to exit the module.

Since you made no changes to the fms task cluster within this module and you are using the default instructional feature set you do not need to save anything.

Action: Select **Module Selection Menu** from the Instructional Features menu.

Fidelity Optimization Module

The Fidelity Optimization Module continues the training-device design process begun with the Instructional Feature Selection Module. The goal of the Fidelity Optimization Module is to specify the levels of technical sophistication on each of a set of fidelity dimensions to maximize the effectiveness of a training device given its development cost. The Fidelity Optimization Module may recommend several optimal training-device designs at different costs. The recommended designs are optimal in the sense that there are no designs that offer both greater effectiveness and lower cost. Each of the recommended designs can then be evaluated by the Training-Device Selection and Resource Allocation Modules. A second function of the Fidelity Optimization Module is to make tradeoffs between technical sophistication in presenting cues and response feedback and technical sophistication in instructional support. To accomplish this goal the Fidelity Optimization Module considers solutions to the Instructional Feature Selection Module as an additional variable in its evaluation.

In this example, we will evaluate the eleven candidate fidelity dimensions shown in Table 3 in order to design a training device for the FMS task cluster. Each of the fidelity dimensions may be represented at a number of levels as shown in the table. This model uses data concerning the cue and response requirements for each fidelity dimension to determine the benefit of each level of each dimension. Using cost formulas based upon the technical performance, cost measures are also calculated for each fidelity option. Then the fidelity options across all fidelity dimensions are ordered according to the incremental benefit-to-cost ratio and optimal simulators are defined for given levels of cost expended. You can select several simulator designs based upon specific levels of cost. These simulator designs can then be input to the next module, Training-Device Selection.

Prerequisites for This Module

Before proceeding with this section of the sample problem, be sure that (a) you have created the FMS task cluster described in the Simulation Configuration section, and (b) you have saved the Instructional Feature package (IF1) described in the Instructional Feature section. Refer to these sections if you have not done so. The Module Selection Menu should be displayed on the screen. As described in the first section and shown in Figure 6.

The Fidelity Optimization Module is demonstrated using the FMS task cluster developed in the Simulation Configuration module. If the Module Selection Menu does not indicate that the

Table 3. Dimensions and Levels Considered by the Fidelity Optimization Module

Dimension 1 - Visual Resolution

Level 1 - M2 at 0.3 km
Level 2 - M2 at 0.5 km
Level 3 - M2 at 1.0 km
Level 4 - M2 at 2.0 km
Level 5 - M2 at 3.0 km
Level 6 - M2 at 4.0 km

Dimension 2 - Visual Content

Level 1 - Plane with Trees
Level 2 - Add Generic Features
Level 3 - Realistic Density
Level 4 - Low Density Hydrographic features
Level 5 - Medium Density Hydrographic features
Level 6 - High Density Hydrographic features

Dimension 3 - Visual Texture

Level 1 - Lines and Polygons
Level 2 - Modulating Functions
Level 3 - Few Digitized Photographs
Level 4 - More Digitized Photographs
Level 5 - Many Digitized Photographs

Dimension 4 - Front Field of View

Level 1 - 40 x 40 degrees
Level 2 - 40 x 50 degrees
Level 3 - 40 x 60 degrees

Dimension 5 - Side Field of View

Level 1 - 40 x 40 degrees
Level 2 - 40 x 50 degrees
Level 3 - 50 x 50 degrees
Level 4 - 50 x 60 degrees
Level 5 - 40 x 50 degrees - two sides
Level 6 - 40 x 60 degrees - two sides
Level 7 - 50 x 60 degrees - two sides

Table 3 (continued). Dimensions and Levels Considered by the Fidelity Optimization Module

---

Dimension 6 - Special Effects - Points

Level 1 - None
Level 2 - Cultural Lights
Level 3 - Add Weapons Blast
Level 4 - Add Damaged Vehicles
Level 5 - Add Airborne Vehicles
Level 6 - Add Moving Ground Vehicles

Dimension 7 - Special Effects - Area

Level 1 - None
Level 2 - Smoke and Dust
Level 3 - Rotor Wash

Dimension 8 - Motion Platform

Level 1 - None
Level 2 - 3 degrees of freedom
Level 3 - 5 degrees of freedom
Level 4 - 6 degrees of freedom

Dimension 9 - Seat Motion

Level 1 - Stationary
Level 2 - Seat Shaker
Level 3 - Add G-Seat

Dimension 10 - Audio Effects

Level 1 - None
Level 2 - Weapons, Skid, Failures
Level 3 - Add Normal Operating Noise
Level 4 - Add Abnormal Operating Noise

Dimension 11 - Data Base Size

Level 1 - 5 x 5 km
Level 2 - 10 x 10 km
Level 3 - 10 x 20 km
Level 4 - 10 x 30 km
Level 5 - 20 x 30 km
Level 6 - 30 x 30 km
Level 7 - 30 x 40 km

---

current task cluster is fms1 then refer to the section on starting the Instructional Features Module (Figure 17) for instructions on how to select the correct task cluster. After selecting the correct task cluster, you will return to the Module Selection Menu as shown in Figure 6.

Starting the Fidelity Optimization Module

Action: Select **Fidelity Optimization** and click the mouse. The Fidelity Optimization Menu will appear on the screen, as shown in Figure 35.

Current Task Cluster: fms1 Fidelity Optimization Menu
Include Inst. Features Results Examine/Edit Task Cluster Constrain Fidelity Dimensions Display Results Save Changes Module Selection Menu

Figure 35. Fidelity Optimization Menu Screen.

Including Instructional Features

The following procedure allows you to incorporate the results of the Instructional Features Selection Module in the current analysis to develop a design that incorporates fidelity dimensions and instructional features.

Action: Select **Include Instructional Features Results** from the Fidelity Optimization Menu and click the mouse.

The screen should look something like Figure 36. The list could contain many instructional feature packages, and should have the example package "if1" listed.

Since we want to include the instructional features package "if1", that package must be selected.

[] [1] ifout --> if1
Cancel

Figure 36. Instructional Feature Package Selection Screen.

Action: Select the **number adjacent to the name** you gave to the instructional features package you saved in the Instructional Features module (IF1) and click the mouse.

The following will appear:

Use ifout#, instructional feature set (y/n)>

The number sign (#) will be replaced by the ifout package number (e.g., ifout1). Enter **'y'** on the keyboard and press ENTER. The features will now be included in the optimization. The Fidelity Optimization menu will reappear.

Editing the Task Set

In the sample problem, we will design an FMS trainer, and that is why we are using the FMS task cluster in this module.

Action: Select **Examine/Edit Task Cluster** from the Fidelity Optimization Menu and click mouse. The Task Inclusion/Exclusion screen will be displayed.

The following tasks should appear on the left side of the screen:

1014, 1015, 1019, 1022, 1026, 1048, 1054, 1056
1057, 1058, 1061, 2000, 2003, 2004, 3010

Verify that the tasks listed above are in the Included column. Refer to the earlier subsection on editing task sets for instructions on editing the task cluster if the tasks are not in the correct columns (see Figure 19). When finished, return to the Fidelity Optimization Menu.

Action: Select **Main Menu** from the menu at the bottom of the screen.

Constraining Fidelity Dimensions

Action: Select **Constrain Fidelity Dimensions** from the Fidelity Optimization menu.

The Fidelity Dimension Constraint Display will appear, with the fidelity dimensions listed down the left side of the screen (see Figure 37). This screen allows you to discard specific intermediate options of any fidelity dimension. The following actions demonstrate the elimination of G-Force simulation from the model.

Fidelity Dimension Constraint Display		
	Dimensions	Levels
1.	Visual_Resol.	1 2 3 4 5 6
2.	Visual_Content	1 2 3 4 5 6
3.	Visual_Texture	1 2 3 4 5
4.	Visual_Front	1 2 3
5.	Visual_Side	1 2 3 4 5 6 7
6.	Point_Effects	1 2 3 4 5 6
7.	Area_Effects	1 2 3
8.	Platform_Mot.	1 2 3 4
9.	Seat_Motion	1 2 3
10.	Sound_Effects	1 2 3 4
11.	Map_Size	1 2 3 4 5 6 7
12.	inst_features	1 2 3 4 5

Main Menu

Figure 37. Fidelity Dimension Constraint Screen.

Action: Select **9. Seat Motion** by positioning the cursor on the "9" highlighted in yellow and clicking the mouse.

The three levels for seat motion simulation should be displayed on the right side of the screen, as shown in Figure 38.

Selected Dimension: 9 Seat Motion

Lvl	Description	Cost	Benefit
1	Stationary	0.00	0.00
2	Seat Shaker	67.88	7.57
3	Add G-Seat	192.00	8.17

Figure 38. Dimension Level Description Window - Seat Motion.

Action: To eliminate G-Seat from the Seat Motion dimension, position the cursor on the "3" highlighted in yellow and click the mouse.

The third level should now be highlighted in red, indicating that this option has been eliminated from the model.

Action: Select the "3" again and click the mouse.

The color changes to white, indicating that this option is again included in the model.

Action: Select **Main Menu** and click the mouse.

The Fidelity Optimization Menu will reappear on the screen.

Display Results

Action: Select **Display Results** and click the mouse.

The graph of cost and benefit of optimal training-device designs will appear on the screen, and appear as depicted in Figure 39. The Display Results section of the module will use the FMS task cluster to calculate which levels of the fidelity dimensions offer the greatest benefit given the development cost.

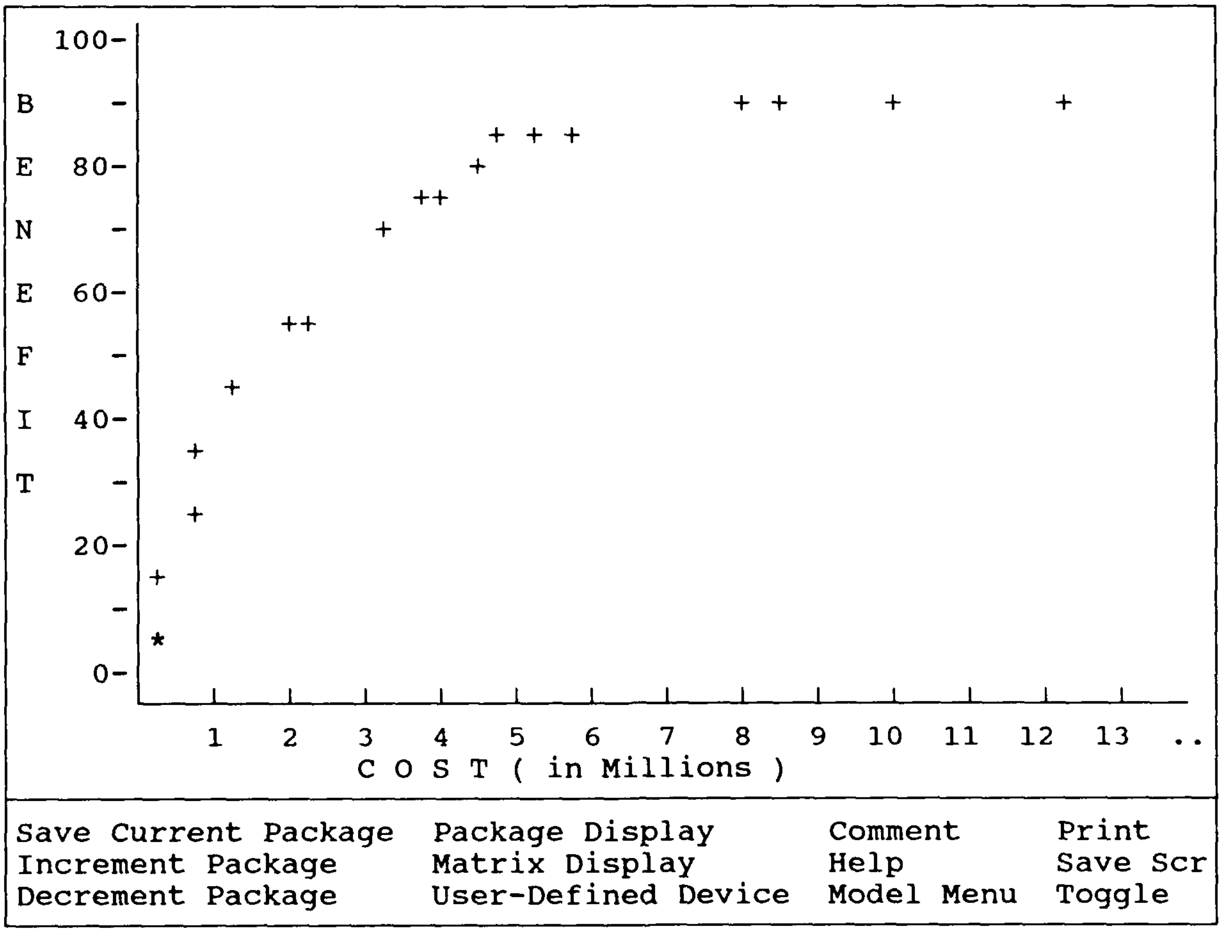


Figure 39. Fidelity Optimization Results Graphical Display Screen.

Graph display. This graph is a plot of optimal training-device designs, by benefit and cost. Each point represents the design that has the greatest benefit at that cost. You can access specific designs at different costs.

The yellow asterisk represents the "current" optimal training-device design. This yellow coloring will always indicate the current package in all of the displays. When you select Package Display from the menu, the details of the current design will be displayed in tabular form. However, before examining the training device designs we will look at the data that support the Fidelity Optimization module.

<u>**Action**</u>: Select **Matrix Display** from the menu at the bottom of the screen.

<u>Matrix display</u>. The screen entitled "Matrix Display of All Packages" should be displayed, and look something like Figure 40. The matrix display shows Benefit-to-Cost ratios for all fidelity-dimension levels.

Current Task Cluster : fms1
Matrix Display of All Packages
Dimension Wts Included Task Wts Included

Benefit/Cost Ratio
(x 100)

Level	1	2	3	4	5	6	7
Visual_Resol.	undef	----	----	----	0.12	----	
Visual_Content	undef	0.88	0.01	----	----	----	
Visual_Texture	undef	----	----	1.36	----		
Visual_Front	undef	2.49	0.13				
Visual_Side	undef	----	----	----	1.64	----	0.07
Point_Effects	undef	----	----	----	----	2.76	
Area_Effects	undef	4.51	----				
Platform_Mot.	undef	----	0.00	----			
Seat_Motion	undef	11.16	0.48				
Sound_Effects	undef	----	11.13	0.95			
Map_Size	undef	0.66	----	----	0.00	----	----
inst_features	undef	0.78	0.54	0.40			

<u>Display Options</u>
1. Description
2. Cost
3. Benefits
4. B/C Ratio
5. % of Cost
6. % of Benefit

*** Current Package
*** Excluded Options

Figure 40. Fidelity Optimization Matrix Display - Benefit/Cost Screen.

The fidelity dimensions are listed in the left column and the seven levels are identified across the top of the matrix. In OSBATS the optimal fidelity-dimension levels are selected according to the incremental benefit-to-cost ratios (the incremental benefit of a given level divided by its incremental cost), as shown in Figure 40. Level 1 is always "undefined" because the measurements are made for increments from one level to the next. Since the benefit-to-cost ratios within a dimension must be decreasing, the module eliminates those levels that are not cost-efficient within each dimension. For example, the benefit-to-cost ratio for the increment from the first to the second level of the Sound Effects dimension is less than the increment from the second level to the third. In this case, the module eliminates the second level from consideration. It then recalculates the benefit-to-cost ratio for the increment from the first level to the third level in order to include the increment from the first to the second level. Entries highlighted in yellow represent benefit-to-cost ratios of the levels used in the "current" design (the design that was represented by a yellow asterisk on the Graph Display). Entries highlighted in red represent the levels that are eliminated by the user in the Constrain Fidelity Dimensions section.

Action: Select number **1** for **Description** from the Display Options and click the mouse.

The screen will appear as shown in Figure 41.

Current Task Cluster : fms1
Matrix Display of All Packages
Dimension Wts Included Task Wts Included

Level	Description 1 2 3 4 5 6 7
Visual_Resol.	Distance at which a standardized unit can be..
Visual_Content	Density of the visual scene content
Visual_Texture	Degree of texturing of visual scene objects
Visual_Front	Visual angle in horiz. and vert. dimensions..
Visual_Side	Visual angle in horiz. and vert. dimensions..
Point_Effects	Level of special effects at a point in vis..
Area_Effects	Level of special effects across areas of vis..
Platform_Mot.	Number of degrees of freedom in platform mot..
Seat_Motion	Degree of force cueing on training device seat
Sound_Effects	Complexity of sound effects available
Map_Size	Size of the simulator's terrain data base
inst_features	Instructional support features of the simul..

Figure 41. Fidelity Optimization Matrix Display - Description Screen.

The Description Screen of the Matrix Display provides a one-line description of each listed dimension.

Action: Select number **2** for **Cost** from the Display Options and click the mouse.

The cost screen will appear, as depicted in Figure 42.

Current Task Cluster : fms1
Matrix Display of All Packages
Dimension Wts Included Task Wts Included

Costs

Level	1	2	3	4	5	6	7
Visual_Resol.	50	887	1744	2235	2391	2471	
Visual_Content	80	496	942	1424	1947	2520	
Visual_Texture	75	393	758	1108	1344		
Visual_Front	20	403	1103				
Visual_Side	10	43	85	121	194	248	319
Point_Effects	0	38	79	167	318	504	
Area_Effects	0	147	336				
Platform_Mot.	0	1173	2084	3024			
Seat_Motion	0	67	192				
Sound_Effects	0	43	96	192			
Map_Size	100	634	918	1216	1855	2564	3360
inst_features	83	325	515	874			

Figure 42. Fidelity Optimization Matrix Display - Cost Screen.

The estimated costs are shown in this screen. (In the screen representation shown in Figure 42, the decimals are dropped to conserve space.) These costs are estimated directly from technical performance using an equation that assumes that low levels of technical performance can be obtained relatively cheaply compared to a level of performance that is closer to the state of the art. The cost estimates represent development cost only.

Action: Select number **3** for **Benefit** from the Display Options and click the mouse.

The screen will appear as shown in Figure 43. The Fidelity Optimization module solution is based on estimates of cost and benefit for the fidelity-dimension levels. The benefit values shown in this screen are based on the number of tasks that can be trained at each level of each dimension. That is, for a given level of a fidelity dimension, the benefit is based on the number of tasks for which the technical performance of that level is at

Current Task Cluster : fms1 Matrix Display of All Packages Dimension Wts Included				Task Wts Included			
		Benefit					
Level	1	2	3	4	5	6	7
Visual_Resol.	0.00	0.40	0.40	1.20	2.92	2.92	
Visual_Content	0.00	3.68	3.73	3.73	3.73	3.73	
Visual_Texture	0.36	1.60	1.60	14.38	14.38		
Visual_Front	0.01	9.57	10.49				
Visual_Side	1.86	1.86	2.10	2.13	4.88	4.88	4.97
Point_Effects	1.77	2.37	2.37	2.37	2.37	15.70	
Area_Effects	1.18	7.81	7.81				
Platform_Mot.	0.75	0.77	0.81	0.81			
Seat_Motion	0.00	7.57	8.17				
Sound_Effects	0.00	0.00	10.71	11.62			
Map_Size	0.09	3.63	3.63	3.63	3.66	3.66	3.66
inst_features	1.69	3.58	4.60	6.03			

Figure 43. Fidelity Optimization Matrix Display - Benefit Screen.

least as great as the corresponding task cue and response requirement.

There are conditions in which you may decide it is inappropriate to use task weights. For example, if the goal of a training device is to provide familiarization training on a variety of tasks, the task weights, which are based on the total cost of training the tasks to criterion, may not be appropriate. In this case, an unweighted average of tasks may more accurately represent the benefit of a fidelity dimension. To demonstrate the feature perform the following actions.

Action: Select **Task Wts Included**, in the upper right corner of the screen, and click the mouse.

The screen indicates the task weights are now excluded from the analysis. There should be a change in the displayed results.

Action: Since we want to include the task weights in the analysis select **Task Wts Excluded** and click mouse.

The screen should indicate that task weights are again included. When the benefit values change due to a change in the weights, the ordering of the optimal designs also changes. Therefore, the "current" package (i.e., the package highlighted in yellow) will always be reset to the lowest level in each dimension.

The fidelity dimension weights reflect the relative importance of the fidelity dimensions. A weight is high for a dimension if most of the tasks have high cue and response requirements for that dimension. The weights tend to correct for the effects of the simplifying assumptions that are used in the Fidelity Optimization Module. There may be situations, however, in which you want to examine the results with just the task weights included. For example, you may want to compare the number of task requirements that are met for different fidelity dimensions. In this case, you can select to exclude dimension weights and weight all fidelity dimensions equally.

<u>**Action**</u>: Select **Dimension Wts Included** and click the mouse.

The screen and results should indicate that the dimension weights are now excluded from the analysis.

<u>**Action**</u>: Select **Dimension Wts Excluded** and click mouse.

The screen and results should indicate that the dimension weights are again included.

<u>**Action**</u>: Select number **4** for **B/C Ratio** and click the mouse.

This should return to the Benefit-to-Cost Ratio screen.

<u>**Action**</u>: Select number **5** for **% Cost** and click the mouse.

The screen should now display the percentage of cost for each fidelity-dimension level, as shown in Figure 44. This display shows the costs as a percentage of the cost for the highest active level of each fidelity dimension. This information can help you determine the relative impact on cost of the various levels of a single fidelity dimension.

Current Task Cluster : fmsl Matrix Display of All Packages Dimension Wts Included Task Wts Included							
	% of Cost						
Level	1	2	3	4	5	6	7
Visual_Resol.	0.02	0.36	0.71	0.90	0.97	1.00	
Visual_Content	0.03	0.20	0.37	0.57	0.77	1.00	
Visual_Texture	0.06	0.29	0.56	0.82	1.00		
Visual_Front	0.02	0.37	1.00				
Visual_Side	0.03	0.14	0.27	0.38	0.61	0.78	1.00
Point_Effects	0.00	0.08	0.16	0.33	0.63	1.00	
Area_Effects	0.00	0.44	1.00				
Platform_Mot.	0.00	0.39	0.69	1.00			
Seat_Motion	0.00	0.35	1.00				
Sound_Effects	0.00	0.23	0.50	1.00			
Map_Size	0.03	0.19	0.27	0.36	0.55	0.76	1.00
inst_features	0.10	0.37	0.59	1.00			

Figure 44. Fidelity Optimization Matrix Display - Percent of Cost Screen.

Action: Select number **6** for **% of Benefit** and click the mouse.

The screen should appear as depicted in Figure 45. This display shows the relative benefits of the fidelity-dimension levels. The benefit of each level of a dimension is divided by the benefit of the highest active level within the dimension. Thus, the percent benefit of the highest level of a dimension is always 1.00. This information can be used in conjunction with the percentage-of-cost display to understand why certain levels of a fidelity dimension were chosen by the model while others were eliminated.

Current Task Cluster : fmsl
Matrix Display of All Packages
Dimension Wts Included Task Wts Included

	% of Benefit						
Level	1	2	3	4	5	6	7
Visual_Resol.	0.00	0.14	0.14	0.41	1.00	1.00	
Visual_Content	0.00	0.98	1.00	1.00	1.00	1.00	
Visual_Texture	0.03	0.11	0.11	1.00	1.00		
Visual_Front	0.00	0.91	1.00				
Visual_Side	0.37	0.37	0.42	0.43	0.98	0.98	1.00
Point_Effects	0.11	0.15	0.15	0.15	0.15	1.00	
Area_Effects	0.15	1.00	1.00				
Platform_Mot.	0.93	0.95	1.00	1.00			
Seat_Motion	0.00	0.93	1.00				
Sound_Effects	0.00	0.00	0.92	1.00			
Map_Size	0.03	0.99	0.99	0.99	1.00	1.00	1.00
inst_features	0.28	0.59	0.76	1.00			

Figure 45. Fidelity Optimization Matrix Display - Percentage of Benefit Screen.

Action: Select **Graphical Display** and click the mouse.

The graph of optimal training-device designs will appear on the screen (see Figure 46). Recall that the yellow asterisk represents the "current" optimal training-device design. When you select Package Display from the menu, the details of the current design will be displayed in tabular form. For this example, assume you have a development budget of $7 million.

Action: Select **Increment Package** from the menu at the bottom of the screen and click the mouse one time.

The yellow asterisk should advance one point. Each time the mouse is clicked the yellow asterisk will move to the next higher point. Each time the mouse is clicked while the cursor is positioned over Decrement Package the opposite will happen. Because of limits in the resolution of the graph, the yellow asterisk will disappear occasionally when it is overwritten by another point.

Action: Select **Increment Package** and continue to click the mouse until the yellow asterisk is close to the $7 million point (**boldfaced**, and indicated by an arrow in Figure 46) but does not exceed it.

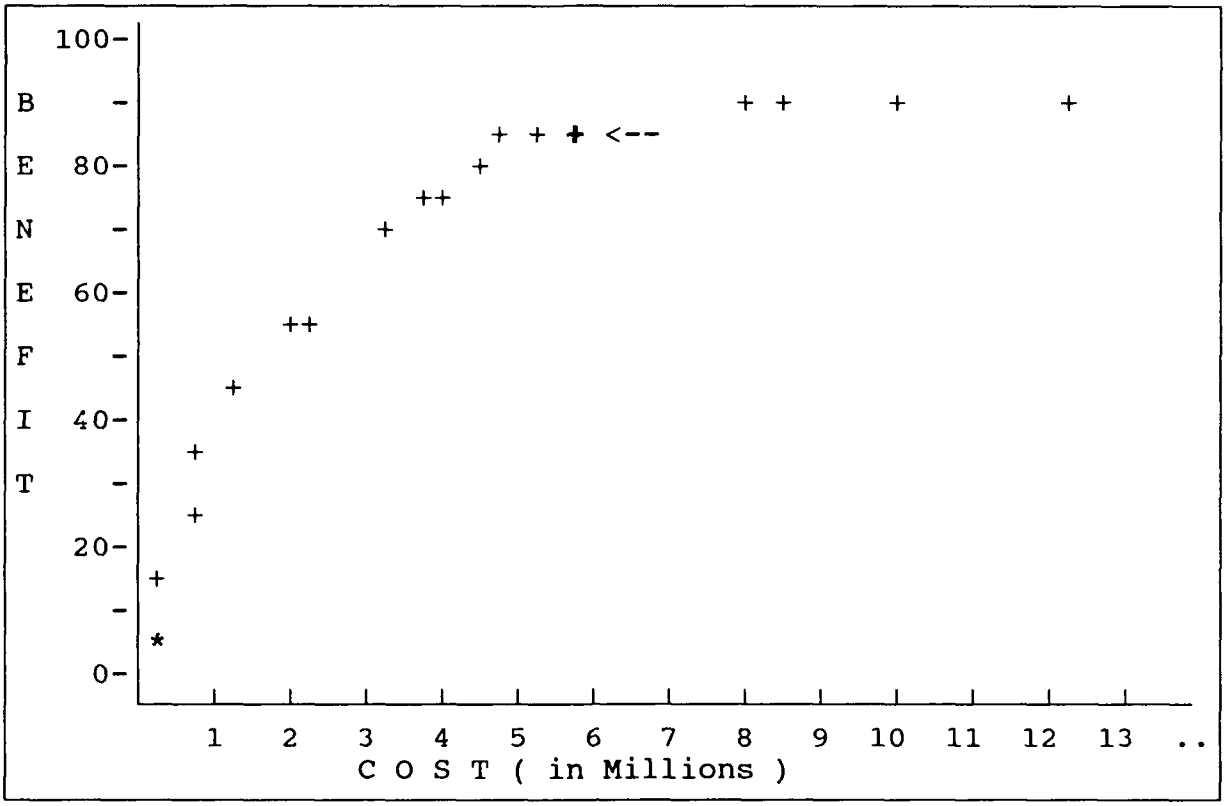


Figure 46. Fidelity Optimization Results Graphical Display Screen - 7 Million Dollar Package.

<u>Optimal training-device design package display</u>. The package display shows the levels of each fidelity dimension for a specified optimal design.

<u>Action</u>: Select **Package Display** from the menu at the bottom of the screen.

The optimal training-device design for the "current package" should be displayed on the screen as illustrated in Figure 47.

This design has an estimated development cost of $5.5 million. The column furthest left is a list of the fidelity dimensions. Next to each fidelity dimension is the number and description of the level selected for this particular design. The benefit and cost columns refer to the selected level.

This design is under the budget by $1.5 million. To examine the next most expensive optimal design perform the following action.

		Package Display		
Dimension Wts	Included		Task Wts	Included
		Current Package		
Dimension	Level	Description	Benefit	Cost
Visual_Resol.	1	m2 at 0.3 km	0.0	50.00
Visual_Content	2	Add Generic Featrs	3.7	496.08
Visual_Texture	4	More Digit Ph	14.4	1108.32
Visual_Front	3	40 x 60 Deg	10.5	1103.93
Visual_Side	5	40 x 50 Deg	4.9	194.67
Point_Effects	6	Add Mvng Grnd Veh	15.7	504.00
Area_Effects	2	smoke and dust	7.8	147.22
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	3	Add G-Seat	8.2	192.00
Sound_Effects	4	Add abnor opt nse	11.6	192.00
Map_Size	2	10 x 10 km	3.6	634.40
inst_features	4	Inst Feat, Lev 4	6.0	874.00
Totals			87.1	5496.62
			Enter Cost Constraint	

Save Current Package	Graphical Display	Comment	Print
Increment Package	Matrix Display	Help	Save Scr
Decrement Package	User-Defined Device	Model Menu	Toggle

Figure 47. Fidelity Optimization Package Display Screen - 5.4 Million Dollar Package.

__Action__: Select **Increment Package** and click the mouse one time.

The next highest design should be displayed, as shown in Figure 48.

This design is considerably over the budget, with a cost of approximately $7.8 million. Examination of the two designs shows that the more expensive design includes a significantly better Visual Resolution system than the less expensive design. The cost of the enhancement is the difference between $2391K (Level 5) and $50K (Level 1), or $2.3 million. Given these estimates, you would probably wish to examine whether there are other useful ways to fill the $1.5 million gap between the recommended solution, a $5.5 million design, and the $7 million budget.

Suppose you decide to eliminate the enhanced visual resolution system levels from consideration. The training-

Dimension	Level	Description	Benefit	Cost
Visual_Resol.	5*	m2 at 3.0 km	2.9	2391.12
Visual_Content	2	Add Genric Featrs	3.7	496.08
Visual_Texture	4	More Digit Ph	14.4	1108.32
Visual_Front	3	40 x 60 Deg	10.5	1103.93
Visual_Side	5	40 x 50 Deg	4.9	194.67
Point_Effects	6	Add Mvng Grnd Veh	15.7	504.00
Area_Effects	2	smoke and dust	7.8	147.22
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	3	Add G-Seat	8.2	192.00
Sound_Effects	4	Add abnor opt nse	11.6	192.00
Map_Size	2	10 x 10 km	3.6	634.40
inst_features	4	Inst Feat, Lev 4	6.0	874.00
Totals			90.1	7837.74

Enter Cost Constraint

Figure 48. Fidelity Optimization Package Display Screen - 7.8 Million Dollar Package.

device designs will be recalculated and the $1.5 million formerly designated for visual resolution can be allocated to other options. You can accomplish this by returning to Constrain Fidelity Dimensions.

__Action__: Select **Model Menu** from the menu at the bottom of the screen to return to the Fidelity Optimization menu. From the menu select **Constrain Fidelity Dimensions.**

The Fidelity Dimension Constraint screen should be displayed, as shown in Figure 37.

__Action__: Select **1. Visual_Resol.** from the left side of the screen. (See the earlier presentation on Constraining Fidelity Dimensions for a detailed presentation.)

The six levels for this dimension are displayed on the right of the screen as shown in Figure 49.

Selected Dimension : 1 Visual_Resol.

Lvl	Description	Cost	Benefit
1	m2 at 0.3 km	50.00	0.00
2	m2 at 0.5 km	887.71	0.40
3	m2 at 1.0 km	1744.05	0.40
4	m2 at 2.0 km	2235.88	1.20
5	m2 at 3.0 km	2391.12	2.92
6	m2 at 4.0 km	2471.59	2.92

Figure 49. Dimension Level Description Window - Visual Resolution.

Action: Use the mouse to eliminate levels 4, 5 and 6.

The three eliminated levels will be highlighted in red. The module will now recalculate optimal designs without considering the top three levels of visual resolution.

Action: Select **Main Menu** from the bottom of the screen to return to the Fidelity Optimization menu.

Action: Select **Display Results** from the Fidelity Optimization menu to recalculate the data.

The Display Results screen should be displayed. Note that the points on the graph have moved.

Action: Select **Package Display** from the menu at the bottom of the screen.

The Optimal Training-Device Design for the lowest cost package should be displayed on the screen. The Package Display provides a feature for entering a specific cost constraint through use of the keyboard. This feature can be used as an alternative to using the Increment/Decrement Package feature. To demonstrate the feature perform the following action.

Action: 1. Position the cursor over the **Enter Cost Constraint** label and click the cursor.

2. Type in the dollar figure in thousands using the keyboard. Enter 7000 for $7 million.

3. Press **Enter**.

The module finds the package on the curve that has the greatest benefit without going over the specified constraint and displays the results on the screen. The screen should show a $6.9 million design matching Figure 50.

Dimension	Level	Description	Benefit	Cost
Visual_Resol.	2	m2 at 0.5 km	0.4	887.71
Visual_Content	3	Realistic Densty	3.7	942.64
Visual_Texture	4	More Digit Ph	14.4	1108.32
Visual_Front	3	40 x 60 Deg	10.5	1103.93
Visual_Side	7	50 x 60 Deg	5.0	319.68
Point_Effects	6	Add Mvng Grnd Veh	15.7	504.00
Area_Effects	2	smoke and dust	7.8	147.22
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	3	Add G-Seat	8.2	192.00
Sound_Effects	4	Add abnor opt nse	11.6	192.00
Map_Size	2*	10 x 10 km	3.6	634.40
inst_features	4	Inst Feat, Lev 4	6.0	874.00
Totals			87.7	6905.89

Enter Cost Constraint

Figure 50. Fidelity Optimization Package Display Screen - 7 Million Dollar Cost Constraint.

Note that the recommended design now includes the second level of visual resolution, which costs an additional $837,000 over the first level. It also includes an additional level of the dimension Visual Content, at the additional cost of $450,000, and two additional levels of the dimension Side Field-of-View, for $125,000. The total additional cost over the $5.5 million dollar design is $1.4 million. This is an example of how it is possible to reallocate funds to different dimensions by eliminating levels you do not wish to include.

We will use this design in the Training-Device Selection module.

Action: Select **Save Current Package** from the menu at the bottom of the screen.

A window will appear. Type in a device name, such as "seven_mill," using a maximum of 20 characters. The name must always begin with a letter. Press enter, and the current package is saved as "seven_mill".

In addition to saving a $7 million optimal design for further evaluation, save a $3 million optimal design for comparison. These two designs will be used as the basis of the analyses performed later in the Training-Device Selection Module.

Action: 1. Position the cursor over the **Enter Cost Constraint** label and click the mouse.

2. Type in the dollar figure for the constraint using the keyboard. Type **3000**.

3. Press **ENTER**.

The module finds the package on the curve that has the greatest benefit without going over the specified constraint, as shown in Figure 51.

Dimension	Level	Description	Benefit	Cost
Visual_Resol.	1	m2 at 0.3 km	0.0	50.00
Visual_Content	1*	Plane w/ Trees	0.0	80.00
Visual_Texture	4	More Digit Ph	14.4	1108.32
Visual_Front	2	40 x 50 Deg	9.6	403.27
Visual_Side	5	40 x 50 Deg	4.9	194.67
Point_Effects	6	Add Mvng Grnd Veh	15.7	504.00
Area_Effects	2	smoke and dust	7.8	147.22
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	2	Seat Shaker	7.6	67.88
Sound_Effects	4	Add abnor opt nse	11.6	192.00
Map_Size	1	5 x 5 km	0.1	100.00
inst_features	1	Inst Feat, Lev 1	1.7	83.00
Totals			74.1	2930.36

Figure 51. Fidelity Optimization Package Display Screen - 3 Million Dollar Cost Constraint.

Action: Select **Save Current Package**. Type in a device name, such as "three_mill." Press **ENTER**.

User-defined device. Suppose you are satisfied with the $7 million dollar design except that you would like to replace the high level of instructional features with greater visual resolution. (Recall that in the $7 million design the instructional features dimension is at the fourth and highest level.) You can create and test a device design to include the first level of instructional features and the third level of visual resolution. This design is not one of the optimal designs selected by the module.

Action: Select **User-Defined Device** from the menu at the bottom of the screen.

The User-Defined Package Display will appear, as shown in Figure 52.

Current Task Cluster User Defined Package Display Dimension	Level	Description	Benefit	Cost
Visual_Resol.	1	m2 at 0.3 km	0.0	50.00
Visual_Content	1	Plane w/ Trees	0.0	80.00
Visual_Texture	1	Lines+Polygons	0.4	75.00
Visual_Front	1	40 x 40 Deg	0.0	20.00
Visual_Side	1	40 x 40 Deg	1.9	10.00
Point_Effects	1	none	1.8	0.00
Area_Effects	1	none	1.2	0.00
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	1	Stationary	0.0	0.00
Sound_Effects	1	none	0.0	0.00
Map_Size	1	5 x 5 km	1.0	100.00
inst_features	1	Inst Feat, Lev 1	1.7	83.00
Totals			7.7	418.00
Save This Package Compare Graphically				

Figure 52. Fidelity Optimization User Defined Package Display Screen.

This screen can show the cost and benefit of user-defined devices. You can represent one or more user-defined devices as points on the Graph Display of optimal training-device designs. The following action will demonstrate this feature.

By repeatedly selecting the yellow area labeled "Level" corresponding to a particular dimension you can circulate through the available levels. However, you cannot decrease levels. To return to a lower level, continue to increase the level until it is 1 again.

Action: Recreate the $7 million design with the level of the Instructional Features dimension decreased to 1 and the level of Visual Resolution increased to 3, as instructed below:

1) Increase the level for Visual_Resol. to 3.

2) Increase the level of Visual_Content to 3.

3) Continue to increase the levels for each dimension until the results match those shown in Figure 53.

Dimension	Level	Description	Benefit	Cost
Visual_Resol.	3	m2 at 1.0 km	0.4	1744.05
Visual_Content	3	Realistic Dens	3.7	942.64
Visual_Texture	4	More Digit Ph	14.4	1108.32
Visual_Front	3	40 x 60 Deg	10.5	1103.93
Visual_Side	7	50 x 60 Deg	5.0	319.68
Point_Effects	6	Add Mvng Grnd Veh	15.7	504.00
Area_Effects	2	smoke and dust	7.8	147.22
Platform_Mot.	1	none	0.8	0.00
Seat_Motion	3	Add G-Seat	8.2	192.00
Sound_Effects	4	Add abnor opt nse	11.6	192.00
Map_Size	2	10 x 10 km	3.6	634.40
inst_features	1	Inst Feat, Lev 1	1.7	83.00
Totals			83.4	6971.22

Current Task Cluster
User Defined Package Display

Save This Package
Compare Graphically

Figure 53. Fidelity Optimization User Defined Package - 7 Million Dollar Package.

Notice that this package also costs $7 million. In order to compare this design to the system-defined designs perform the following action:

Action: Select **Compare Graphically** from the menu and click the mouse.

The aggregate cost of the selected levels is displayed on the Graph Display of optimal training-device designs as a point labeled "P". Notice that "P" falls below the curve of optimal designs. Any device other than the system-defined devices will fall below the curve. You can conclude that (according to the model information and manipulations) the fourth level of instructional features provides relatively more benefit with respect to cost than the third level of Visual Resolution.

Action: Select **Return** to return to the User-Defined Device screen.

Like other training-device designs developed in this module, the user-defined designs can be saved for evaluation in the Training-Device Selection Module. To save a user-defined device, you would select SAVE THIS PACKAGE from the menu. The module would prompt for a keyboard entry of a device name with the prompt "Save As:". You would enter a name with fewer than 20 characters and press the <ENTER> key. For the sample problem, do not save any user-defined packages.

Action: Select **Model Menu** to return to the Fidelity Optimization Menu.

Saving Changes and Exiting the Module

The last function of the Fidelity Optimization module is called Save Changes. You would select SAVE CHANGES if you had made changes to the task cluster that you wished to save or if you wished to save a given set of constraints. The information would be stored in a file. To retrieve the information you would go to the Task Cluster Library and select the task cluster with the appropriate name.

When you select Save Changes the system prompts you for a keyboard entry of a file name. File names can have up to 8 alphanumeric characters. Underscores (_) can be used. Do NOT use spaces as a part of the file name. All keyboard entries are entered by pressing <ENTER>.

Do not select Save Changes since you made no changes to the task cluster and it is not necessary to save the constraints. You already saved your training device designs by using the menu option SAVE PACKAGE, which is appropriate for saving designs without saving the task cluster. These designs will only be accessible in the Training Device Selection module. You will not find them listed in the Task Cluster Library.

Action: Select **Module Selection Menu** to exit the module.

Training-Device Selection Module

The Training-Device Selection Module takes as input a set of candidate training devices for the set of tasks. These training devices include full-mission simulators, part-mission simulators, and other training devices designed by the Instructional Feature Selection and Fidelity Optimization Modules. Also included are definitions of existing training devices or templates describing training-device prototypes. Unless you are considering the purchase of two different full-mission simulators, this module should be exercised separately for each FMS defined in the Fidelity Optimization Module. The Training-Device Selection Module then minimizes the cost to train each task with available devices, using learning curve data for each task and training-device combination with learning assumptions. The output of this model is the aggregated usage of each training device across all tasks. This module does not consider complex cost functions or task interactions in determining the optimal assignment of training devices to tasks; this more complex task is performed by the Resource Allocation Module.

In this example, we will compare the two FMS candidates developed in the Fidelity Optimization Module in a training system that consists of actual equipment, other training devices, and classroom. The complete list of available training devices and their abbreviated names is shown below. For simplicity, the example analyses will focus on small subsets of these training devices. For each subset of training devices, the module calculates the minimum cost to meet the training requirements using the specified training devices. You may then examine which tasks are assigned to which device and the extent to which each device is used to modify the subset of training devices being considered.

Table 4. Training Devices Evaluated by the Training-Device Selection Module

Abbreviation	Training Device Name
CLASSROOM	Classroom Trainer
CPT	Cockpit Procedures Trainer
DOPPLER	Doppler Navigation Trainer
IMC FT	Instrument Conditions Flight Trainer
VMC FT	Visual Conditions Flight Trainer
WEAPON	Weapon System Procedures Trainer
NOE NAV	Nap-of-the-Earth Navigation Trainer
ACT EQUIP	Actual Equipment
seven_mill	$7 million FMS from Fidelity Optimization
three_mill	$3 million FMS from Fidelity Optimization

The model allocates tasks to training devices by choosing at each level of performance the training device that produces the greatest improvement in performance for the cost. Training continues on this device until a performance level is reached at which the training device is no longer optimal. Training is then switched to the device that is optimal at that performance level. This process continues until the training standard is reached. When training devices have been assigned to all tasks, a summary of training-device use is calculated and presented in the Display Results section.

The example assignment of training devices will be carried out using the default task cluster, all 38 tasks.

Prerequisites for This Section

Before proceeding with this section of the sample problem be sure that (a) you have created the FMS task cluster described in the Simulation Configuration section, (b) you have saved the instructional feature packages described in the Instructional Feature section, and (c) you have saved the training device designs created in the Fidelity Optimization section. Refer to these sections if you have not already done so before proceeding.

Starting the Training-Device Selection Module

The Module Selection Menu should be displayed on the screen. The Training-Device Selection Module is demonstrated using the default task cluster. The default task cluster is selected with the following action.

Action: Select **Task Cluster Selection Menu** from the module selection menu.

The Task Cluster Library should be displayed, as shown earlier in Figure 17.

Action: Select number **1 default** by positioning the cursor on the "1" and clicking the mouse.

The Module Selection Menu should reappear.

<u>Action</u>: Select **Training Device Selection** from the Module Selection Menu.

The Training-Device Selection Menu will appear on the screen, as depicted in Figure 54.

Current Task Cluster : default
Training Device Selection Menu

Examine/Modify Task Set
Show/Edit Training Devices
Display Results
Save Changes
Module Selection Menu

Figure 54. Training Device Selection Menu Screen.

The Training-Device Selection Menu presents the four functions of the module. Each function can be selected, not necessarily in the order presented, by placing the cursor on the name of the function and clicking the mouse.

You have already selected a task cluster to use in this module. You should now verify the task cluster and select a set of training devices. The task cluster may be verified and modified from the Task Inclusion/Exclusion screen. Similarly, the training device set is modified from the Training Device Selection screen.

<u>Editing the Task Set</u>

You may modify the task cluster used in this module by adding or deleting tasks within the function called Examine/Modify Task Set.

<u>Action</u>: Select **Examine/Modify Task Set** from the Training-Device Selection Menu and click the mouse.

The Task Inclusion/Exclusion screen should be displayed.

<u>Action</u>: Verify that ALL tasks will be INCLUDED in this analysis.

<u>Action</u>: Select **Main Menu**.

The system should return to the Training-Device Selection Menu.

Training-Device Selection

To select which training devices you will use in the initial analysis, perform the following action:

Action: Select **Show/Edit Training Devices.**

The Training-Device Selection screen should appear as shown in Figure 55. The Training Device Selection screen will allow you to choose which training devices will be analyzed to determine the optimal training devices. The display shows eight prototype devices plus the devices designed in the Fidelity Optimization module.

The devices included in the analysis are listed on the left side of the screen. The devices on the right side of the screen will not be considered in the analysis. Use the mouse to move devices from one side of the screen to the other, as follows:

TO INCLUDE A DEVICE in the analysis, use the mouse to position the cursor over the name of the device on the right side of the screen and click the mouse. The device name will move to the left side of the screen.

TO EXCLUDE A DEVICE from the analysis, position the cursor over the name of a device on the left side of the screen and click the mouse.

Current Task Cluster : default Training Device Selection	
Included Devices	Excluded Devices
Classroom Training Cockpit Procedures Trainer Doppler Navigation Trainer Instrument Flight Trainer Visual Flight Trainer Weapons System Trainer Nap-of-the-Earth Navigation Actual Equipment	three_mill seven_mill
	User Comment Help Main Menu

Figure 55. Initial Training Device Selection Screen.

Action: Select the devices

1. Classroom Training
2. Actual Equipment

to be INCLUDED in the initial analysis, by selecting the remaining devices to be excluded from the analysis.

The screen should show classroom training and actual equipment in the left column (see Figure 56).

Action: Select **Main Menu.**

You will return to the Training-Device Selection Menu.

Current Task Cluster : default Training Device Selection	
Included Devices	Excluded Devices
Classroom Training	
	Cockpit Procedures Trainer
	Doppler Navigation Trainer
	Instrument Flight Trainer
	Visual Flight Trainer
	Weapons System Trainer
	Nap-of-the-Earth Navigation
Actual Equipment	
	three_mill
	seven_mill

Figure 56. Adjusted Training Device Selection Screen.

Display Results

Action: Select **Display Results** from the Training-Device Selection Menu.

The Overall Result Display should be displayed as shown in Figure 57. This section of the module will allocate training of the tasks in the default task cluster to the devices you chose to be included. It contains several different screens.

Overall result display. The user can quickly view the overall results of the analysis on this screen. To provide a baseline measure, you first applied the Training-Device Selection Module to a set of training devices consisting of Classroom Training and Actual Equipment only. The Overall Result Display shows how many tasks were trained by each training device, the per-student training cost for each device, how many hours each device was used and how many devices of each type were required based on training 800 students per year. In addition, the display shows how many hours each device would be used annually, and compares these values to the values that were used to estimate the hourly cost. Below the chart is given the number of tasks that could not be training to the standard performance with the current training system. In this situation, the model estimates the cost of this training system as $51,920 per student (see Figure 57). This value will be used to compare the savings that would occur with the introduction of additional training devices into the system.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000's)	Training Hours / Student	Dev. Rqd.	Hours / Year / Device	Assumed Hours / Dev/Yr
Classroom Training	4	0.19	5.97	3	1593	2000
Actual Equipment	34	51.73	59.80	20	2392	2500
Totals		51.92	65.77			

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Save Results	Graph This	Comment	Print
Re-iteration	Results by Task	Help	Save Scr
Restore Res.	Device Data	Model Menu	Toggle Scr

Figure 57. Initial Training Device Selection Overall Results Display Screen.

Action: Select **Model Menu** to return to the Training-Device Selection Menu.

The next step in this example analysis is to analyze the $7 million FMS designed in the Fidelity Optimization Module. To do this you need to modify the set of training devices to include the $7 million training device.

Action: Select **Show/Edit Training Devices** from the module menu.

The Training-Device Selection screen will be displayed.

Action: Select the "seven_mill" device to be INCLUDED in the analysis, as shown in Figure 58.

Current Task Cluster : default Training Device Selection	
Included Device	Excluded Devices
Classroom Training	
	Cockpit Procedures Trainer
	Doppler Navigation Trainer
	Instrument Flight Trainer
	Visual Flight Trainer
	Weapons System Trainer
	Nap-of-the-Earth Navigation
Actual Equipment	
seven_mill	
	three_mill

Figure 58. Training Device Selection Screen with "seven-mill" Included.

Action: Select **Main Menu**.

This will return you to the Training Device Selection Module menu.

Action: Select **Display Results** from the menu.

The Overall Result Display should be displayed on the screen, as shown in Figure 59.

The results of this analysis, in which the $7 million FMS is added to the training system, are shown above and on the screen. The per-student cost for this configuration, $40,500 represents an $11 thousand improvement over the baseline. The $7 million FMS takes over much of the training that was conducted on the actual equipment in the baseline calculations. Though the total hours of training per student have increased compared to the baseline, the total cost per student has decreased.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000's)	Training Hours / Student	Dev. Rqd.	Hours / Year / Device	Assumed Hours / Dev/Yr
Classroom	4	0.19	5.97	3	1593	2000
Actual Equipment	20	19.46	22.49	8	2249	2500
seven_mill	31	20.87	64.38	18	2860	3000
Totals		40.52	92.84			

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Save Results	Graph This	Comment	Print
Re-iteration	Results by Task	Help	Save Scr
Restore Res.	Device Data	Model Menu	Toggle Scr

Figure 59. Training Device Selection Overall Results Display Screen with "seven-mill" Device Added.

In the second part of this analysis, the $3 million FMS is included in the training system in place of the $7 million FMS.

Action: Select **Model Menu** from the menu at the bottom of the screen.

Action: Select **Show/Edit Training Devices** from the menu.

Action: Select the "three_mill" device to be INCLUDED in a second evaluation and the "seven-mill" device to be excluded.

The $3 million training device, which you designed in the Fidelity Optimization Module will now be included in the calculations as shown in Figure 60.

Current Task Cluster : default Training Device Selection	
Included Devices	**Excluded Devices**
Classroom Training	
	Cockpit Procedures Trainer
	Doppler Navigation Trainer
	Instrument Flight Trainer
	Visual Flight Trainer
	Weapons System Trainer
	Nap-of-the-Earth Navigation
Actual Equipment	
	seven_mill
three_mill	

Figure 60. Training Device Selection Screen with "three-mill" Included.

Action: Select **Main Menu** from the menu at the bottom of the screen.

Action: Select **Display Results** from the menu.

The Overall Result Display should be displayed on the screen, as shown in Figure 61.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000s)	Training Hours / Student	Dev. Rqd.	Hours / Year / Device	Assumed Hours / Dev/Yr
Classroom Training	4	0.19	5.97	3	1593	2000
Actual Equipment	29	24.82	28.69	10	2295	2500
three_mill	27	12.84	93.31	25	2986	3000
Totals		37.85	127.98			

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Save Results	Graph This	Comment	Print
Re-iteration	Results by Task	Help	Save Scr
Restore Res.	Device Data	Model Menu	Toggle Scr

Figure 61. Training Device Selection Overall Results Display Screen with "three-mill" Device Added.

The solution shows an overall per-student cost of $37,900, a savings of $2,700 per student compared to the first training system you evaluated. Although the current training system requires more training on the Actual Equipment than the first training system, the current training system is less expensive to use.

Examination of the table shown in Figure 61 and on the screen indicates that the $3 million FMS is used to train 27 tasks. The module can also present information about the selected training devices for each task.

Results by task. This display will provide additional information about the training devices and amount of training assigned to each task.

Action: Select **Results by Task** from the menu at the bottom of the screen.

The screen entitled Devices and Training Times should be displayed, as shown in Figure 62.

```
                 Current Task Cluster : default
              Devices and Training Times, by Task (hrs)
                   Results by Task              Device Legend
 ATM #    Task
 1003 T/O_CHECKS       10                     1. Classroom Training
                       3.42                   8. Actual Equipment
 1004 HOVER_PWR_CK     10     8              10. three_mill
                       1.27   0.10
 1005 HOVER_FLT        10     8
                       1.20   0.10
 1006 NORMAL_T/O       10
                       1.59
 1007 S/MAX_P_T/O      10
                       2.08
 1008 DECEL_ACCEL      10     8
                       1.94   0.10
 1009 TRFC_PTRN        10
                       2.10
 1012 DOPPLER_NAV      10     8
                       5.95   5.12

Next Page         Indiv. Task Data    Comment       Print
Previous Page     Device Data         Help          Save Scr
                  Result Summary      Model Menu    Toggle Scr
```

Figure 62. Training Device Selection, Devices and Training Times by Task Screen.

The Devices and Training Times display shows the optimal time in hours to train each task on each training device. Task numbers and names are listed on the left side of the screen. In the right hand corner is the training-device legend. Each device is assigned a reference number. The columns in the center of the screen, labeled Results by Task, contain the reference numbers of the devices that are used to train the task on the left. Below each reference number is listed the number of hours that training is conducted on that device.

Tasks may be listed on more than one screen. Additional tasks may be viewed by selecting the NEXT PAGE or PREVIOUS PAGE menu options.

As you examine this screen, note which tasks are trained on the FMS. This information is summarized in the following text. For five tasks (Takeoff checks, Normal takeoff, Maximum performance takeoff, Traffic pattern flight and SCAS off flight), the FMS completely replaces actual equipment. For many other tasks the FMS is used at early levels of training; training on the FMS is followed by training on actual equipment. Four tasks are trained by classroom training.

The $3 million FMS is used to train more tasks than it was designed for. Of the 15 tasks in the FMS task cluster, 12 are assigned training on the FMS. The other three are trained entirely on the actual equipment. On the other hand, 13 of the 18 tasks in the PMS task cluster are trained partially or fully on the FMS. This result makes sense since we did not design a training device for the PMS task cluster. However, the FMS might have greater fidelity than is actually required since its design considered the requirements for three tasks for which it was not used. Consequently, the results of the Training-Device Selection Module have implications for earlier modules.

To further investigate this aspect of the results, you would define a smaller FMS task cluster to use as the basis for the Instructional Feature Selection and Fidelity Optimization Modules. For example, you might select to include in the FMS task cluster only those 12 tasks that were assigned training on the FMS. This would result in a smaller FMS task cluster. The training-device designs produced by the Instructional Features and Fidelity Optimization modules would be specific for a smaller number of tasks and therefore would probably have lower fidelity requirements. These designs would then be evaluated by the Training-Device Selection Module to determine if further savings could be obtained.

Action: Select **Model Menu** from the menu at the bottom of the current screen to return to the Training-Device Selection Menu.

You may wish to compare the results obtained using the $3 million FMS with the results obtained from using one of the prototype training devices. There are a number of weapons tasks for which the students have very low entry levels of knowledge. It is possible that the training system would be less expensive if a weapons trainer were used. Since a template for a weapons system trainer exists in the data base, we will add it to the list of devices to replace the current FMS.

Action: From the Training-Device Selection menu, select **Show/Edit Training Devices.**

Action: Select the devices

1. Classroom Training
2. Weapons System Trainer
3. Actual Equipment

with the mouse to be INCLUDED.

The Training-Device Selection screen should be displayed, as shown in Figure 63.

Current Task Cluster : default Training Device Selection	
Included Devices	Excluded Devices
Classroom Training	
	Cockpit Procedures Trainer Doppler Navigation Trainer Instrument Flight Trainer Visual Flight Trainer
Weapons System Trainer	
	Nap-of-the-Earth Navigation
Actual Equipment	
	seven_mill three_mill

Figure 63. Training Device Selection Screen with "Weapons System Trainer" Included.

Action: Select **Main Menu** from the menu at the bottom of the screen to return to the Training-Device Selection menu.

This defines a new combination of training devices which includes Classroom Training, the Weapons trainer and the Actual Equipment. The next step is to reassign training devices to tasks and recalculate training times.

Action: Select **Display Results** from the module menu.

The Overall Result display should be appear on the screen, as shown in Figure 64.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000s)	Training Hours / Student	Dev. Rqd.	Hours / Year / Device	Assumed Hours / Dev/Yr
Classroom Training	4	0.19	5.97	3	1593	2000
Weapons System Trainer	8	2.79	32.39	13	1993	2000
Actual Equipment	33	46.31	53.54	18	2379	2500
Totals		49.29	91.90			

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Figure 64. Training Device Selection Overall Results Display Screen with "Weapon System Trainer" Device Added.

The total per-student cost for this training system is $49,000, or more than $10,000 more than the training system with the $3 million FMS. The Weapons System Trainer does not have the fidelity requirements necessary to train a substantial proportion of the tasks.

Our conclusion is that the most cost-effective training system, of those we have tested, includes Classroom Training, Actual Equipment and the $3 million FMS you designed in the Fidelity Optimization Module. The last step in this analysis is to modify the Training-Device Selection screen to include these tasks and to save the training system for a more complex analysis in the Resource Allocation Module.

Action: Select **Model Menu** to return to the module menu.

Action: From the Training-Device Selection Menu, select **Show/Edit Training Devices**.

Action: Select the devices

1. Classroom Training
2. Actual Equipment
3. three_mill

to be INCLUDED.

Action: Select **Main Menu.**

Action: Select **Display Results** from the menu.

The Overall Result Display with the "three-mill" device should appear on the screen as shown in Figure 65.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000s)	Training Hours / Student	Dev. Rqd.	Hours / Year / Device	Assumed Hours / Dev/Yr
Classroom Training	4	0.20	5.97	3	1593	1593
Actual Equipment	29	25.13	28.35	10	2267	2295
three_mill	27	13.18	95.47	25	2938	2986
Totals		38.50	129.80			

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Figure 65. Training Device Sele‚tion Overall Results Display After Reiteration.

Save results. Training systems can be saved for complete analysis in the Resource Allocation Module.

Action: Select **Save Results** from the menu at the bottom of the screen.

The following will appear on the screen:

Save As:
Hit <RET> to Cancel

Use the keyboard to type in the name "optimal" for the name of this training system (excluding the quotes). It will be evaluated further in the Resource Allocation module. Press the **Enter** key when finished.

Re-iteration. The calculations for the per-student cost and per-student time to train the tasks depend on an estimate of the annual usage of each device. Sometimes the value of the calculated annual usage is very different from the estimated value.

The Reiteration function is used when there is a large discrepancy between the "Assumed Hours / Device / Year" and the actual "Hours / Year / Device". The value of the actual annual usage is substituted for the estimated annual usage and the module recalculates the results.

Recall that the value of the actual hours used / year / device for the $3 million FMS (2986 hours) was very close to the value that was used to estimate the hourly cost (3000 hours). We may recompute the results using the actual utilization in place of the value that was assumed.

Action: Select **Re-iteration** from the menu.

The results of the reanalysis, as shown in Figure 65 and on the screen, indicate a per-student cost of $38,500, similar to but slightly higher than the cost before Re-iteration. The per-student cost of training increased because the hourly cost of each device increases as the estimated annual usage decreases. The increased hourly cost of each device caused more training to be allocated to the actual equipment. In this case, the reiteration did not change the per-student cost substantially. Reiteration is useful mainly when there is a large difference initially between the estimated and actual annual usage.

Action: Select **Restore Res.** from the menu to restore the results obtained before the Reiteration.

There are many different displays of the data and results of this module available for you to view. You can examine these displays using the menu on the Overall Result screen.

Graph This. The Graph screen will allow you quickly to assess the hours allocated to each device and the cost of each device.

Action: Select **Graph This** from the menu.

The Graphical Comparison of Devices should be displayed, as shown in Figure 66. The display allows the user to view, by device, (a) the Cost per Student (thousands) and (b) the Actual Hours Used per Student. This information is found in tabular form in the Overall Result Display.

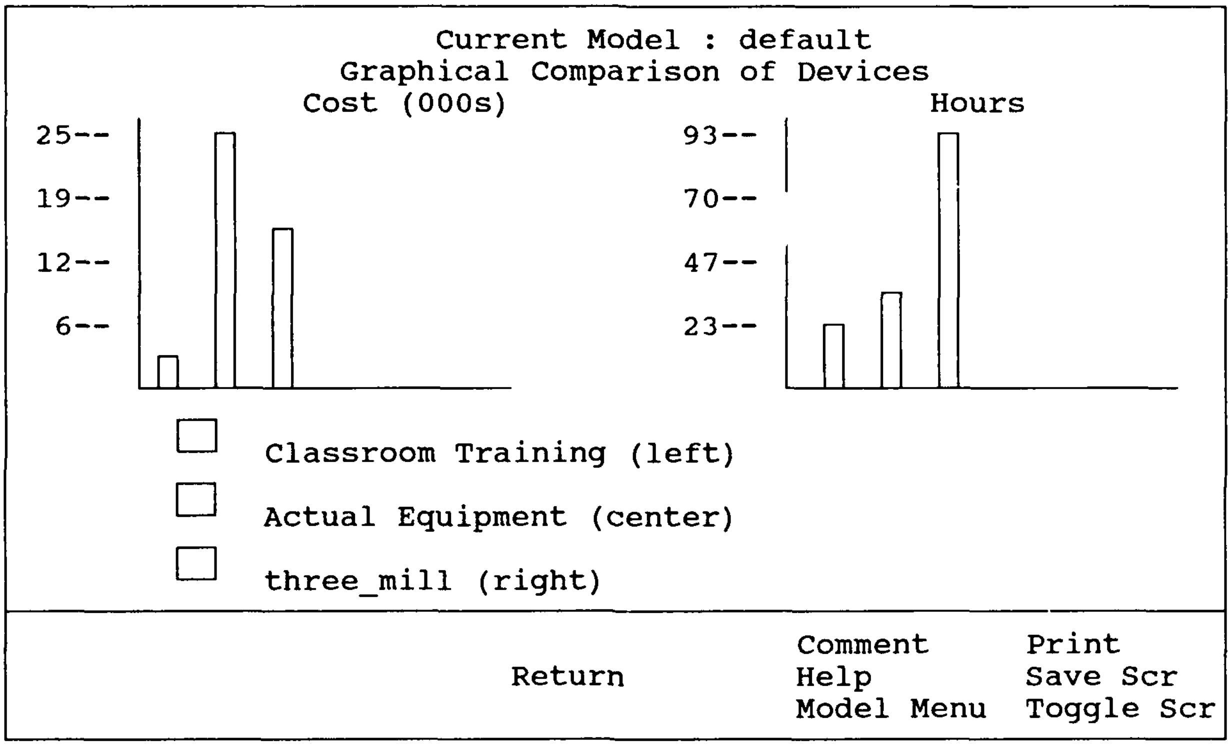


Figure 66. Training Device Selection Graphical Comparison Screen.

Action: Select **Return** from the bottom of the screen to return to the Overall Result Display.

Action: From the menu at the bottom of the Overall Result Display select **Results by Task**.

The Devices and Training Times, by Task screen should be displayed.

Individual task data. The Individual Task Data screen will allow you to examine the hours, cost and performance levels related to the training of each task as shown in Figure 67.

Action: Select **Indiv. Task Data** from the menu at the bottom of the screen.

```
Task Number        : 1003    Task Name          : Start, Runup..
Entry Performance : 0.49    Training Standard : 0.70
---------------------------------------------------------
Device          Hours Trained    Cost of Training   Performance
---------------------------------------------------------
Classroom Training     0.00            0.00             0.00
Actual Equipment       0.00            0.00             0.00
three_mill             3.42            0.47             0.70
---------------------------------------------------------
  Totals               3.42            0.47

Next Task              Graph          Comment       Print
Previous Task          Return         Help          Save Scr
                                      Model Menu    Toggle Scr
```

Figure 67. Training Device Selection Individual Task Data Screen.

The Individual Task Data display shows data about a single task, including

1. The entry performance level and training standard,
2. The optimal allocation of training on this task to training devices,
3. The cost to train this task on a per-student basis, and
4. The performance level to which the task is trained on the given device in the allocated time of training.

You may look at different tasks by selecting the NEXT TASK or PREVIOUS TASK menu options.

Individual task graph. This graph will show the improvement in performance as a function of training time on the selected training devices (see Figure 68).

Action: Select **Graph** from the menu at the bottom of the screen. The Individual Task graph will be displayed.

The model assigns training devices to a task by choosing at each level of performance the training device that produces the greatest improvement in performance for the cost. Training continues on this device until a performance level is reached at which the training device is no longer optimal. Training is then switched to the device that is optimal at that performance level. This process continues until the training standard is reached.

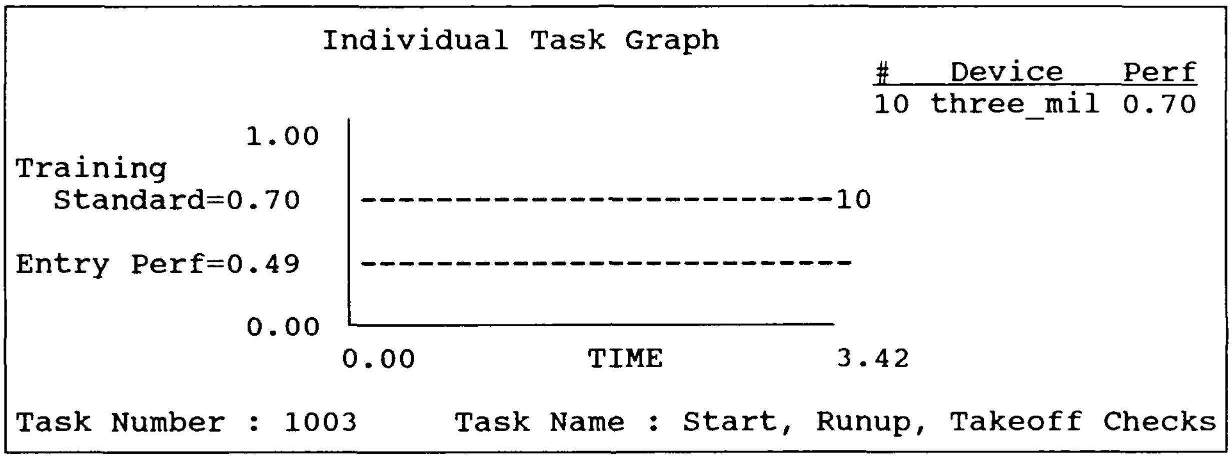


Figure 68. Training Device Selection Individual Task Graph Screen.

The Task Graph shows the estimated performance (y axis) as a function of training time (x axis). Points on the graph are represented by the number of the training device to which they correspond. They are located on the graph according to the training time required on the device and the performance level obtained from training on that training device.

In the graph shown in Figure 68, the entry performance at time zero, marked by a dashed line, is 0.49. The training standard, also marked by a dashed line, is 0.70. Training for this task is conducted entirely on the $3 million FMS. The point marked by the '10' shows the expected performance and time when training on the FMS is completed.

You may view the graphs for different tasks by selecting the NEXT TASK or PREVIOUS TASK menu options.

Device data. The Device Data screen will allow you to view the data that are used to determine the cost of each training device.

Action: Select **Return** to return to the Individual Task Data screen and **Return** again to return to the screen entitled Devices and Training Times. Select **Device Data** from the menu at the bottom of this screen.

The Device Data Display should be displayed as shown in Figure 69.

Device Data Display

Training Dev	Life Cycle (yrs)	COST IN THOUSANDS Investment Total	Investment Hrly	Fixed Annual	Fixed Hrly	Variable Ops.Cost	Total Hrly
Classroom Trainer	50	0.00	0.00	5.00	0.00	0.030	0.032
Actual Equipment	10	5000.00	0.20	100.00	0.04	0.625	0.865
three_mill	10	2930.36	0.10	9.77	0.00	0.037	0.138

Results by Task	Comment	Print
Result Summary	Help	Save Scr
	Model Menu	Toggle Scr

Figure 69. Training Device Selection Device Data Display Screen.

Four items in the display come directly from the data base:

1. The equipment life cycle in years,
2. The total equipment investment cost,
3. The annual fixed operating cost, and
4. The hourly variable operating cost.

Other items are calculated, based on these values, and on the estimated annual hours of utilization for the training device (see Overall Result Display, last column). These values are:

1. The hourly investment cost,
2. The hourly fixed operating cost, and
3. The total hourly cost.

Investment costs are amortized over the hours of use in the training-device life-cycle. Fixed operating costs are amortized over the hours of use in a year.

This completes the review of the screens available in the Display Results section of this module.

Action: Select **Model Menu**.

This will return to the Training Device Selection Menu.

It is clear from the analysis that the $3 million FMS is superior to the $7 million FMS. The cost of the $7 million FMS was too high for it to replace significant amounts of actual equipment training at a cost comparable to the cost of the $3 million FMS. For the purposes of this example we assume that the training system that will be analyzed in further detail in the Resource Allocation Module includes the classroom trainer, the $3 million FMS, and the actual equipment. Recall that you saved this training system as a package called "optimal."

The results of the Training-Device Selection Module have several implications for reanalysis of the problem by earlier modules. The implications are enumerated below.

1. The Instructional Feature Selection and Fidelity Optimization Modules might be run using a reduced task set. The set might include tasks in the FMS task cluster for which training on the FMS was selected by the Training- Device Selection Module. You may also wish to include those tasks from the PMS task cluster for which a substantial amount of training was selected to be on the FMS by the Training-Device Selection Module.

2. If you wanted the FMS tasks, Terrain flight, Pinnacle Ridgeline Operation and Standard Autorotation, that were assigned training on the actual equipment to be trained in a simulator, you might design a device based on a task cluster consisting of only these three tasks. You might decide to rerun Training-Device Selection and include this device in the current training system to see if the total cost to train each student decreases even further.

3. The current analysis of the Fidelity Optimization Module could be examined to identify other lower-fidelity options that might be more cost-efficient. Since the $3 million solution performed better than the $7 million solution, there may be other candidate designs less expensive than the $3 million simulator that would perform even better.

Saving Changes and Exiting the Module

The Training-Device Selection Menu should be displayed at this point, as shown in Figure 54. The remaining function is called Save Changes. You would select SAVE CHANGES only if you had made changes to the task cluster or the training-device set and you wished to save these changes for further use. The information would then be stored in a file. To retrieve the information you would go the Task Cluster Library and select the task cluster with the appropriate name.

When you select Save Changes the system prompts you for a keyboard entry of a file name. File names can have up to eight alphanumeric characters. Underscores (_) are permitted but do not use spaces. All keyboard entries are completed by pressing <ENTER>.

Recall that in this example, the package you selected for further evaluation was saved using the SAVE RESULTS option in the function Display Results. Training device packages saved with the Save Results option are available for further analysis in the Resource Allocation Module. However, you will not find these packages listed in the Task Cluster Library.

Action: Select **Module Selection Menu** to return to the Module Selection Menu.

Resource Allocation Module

Thc Resource Allocation Module provides results that are similar to those provided by the Training-Device Selection Module. However, these methods differ from those of the Training Device-Selection Module in two important respects. (a) The Training-Device Selection Module assumes that cost is a simple linear function of training-device use, while the Resource Allocation Module breaks the cost curve into a number of linear segments. (b) The Resource Allocation Module allows the user to specify constraints on training-device use. These constraints may specify the maximum time that a training device may be used or the minimum performance level for which a training device may be employed on a specific task.

As a result of its increased accuracy and flexibility, the Resource Allocation Module involves greater computational complexity and calculation time than the Training-Device Selection Module. For the current example problem, the calculations of the Resource Allocation Module take approximately ten times as long as those of the Training-Device Selection Module. This increased computational load limits the extent to which the Resource Allocation Module may be used interactively, although limited interactions are possible.

In the example problem, you will apply the Resource Allocation Module twice to the results of the Training-Device Selection Module. The first time, you will not apply any external constraints to the solution. The second time you will add constraints and determine their effect on the solution.

Prerequisites for This Section

Before proceeding with this section of the guide be sure that (a) you have created the FMS task cluster described in the Simulation Configuration section, (b) you have saved the instructional feature packages described in the Instructional Feature section (c) you have saved the training-device designs created in the Fidelity Optimization section and (d) you have saved the training-device package created in the Training-Device Selection section. Refer to these sections if you have not already done so before proceeding.

Starting the Resource Allocation Module

The Module Selection Menu should be displayed on the screen. The Resource Allocation module is demonstrated using the default task cluster. The default task cluster is selected with the following actions.

Action: Select the **Task Cluster Selection Menu** from the Module Selection Menu.

The Task Cluster Library should be displayed. The Task Cluster Library is used to select the task cluster data base previously developed for demonstrating the features of the system.

<u>Action</u>: Use the mouse to place the cursor on the **number "1"** next to the **default** cluster and click the mouse.

The Module Selection Menu will reappear on the screen.

<u>Action</u>: Select **Resource Allocation** from the Module Selection menu.

The Resource Allocation Selection Menu will be displayed as shown in Figure 70. The Resource Allocation Menu presents the four functions of the module. Each function can be selected by placing the cursor on the name and clicking the mouse.

```
       Current Task Cluster : default
  Resource Allocation Selection Menu
  ----------------------------------
            Select Problem
         Show/Edit Constraints
          Optimize Allocation
           Save Constraints
         Module Selection Menu
```

Figure 70. Resource Allocation Selection Module Menu Screen.

Selecting the Problem

Action: Select **Select Problem** from the Resource Allocation Menu.

The Problem Solution Selection Menu should be displayed, as illustrated in Figure 71. The Resource Allocation Module uses the results of the Training-Device Selection Module as the starting point for its calculations. This display requests that you select which run of the Training-Device Selection Module will be used.

```
                Current Model : default
            Problem Solution Selection Menu

 D   # of Solution Set                Solution Name
 ----------------------------------------------------------
     1 device package 1               optimal
```

Figure 71. Resource Allocation Problem Selection Menu Screen.

The options are listed on the screen with a number to the left of each option highlighted in yellow. To select the proper starting point for the analysis, position the cursor with the mouse until it is over the number of the option you desire. Then press the left mouse button. Be sure to place the cursor in the yellow area. The red area is used to delete packages.

Action: Select the number corresponding to the package called **optimal** that you created in the Training-Device Selection Module.

The system will respond with the prompt

Use device package # (y/n)?

The number sign (#) will be replaced by the number corresponding to the package called optimal. Use the keyboard to enter '**y**' and press **ENTER**. You will return to the Resource Allocation Menu.

Optimizing Allocation and Viewing Overall Results

You are now ready to calculate the optimal allocation of training time to training devices. Because of the complexity of the calculations, the optimization process for this sample problem may take 5-8 minutes or longer.

Action: Select **Optimize Allocation.**

The following message will appear.

"System Performing Optimization
Please Wait 2-20 minutes..."

Overall Result Display. The Overall Result Display screen should be displayed as shown in Figure 72. The Overall Result Display shows how many tasks would be trained by each training device, the per-student training cost for the device, how many hours each device would be used, how many devices would be needed to accomplish the specified training and how many hours each device would be used annually.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000's)	Training Hours / Student	Dev. Rqd.	Hours / Year
Classroom Training	4	0.20	5.94	3	4752
Actual Equipment	29	24.13	27.80	9	22241
three_mill	27	13.87	99.84	27	79870
Totals		38.20	133.58		

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Graph This	Comment	Print
	Help	Save Scr
Results by Task	Model Menu	Toggle Scr

Figure 72. Resource Allocation Overall Results Display Screen.

This is a solution to the same problem that was addressed in the Training-Device Selection Module. Differences in the solution are a result of the increased accuracy of the cost function. The Resource Allocation Module will tend to allocate time to a training device until the device is fully utilized. Then it will not allocate additional time unless there is sufficient time to justify the purchase of an additional device. In this example, the Resource Allocation Module allocates a smaller proportion of training to the actual equipment than did the Training-Device Selection Module (24.13 hours in Resource Allocation vs. 24.82 hours in Training Device Selection). Additional time was allocated to the $3 million FMS (13.87 hours in Resource Allocation vs. 12.84 hours in Training Device Selection).

Action: Select **Model Menu** from the menu at the bottom of the screen to return to the Resource Allocation Menu.

Editing Constraints

Action: Select **Show/Edit Constraints** from the Resource Allocation Menu.

The screen entitled Overall Device and Individual Task Constraints should be displayed, and look something like Figure 73. This module optimizes the allocation of training time to training devices subject to several constraints. In this display you may set the constraints on the maximum number of devices considered by the model and the minimum performance level at which a device will be used. The maximum number of devices is a global value that is valid for all tasks. The minimum performance level is specified separately for each task.

```
                 Current Model : default
        Overall Device and Individual Task Constraints

     --Device Constraints--           ----Task Constraints----
                                      ATM    1003
                                      Name   Start, Runup, ...
Training      maximum    maximum               minimum
Device     # of devices   hours/              perf level
                         student
-----------------------------------------------------------------
CLASSROOM   + No Max -    No Max                + 0.00 -
ACT_EQUIP   + No Max -    No Max                + 0.00 -
three_mill  + No Max -    No Max                + 0.00 -

  Next Task                                        User Comment
  Previous Task                                        Help
                                                    Main Menu
```

Figure 73. Resource Allocation Overall Device and Individual Task Constraints Screen.

1. To change the maximum number of devices, move the cursor to the areas labeled "+" or "-" on the screen, next to the

current value of the constraint. Press the left mouse button carefully and quickly to raise or lower the maximum number of devices. To remove a constraint on a device, select "-", and **press** and **hold** the mouse button until the value "No Max" appears on the screen.

2. To change the minimum performance level, first choose the task by selecting the NEXT TASK or PREVIOUS TASK areas on the menu. Then carefully and quickly click on the "+" or "-" areas next to the appropriate values to raise or lower them, respectively.

In the next analysis, we constrain the hours in which the $3 million FMS may be used. The initial results suggest that 27 such training devices would be required. To derive this number, recall that the initial results assigned each student 95.47 hours of training on the $3 million FMS (see Figure 65). If one FMS allows a maximum of 3.75 hours of training for each student, then 95.47 hours of training per student would require 25 training devices.

In the next analysis, if we assume that only 12 $3 million FMSs are available, then each student can be allocated a maximum of 45.00 hours on the FMS.

Action: Place the cursor over the "+" to the right of the device called three_mill and click the mouse. Continue to carefully and rapidly click the mouse until the maximum number of devices that can be used is set to 12.

The Show/Edit Constraints screen is shown in Figure 74.

Current Model : default
Overall Device and Individual Task Constraints

--Device Constraints-- ----Task Constraints----
ATM 1003
Name Start, Runup, ...

Training Device		maximum # of devices		maximum hours/ student		minimum perf level	
CLASSROOM	+	No Max	-	No Max	+	0.00	-
ACT_EQUIP	+	No Max	-	No Max	+	0.00	-
three_mill	+	12	-	45.00	+	0.00	-

Next Task
Previous Task

User Comment
Help
Main Menu

Figure 74. Resource Allocation Overall Device and Individual Task Constraints After Adjustment.

<u>Action</u>: Select **Main Menu** to return to the Resource Allocation Menu.

<u>Obtaining Revised Results</u>

<u>Action</u>: Select **Optimize Allocation.**

A window will be superimposed on the Resource Allocation Menu. The window is shown in Figure 75. This window allows the user to select whether the constraints specified in the Show/Edit Constraints display will be used in the resource allocation calculations.

```
Use Constraints, or No Constraints

            Original
            Modified
```

Figure 75. Resource Allocation Optimize Allocation Window.

<u>Action</u>: Select **Modified.**

The screen will display the following message:

> "System Performing Optimization--Please wait 2 - 20 minutes"

When the model completes the optimization calculations the Overall Result Display will appear on the screen.

Occasionally, the Resource Allocation optimization problem is too large to fit into the available memory. In this case a message will appear informing you of the situation. After you have read the message, press <ENTER>. A screen will appear giving you the opportunity to exit OSBATS and run Resource Allocation outside OSBATS. If you wish to obtain results for the problem using the Resource Allocation module, type **'y'** for yes. You will exit OSBATS. At the C:\OSBATS\CODE> prompt type **'ra'**. The resource allocation optimization procedure will run just as it would within OSBATS. When it has completed the allocation and the system prompt returns you should reenter OSBATS. After loading the data go immediately to the Resource Allocation Module. Select the same sample problem from the Select Problem function. Then select Optimize Allocation from the menu. The warning about too little memory will again appear. Press **ENTER**. The Resource Allocation Module will find the files that were created when the module was run from outside OSBATS and display the results.

Overall Result Display. The new Overall Result Display screen should be displayed and appear similar to Figure 76. The results of this analysis (shown in Figure 76) indicate that the training requirements can be met under the new constraints, although at a somewhat greater cost. The increased per-student cost is the direct result of the addition of the constraint. The mandated reduction in the $3 million FMS was compensated for by increased use of the actual equipment, which is more expensive than the $3 million FMS.

Current Task Cluster : default
Overall Result Display

Training Devices	Tasks Trained of 38	Cost to Train (000's)	Training Hours Student	Dev. Rqd.	Hours / Year
Classroom Training	4	0.20	5.94	3	4752
Actual Equipment	33	34.13	39.00	13	31202
three_mill	20	6.19	44.88	12	35903
Totals		40.51	89.82		

Number of Students / Year : 800
Number of Tasks NOT trained to standard: 0

Graph This	Comment	Print
	Help	Save Scr
Results by Task	Model Menu	Toggle Scr

Figure 76. Resource Allocation Overall Results Display Screen After Constraints.

While at this Overall Result Display you should explore the options available in the menu section of the screen.

Graph This. This display shows the number of hours each device is used and the total cost associated with these hours.

Action: Select **Graph This** to view Graphical Comparisons of Devices.

The Graphical Comparisons of Devices is displayed on the screen, and should appear something like Figure 77. The Graphical Comparison of devices contains two graphs:

1. A graph that shows the total cost, in thousands, associated with each device, and

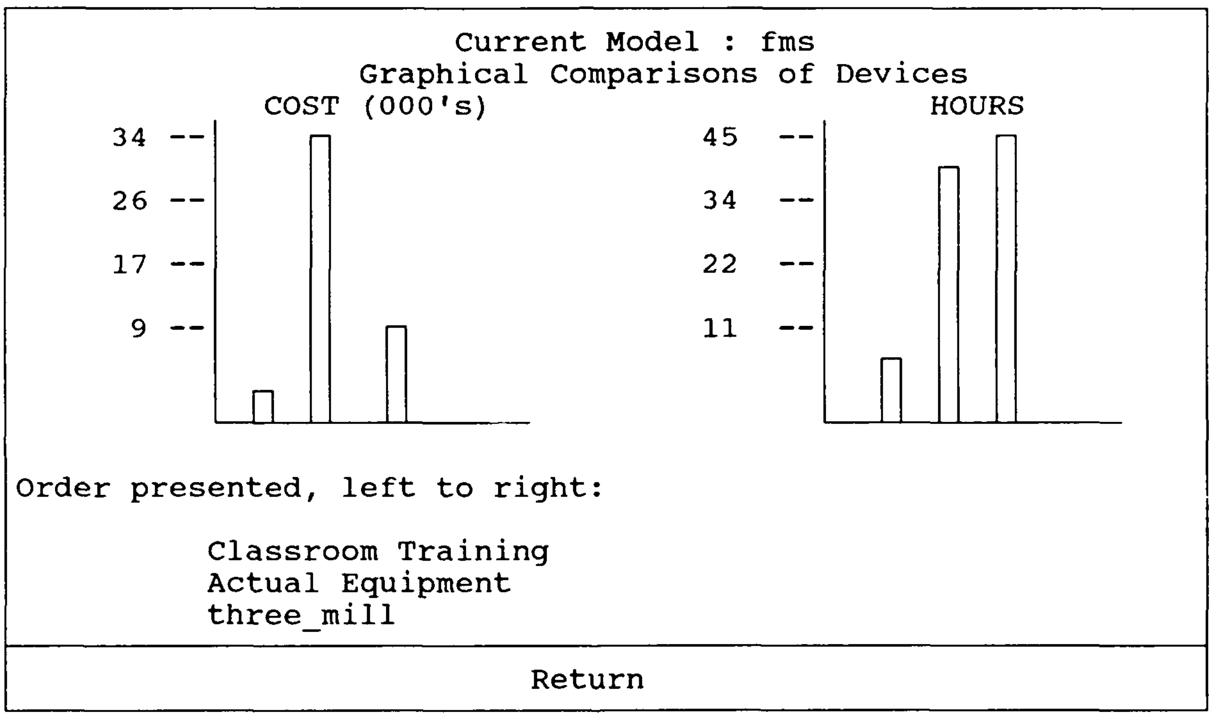


Figure 77. Resource Allocation Graphical Comparison Screen.

2. A graph that shows the number of hours each training device is used.

The user can quickly assess from viewing these graphs that classroom training is relatively inexpensive while the actual equipment is relatively expensive. Notice that the FMS costs less than the actual equipment and is used more.

Results by task. The Results by Task Display shows the number of hours each device is used to train each task.

Action: Select **Return** to return to the Overall Result Display.

Action: Select **Results by Task** from the menu at the bottom of the screen.

The screen entitled Devices and Training Times, by Task should be displayed, as shown in Figure 78. The Results by Task display shows the optimal time in hours to train each task on each training device. Task numbers and names are listed on the left side of the screen. In the right-hand corner is the training-device legend. Each device is assigned a reference number. The columns in the center of the screen, called Results by Task, contain for each task the reference numbers of the devices that are used to train the task and, below, the number of hours training is conducted on each device. For example, optimal training of task 1005 in this problem is 0.39 hours of training on the $3 million FMS and 0.27 hours on the actual equipment.

```
                    Current Task Cluster : default
                 Devices and Training Times, by Task (hrs)
                          Results by Task       Device Legend
ATM #   Task

1003 T/O_CHECKS      10                      1. Classroom Training
                     3.41                    8. Actual Equipment
1004 HOVER_PWR_CK    10      8              10. three_mill
                     0.31  0.30
1005 HOVER_FLT       10      8
                     0.39  0.27
1006 NORMAL_T/O      10      8
                     1.31  0.08
1007 S/MAX_P_T/O     10      8
                     0.91  0.25
1008 DECEL_ACCEL     10      8
                     0.66  0.37
1009 TRFC_PTRN       10      8
                     0.92  0.26
1012 DOPPLER_NAV     10      8
                     2.86   5.82

Next Page        Indiv. Task Data      Comment      Print
Previous Page                          Help         Save Scr
                 Result Summary        Model Menu   Toggle Scr
```

Figure 78. Resource Allocation Devices and Training Times By Task Screen.

Additional tasks may be viewed by selecting NEXT PAGE or PREVIOUS PAGE menu options with the mouse.

<u>Individual task data</u>. The Individual Task Data Display shows the results in greater detail for a selected task, as shown in Figure 79.

<u>Action</u>: Select **Indiv. Task Data** from the menu.

Current Task Cluster: default
Individual Task Data

Task Number : 1003 Task Name: Start, Runup, Takeoff checks
Entry Performance: 0.49 Training Standard: 0.70

Device	Hours Trained	Cost of Training	Performance
Classroom Training	0.00	0.00	0.00
Actual Equipment	0.00	0.00	0.00
three_mill	3.41	0.12	0.70
Totals	3.41	0.12	

Return

Figure 79. Resource Allocation Individual Task Data Screen.

The Individual Task Data display shows data about a single task, including

1. The training standard and entry performance level,
2. The optimal allocation of training on this task to training devices,
3. The cost to train this task on a per-student basis, and
4. The exit performance expected after training for the given time on a given device.

For example, training of task 1003 is conducted for 3.41 hours on the $3 million FMS. Students enter with a performance of 0.49 and exit with a performance of 0.70. No training is conducted in the classroom or on actual equipment. The total cost of training is $120 per student.

You may view different tasks by selecting NEXT TASK or PREVIOUS TASK menu options.

Individual task graph. The following action will produce a display that shows the improvement in performance as a function of training time on the selected training devices. The display should appear as shown in Figure 80.

Action: Select **Graph**.

```
                        Current Task Cluster: default
                         Individual Task Graph
                                                   # Device     Perf
                    1.00 |                        ________________
                         |                        10 three_mill 0.70
                         |
Training Standard = 0.70 |---------------------12
                         |
Entry Performance = 0.49 |----------------------
                         |
                    0.00 |_____________________|__
                          0.00       TIME      3.41

Task Number: 1003       Task Name: Start, Runup, Takeoff checks
```

Figure 80. Resource Allocation Individual Task Graph Screen.

The task graph shows the estimated performance as a function of training time. The entry and standard performance levels are represented on the graph by dashed lines. Each point on the graph, indicated by a number, represents a training device. The legend in the upper right corner shows how the numbers correspond to the devices. Points are located on the graph according to the time (x-axis) required for and performance level (y-axis) obtained from training the task on the subject training device.

In this graph, the performance at time zero hours is 0.49. Training of this task is conducted on the $3 million FMS, represented by the "12" at time 3.41 hours.

Action: Select **Return** to return to the Individual Task Data display.

Action: Select **Return** again to return to the display entitled Devices and Training Times, by Task.

Action: Select **Model Menu** to return to the Resource Allocation Menu.

The Resource Allocation Menu should be displayed (see Figure 70).

The last function of this module is called SAVE CONSTRAINTS. The constrained problem can be saved as a new problem by using this option. When you select to save constraints you are in effect resaving the original problem (e.g. optimal) with the constraints you introduced (e.g. **maximum** of 12 $3 million FMSs) as a new problem with a new name. When you want to recover the results of the constrained problem you would select the new problem from the Select Problem function to use in the Optimize Allocation function. To exit OSBATS perform the following action.

Action: Select **Module Selection Menu** from the Resource Allocation Menu.

Action: Select **Quit** from the Module Selection Menu.

This terminates the exploration of available menu options.

Summary of Example Problem

The sample problem has illustrated how the OSBATS modules interact to make recommendations about the kinds of training devices that should be developed, the specific device designs that should be employed, and the extent to which training devices should be used. The five modules performed the following functions.

1. The Simulation Configuration Module organized the training requirements to specify the relative need for training in a simulated environment. In addition, the module recommended which tasks would best be trained by a full-mission simulator rather than a simpler training device.

2. The Instructional Feature Selection Module evaluated a range of instructional support features for a full-mission simulator, and specified the optimal set of features to include at several budget levels.

3. The Fidelity Optimization Module evaluated several critical areas in which the technical capability of a training device to present cues and response feedback could vary, and recommended the optimal levels of these areas as a function of the training-device investment budget.

4. The Training-Device Selection Module evaluated the training-device designs produced by the Fidelity Optimization Module in the context of the entire set of training requirements. It evaluated the FMS alternatives and specified which tasks would use each available training device to meet training requirements at the minimum cost.

5. The Resource Allocation Module refined the solution of the Training-Device Selection Module to account for complexities in the cost function and constraints in training-device availability and use.

This analysis was illustrative and is not complete. The description noted several places where further analysis would be required to arrive at a definitive recommendation. However, the example points out how the OSBATS model can be applied to concept-formulation problems of reasonable complexity.

REFERENCES

Sticha, P.J., Blacksten, H.R., Buede, D.M. (Decision Logistics, Inc.), Singer, M.J. (ARI), Gilligan, E.L., Mumaw, R.J., Morrison, J.E. (HumRRO) (1990). Optimization of simulation-based training systems: Model description, implementation, and evaluation (Technical Report 896). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A227 249)

Sticha, P.J., Blacksten, H.R. (HumRRO), Buede, D.M. (Decision Logistics, Inc.), & Cross, K.D. (Anacapa Sciences, Inc.) (1986). Optimization of simulation-based training systems. Volume III: Model description (HumRRO Final Report FR-PRD-86-13). Alexandria, VA: Human Resources Research Organization.

APPENDIX A

HOW TO USE THE RULE BASES

The OSBATS software includes two rule bases, entitled the Fidelity Requirements rule base and the Instructional Features rule base, that were developed using the EXSYS Expert System Development Package (copyright EXSYS, Incorporated). Although the delivered software includes data for you to use when running these rule bases, you may wish to use your own data. The following sections will provide information on how to run the rule bases and how to change the data files. The information applies to both the complete AH-1 data set consisting of 125 tasks and the sample data set consisting of 38 tasks.

The Fidelity Requirements rule base contains rules that process information about a task to produce the cue and response requirements for training that task. The results of this rule base are directed to a file called CUERSP.INP, a table of cue and response requirements organized by task and fidelity dimension. The OSBATS software will not run without this file.

The Instructional Features rule base produces a file called TABLE9.INP. This file is a two-dimensional matrix of zeros and ones that indicates which instructional features are appropriate for training each task. OSBATS will not run without this file, either.

Overview: File Names and Contents

In the OSBATS\RULES directory you will find several files with the name FIDELITY.* and several with the name INSTFEAT.*, where "*" is replaced by an extension. Files with the name FIDELITY.* belong to the Fidelity Requirements rule base and files with the name INSTFEAT.* belong to the Instructional Features rule base. The files described below will be present in this directory at some point during operation of the rule base, although they may not all be present at a given time. The *.RUL and *.TXT files contain the rules, or logic, used by the rule bases. The *.CF1 and *.CFG files are "configuration" files. They contain command line information that specifies some of the details about the operation of the rule bases. The *.RUN and *.BLD files are "report" files. Report files provide the rule bases with directions for printing the results to the CUERSP.INP and TABLE9.INP files. When one the report files is activated its extension is replaced with *.OUT. <u>You should not attempt to alter or delete any of the aforementioned files</u>. Files with the extension *.DAT, known as "data" files, contain the task input data needed to produce the results. When you choose to change the data used by a rule base the data file for that rule base is updated.

Changing the Data Files

You may decide to change the data used by either the Fidelity Requirements or Instructional Features rule base. In order to do this you must have pertinent data available for each task in the rule base. Begin the process by changing directories to the OSBATS\RULES directory. When you are in this directory you can activate the appropriate rule base by typing:

FID_RULE

or

IF_RULE

depending whether you want to change the FIDelity data file or the Instructional Features data file, respectively.

A screen will appear as shown below. (This example is for the FID_RULE batch file.)

```
Please choose from the following options for running the fidelity
rule base.

 TYPE AT THE PROMPT as shown below:

   >A
   to run the rule base using USER INPUT, and
   to APPEND results onto existing data files.

   >B
   to run the rule base using USER INPUT, and to make
   a BACKUP of existing data files before erasing them.

   >E
   to run the rule base using USER INPUT, and
   to ERASE existing data files before running.

   To quit, press <ESC>
```

Creating a new data file. If you have new data to use in the rule base, but wish to save the existing data file, type **B** for Backup. The current data (*.DAT) and results (*.INP) files will be backed up (copied to *.BAK) and the new data you enter will be saved in the *.DAT file. The rule base will then prompt you for new data.

Deleting the current data file. If you decide to delete the current data file and create a new file type **E**, for Erase. The current *.DAT and *.INP files will be erased. The rule base will then prompt you for new data. These data will be written to a new *.DAT file.

Appending data to the new data file. If you are interrupted while entering your new data you can add the remaining data at a later time by activating the appropriate batch file and typing **A**, for Append. The Append option allows you to add data to the current *.DAT file and directs the results to be added to the *.INP file. The rule base will prompt you for new data.

Using the Rule Bases

When the rule base is activated it begins by reading the rules. After the rules have been read the following message will be displayed:

Do you wish instruction on running the program?

If you wish to view the instruction screen type **Y**. Otherwise type **N** or <ENTER>.

You will then be asked:

Do you wish to have the rules displayed as they are used?

If you wish to see the rules as they are used type **Y**. Otherwise type **N**.

You will first be asked to enter the task number of the task about which you will be supplying the information. Following this you will be asked a series of questions about training and performing the task. You may find that more than one response is appropriate for some questions. Enter all appropriate responses with either a space or a comma between each. If you are curious as to why you are being asked for a particular piece of information you can type **WHY**. The rule that needs this information will be displayed. If you type **H** a help screen will be displayed.

When you have answered all questions a message will appear indicating that the results are being printed (to the screen). The results, which were calculated based on the data you entered, will be displayed. For instance, the Fidelity Requirements rule base displays the cue and response requirements for the current task. The Instructional Features rule base displays the appropriate instructional features for training the current task.

When the results are displayed you have several options, which are listed across the bottom of the screen. You may review the derivation of the results, change the results by typing **C**, or continue entering data for another task by typing **D**. Each of these options is described below.

Review derivation. When examining the results, if you wish to see how a certain result was derived you can type the line number of the result and press <ENTER>. The rule which produces the result will be displayed.

Rules take the IF-THEN-ELSE form. The system executes the THEN section if the IF section is true and executes the ELSE section if the IF section is false. The executed section is indicated by **highlighting**. For more information on the "IF" statements of a rule you can type the number of the IF statement and press <ENTER>. For example, suppose you were investigating the following rule:

IF (1) If you are making a right turn
and (2) If the traffic light is green
and (3) If there are no pedestrians in your way

THEN You have the right-of-way

ELSE You may not have the right-of-way.

The THEN section is highlighted meaning that the THEN section was executed, as opposed to the ELSE section. This means that each statement in the IF section was determined to be true. Now suppose you question how the system determined that the traffic light is green. You would type **2** and press <ENTER>. The system could respond to your inquiry in several ways. You may receive the message, "You told me," meaning that you provided the information. Or you may be shown a new rule indicating that the information was derived from the firing of another rule. Ultimately you can trace how each result was derived.

Change and rerun. When examining the results, if you realize you have made a mistake, you may wish to correct the error while preserving the other information entered for the task. Type **C** to activate a display of the responses you gave to each question for the current task. Examine the responses until you locate the incorrect response. Type the number of that response and press <ENTER>. The rule corresponding to that response will appear and you can choose the correct answer. Then type **R** to let the system recalculate the results based on the new information.

> NOTE: When you make a change in your responses by using the Change and Rerun option, both the incorrect data and the correct data are sent to the *.INP file. Before running OSBATS you must correct the *.INP file. For example, suppose you are using the Fidelity Requirements rule base and you make a change to Task 2002. The CUERSP.INP file will contain two entries for this task, as shown below. Before you run OSBATS with the new data file you must use a text editor to delete the incorrect information. In the example below you would delete the rows marked by brackets "{ }". Be sure to save the corrected file as an ASCII file.

2001	0.50	0.74	0.74	0.86	0.00	0.63	0.00	0.36	0.00	0.90	0.74
{ 2002	0.54	0.66	0.50	0.94	0.81	0.36	0.00	0.36	0.00	0.90	0.66 }
{ 2002	0.50	0.66	0.50	0.94	0.81	0.36	0.00	0.36	0.00	0.90	0.66 }
2003	0.54	0.58	0.84	0.77	0.46	0.63	0.00	0.36	0.00	0.90	0.62

Run again. To indicate that you are done with the current task, type **D**. The following message will be displayed:

Run Again? (Y/N)

Type **Y** to run the rule base again for the next task. Type **N** if you have entered data for all tasks or if you wish to stop entering data and resume later.

Using OSBATS to Create the Results Files

When you start the OSBATS software the following options will appear after the title screen.

> The Instructional Features Appropriateness Data has already been calculated.
>
> Your Options:
>
> 1 Recalculate Data Using Instructional Features Rule Base
> 2 Run OSBATS Using Current Values
>
> The Fidelity Optimization Features Appropriateness Data has already been calculated.
>
> Your Options:
>
> 1 Recalculate Data Using Fidelity Optimization Features Rule Base
> 2 Run OSBATS Using Current Values

If you choose to "Recalculate the Data Using ... Rule Base," the system will search for the appropriate data file. For example, if you choose to recalculate the data for the Instructional Features rule base, the system will search for the INSTFEAT.DAT file. Once the data file is found the rule base will use the data to produce the TABLE9.INP file. If no data file is present in the directory the rule base will prompt you to input the necessary data.

If you choose to "Run OSBATS Using Current Values," the system will search for the current version of the *.INP results file. The results of OSBATS will be based on the data contained in this file. Therefore, if you have made changes to either rule base data file you should choose to Recalculate the Data in order to insure that the *.INP file is updated.