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INSTRUCTOR CONSIDERATIONS IN THE DESIGN OF OPTIMAL TRAINING DEVICES

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The purpose of this project was to develop a cost-benefit model for use in choosing instructor support features to be incorporated into the instructor/operator stations (IOS) of simulators. The cost-benefit model was developed in the form of an expert system. Alternative configurations for IOSs are generated using a taxonomy of terms with which to describe characteristics and features needed by an instructor. These alternatives are subjected to a cost-benefit analysis in which the major benefit for the use of an instructor support feature is the reduction of overhead time, which is defined as that time required for (trainer) operations that reduces the time available for student practice on assigned tasks. For each configuration the model produces estimated (1) total annual training time, (2) total annual training overhead time, (3) total trainer acquisition cost, and (4) lifecycle costs expressed as net present value. The program is written in FORTRAN and runs in the IBM XT environment using MS DOS 3.0 or higher operating system.

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Block 18. SUBJECT TERMS (cont.)

Instructor Support Features Taxonomy of Trainer Terms

Instructor Considerations
in the Design of Optimal Training Devices

EXECUTIVE SUMMARY

The purpose of this project was to develop a cost-benefit model for use in choosing Instructor Support Features (ISF) to be incorporated into the Instructor/Operator Station (IOS) of simulators. The model, called the ISF Model, is part of a larger effort by the Army Research Institute to develop tools for engineers to use in optimizing the design of simulators.

The ISF Model was developed in the form of an expert system. Alternative configurations for IOSs are generated using expert rules and a taxonomy of terms which describe both trainer characteristics and features needed by an instructor. Alternative IOS configurations are subjected to a cost-benefit analysis in which the major benefit for the use of each instructional feature is the reduction of overhead time. Overhead time is defined as that time required for (trainer) operations that reduce time available for student practice on assigned tasks.

To run the ISF Model the user answer a short series of questions describing the specific training program to be supported with a simulator. These answers are used as input by the model to perform cost-benefit trade-offs. The data needed to run the model are stored in the model, except the limited input data supplied by the user.

For each technically acceptable IOS configuration the model produces (1) total annual training time, (2) total annual training overhead time, (3) total trainer acquisition cost, and (4) life cycle costs expressed as net present value. The design engineer reviews this information and chooses one configuration.

The program is in FORTRAN and runs in the IBM XT environment using MS DOS 3.0 or higher operating system.

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Instructor Considerations in the Design of Optimal Training Devices

Introduction

Background

The Army Research Institute (ARI) and the Army Program Manager for Training Devices (PM TRADE) are developing computer software for conducting trade-off studies leading to the design of cost-effective training simulators. One of these software programs is the Optimization of Simulation-Based Training Systems (OSBATS). In its present form OSBATS 1.0 (Sticha, Singer, Blacksten, Munaw & Buede, 1987) contains five computer routines. The first routine determines if simulation is required; the second routine determines which instructional features should be included; the third, what level of fidelity is required; the fourth, which type of training device is recommended; and the fifth addresses how training time is to be allocated among the various types of training devices.

These computer routines are meant to be used by training analysts (e.g., engineers and education specialists) as they develop device concepts. The routines should be able to:

- reduce concept formulation time
- reduce total manpower required for concept formulation
- make the designing of training devices a more objective process.

Not considered to date in the OSBATS process are issues relating to the design of the instructor/operator station (IOS) for training devices. The design of the IOS is a significant part of the training device development project, both in terms of cost and impact on training effectiveness.

Simulation-based training devices have had a long history of user problems, especially in terms of a lack of effective use by instructor personnel. See Charles (1987) for a comprehensive bibliography. In general, the IOS on trainers has not been designed to implement training functions, and has not supported the instructor in a user friendly manner.

However, a wide variety of features have been proposed and incorporated in trainers. Most of the features have been concerned with trainer operation. Few of the features have been used to support the instructing process. Also, recent studies of operational trainers and trainers under development have shown that features are not equally effective across all trainer applications.

Purpose

The purpose of this project is to develop a prototype process for simulator designers to use in choosing which instructor support features should be built into the IOS. This process considers the instructor's function in various types of simulators at different phases of training and defines the types of instructor support features (ISFs)that are needed to support each requirement. This selection process requires a cost-benefit analysis technique which identifies alternative configurations of IOSs for a given trainer and then assesses the cost and benefit of each alternative.

Organization of the Report

Following this Introduction, there are four additional sections to the report. The second section describes a conceptual framework for choosing ISFs for simulators based upon an expert system approach. The next section describes the cost-benefit analysis approach for choosing specific configurations of an IOS. This section is followed by a brief description of the computer program itself. The last section of the report presents observations concerning the feasibility of using expert system techniques in designing IOSs for simulators and recommendations arrived at in this project.

Detailed information about the process is contained in the various appendices. Appendix A is the resume of the expert in IOS design. The entire model functions in accordance with the rules and logic this expert uses in choosing instructor support features for simulators. Appendix B contains the definitions of each of the terms in the Taxonomy of Training Terms. These formally defined terms give structure to the expert system. Appendix C contains the tables which store the expert judgments used in choosing ISFs. This is followed by Appendix D, a demonstration of the first half of the model and Appendix E, a demonstration of the second half of the model which concerns the cost-benefit analysis. Appendix F contains the complete set of training requirements for instructor training programs. Included are requirement statements that can be used to meet the needs of every possible configuration of an IOS. It also presents a detailed look at instructor performance within a simulator exercise. Appendix G is made up of sample benefit data used with all IOS configurations. The chief contribution in the use of an instructor support feature is overhead time saved. Therefore this appendix illustrated how time saved was estimated. The cost factors used in analyzing the cost of specific levels of benefit are presented in Appendix H. And finally, Appendix I presents training guidelines and parameters for part task training. These are presented to allow an in-depth study of instructor functions in the various types of part task trainers.

Instructor Support Feature Selection

A two part process is used in choosing ISFs to be included in an IOS for a simulator. This process is implemented in a computer model, the Instructor Support Feature Model. In the first part of this model alternative sets of ISF are identified. Although each set includes different ISF combinations, all the sets satisfy the training requirements. In the second part of the model these alternative sets of features are subjected to a cost-benefit analysis. Based on this information, the training system designer then chooses which ISF package to include in the simulator design.

Expert System Approach

The ISF Model is based on an expert system design. This model incorporates the decision making logic of an individual established as an expert in this type of task. Not only does the routine's logic emulate the logic of the expert, the data used within the model originated with the expert. Therefore the decisions made with the expert system are similar to the decisions made by the expert.

The expert being modeled by these routines is Dr. John Charles. He is a specialist in IOS design, and recently developed IOS acquisition and design guides for the U.S. Navy (Charles 1984) and U.S. Air Force (Charles 1987). His work in IOS design is part of a career concentrated on issues related to the design of simulators with a focus on user needs and constraints. His advanced degrees are in experimental psychology, and he has a broad background in human factors engineering, operations analysis, and training. For more information on Dr. John Charles see Appendix A.

General Framework of Concepts

What follows is a general framework or architecture of concepts underlying the design of the expert system. In this conceptual framework, a simulation-based training system consists of five major subsystems. These subsystems are:

- o student station (crewstation mock-up)
- o simulation subsystem (software, environmental simulations)
- o instructional subsystem (instructional features, training exercises and scenarios)
- o instructor/operator station (operating consoles)
- o utility subsystem (e.g., hydraulics, pneumatics)

The relationship among these subsystems is presented in Figure 1. There are three ways in which the instructor affects the student. First, there is direct contact between the instructor and the student. Second, the instructor can affect the student through the selection and control of training exercises in the Instructional Subsystem. And third, the instructor can manipulate the environmental conditions of the problem created in the Simulation Subsystem. The second and third types of control are through the IOS.

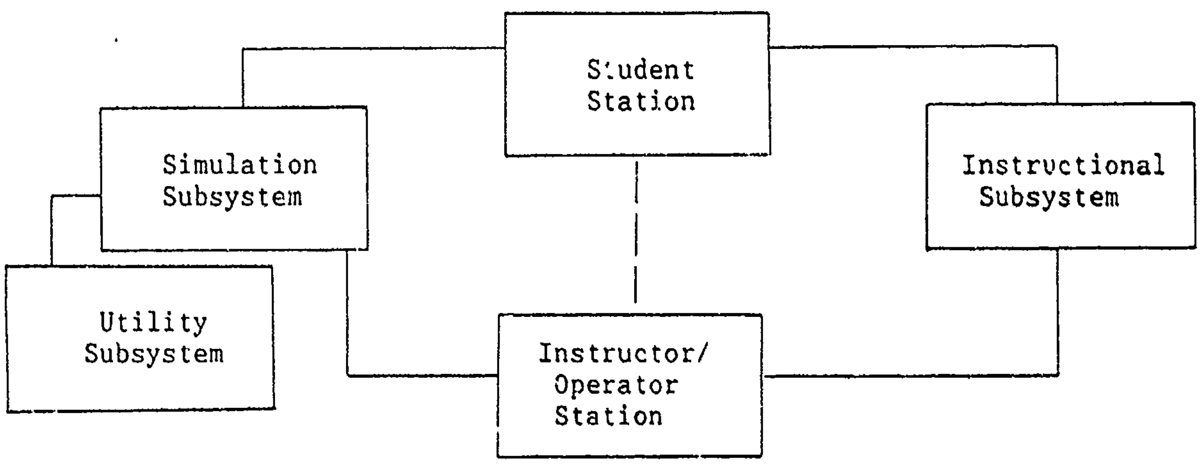

Figure 1. Block diagram of the simulation-based training subsystems

The instructor's use of the ISFs in the IOS is a major determinant of the overall efficiency of training provided by the simulator. Because of its impact on training efficiency, the IOS should be well designed.

Taxonomy of Training Terms

The architecture for this expert system includes the following types of elements:

8 major phases (types) of training
8 training functions
6 types of instructors
3 training strategies
3 IOS locations
43 instructor support features

Each IOS configuration is defined in terms of these elements. Together the names of these elements and their definitions make up a taxonomy of training terms. The terms in this taxonomy are presented in Tables 1, 2, and 3. Table 1 contains the high level terms. In Table 2 training functions are broken down into subfunctions, and in Table 3 ISFs are grouped into the operating features, instructing features and managing features, categories listed on Table 1. All terms are defined in Appendix B in such a way that they can be used in defining IOS requirements in any training domain, such as armor, aviation, and artillery.

The feature selection process within the ISF Model is based on naturally occurring relationships among the system elements. For instance, an "operational instructor" (such as an instructor pilot) can teach all phases of training, while a "technician/operator" does not have the tactical experience to conduct "crew" or "mission" exercises.

Another example of a naturally occurring relationship described by this model is that when an "operational instructor" conducts a "mission" type exercise where a tactical team practices a combat mission in a simulator, the only acceptable training strategy is "monitor" in which the instructor observes the simulated mission and debriefs the team at the conclusion of the mission. Still another example of a naturally occurring relationship is when an exercise is used to teach emergency procedures to a pilot, then the training strategy will be "tutor" or "interact;" "monitor" will not be an option.

Table 4 shows the types of relationships that were analyzed. Twenty-one sets of relationships were found to be significant for purpose of defining requirements for ISFs.

Table 1

Instructional System Taxonomy

TRAINING PHASES	TRAINING FUNCTIONS
Familiarization	Prepare
Part Task	Brief
Rules	Initialize
Decision Making	Train
Detection	Evaluate
Classification	Debrief
Voice Procedures	Document
Procedures	Develop
Steering/Guiding	
Position	
Crew	
Mission	
Proficiency	
Advancement	
Special	

TRAINING STRATEGY
Tutor
Interactive
Monitor

TRAINER MANNING	INSTRUCTOR LOCATION
Operational Instructor	Remote
Simulator Instructor	On-Board Remote
Operator/Instructor	Over-the-Shoulder
Technician/Operator	
Student Instructor	
Peer Instructor	

INSTRUCTOR SUPPORT FEATURES
Operate (19 feature)
Instruct (16 feature)
Manage (8 feature)

Table 2

Training Functions

Prepare

Identify requirements
Assemble required data
Review data
Develop plan

Brief

Brief trainee
Brief support staff

Initialize

Configure trainer
Configure IOS
Initialize systems
Establish system readiness

Train

Control simulation
Play human roles
Instruct
Monitor student performance
Record performance data

Evaluate

Establish if criterion performance is met
Diagnose learning problems
Modify exercise to meet learning difficulty
Record evaluations

Debrief

Debrief trainee
Debrief support staff

Document

Update trainee records/reports
Update instructor records/reports
Update trainer records/reports
Document modifications

Develop

Develop new exercises
Implement new exercises
Validate new exercises

Table 3

Instructor Support Features

Operating Features

a. Automatic Exercise
b. Automatic Freeze
c. Automatic Malfunction
d. Automatic Vehicle
e. Configuration Check
f. Crash Override
g. Exercise Modification
h. Flag Set
i. Freeze
j. Help
k. Initial Conditions (IC) Load
l. Instructional System Check
m. Manual Stack
n. Prompts/Cues
o. Reset
p. Simulation System Check
q. Speech Output
r. Speech Control
s. Tutorial

Instructing Features

a. Adaptive Syllabus
b. Automatic Diagnosis
c. Automatic Syllabus
d. Brief/Debrief
e. Conditions Capture
f. Communications Records
g. Demonstration
h. Environment Modification
i. Hard Copy
j. Parameter Freeze
k. Performance Monitor
l. Performance Measurement
m. Performance Record
n. Procedures Monitor
o. Programmed Exercise
p. Replay

Managing Features

a. Degraded Training
b. Exercise Development
c. Instructor Records
d. Reports
e. Scheduling
f. Student Records
g. Training Evaluation
h. Trainer Records

Table 4

Parameter Tables Developed

	Phase	Function	Manning	Strategy	Location	Features
Phase	-	-	-	-	-	-
Function	x	-	-	-	-	-
Manning	x	x	-	-	-	-
Strategy	x	NA	x	-	-	-
Location	x	x	x	x	-	-
Features						
Operate	x	x	x	x	x	-
Instruct	x	x	x	x	x	-
Manage	NA	x	x	NA	NA	-

NA - not applicable - table insensitive

x - table developed

Storing Expert Rules in Tables

These relationships were recorded in the form of matrices. Twenty-one matrices were developed, one for each of the sets of relationships identified in Table 4. As an example, Table 5 is the table showing the relationship between "training strategy" and "phase" of training. Each "x" or cluster of "x"s could be expressed as a rule. For instance three of the "x"s could be expressed with the following If/Then statements.

- o If the phase of training is "familiarization", then the training strategy is "tutor."
- o If the phase of training is "procedures", then the training strategy is "tutor" or "interact."
- o If the phase of training is "mission", then the training strategy is "monitor."

There are approximately 320 of these relationships coded in the matrices. The names of the 21 matrices are listed in Table 6 and the matrices themselves are located in Appendix C.

Table 5

Phase And Training Strategy

	Training Strategy		
Phase	Tutor	Interact	Monitor
Familiarization	X		
Part Task			
Procedures	X	X	
Decision Making		X	
Detecting		X	
Classifying	X	X	
Steering/Guiding	X	X	
Rule Using		X	
Voice Procedures		X	
Position		X	X
Crew		X	X
Mission			X
Proficiency			X
Advancement *	X	X	X
Special *	X	X	X

* As Required by Course Involved

Table 6

List Of Tables

1. Phase and Manning
2. Phase and Training Strategy
3. Phase and Location
4. Manning and Location
5. Manning and Strategy
6. Strategy and Location
7. Function and Manning
8. Function and Phase
9. Function and Location
10. Operating Features and Phase
11. Operating Features and Manning
12. Operating Features and Strategy
13. Operating Features and Location
14. Operating Features and Features
15. Instructing Features and Phase
16. Instructing Features and Manning
17. Instructing Features and Strategy
18. Instructing Features and Location
19. Instructing Features and Function
20. Management Features and Manning
21. Management Features and Function

Model Architecture

The ISF Model for choosing ISFs to be used in a simulator is a two part process. In the first part certain global characteristics are established defining a set of acceptable configurations and then the specific ISFs are identified for each configuration. In the second part of the process the cost-benefit analysis of the various configurations is conducted. The process starts by identifying the phase of training to be supported by the simulator. This is a judgment made by the analyst after inspecting the tasks to be practiced in the simulator. For example, tasks would be classified as "crew" tasks if they concern a pilot and copilot performing tactical maneuvers.

Next the top level IOS design options are identified using the rules that concern the relationships among phase, manning, location and strategy characteristics within IOS designs. For instance, for the training phase called "crew", one rule states that only "operational instructors" and "simulator instructors" are appropriate (Table C-1, Appendix C). Another rule states that for crew training only the strategies of "interact" and "monitor" are to be used

(Table C-2 , Appendix C). Still another rule states that "remote" and "onboard remote IOS" locations are appropriate with "crew" training (Table C-3, Appendix C). The rules within the first 9 tables in Appendix C are used to identify compatible sets of global IOS characteristics. At the end of this operation all appropriate alternatives are identified and expressed by descriptions such as:

Phase:	Crew
Manning:	Simulator Instructor
Strategy:	Interact
Location:	On-board Remote

In the next phase of the analysis, ISFs are assigned to each of the alternatives selected for further analysis. This is accomplished by applying a different cluster of rules that concern ISFs for each type of phase, manning, strategy, and location. Also considered are the training functions being performed, and the ISFs that are useful in performing these functions. One rule states that "crash override" is a feature that is useful with "crew" training (Table C-10, Appendix C). Another rule states that "crash override" should only be used with "operational instructors" and "simulator instructors" (Table C-11, Appendix C). And another rule states that "crash override" supports a single training function of "control simulator" (Table C-14, Appendix C). As a result of using a large set of these rules, specific ISFs emerge that satisfy all the pertinent rules. This process is repeated for each set of top level IOS characteristics identified in the previous step and selected for further analysis. Table 7 shows the description of one configuration generated by this process.

An annotated demonstration of this process is presented in Appendix D. The example shows the step by step procedure and outcome of using each of the matrices. It illustrates the operations performed by the computer in the automated version of this process.

In the next section, the competing alternative configurations derived from the process described above, are subjected to cost-benefit trade-off analysis. Here the impact of cost and benefit factors are evaluated and displayed in such a manner as to assist the analyst in selecting one configuration. An annotated demonstration of this is presented in Appendix E.

Table 7

Information Passed to the Cost-Benefit Analysis for One IOS Configuration

PHASE: Crew
MANNING: Simulator Instructor
STRATEGY: Interactive
LOCATION: On-board Remote IOS

THE FOLLOWING OPERATING FEATURES ARE APPROPRIATE:

- Automatic Exercise
- Automatic Malfunction
- Automatic Vehicle
- Configuration Check
- Crash Override
- Exercise Modification
- Flag Set
- Freeze
- Help
- Initial Condition (IC) Load
- Manual Stack
- Reset
- Simulation System Check
- Speech Output

THE FOLLOWING INSTRUCTIONAL FEATURES ARE APPROPRIATE:

- Adaptive Syllabus
- Automatic Syllabus
- Brief/Debrief
- Conditions Capture
- Demonstration
- Environment Modification
- Hard Copy
- Performance Monitor
- Performance Measure
- Performance Record
- Procedure Monitor
- Programmed Exercise
- Replay

THE FOLLOWING MANAGEMENT FEATURES ARE APPROPRIATE:

- Scheduling
- Student Records
- Instructor Records
- Trainer Records
- Degraded Training
- Exercise Development
- Training Evaluation

Cost-Benefit Analysis

A cost-benefit analysis is conducted on the set of alternative trainer configurations identified for a specific phase of training. The relative cost and benefit of the various configurations are described in terms of differences in (1) total training time required, (2) total overhead time, (3) acquisition cost of total trainer(s) and (4) net present value of all cash outflows during the life of the trainer(s). The net present value includes all the acquisition and operating costs involved in the trainer configuration, but not the maintenance costs or adjustments for inflation. The analyst must use these four criteria as displayed in the various result outputs to choose the appropriate configuration.

Optimization Goal In IOS Design

The goal to be achieved is to select the most appropriate set of ISFs to be included in the IOS configuration so as to make the simulator training more efficient. This efficiency can be described in terms of minimizing certain costs associated with simulator use, i.e., such as for overhead time, manning, and instructor training. Efficiency can also be added by maximizing the support provided to the various training functions. Each of these alternative ways to increase efficiency is presented in the following sections.

Minimize overhead time

Overhead time is defined as that time required for operations that reduce the time available for student practice on assigned tasks. This includes a wide range of trainer operations. For instance the time required for the instructor to set up the trainer for an exercise is time which is no longer available to the student. In other instances the instructor is engaged in mechanical operations that demand his full attention, thus making it impossible to attend to his primary job of instructing. In still other instances the student must perform operations already overlearned in order to be in a position to practice critical skills. In our model, the fundamental goal for using any of the ISFs is to reduce one or more elements in overhead time whenever and as much as possible. For instance, significant reductions in time required to practice landings in a flight simulator can be achieved by setting a "flag" at the beginning of the glide path. This causes the aircraft to return immediately to a position for another practice landing without any loss of time, therefore making it feasible to conduct more practices than would have been otherwise possible during the same amount of time. In other words, the usage of the "flag" as a instructional feature makes it feasible for the student to avoid the overhead time normally required to reposition his aircraft for another landing.

Minimize manning requirements

A trainer can be manned by different types of instructors. Because each type of instructor is paid at a different rate, the cost of manning the trainer is dependent, in part, on the type of instructor used. The type of instructors that are appropriate is determined by the phase of training, and is constrained by the training strategy and IOS location selected. For example, using an operational instructor (such as a pilot with flight pay) involves a considerably higher cost per hour than using a technician/operator. The number of instructors/operators required for a trainer can vary with any configuration. In addition an efficient trainer (i.e., low overhead time due to the use of effective ISFs) requires less instructor time.

Minimize instructor training cost

In some instances instructor training is a significant cost. What is required is the acquisition of a training plan, training materials, instructors, and trainer time dedicated to instructor training. The development and initial use of the course are often a part of the trainer procurement. In this model, instructor training is modeled using data in Appendix F. It should be noted that poorly trained instructors result in limited understanding, acceptance, and use of the ISFs by the instructors (Polzella, 1983; Osborne, Semple, & Obermayer, 1983). This in turn, causes excessive overhead time in the student training exercises on the trainer. Therefore, minimizing instructor training costs requires that instructors be properly trained with an efficient media/method mix that has a lower cost when compared with other acceptable sets of media/methods.

Maximize the number of trainer functions supported

In conducting training in major training devices there are 8 training functions (e.g., brief, initialize, train) which together include 28 subfunctions (e.g., brief students, brief staff) that can be supported with ISFs (see Table 2). Not all subfunctions must be supported in every trainer. However, one measure of the level of optimization achieved in a trainer design is the degree to which the required subfunctions are supported with useful ISFs and the associated savings involved in time and costs.

Criteria Measures

Each trainer configuration is evaluated in terms of the following six criteria. The corresponding notations are shown in parentheses.

Total Training Time (annual)	(TT)
Total Overhead Time (annual)	(OT)
Total Instructing Time (annual)	(IT)
Number of Trainers Required	(N)
Acquisition Cost of Trainer	(A)
Net Present Value of all Cash Outflows	(P)

As stated earlier the system is interactive. The analyst must first set the scope of the ISF evaluation by answering the following seven questions. These possible questions are indicated by "Q". "A" indicates where the answers are to be used in the model.

Q1. Given a trainer with an IOS configuration having all the possible features of the configuration, "What is the Total Time a trainer will be available in a year?"

A1. Denote this answer as (Tmax). It is expressed in hours.

Q2. How many years will the trainer be used? (This is the maximum useful life expectancy of the trainer).

A2. Denote this answer as (n).

Q3. What is the <u>maximum</u> number of hours a trainer is expected to be used for training during a year? (This is the Total Instructing Time required in a year).

A3. Denote this answer as (IT).

Q4. What is the average student pay scale per hour for the students in training? (The possible pay scales involved will be displayed on the screen).

A4. Denote this answer as (PS).

Q5. What is the number of students per session?

A5. The default number for this is 1, for all the phases of training with the exception of <u>CREW</u> or <u>MISSION</u> training. Otherwise, the analyst must enter the exact number of students involved in the CREW or MISSION training being considered. Denote this answer as (S).

Q6. What is the number of Instructors trained per year?

A6. Denote this answer as (I).

Q7. What is the estimated overall acquisition cost of a trainer?

A7. Denote this answer as (C).

Using the data supplied by the analyst, the system performs the necessary evaluations needed in the cost-benefit trade-off analyses.

<u>Total Training Time (TT)</u>

Let t_j be the overhead time per hour of instruction using any configuration j.

To calculate t_j refer to appendix G pages G-5 and G-6. As previously stated, overhead time is defined as the time required for operations that reduce the time available for student practice on assigned tasks. This time can be calculated by adding the times the instructor spends performing certain non-training functions, i.e., setting up and reconfiguring the trainer. The date in Appendix G describes estimates of the time required to perform these various operations with and without instructor support features during a typical one hour exercise. After identifying the one time use of specific instructor support features used in a specific configuration "j", and the repetitive use of a subset of these features during the instruct phase, the total overhead time required for any configuration can be calculated by adding the times required. This is expressed as a ratio of overhead minutes to fifty minutes (length of one instructional hour), represented as t_j.

Given the expected instructing time (IT), the total training time for configuration j is computed as

$$TT_j = (1 + t_j) * IT$$

Total Overhead Time (OT)

The total training overhead time for configuration j is computed as

$$OT_j = IT * t_j$$

Total Instructing Time (IT)

This is the ideal time desired to conduct simulation instruction using the trainer. This time is given as an input data by the designer as (IT) in question Q3. It is the same for all configurations.

Number of Trainers (N)

The number of trainers required for configuration type j is given by the following formula:

$N_j = TT_j/Tmax$

Decimal numbers are rounded up to the nearest whole number.

Acquisition Cost of the Trainer (A)

Let AA denote the cost of a "bare" simulator. A bare simulator is a simulator without an Instructor/Operator Station. To obtain the cost corresponding to this, it is first necessary to evaluate the costs for each possible IOS configuration for the phase of training selected by noting the acquisition costs of all the ISFs. Let M denote the most expensive of the calculated family of IOS configuration costs. Using C, which is obtained in question 7 above, and M, AA is given by the following equation:

$AA = C - M$

Let A_j denote the Total Acquisition Cost of a Trainer with an IOS configuration j, and let D_j denote its Annual Operating Cost (excluding the manpower costs required). Let p be the proportion of the total acquisition cost which is equivalent to the annual operating cost for the trainer. Let E_j denote the total manpower cost involved in all operations and training on the IOS, and let F_j denote the Total Annual Operating and Manpower Cost. The remaining cost calculations related to any configuration j are as seen below.

A_j = AA + Sum of the costs of each ISFs in configuration j,

$D_j = A_j * p$,

$E_j = TT_j$ * (Cost of Instructors/hour + Cost of Students/hour),

$F_j = (D_j * N_j) + E_j$.

It should be noted that $C = A_j$ only when A_j is for the configuration with the most expensive ISF package.

Net Present Value (P)

The net present value of all cash outflows related to any configuration j is calculated as follows (no maintenance costs or adjustments for inflation are included):

$$P_j = A_j * N_j + F_j \ (P/A,\ i,\ n),$$

where (P/A, i, n) are the appropriate applicable discount factors given by

$$(P/A,\ i,\ n) = [(1 + n)^n - 1]/[i(1 + i)^n].$$

The term i is the interest rate used for discounting all future cash outflows, and n is the number of years considered for the use of the trainer (as given in response to question Q2). The interest factor of i = 10% is used in the evaluation procedures. A typical cash flow diagram can be seen in Figure 2. As an example, the present cost in year 3 of the life cycle equals the acquisition cost times number of devices acquired plus Total Operating and Manpower costs for year 3, adjusted by the discount factors.

Years in Lifecycle

0 1 2 3 - - - - - - - - - - - - - -

F_j F_j F_j F_j F_j F_j

Aj Nj
(Acquisition Cost for all devices j)

Figure 2. Typical Cash Flow Diagram

Evaluation Methodology

For each configuration j identified as feasible and appropriate by the selection procedure based on the expert system methodology explained in the previous sections, the designer generates three scenarios:

1. Configuration j equipped with All possible useful ISFs.

2. Configuration j equipped with the Essential ISFs only.

3. Configuration j equipped with the Essential ISFs augmented by a combination of selected unessential ISFs. These added unessential features are selected by the designer who may wish to use them in his own special IOS design configuration for comparison purpose.

The designer then evaluates each of the above configurations in terms of the six cost-benefit criteria. The data files used to evaluate the configurations are described below.

Cost-Benefit Data

The following data are included in files within the ISF Model. They are in addition to the data in the matrices and the data the decision maker inputs directly into the routine at the time the model is being run.

Average single use time for features. Typical exercises were defined for each phase of training (see Appendix G). Using these exercise descriptions, expert judgments were made concerning the typical single use time for each feature during the exercise. Except for features used during the Instruct function which were handled separately, all features were judged to be used a single time in the exercise (i.e., instructor support features used in briefing student would be used once per exercise). For those features considered significant or convenient, expert judgments were made concerning the time it would take for the instructor to perform the function without the aid of the ISF. A sample of these times in minutes for typical exercises in each Phase of training are recorded in Table 8. The complete set of data is in Appendix G. These data are used in the model to calculate overhead time and time saved through the use of ISFs.

Average number of times a feature is used during instruction. While many ISFs such as "configuration check" are used only a single time during an exercise, other features employed during actual instruction are used more than once. Table 9 records an estimate of the number of times selected feature would be used during a typical exercise. The complete set of data is in Appendix G. Separate numbers are presented for exercises in each phase of training. These times are used in the model to calculate overhead time saved during instruction through the use of ISFs.

Cost data. Data have been accumulated on the acquisition and operating cost of ISFs, instructor and student costs, and the cost of various forms of media used in instructor training.

Table 8
Sample Data for Instructional Support Features: Importance and Use Time in Minutes

	Feature	Time										
		Manual										
OPERATING FEATURES		Fam	Proc		Pos		Crew		Miss		Prof	
Auto Exercise	.01	-	C	2.0	C	2.0	C	2.0	S	2.0	S	2.0
Auto Freeze	.01	-		-	C	2.0		-		-		-
Auto Malf	.01	-	S	.2	S	.1	S	.1	S	.1	S	.1
Auto Vehicle	.01	-	E	.5	E	.1	S	2.0	S	5.0	S	5.0
Config Check	.2	-	S	1.0	S	1.0	S	1.5	S	1.5	S	1.5
Crash O'Ride	.01	-		-	S	.2	S	.4		-		-
Exercise Mod	.1	-	E	.5	E	.3	E	.4	S	.5	S	.5
Flag Set	.01	-	S	.2	S	.2	S	.3	S	.3	S	.3

E = Essential
S = Significant
C = Convenient

Table 9
Sample Data for the Instruct Phase of Training: Feature Frequency Of Use

	Manual Time					
CONTROL FEATURE	Fam	Proc	Pos	Crew	Miss	Prof
Auto Exercise	x	x	x	x	x	x
Auto Freeze	-	-	-	-	-	-
Auto Malf	-	10	5	5	1	2
Auto Vehicle	-	10	5	5	1	2
Config Check	x	x	x	x	x	x
Crash O'Ride	-	-	5	5	1	1
Exercise Mod	-	2	2	2	-	-
Flag Set	-	5	2	2	5	5

x feature not used in TRAIN function
- feature not used in phase

Acquisition cost. The cost of procuring first units of individual ISFs, and follow-on production units was estimated using the Constructive Cost Model (COCOMO) described by Boehm (1981).

COCOMO estimates software development costs based on the size of the software product in terms of instructions or lines of code. Since a large percentage of the cost of instructional features is software cost, this model was selected. The COCOMO was also used to generate the cost of instructional features for the Resident Data Base for the OSBATS Model (Willis 1988). Therefore the approach used here is compatible with the larger OSBATS effort.

The COCOMO estimation of required effort varies with program size in a non-linear manner. Table 10 reproduced from Boehm illustrates the effort levels required for standard size products for three different modes of software development (organic, semidetached and embedded). Use of the model requires selection of the mode of software development and the size of the programs to be developed.

Table 10

Basic COCOMO Man Month Estimates for Standard Size Programs

	Program Size in Thousands of Delivered Source Instructions				
Mode	2	8	32	128	512
Organic	5.0	21.3	91	392	
Semidetached	6.5	31	146	687	3,250
Embedded	8.3	44	230	1,216	6,420

The organic mode, as described by Boehm, appears to reflect typical trainer software module development. In this mode, relatively small software teams develop software in a highly familiar, in-house environment. Most programmers connected with the project will have extensive experience in working with trainer software and have a thorough understanding of how the software contributes to the trainer's performance. The programmers will have contributed to the project design in its early stages without extensive communications overhead. There will be a stable development environment with a minimum need for the design of innovative data processing architectures or algorithms and a relatively low premium on early completion of the project. While other modes of software development may be appropriate for certain projects, the cost tables developed for instructor support software development are based on the "organic" mode.

While the organic mode was selected for projecting costs in this project, a brief description of the other modes is presented to give perspective to this decision. The semidetached mode is characterized by team members all having an intermediate level of experience with related projects, or the team being composed of a mixture of experienced and inexperienced people. Also important in this classification is a more complex interface with other parts of the project. This is the origin of the name, "semidetached mode". The embedded mode is distinguished by the need for the software to operate within tight constraints. The software must be strongly coupled to complex hardware, software, regulations, and operating procedures (i.e., such as a national electronic funds transfer system). In general, the cost of changing the other parts of this complex are so high that their characteristics are considered essentially unchangeable. The software development team does not have the option of negotiating easier software changes and fixes by modifying the requirements and interface specifications. In this mode, the software team is charting its way through unknown territory, and gets swamped in communication overhead and therefore makes inefficient use of personnel.

The part task phase of training was used for baseline estimation of software size. The trainers for the other phases represent increasing complexity in terms of training requirements. Again, expert opinion was utilized in estimating the average size of the required programs. Five different levels of program size were identified for input to the model. The levels were 4, 6, 8, 12, and 16 KDSI (thousands of delivered source instructions).

Table 11 was then developed using the COCOMO basic "effort" equation for the organic mode:

$$MM = 2.4\,(KDSI)^{1.05}$$

Where:

MM = man months of effort required

KDSI = thousands of delivered source instructions

Table 11

Basic COCOMO Manpower Estimates for Software Development

	Program Size in KDSI				
	4	6	8	12	16
Man Months	10.3	15.7	21.3	32.6	44.1

The next step involved estimation of the increasing size of the feature software as a function of trainer complexity as required by the different phases of training. Review of feature characteristics as a function of phase of training revealed that three different types of feature changes are involved.

1. Some features do not change in size with phase of training.

2. Some features involve minimum changes with phase and require primarily a change in the size of the data base or formats.

3. Some features involve major software changes in terms of parameters, processing or basic design.

Table 12 outlines the features by size and type of change involved.

Table 12
Support Features by Size and Change Characteristics

Size	Features By Type Of Change: No Change	Minimum Change	Maximum Change
LARGE			
	Schedule	Tutorial Adaptive Syllabus	Automatic Diagnosis Brief/Debrief Exercise Development Performance Measure
MEDIUM TO LARGE			
	Automatic Malfunction	Replay	Programmed Exercise
	Automatic Syllabus	Perform Monitor Automatic Vehicle	Automatic Exercise
MEDIUM			
	Manual Stack	Speech Output Perform Record	Demonstration
MEDIUM TO SMALL			
	Hardcopy	Procedures Monitor	Configuration Check
	Automatic Freeze	Help Exercise Modification Environmental Modification	Prompts/Cues
SMALL			
	Parameter Freeze Crash Override Flage Set Freeze Initial Conditions Load Reset Conditions Capture Trainer Record Degraded Training Reports Instructor Record Student Record Training Evaluation	Instrtuctional System Check Simulation Systems Check	

To construct the cost table for the support features for each phase of training, man months were converted to man hours using the COCOMO standard of 152 working hours per man month. The hours were converted to dollars using the U. S. Department of Labor wage rate for a software support engineer. The rate ranged from $18.50 to $28. An average of $23 per hour was utilized.

The magnitude of the changes required by phase were analyzed. Minimum change features were estimated to increase in size by an average of 2.5% from part task to position to crew to mission. Maximum change features were estimated to change at 5%.

Table 13 presents these data for a crew phase trainer and reflects the differential costs for the features as a function of the type of change involved.

Table 13
Typical Feature Cost Data - Crew Phase of Training

	Software Cost Estimates ($K)		
PROGRAM SIZE	No Change	Minimum Change	Maximum Change
Large	154.2	161.7	169.7
Medium Large	114.0	119.7	169.6
Medium	74.5	78.2	82.0
Medium Small	54.9	60.4	57.6
Small	36.0	37.8	39.6

Finally cost tables were developed for use in the ISF Model. The software costs developed using the COCOMO model were utilized as an estimate of initial acquisition costs. The cost of any required hardware was estimated by experts. Software production costs were estimated at 14.3% of initial acquisition costs. Table 14 is a typical cost data table developed for use in the costing model. It contains the position phase trainer data. Similar table were developed for each phase of training. They appear in Appendix H. It should be noted that by updating the wage rates used these projections are easily kept current. Also any time the COCOMO model is used the results should be spot checked against available costs to ensure that the cost analyst has adapted the model properly.

Table 14
Position Trainer Feature Costs Data (Thousands of Dollars)

Feature by Size	ACQUISITION SOFT	ACQUISITION HDW	ACQUISITION TOTAL	PRODUCTION SOFT	PRODUCTION HDW	PRODUCTION TOTAL
LARGE						
Scheduling	154.2	-	154.2	22.1	-	22.1
Auto Diagnosis	161.7	-	161.7	23.1	-	23.1
Brief/Debrief	161.7	-	161.7	23.1	-	23.1
Exercise Dev	161.7	-	161.7	23.1	-	23.1
Perform Measure	161.7	-	161.7	23.1	-	23.1
Adap Syllabus	156.1	-	156.1	22.3	-	22.3
Tutorial	156.1	-	156.1	22.3	-	22.3
MEDIUM LARGE						
Auto Malf	114.0	-	114.0	16.3	-	16.3
Programmed Exer	114.0	-	114.0	16.3	-	16.3
Auto Exercise	119.7	-	119.7	17.1	-	17.1
Replay	116.8	-	116.8	16.7	-	16.7
Perform Monitor	116.8	-	116.8	16.7	-	16.7
Auto Vehicle	116.8	-	116.8	16.7	-	16.7
MEDIUM						
Speech Control	74.5	3.0	77.5	10.6	3.0	13.6
Demonstration	76.4	-	76.4	10.9	-	10.9
Speech Output	76.4	3.0	79.4	10.9	3.0	13.9
Performance Record	76.4	-	76.4	10.9	-	10.9
MEDIUM SMALL						
Manual Stack	54.9	-	54.9	7.9	-	7.9
Procedures Check	56.3	-	56.3	8.1	-	8.1
Help	56.3	-	56.3	8.1	-	8.1
Config Check	57.6	-	57.6	8.2	-	8.2
Prompts/Cues	57.6	-	57.6	8.2	-	8.2
Exercise Mod	57.6	-	57.6	8.2	-	8.2
Environmental Mod	57.6	-	57.6	8.2	-	8.2
SMALL						
Hardcopy	36.0	2.0	38.0	5.1	2.0	7.1
Auto Freeze	36.0	-	36.0	5.1	-	5.1
Parameter Freeze	36.0	-	36.0	5.1	-	5.1
Crash Override	36.0	-	36.0	5.1	-	5.1
Flag Set	36.0	-	36.0	5.1	-	5.1
Freeze	36.0	-	36.0	5.1	-	5.1
I.C. Load	36.0	-	36.0	5.1	-	5.1
Reset	36.0	-	36.0	5.1	-	5.1
Conditions Capture	36.0	-	36.0	5.1	-	5.1
Comm. Record	36.0	-	36.0	5.1	-	5.1
Trainer Record	36.0	-	36.0	5.1	-	5.1
Degraded Training	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1
Trainer Evaluation	36.0	-	36.0	5.1	-	5.1
Inst Sys Check	36.9	-	36.9	5.7	-	5.7
Sim Sys Check	36.9	-	36.9	5.7	-	5.7

Operating cost. The cost of operating individual instructional features is not directly available. To obtain these cost factors it was necessary to utilize cost estimating relationships. Data are available on the annual operating cost of various types of trainers, and these operating costs were compared with the acquisition costs of the trainers to obtain ratios of annual operating costs to acquisition costs for the various types of trainers. The assumption is made that the ratio of operating costs of individual ISFs to the acquisition costs of these features is the same for the entire trainer.

Based on these assumptions, the annual operating cost of ISFs are:

Phase of Training	Percent of Acquisition Cost
Familiarization	35
Part Task	30
Position	10
Crew	7
Mission	5

It should be noted that only a small sample of data was used to generate these relationships, and the further refinement of these ratios should be undertaken for more valid factors.

Instructor and Student Cost. The cost of instructor and student hours is a significant factor in use of the trainers. In an efficient trainer, instructional goals are achieved in fewer hours, thereby saving life-cycle costs of a training program. To model the impact of trainer design on instructor and student labor costs requires data on the cost of various types of instructor and student labor. The labor costs used are presented in Appendix H.

Cost of media used in instructor training. The cost of preparing the course of instruction for training instructors is included in the cost-benefit model. Typical costs for developing materials to support one hour of instruction are presented in Table 13. Back-up data on how each cost was estimated is presented in Appendix H.

Table 15

Cost of Developing Media for Instructor Training

Media	Development Cost per Hour of Instruction
Instructor's Lesson Plan	$ 200
Operator's Guide (JPA)	350
VCR Tape	8,700
Computer-based Training	
Computer Graphics	2,200
Videodisc	73,000
Embedded Training	22,000

Choosing The Optimal Configuration

The individuals who make the design decisions concerning which instructor support features to include in a training device can systematically organize data from the ISF Model to use in making these decisions. However, the model does not make, or even propose, a final decision. In keeping with cost-benefit modeling protocols, the final decision is a judgment made by a professional in which the data organized by the cost-benefit model are carefully considered.

In the demonstration exercise presented in Appendices D and E, three configurations emerge as both efficient (low total training time and overhead time) and low cost (low acquisition and net life cycle cost). These configurations are:

CONFIG.	MANNING	STRATEGY	LOCATION
2	Operational Inst.	Interactive	On-board Remote IOS
6	Simulator Inst.	Interactive	Over-the-Shoulder IOS
9	Operator/Inst.	Interactive	On-board Remote IOS

Ranked in order of time required, the configurations are 9, 2, and 6. However, when ranked in order of cost, the configurations are 2, 6 and 9. In this instance the type of manning could be a critical characteristic, i.e., highly qualified operational instructors may not be readily available to the training command. Therefore configuration 6 or 9 may be most useful. In another instance, acquisition cost may be the critical factor and configuration 2 would be most attractive. In still another instance, the user command may be requesting still another configuration, (i.e., such as configuration 1, operational instructor, interactive training strategy and an on-board remote IOS). The life cycle cost penalty for choosing configuration 1 over 2 is $400,000 and the overhead time penalty is 184 hours per year. Using this general process the decision maker studies the data generated by the ISF Model and then chooses an IOS configuration. He does not depend upon a solution generated automatically by the model.

DESCRIPTION OF COMPUTER PROGRAMS

The computer software in this project was designed as a prototype system for use in conducting field trials to determine the utility of such a system and to be modified and retested until it meets the full requirements of simulator designers. The computer routines are all written in FORTRAN, compiled using the Microsoft Compiler Version 3.0 and adapted for the MS DOS 3.0 or higher operating systems. The objective was to use an appropriate and reliable programming language for handling the large number of table manipulations and other calculations involved in the cost modeling. The selection of the FORTRAN language met these objectives. All of the programming was done in an IBM/XT environment requiring a minimum of 256K of memory. Also, the file ANSI.SYS must be in the root directory and the file CONFIG.SYS must contain the following commands: files = 16, buffers = 6, Device = ANSI.SYS.

The software system is implemented in two independent modules, each of which is on its own diskette. The first module, located on Disk #1, implements the routines for identifying alternative IOS configurations. It also performs the training requirements analysis for qualifying instructors to use the IOS. The second module, located on Disk #2, implements the cost-benefit trade-off analysis. The alternative configurations are subjected to analysis to determine the benefits of using the instructor support features, measured in overhead time saved, and the cost of achieving this economy.

Input data required to run the programs are reduced to a few local requirements of the type that a training analyst should easily supply. The extensive data presented in the previous section are resident within the program.

Module 1: Model for Identifying Candidate Instructor Support Features

This model performs three analyses. It includes: (1) the identification of global alternative IOS designs, (2) the selection of instructor support features for each design alternative, and (3) determination of instructor training requirements. While these programs can be run independently, the logical order is presented here. The purpose of this module is to allow the user to explore various alternatives, and to control manually the examination of the configurations. See Appendix D for directions on running this program and for a demonstration of the program.

Module 2: Model for Conducting Cost-Benefit Assessments of the IOS Configurations.

This module aids the analyst in estimating the cost of various configurations and the benefits of these configurations. It organizes the information needed by the analyst to choose an optimum set of instructor support features for a specific trainer, and provides back-up data with which the analyst can justify this choice.

Module 2 repeats many of the functions performed in module 1, but in a more structured and automatic manner. The goal here is to generate all alternatives, and conduct a cost-benefit analysis on all these alternatives. This is to be done as quickly and effortlessly as possible. See Appendix E for directions on running this program, and for a demonstration of the program.

RESULTS, OBSERVATIONS AND RECOMMENDATIONS

Based on the analytic process of designing the ISF Model as an expert system for use in choosing instructor support features for various types of simulators, certain results, observations and recommendations can be presented. These comments are ones that can be made at the current stage in the development of the prototype ISF Model. Therefore these comments generally reflect insights gained during the design process.

Results

Result 1. A prototype expert system was developed for choosing useful sets of instructor support features for incorporation in IOS designs. It consists of 21 tables which express the allowable relationships among 14 phases of training, 3 training strategies, 3 locations for IOSs, 6 types of instructors, and 43 instructor support features. Given a phase of training, the expert solution is a combinations of characteristics and features that do not violate any allowable relationships, as defined by tables. This process has been programmed in FORTRAN and runs in the MS DOS IBM XT environment.

Result 2. A prototype cost-benefit model was developed for evaluating the alternative configuration of an IOS. While all IOS configurations, based on different sets of selected features, will be generally useful, they will differ in efficiency. This model analyzes the training requirement and estimates the following values for each alternative design: (1) total training time required, (2) total overhead time, (3) acquisition cost of the trainer(s), and (4) present value of all cash outflows during the life of the trainer(s). The necessary cost and overhead time data required to run the model are included in the model. The user of the model enters general data about the local training program and chooses acceptable alternatives at stages in the process.

The credibility of the ISF Model is based on the credibility of the expert on which the model was designed. The expert in this instance recently prepared handbooks on IOS design for the Air Force and Navy. This current effort for

Army training is based upon these earlier efforts. It is also an expansion of this earlier work, including an in depth look at IOS designs for part task trainers, and in cost-benefit modeling. In this regard a significant new contribution is the analysis of the extent to which overhead time (time lost to instruction during an exercise) can be saved through the proper selection of instructor support features.

The ISF Model in its current state is a simplified model which can be used to evaluate the potential impact of this type of model on trainer acquisition, as well as to determine user acceptance of this type of model. As such, the supporting data base is generic and may not be optimum for any specific trainer acquisition. There are many different types of trainers in operation and development, from basic equipment operating trainers to tactics and strategy trainers including those supporting a large number of trainees and instructors. Across these many types of trainers there is a broad spectrum of IOSs involved. The developed model reflects primarily small weapon system initial qualification training for aircraft or tank type systems. Thus the overhead tables, for example, reflect operator skill acquisition from initial crew position familiarization through basic procedures training to crew integration and specific mission training. Although the architecture of the model does not support all type of trainers, it has been designed to be expanded to include the wide variety of trainers requiring IOSs.

The ISF Model is highly dependent on the input of training system data, in particular:

a. the phase of training to be supported
b. the type of instructor to be employed
c. the training strategy to be used
d. the location of the instructor relative to the crew station and trainee(s).

Normally, the phase(s) of training involved will have been established as part of the initial requirement based on the allocation of training objectives.

Similarly, the type of instructor to be used will typically have been proposed in the training plan. The training strategy is highly dependent on the phase of training and type of instructor and options developed by the model. However, the cost-benefit model can evaluate any feasible mix of these design parameters to provide the acquisition or design engineer with cost-benefit trade-off data for any ISF configuration being evaluated.

The ISF Model has been designed to permit trainer acquisition or design staff to identify feasible trainer instructor support features and evaluate them in terms of costs and benefits. Alternative features (as well as no features) can be evaluated or compared in terms of acquisition, production and life cycle costs. The impact of the use of these features on required training time is also presented.

In general, trainer costs are determined by both the complexity of the device and the efficiency with which it meets the required training syllabus. Thus for example, two inefficient trainers (trainers with high training overhead) or a single trainer (with low training overhead) may both be capable of training the number of students required annually. Selection of the optimum solution should be based on the constraints and costs involved. The model is designed to permit these evaluations relative to the IOS instructor support features. These features are a significant factor in the overall cost analysis as the model illustrates.

Assumptions and Constraints

It should be noted that in its present form the ISF Model is a prototype and does not support a full range of trainers. Therefore its use must be limited to the typical family of weapon system position and crew trainers from which it and the data base were developed. Additional assumptions and constraints are as follows.

1. Instructing functions are not selectable. Effective instruction dictates that all the basic functions be performed. (i.e., prepare, brief, initialize, train, evaluate, debrief, document and develop.)

2. Instructor training costs reflect only the cost of training the instructor in the operation of the selected training support features. It does not include the costs of instructor training in how to instruct, in how to use simulation training as an effective media, or in weapon system knowledge and skills. Therefore, the model assumes that the trainer instructor will have completed an instructor training course and be qualified as required in the weapon system.

3. The costs of the fabrication of the instructor station are considered to be part of the overall trainer costs and are not reflected in the model. Thus it is assumed that an IOS will be provided with the required controls and displays. What is analyzed in the ISF Model is the cost of the instructor support features incorporated in the instructor station.

4. The features are considered to be software with the exception of the hard copy feature for which a printer is costed. The use of off-the-shelf software is included and for several features forms the basis of the cost estimate (e.g., speech output, voice control, training management).

5. Feature usage time (and related time required to perform these functions manually) and frequency of usage are critical data to the analysis of overhead time. The data developed for the model (see Appendix G) are based on a typical single place aircraft system and a generalized syllabus. For example, procedures training was based on ten practice events for each hour of training. This is typical for average complexity procedures but wide variation exists ranging from one or two procedures per training hour to 15 or 20 for the simplest procedures. Therefore the results must be interpreted accordingly.

6. Brief/Debrief time was incorporated as training time since few existing trainers provide a remote brief/debrief capability. In the future, the incorporation of a remote brief/debrief station in trainers will typically provide significant cost savings.

7. Training management related to trainer operations is a critical training function. The features outlined are limited to the trainer system and do not provide for a total school management system. Thus, for example, the features

provide for trainer data, trainer instructor data, trainee-trainer performance data, and trainer scheduling only. Thus a relatively simple data base system such as is available off-the-shelf, can meet the requirements. If a large training management system for the entire training complex is available and supports the trainer as another media, the cost of the management features in terms of the IOS would be inconsequential.

8. Software life cycle costs were developed using the Constructive Cost Model (COCOMO). The model has been widely used in software development. However, the data appear to reflect both operating and application software development for relatively large systems. Trainer instructor support feature software in general, consists of very small simple modules. Thus the software costing would appear to be conservative, i.e., the cost of many of the features is overestimated.

9. Finally, when the software for training features becomes exportable from trainer to trainer, the actual costs of the features could be amortized across a large number of trainers. Modular design of the IOS is being considered and would permit significant reduction of instructor support feature costs.

Recommendations

Recommendation 1. Conduct field evaluations.

Select a small group of simulators under development or recently fielded. Using the expert system and cost-benefit routines developed in this study, have the PM TRADE engineers select instructor support features for these simulators. Compare the earlier solutions with the solutions arrived at using these new analytic tools. Where features differ, assess the merit of the different solutions.

Recommendation 2. Modify the ISF Model based on the results of the field evaluations.

A variety of changes may be suggested by the field evaluation. The PM TRADE engineers may find certain screen output difficult to interpret (i.e., user friendliness issue); the models may not contain features that are considered important in the types of trainers being built for Army training (i.e., model design issues); the data used in the models may need to be adjusted to current trends (i.e., data validity issues); or the model may need to be modified to take less of the PM TRADE engineers time to use (i.e., efficiency issues). While major changes are not expected, the goal is to adjust the model to meet the needs of the prime users.

Recommendation 3. Enhance the ISF Model based on observations made during the development of the prototype.

a. The sample syllabi descriptions used in calculating the number of times and the duration of time that the various instructor support features are used needs further work. Since usage time and frequency are major determinants of overhead time, a more detailed model of sample syllabi will be essential for getting better cost estimates. The sophisticated user will also want a means to modify the syllabi to tailor it to the specific training program.

b. Individual features should be clustered into frequently used sets of features, and the estimated acquisition cost should be based on procuring the cluster of features. This should result in a reduction in estimated acquisition cost.

c. The models need to be improved in terms of user friendliness. The more significant changes needed concern passing configuration data from one program to another and in the graphic display of data, making it easier for the decision maker to choose an option.

d. There should be an option for the Brief/Debrief feature to be an independent station. Significant increases in trainer efficiency resulting in substantial cost savings should be achievable in many settings if this design were adopted. The program should allow the user to model this option.

e. A capability to model instructor support features for multiple independent trainers tied to a single IOS needs to be built into the program. Many trainers of this type are being developed.

Recommendation 4. Integrate the ISF Model into the MOST system.

As the Models for Optimizing Simulation-based Training (MOST) are developed, use the lessons learned during the design and field evaluation of the ISF Model. Specifically, use expert system techniques in choosing simulator features, use cost estimating relationships in generating cost data, and use cost-benefit models in comparing alternatives. In addition, design models that incorporate a comprehensive set of dimensions used by the experts in designing simulators.

Recommendation 5. Use the enhanced ISF Model in performing an operations research type study on the cost and benefit of various types of instructor support features.

While the model was created as a job aid to be used during the design of instructor/operator stations for individual trainers, it can also be adapted for use in studying the general problem of how to minimize overhead time in various class of trainers and training exercises and the cost impact of minimizing overhead time.

The study would result in general principles for designing simulators that achieve high levels of efficiency in training exercises. It would also be helpful in designing more efficient training exercise plans.

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APPENDIX A

RESUME OF EXPERT

NAME

John P. Charles

LOCATION

San Diego, CA

LABOR CATEGORY

Senior General/Experimental/Quantitative/Human Factors Psychologist

EDUCATION

University of Minnesota, 1950 - BS, Psychology/EE
Northwestern University, 1958 - MS, Experimental Psychology
Northwestern University, 1963 - PhD, Experimental Psychology

WORK EXPERIENCE:

ICON, Inc., 1976 - Present, President and Senior Scientist. Dr. Charles is currently developing a simulator instructor/operator station (IOS) design guide for the U.S. Air Force. The project includes a survey of major Air Force training device IOSs in terms of design, utilization and operational problems. The study builds on several studies conducted for the Naval Training Systems Center on IOS problems and design and acquisition procedures.

Dr. Charles recently completed an instructor/operator training package for a cutter bridge/CIC simulator training system for the U.S. Coast Academy. The simulator provides training in both bridge and CIC functions and incorporates and extensive feedback subsystem. It also provides an observation training capability. The project included analysis and design of the instructor station and the development and initial presentation of an instructor/operator training course for use in training an initial cadre of instructors and subsequent training of instructors on a continuing basis.

He recently completed an extensive test and evaluation of a major electronic warfare training system. Data were collected on both system operation and system employment for both initial system training and for operation crew training.

Over the past four years, Dr. Charles has completed a series of studies and analyses of operational problems which have surfaced in instructor/operator consoles of training devices, ranging from part-task trainers to special part-mission trainers, weapons systems trainers and maintenance trainers. It included the development of general instructor operator console acquisition design guidelines and specifications documents for the Naval Training Systems Center. The effort included the review of console requirements for land, surface, subsurface and aviation trainers based on surveys of recently acquired weapon system trainers conduced by Dr. Charles

John P. Charles (continued)

which had identified utilization problems and developed solutions, both short and long term. A related study also conducted by Dr. Charles, reviewed the Navy's Fleet Project Team's impact on trainer acquisition and developed feasible approaches to enhancing their input to the process.

He recently completed a trade-off analysis of training-instructional features for a conceptual crew trainer for the B-1 weapons system.

Dr. Charles conducted a series of requirements studies for a computer supported training system for the Navy and the Army. The program included the analysis and definition of advanced training applications utilizing the computer technology. The program was designed to exploit the capabilities of advanced mini and micro-computer systems in support of operational units and commands as well as schools. He conducted survey studies of the user requirements and constraints for the Second Marine Air Wing including the Marine Corps Air Stations involved, the Army artillery school at Fort Sill, the U.S. Navy Reserve Command including headquarters, centers and units, and a carrier air wing and related functional wings and logistics support elements. In addition, he completed a survey of the Surface Warfare Officer's school training program to identify feasible applications of VTS. Overall, Dr. Charles was directly involved in the identification and specification of training needs and feasible approaches or solutions to meet these needs within the capabilities of the computer technology and state-of-the-art training methodology.

At ICON, Dr. Charles was the program manager and principle investigator for a detailed study of safety requirements at commercial and Navy shipyards. A total of eleven shipyards on both coasts were surveyed and safety problems and techniques were reviewed. The end product of the study included, (a) an analysis of the cost of complying the OSHA requirements, (b) the development of a revised set of OSHA safety and health requirements which could be applicable to the shipyards, and (c) a detailed plan for implementing these requirements for use by both Navy and commercial shipyards.

Appli-Mation, Inc., 1974 - 1976, Vice President/Director. At Appli-Mation, Inc., Dr. Charles continued the work in automated adaptive training developments and designed the first full scale demonstration of the application of automated adaptive training to a basic flight training syllabus. In addition, Dr. Charles began what turned into a three-phase study of the simulator operator consoles. The studies concentrated on the problems of optimally interfacing the simulator instructor. The studies included the development of standardized modules which could be applicable to a wide range of Navy training device and simulators.

He conducted a detailed requirements analysis and interface design for an automated materials handling system. At the time, the system was the largest application of automated warehousing and production in the United States. The analysis essentially showed that significant problems arose when automation in these areas was undertaken without adequate consideration of the human operator. Similar results were subsequently shown for other automated materials handling systems, such as air freight and chemical product handling.

John P. Charles (continued)

LOGICON, Inc., 1970 - 1974, Director of Human Factors. At Logicon, inc., Dr. Charles initiated a series of studies concerned with the detailed analysis of training requirements in terms of training device support and the application of advanced computer technology to the area. The study led to a sequence of studies and developments in automated adaptive training concepts including the application of automatic speech recognition and speech generation in support of training systems. Experiments were conducted and laboratory systems developed involving the modeling of human controllers such as ground approach controllers, CIC officers and intercept controllers. The sequence of studies clearly demonstrated that training systems could be significantly enhanced with the application of modern computer hardware and software technology. It was demonstrated that the key to this application lay in a rigorous application of systems engineering techniques to training equipment design.

In addition to the training research, Dr. Charles was responsible for a detailed analysis of the training requirement and human interface problems in war gaming systems. This included the detailed study of political, economic and psycho/sociological variables in war gaming. The studies were related to the modernization of the war gaming system at the Naval War College in Newport, RI. The analysis led to the differentiation of the data requirements and implementation requirements to support the different kinds of games. The analyses clearly showed that significant trade-offs in terms of costs are relevant to the different types of games.

U.S. Navy, 1950 - 1970, Various jobs including: ROT&E Planning Division, Chief of Naval Operations (OPNAV); Head, Human Factors Lab, Naval Missile Center, Pt. Mugu, CA; Human Factors Engineer, Bureau of Naval Weapons; Head, Medical Safety Branch, Naval Aviation Safety Center.

During his Navy career, Dr. Charles established a Medical Safety department and Human Factors Branch within the Navy Aviation Safety Center at Norfolk, VA. The purpose of this branch was to provide for an in-depth analysis of the human engineering and "Pilot Error" accident causal factors. He developed the early techniques for the inclusion of human factors personnel in on-site investigation of aircraft accidents and developed a new accident reporting form and data collection analysis system.

As Head of the Human Factors Branch of the Bureau of Aeronautics/Bureau of Naval Weapons, he was responsible for the human interface design of aircraft avionics systems including cockpit design. He represented the Navy on joint service and international committees on cockpit standardization and human factors requirements. During this period he initiated and monitored the exploratory studies of low flying aircraft vulnerability. He also prepared the first human factors engineering data requirement specification for Naval Air and published the first Navy military standards and specifications for cockpit layout and control panel design.

As Head of the Human Factors Laboratory at the Naval Missile Center, he was responsible for a wide range of tasks from basic research in control and display to human factors engineering tests and evaluations of major weapons systems including Walleye, Condor, Shrike and Phoenix. He was successful

John P. Charles (continued)

in bringing a six degree of freedom simulator into the laboratory and initiated the long range JANAIR Program cockpit instrumentation research and development at Pt. Mugu.

As the Human Factors Officer in the Office of the Deputy Chief of Naval Operations, Research, and Development, he was responsible for the sponsoring and the monitoring of all the human factors programs in the Navy ROT&E program. All operational requirements were reviewed and coordinated within the Navy and with the other services. He was responsible for the development of the first advanced development programs in training equipment and human factors analysis and development. He was also instrumental in achieving the first major revision of the operational requirement format to include statements of environment, manning, and supportability requirements.

During the same period, Dr. Charles was selected to join a ten-man team to investigate the series of catastrophic carrier accidents which had occurred in the late and mid-sixties. This committee headed by Admiral Russell included Rear Admiral Jim Holloway, Rear Admiral Bouie, and six other senior officers and engineers from the technical bureaus in Washington. Human factors engineering problems were shown to be one, if not the prime causal factor of all the accidents, so heavily involved in all of them, that significant steps had to be taken to institute better human engineering of carrier systems. As a result, Dr. Charles initiated a R&D Program for a full scale human engineering investigation of all carriers, and analysis of operations and the systems involved in carrier operations.

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EMPLOYMENT STATUS

Consultant

APPENDIX B

TAXONOMY OF IOS TERMS

INSTRUCTIONAL SYSTEM TAXONOMY

TABLE OF CONTENTS

TAXONOMY OF IOS TERMS

Six training system parameters are used in determining what type of instructor support should be provided in a training device. These parameters include:

Training phases	- the type or level of training being conducted which must be supported by the trainer,
Training functions	- the operations an instructor performs while training students and while operating and maintaining the training system,
Trainer manning	- the categories of personnel who will serve as instructors at the IOS,
Training strategy	- the type of training method which will be used,
Instructor location	- the position of the instructor in the training complex when performing the training,
Trainer features	- the features available to the operator/instructor to enhance or implement instruction.

Terms that define the various states of these broad parameters make up this taxonomy of training terms. Each term is presented and defined.

Training Phase

Each phase imposes different instructor requirements, IOS requirements, manning, features, and training strategy, especially in terms of instructor-simulator interaction.

Familiarization training - concerned with acquainting the trainee with the general characteristics of the system and the configuration and layout of the crewstation. At the conclusion of training, the trainee is expected to know the location and function of all controls and displays, subsystems and crewstation components such as seating, lighting, oxygen, escape and restraint devices.

Part task training - concerned with teaching the student specific skills and knowledge related to the training task. Part task training requirements are typically identified in enabling objectives. Seven different types of part task training were identified. Training guidelines and the matrices associated with part task training can be viewed in Appendix B.

a. Rules Training - concerned with the selection and application of established practices or fixed principles (rules) to guide courses of action such as navigation Rules of the Road.

b. Decision Making Training - concerned with selecting a course of action when the alternatives are unspecified or unknown. It involves the application of a specific action model of unknown probability of success to establish a course of action such as combat tactics.

c. Detection Training - concerned with scanning and detecting a few low threshold cues embedded in a relatively large background and typically in a low signal-to-noise environment and over a relatively large block of time. Detection of radar targets is an example.

d. Classification Training - concerned with the assigning of a name to a detected signal based on identifiable characteristics. It typically follows the signal detection task. Identification of an acoustic target as a diesel submarine or an electro-optical target as a tank are examples.

e. Voice Procedures Training _ concerned with the use of brief, specialized and formalized voice message formats to exchange information such as in an aircraft ground controlled approach (GCA)

f. Procedures Training - concerned with conduct in normal and emergency operating procedures on a piece of equipment. At the conclusion of training, the trainee is expected to be able to power up, operate, power down, and perform specified emergency procedures for each system involved.

g. Steering/Guiding Training - concerned with the dynamic control of a system or subsystem relative to visual stimuli. It ranges from tracking of a target on a radar scope to control of a vehicle or an aircraft.

Position training - concerned with teaching the trainee the tasks and functions required at the crewstation. Integration of subsystem and part task skills and knowledge is involved. At the conclusion of training, the trainee is expected to be able to operate all of the equipment and perform all of the functions of the position independently of other crew members. Basic tactical employment can be included. As an example, Pilot position training includes training in basic flight maneuvers and instrument flight.

Crew training - concerning with initial mission qualification. Integration of all skills and knowledge individually and as a crew is required. Basic mission training and qualification are included.

Mission training - concerned with the training and qualification of the crew members to perform a unit's specific mission from start to finish.

Proficiency training - concerned with maintaining crew member position qualification and proficiency.

Advancement training - concerned with training for additional qualifications such as radar navigator, aircraft commander and instructor. Position upgrade involves initial qualification training for the new position.

Special training - concerned with unique training requirements in special tasks, systems, missions or tactics. Training devices are used as feasible to support the unique training requirements.

Training Functions

Training functions include all of the tasks which must be completed to effectively implement training. They have been categorized under nine headings which represent a logical flow of training activities. Each of the training functions are described below.

Preparing function. The preparing function includes the following training subfunctions:

a. Identification of the training event in terms of trainees, training time, trainer to be used, the course event, and the status of the simulator.

b. Assembly of required training data including trainee training history relative to the trainer, training event descriptions, performance recording forms, initialization data.

c. Review of data by the instructor.

d. Development/formulation of the training session in detail including mission detailed characteristics and trainee/staff briefing.

Briefing function. The briefing function includes the following subfunctions:

a. Brief the trainee on the objectives of the training event, procedures to be used and any trainer problems.

b. Brief any training support staff on the procedures to be employed and support functions to be provided.

Initializing function. The initializing function includes the following subfunctions:

a. Configuring the trainer system tc meet the event requirements including configuring the simulation system and the trainee station(s).

b. Configuring the instructor/operator station to meet the event requirements.

c. Initializing the simulation system to the training event starting conditions including the control loading, motion and visual systems if used.

d. Establishing system readiness in terms of trainee, trainer systems (including communications) and staff and verify area security.

Training function. The function include the following subfunctions:

a. Controlling of the simulation to implement the selected training event including simulation of environment (geophysical, electronic, warfare, etc.), controllers, threats and other aircraft/platforms and "missing" crew member actions/inputs and inserting/removing malfunctions.

b. Providing any simulations required by the scenario which have not been implemented by software or hardware. This typically include human controller voice inputs for GCA, traffic control, ground control, tactical control, other vehicle, fire control, electronic warfare actions and tactics; "missing" crewmembers actions and inputs.

c. Instructing of the trainee including providing of feedback, demonstrations, operational data, knowledge and correct procedures.

d. Monitoring of trainee performance including procedures, techniques, skill level, attitude and approach.

e. Recording data for feedback, debriefing, scenario changes, hardware and software reports and inputs to the trainee's training files.

Evaluation function. The evaluating function includes the following subfunctions:

a. Establishing if performance meets criteria or is within the learning "envelope,"

b. Diagnosing learning problems,

c. Developing/modifying the exercise to meet learning difficulty,

d. Record evaluations in exercise notes.

Debriefing function. the debriefing function includes the following subfunctions:

a. Debriefing the trainees on the training mission including a review of the objectives, procedures, performance, problems and recommendations.

b. Debriefing of the training support staff in terms of problems, performance and recommendations.

Documenting function. The documenting function includes the following subfunctions:

a. Updating trainee training records/reports,

b. Updating instructor records/reports,

c. Updating trainer utilization and discrepancy records/reports.

d. Document modifications to standard training exercise plans.

Developing training events function. Developing training events function includes the following subfunctions:

a. Formatting new missions/exercises and any changes to existing missions/exercises,

b. Implementing the changes and new missions/exercises,

c. Validating the changes and new missions/exercises.

Trainer Manning

The various manning options can be summarized in terms of six categories which reflect decreasing instructor system sophistication.

Operational instructor. Operational aircrew instructors are defined as personnel who are weapon system qualified and have completed instructor up-grade training. Included are for example, instructor pilots, instructor navigators, instructor flight engineers and instructor gunners. Operational instructors are typically also instructor qualified in the weapon system. They may also be qualified as academic instructors.

Simulator instructor. The dedicated simulator instructor is one whose sole training function is conducting training using the training device. Two different background personnel have been utilizes an impose different constraints on IOS design. They are 1) military personnel with flight and possibly weapon system experience, and 2) a contract instructor who may have flight but not necessarily weapon system experience.

Operator/instructor. The simulator operator/instructor is a dedicated simulator instructor who provides and expertise in trainer operation with limited system operational expertise. Therefore, the manning option provides skilled trainer technical operation, but not necessarily instructional skill in system tactical or operational capabilities and nuances. A wide variety of personnel background can be utilized. Therefore, the IOS subsystem must be designed to the unique qualifications of the proposed manning. Typically, instructional tasks such as performance assessment and scenario tailoring may need to be supported by the training system software

Technician/operator. The simulator technician/operator is trained in the details of simulator system/subsystem operation and "line-level" maintenance. The operator typically has no training or experience in the weapon system. The operator training course generally consists of the first level of the trainer maintenance course.

The simulator operator can provide two training functions, i.e., as a "training instructor" for automated mission/qualification simulator events and as an instructor support "technical expert" on trainer capabilities implementation. Thus a high level of automated instruction must be incorporated if a simulator operator manning concept is to be implemented.

Student/Peer Instructor . The student instructor is either the student being trained or a student functioning as a "peer instructor." The option is employed only for practice training with an instructor on-call to solve performance problems. The student instructor training in simulator operation consists of a brief (typically 15 minutes) check out of trainer student mode operation and guidance in exercise scenario options. The manning options is supported by extensive operation and training control software.

None. When the system is designed to teach without an instructor, an automated instructor manning option provides a fully automated instructional capability in which training operation and instructor functions are programmed and performed under computer control.

Training Strategy

Training strategy refers to the mode of instructing employed by the instructor. The options range form instructor conducted demonstrations with the student observing (student "hands-off") to instructor observation of trainee performance (instructor "hands-off"). The modes can be grouped into three categories in terms of instructor level of involvement as follows.

Tutor level. The tutor level involves imparting knowledge and procedures directly to the trainee in a one-on-one approach. The method is used primarily at the weapon system familiarization, basic position and initial procedures phases of training. Trainer devices used vary from a Cockpit Familiarization Trainer (RFT) for familiarization and orientations training to part task procedures trainers for providing segmentized mission simulations.

Interactive level. The interactive level involves presenting problems, assisting in initial solutions as necessary and providing practice and qualification problems. Direct interaction with the trainee generally diminishes as proficiency is gained in the tasks being trained. The Aircrew Training Devices (ATD) used are typically part-task trainers which permit presenting task problems (part mission tasks) to the student across the spectrum involved in the mission.

Monitor level. The monitor level involved controlling the exercise/scenario, managing the training event and monitoring and evaluating student performance. Interaction is minimal. Exercises and missions are well defined and typically involve full mission execution from mission briefing to mission debriefing.

Instructor Location

The location of the instructor is a major determiner of the IOS characteristics. Although a wide variation of specific locations are feasible, three variants are major determiners of IOS design. Combinations of the stations may be required where the trainer support different phases of training with different manning constraints and training strategies.

Each type of IOS assumes that a technician will be available "on-call" for trouble shooting, on-line maintenance and technical operation support. Thus the IOS does not support maintenance functions in its normal mode of operation.

Remote IOS. The remote IOS is a "self-contained" simulator instructor station. As such it provides controls for all instructor simulator operation and training event implementation and displays for monitoring trainee performance, simulated system status and training device status. (The remote IOS is not the computer system operating console which is normally located with the computer equipment.)

On-board remote IOS. The on-board but isolated instructor station performs the same functions as the remote IOS except that space, weight and operating constraints normally limit the functions performed at the station. "Over-the-shoulder" instructing is often supported and partially justifies the IOS location "on-board." Therefore, display requirements can be reduced by the extent to which the instructor is provided the capability of directly viewing trainee activity and trainee displays and controls. The isolation of the instructor from ready access to the supporting training subsystem control generally imposes a requirement for at least technician stand-by support. This is especially true for motion based systems where the instructor may not be able to access trainer utility system control panels without interrupting the ongoing simulation.

Over-the-shoulder IOS. The over-the-shoulder station provides the instructor direct view of student actions and system displays and controls. The station presents the most severe constraints to IOS design since control and display area and instructor space is minimum, especially on motion based trainee stations where the instructor is confined by a lap belt. Instructor eye to display/control distances can create readability problems. Trainee positions typically block the instructor's view of some control/display areas. Lighting conditions will generally be restrictive in that weapon system lighting will be used. Inter phone communications and communication simulations present equally difficult implementation problems.

Trainer Features

Three types of design features are utilized in training devices to enhance utilization and effectiveness.

The features categories reflects the different tasks performed by the instructor. They also overlap in function. Some features can be classified as either an operating or an instructing feature depending on the detailed application. The classification ascribed reflects the dominant use of the feature. Appendix C contains definitions of these features.

Operating features. Operating features are hardware or software capabilities designed to unburden the instructor/operator and to enhance the performance of instructing tasks using the training device. Operating features do not include computer system (and peripherals) operation. Features include:

a. Automatic Exercise. Automatic exercise provides the instructor the capability of entering the scheduled exercise with resultant automatic loading of initial conditions, verifying training and instructional subsystems readiness, checking trainee station configuration and initializing any peripherals required for the exercise. It differs from the automated syllabus feature in not identifying trainee scheduling and from adaptive syllabus in not reflecting trainee training needs. It unburdens the instructor of the trainer initialization and configuration checks and significantly reduces "set-up" time.

b. Automatic Freeze. Automatic freeze provides for setting of the freeze state of the trainer whenever pre selected or programmed simulation or performance limits are exceeded. It unburdens the instructor of the task of continuously monitoring all training relevant parameters during the exercise. "Crash" freeze is a typically used automatic freeze.

c. Automatic Malfunction. Automatic malfunction provides for the insertion and removal of system malfunctions and emergencies under programmed conditions or "triggers." It unburdens the instructor of the attention demanding task of monitoring the conditions for control of malfunctions.

Although often treated as an instructional feature, the control of malfunction simulation is an operating feature in so far as its mechanization unburdens the instructor of the required operating procedure. Automated malfunctions require meaningful "triggers." The design of irrelevant triggers have in the past, denigrated the feature. for example, mission or training elapsed time, altitude, airspeed etc., have proven unsatisfactory. Logical statements can be used if the implementation is simple and in instructor terms. An alert with instructor override should be provided.

d. Automatic Vehicle. Automated vehicle provides for programmed control of the vehicle involved and is used in support of position and part task training in which vehicle control is not part of the training objectives or the vehicle controller is not involved. It is also used for control of other vehicles involved in the training scenario. The feature unburdens the instructor of the vehicle control task in support of the on-going training.

e. Configuration Check. Configuration check provides for a programmed test of the trainer configuration to verify readiness to initiate the training scenario. It normally includes tests of safety, utilities, simulations, and instructional system. It unburdens the instructor of a check list procedure which is time consuming and adds to the instructor training program.

f. Crash Override. Crash override provides the instructor the option to override the automatic freeze feature when pre-defined crash conditions have been broached. It is routinely used by instructors primarily because of the disrupting procedures required to recover from the crash freeze. (Design of a "crash" which could be removed or recovered from without requiring reinitializing the trainer and which permitted use of the instructional features of reset, replay and hard copy could result in more extensive use of the "crash" feature.)

g. Exercise Modification. Exercise modification permits the instructor to alter exercise parameters during training to meet changing training needs and conditions. It unburdens the instructor of the requirement to identify the changes needed and how to implement them and then to reinitialize the trainer to those conditions.

h. Flag Set. Flag set provides the capability of inserting a "tag" at any point during training for the purpose of, for example, resetting, replaying or debriefing. It unburdens the instructor of annotating the specific point of interest in the training evolution at a time when his attention is typically concentrated on student performance.

i. Freeze. Freeze provides for "halting" simulation time with the capability of starting time and continuing the training scenario from the same point. It relieves the instructor of the task of identifying the simulation parameters involved to reset the trainer to the halted time.

j. Help. Help is a trainer software module which provides the instructor with operating instructions and aids upon request. It unburdens the instructor of the task of searching through an operating manual for guidance during training.

k. Initial Conditions Load. Initial conditions (IC) load provides the instructor the capability of initializing the trainer to any of a stored set of simulation parameters. It unburdens the instructor of the task of inserting all parameters required to set a training scenario to a new starting point. IC Load is also in integral part of the Automatic Exercise feature.

l. Instructional System Check. The instructional system check provides the instructor with the status of the instructional system prior to beginning the simulation. The status check includes configuration and state, features implemented and conditions set. It unburdens the instructor of the task of completing a check list and reduces the time required to initiate training.

m. Manual Stack. Manual stack provides the instructor to pre-load simulation parameters/conditions for future activation. Many training mission simulations can only be initiated in response to trainee actions and performance. This holds true for example, for malfunctions, threats, traffic control and environment changes. The feature provides the instructor the option to create a "stack" of selected inputs which can then be implemented in sequence (with override) with a simple insert action. It unburdens the instructor of the task of identifying and entering simulation parameters during training, permits timely insertion of time sensitive parameters and frees the instructor of operating tasks during training intensive training periods.

n. Prompts/Cues. Prompts and cues for the instructor/operator provides scenario or time programmed "advisories" regarding actions which should be taken. They range from messages regarding voice communications which should be output to fire control envelope information. They free the instructor from tracking a script or monitoring the scenario to identify instructor simulation inputs and actions. Note: prompts and cues are also an instructional feature when they are provided to the trainee.

o. Reset. The reset feature provides the capability for reinitializing the simulation to a specified set of initial conditions, e.g., a preprogrammed set or a set defined by a "flag" during the training event. Preprogrammed sets include the initial set and the set for any of the programmed segments/legs. The feature simplifies the trainer initialization task.

p. Simulation Systems Check. The simulation systems check provides a programmed test of the simulations systems configuration, state and status relative to the initialized exercise. Since each training exercise normally has a minimum required trainer configuration requirement, the feature provides the instructor information on the availability or capability of the trainer to meet the simulation requirement involved. It unburdens the instructor of the task of identifying exercise configuration requirements and verifying that the trainer meets these training requirements.

q. Speech Output. Speech output provides for the simulation of audio outputs required for the exercise. It ranges from command and control messages to inter- and intra- vehicle communications. The feature unburdens the instructor of identifying the message content required and the task of outputting the message.

r. Speech Control. Speech control provides for entering control inputs by voice. This feature frees the instructor in terms of location relative to the physical input device, permits use of user terminology and does not interfere with ongoing visually demanding instructional tasks.

s. Tutorial. The tutorial feature provides a trainer computer supported instructor training program in simulator operation and utilization. It provides a hands-on training capability without requiring an instructor-instructor.

Instructing Features

a. Adaptive Syllabus. The adaptive syllabus feature provides for modification of the training syllabus based on individual student training requirements. The feature provides for both exercise selection and exercise modification. Performance measurement and diagnostic features are required to support the feature. The feature aids the instructor in identifying and implementing training exercise selection and modification based on student performance.

b. Automatic Diagnosis. The automatic diagnosis feature provides for identification of student learning problems based on programmed analysis routines reflecting enabling objectives or task structure analysis. The feature assists the instructor in analyzing trainee performance problems based on existing analytical data.

c. Automatic Syllabus. The automatic syllabus feature identifies the training session to be implemented and initiates the exercise involved based on the student's training record. It supports technician/operator, student and automated training.

d. Brief/Debrief. The brief/debrief features provides trainer stored, instructor option material for student briefing and debriefing utilizing the training system. It supports the training requirement to brief the student on the exercise and its requirements prior to training, and to debrief the student on the results of training, i.e., provide feedback, along with recommendations.

The feature utilizes other instructing and operating features including:

1. performance measurement and recording
2. reset, flag and replay
3. demonstration
4. hard copy
5. conditions capture
6. freeze

e. Conditions Capture. Conditions capture provides for storing the simulation parameters at any selected time during the exercise for subsequent use in reset, replay, exercise development. It provides the instructor data for further analysis. Conditions capture and flag set are similar except that flag set is only concerned with identifying a specific point in recorded exercise history, not necessarily the scenario conditions as such.

f. Communications Record. Communications record provides for the recording of selected audio communications during training for subsequent replay for demonstration or debriefing. It unburdens the instructor of the task of recording significant communications for student feedback/debriefing.

g. Demonstration. Demonstration provides pre-programmed/recorded task performance samples for presentation to the student.

h. Environment Modification. Environment modification provides the instructor the capability of modifying the simulation environment parameters during training to meet training needs based on student performance. Parameter changes are monitored and inputs controlled to preclude the entry of incompatible changes. The feature permits the instructor to adjust exercise difficulty to meet student needs.

i. Hard Copy. The hard copy feature provides the instructor with "print-outs" of selected displays and preprogrammed reports for briefing/debriefing and record purposes. The feature reduces the record keeping task of the instructor as well as providing graphic and numeric data for use in debriefing.

j. Parameter Freeze. Parameter freeze provides the instructor the option to simplify the student's exercise by freezing selected simulation parameters. These can range from parameters controlled by the student such as vehicle heading or roll to environment simulation parameters such as weather and enemy actions.

k. Performance Monitor. The performance monitor feature provides for automatic monitoring of selected student/system performance parameters and optional display to the instructor during the training exercise. It differs from performance measurement which provides for performance data processing and reduction and from performance recording which stores selected and sampled parameters. The feature "filters" and presents the instructor with selected performance data during training to assist in student performance evaluation.

l. Performance Measurement. The performance measurement feature samples and processes/reduces student performance data in accordance with programmed algorithms, developed as part of the training development efforts. The objective is to summarize performance data and simplify the instructor's task of interpreting and evaluating student performance. The data is normally stored for use in debriefing and for input to the student's training record. It differs from both the performance monitor and performance recording feature in processing and reducing performance data.

m. Performance Record. The performance recording feature provides for sampling and storing of selected parameter simulation parameters. The sampling rate is typically variable. A limited number of parameters can be sampled. Simple data reduction can be incorporated such as time in or out-of-limits, average for the sampling period and number of weapons fired. It differs from performance measurement which involves analysis and reduction of student performance data. It differs from the performance monitor feature in that the data is stored and not intended for on-line use by the instructor. The data is used for student debriefing and training analysis and development.

n. Procedures Monitor. The procedures monitor feature provides the instructor with current information on any selected operating procedure and the student's performance in completing the procedure. The feature provides the instructor with the details of the procedure as well as the student's progress. The feature frees the instructor of the task of continuously monitoring student actions during procedures performance and is especially useful for monitoring of student related procedural actions which may not be within the instructor's direct view.

o. Programmed Exercise. The programmed exercise feature provides the instructor the capability of implementing a fully programmed training scenario often including programmed performance measurement and recording. The feature provides standardized training and testing/evaluation exercises. It provides the instructor the maximum time to observe student/crew performance and evaluate complex task performance such as tactical decision making.

p. Replay. Replay provides the instructor the option to replay any selected segment of the recorded training exercise for feedback, demonstration and critique. Replay can be implemented on the trainer or on the brief/debrief supporting system. It provides the option for dynamic or graphic/numeric review of the student's performance. It reduces the instructor note-taking task as well as providing a dynamic visual for presentation.

Managing Features

Management features are hardware or software capabilities designed to unburden the instructor/operator of training management tasks and enhance the use of the training device. Features include:

a. Degraded Training. The degraded training feature provides for the storage of the matrix which defines the simulation capabilities for each training exercise. The matrix defines the optional utilization of the trainer in degraded conditions. For example, instrument flight training can be conducted without the visual subsystem. The training manager/system utilizes the degraded training matrix in real time to schedule training events. The matrix is developed as part of the instructional development process. The feature increases effective utilization of the trainer by identifying training capabilities in degraded modes and identifies training exercises which should not be conducted because of lack of required simulation capabilities. The feature is utilized by both instructional and training manager personnel.

b. Exercise Development. The exercise development feature provides for the modification and development and storage of training exercises/scenarios by instructor personnel. The feature normally incorporates several modes to accommodate the different levels of exercise development and users involved. The simplest mode provides for changing of simulation parameters such as environment and locations. The next level provides for construction of new exercises by combining existing exercise segments. The most sophisticated level provides for restructuring the scenario, enemy capabilities and defining new legs and segments.

The feature permits instructors to implement new training objectives and training strategies independent of a software support activity.

c. Reports. The reports feature provides for the preparation and output of trainer related routine and periodic reports according to programmed formats. Typically included are reports of trainer utilization, student training, instructor training, instructor qualifications and activity, trainer systems availability, and exercise/scenarios. The feature unburdens the instructor/operator of the task of preparing the numerous reports required.

d. Instructor Records. The instructor records feature provides for a file on each instructor in terms of qualifications, activity and related training needs.

e. Scheduling. The scheduling feature provides for the development of the trainer training schedule. It is normally instructor/scheduler interactive and maintained in real time. The feature utilizes the following other features or manual inputs of the related scheduling data:

1. Degraded Training (matrix)
2. Instructor Records (qualifications/activity)
3. Student Records (training status/requirements)
4. Training Syllabus
5. Trainer Records (systems status)

The feature provides for optimum scheduling of the trainer in terms of trainer status, student requirements and instructor availability and qualification.

f. Student Records. The student records feature maintains the student trainer training record. The record provides the instructor the data on student progress and needs. The record provides the scheduling feature data on training exercise requirements. It provides the trainer evaluation feature data on trainer utilization effectiveness. The feature reduces the record keeping tasks of the instructor.

g. Training Evaluation. The training evaluation feature provides for analysis of training effectiveness utilizing the data available in the other management features.

h. Trainer Records. The trainer records feature provides for the output of predefined reports such as trainer utilization, instructor activity/qualifications, trainer effectiveness, trainer availability, student throughput and development time. The feature unburdens the instructor/trainer staff of developing and outputting the required training reports as well as providing them definitive data as required for training development.

APPENDIX C

INSTRUCTIONAL SYSTEM PARAMETER TABLES

Phase	Manning						
	OI	SI	O/I	T/O	Stud	Peer	None
Familiarization	x	x	x	x	x	x	
Part Task							
Procedures	x	x	x	x	x	x	x
Decision Making	x	x					
Detecting	x	x	x				
Classifying	x	x					
Steering/Guiding	x	x	x				
Rule Using	x	x					
Voice Procedures	x	x	x	x	x	x	
Position	x	x	x	x	x	x	
Crew	x	x					
Mission	x	x					x
Proficiency	x	x	x		x	x	x
Advancement	x	x	x				
Special	x	x	x				

Table C-1. Phase and Manning

Phase	Training Strategy		
	Tutor	Interact	Monitor
Familiarization	x		
Part Task			
Procedures	x	x	
Decision Making		x	
Detecting	x	x	
Classifying	x	x	
Steering/Guiding		x	
Rule Using		x	
Voice Procedures		x	
Position		x	x
Crew		x	x
Mission			x
Proficiency			x
Advancement*	x	x	x
Special*	x	x	x

* as requried by course involved

Table C-2. Phase and Training Strategy

Phase	Location		
	RIOS	OIOS	O'SH
Familiarization			x
Part Task			
Procedures		x	x
Decision Making		x	x
Detecting		x	x
Classifying		x	x
Steering/Guiding		x	x
Rule Useing		x	x
Voice Procedures	x	x	
Position		x	x
Crew	x	x	
Mission	x	x	
Proficiency	x	x	x
Advancement*	x	x	x
Special*	x	x	x

* as required by course involved

Table C-3. Phase and Location

Manning	Location		
	RIOS	OIOS	O'Shl
Op Inst	x	x	x
Sim Inst	x	x	x
Opr/Inst	x	x	
Tech/Inst	x	x	
Student			
Peer	x	x	x

Table C-4. Manning and Location

Manning	Strategy		
	Tutor	Interactive	Monitor
Op Inst	x	x	x
Sim Inst	x	x	x
Opr/Inst		x	x
Tech/Inst			x
Student			
Peer	x	x	x

Table C-5. Manning and Strategy

Strategy	Location: RIOS	OIOS	O'Shl
Tutor			x
Interactive	x	x	x
Monitor	x	x	x

Table C-6. Strategy and Location

Function	Manning: OI	SI	O/I	T/O	STUD	PEER	None
Prepare							
Identify	x	x	x	x	x	x	x
Materials	x	x	x	x	x	x	
Review	x	x	x		x	x	
Dev/Mod	x	x					
Brief							
Student	x	x	x	x		x	x
Staff	x	x					
Initialize							
Config Tnr	x	x	x	x	x	x	
Config IOS	x	x	x	x	x	x	
Init Sim	x	x	x	x	x	x	x
Verify Ready	x	x	x	x	x	x	
Train							
Control Sim	x	x	x	x	x	x	x
Simulate	x	x	x	x		x	
Instruct	x	x	x				x
Monitor	x	x	x	x		x	x
Record	x	x	x	x	x	x	x
Evaluate							
Peform	x	x	x			x	x
Diagnose	x	x					x
Dev Remed	x	x					x
Record	x	x	x				x
Debrief							
Student	x	x	x	x		x	x
Staff	x	x					
Document							
Stud Rec	x	x	x	x	x	x	x
Trainer Rec	x	x	x	x	x	x	x
Inst Rec	x	x	x	x	x	x	
Mods	x	x	x	x	x	x	x
Develop							
New Exer	x	x	x	x			
Changes	x	x	x	x			
Validate	x	x	x	x			

Table C-7. Functions and Manning

Function	Phase													
	FAM	PRO	DEC	DET	CLA	STG	RUL	VOI	POS	CRE	MSN	PRO	ADV	SPC
Prepare														
Identify	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Materials	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Review	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dev/Mod		X	X	X	X	X	X	X	X	X	X	X	X	X
Brief														
Student	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staff										X	X	X	X	X
Initialize														
Config Tnr		X	X	X	X	X	X	X	X	X	X	X	X	X
Config IOS		X	X	X	X	X	X	X	X	X	X	X	X	X
Init Sim		X	X	X	X	X	X	X	X	X	X	X	X	X
Verify Ready	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Train														
Control Sim		X	X	X	X	X	X	X	X	X	X	X	X	X
Simulate		X				X		X	X	X	X	X	X	X
Instruct	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Monitor	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Record	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evaluate														
Peform	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Diagnose		X	X	X	X	X	X	X	X	X	X	X	X	X
Dev Remed		X	X	X	X	X	X	X	X	X	X	X	X	X
Record	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Debrief														
Student	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staff										X	X	X	X	X
Document														
Stud Rec	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Trainer Rec	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Inst Rec	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mods	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Develop														
New Exer	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Changes	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Validate	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table C-8. Functions and Phase

Function	RIOS	OIOS	O'Shl
Prepare			
Identify	x	x	x
Materials	x	x	x
Review	x	x	x
Dev/Mod	x	x	
Brief			
Student	x	x	x
Staff	x	x	x
Initialize			
Config Tnr	x	x	x
Config IOS	x	x	x
Init Sim	x	x	x
Verify Ready	x	x	x
Train			
Control Sim	x	x	x
Simulate	x	x	x
Instruct	x	x	x
Monitor	x	x	x
Record	x	x	x
Evaluate			
Peform	x	x	x
Diagnose	x	x	x
Dev Remed	x	x	x
Record	x	x	x
Debrief			
Student	x	x	x
Staff	x	x	x
Document			
Stud Rec	x	x	x
Trainer Rec	x	x	x
Inst Rec	x	x	x
Mods	x	x	x
Develop			
New Exer	x	x	
Changes	x	x	
Validate	x	x	x

Table C-9. Functions and Location

Feature	Phase													
	FAM	PRO	DEC	DET	CLA	STG	RDL	VOI	POS	CRK	MSN	PRO	ADV	SPC
Auto Exer		x	x	x	x	x	x	x	x	x	x	x	x	x
Auto Freeze		x				x			x					
Auto Malf		x							x	x	x	x	x	
Auto Vehicle		x	x	x				x	x	x	x	x	x	x
Config Check		x		x	x	x		x	x	x	x	x	x	x
Crash ORide						x			x	x				
Exercise Mod		x	x	x	x	x	x	x	x	x	x	x	x	x
Flag Set		x	x	x	x	x			x	x	x	x	x	x
Freeze		x	x	x	x	x			x	x	x	x	x	x
Help		x	x	x	x	x	x	x	x	x		x	x	x
IC Load		x	x	x	x	x	x	x	x	x	x	x	x	x
Inst Sys Check		x	x	x	x	x	x	x	x	x	x	x	x	x
Manual Stack		x	x			x			x	x		x	x	x
Reset		x	x	x	x	x			x	x		x	x	x
Sim Sys Check		x	x	x	x	x			x	x	x	x	x	x
Speech Output		x						x	x	x	x	x	x	x
Speech Control		x				x		x	x	x	x	x	x	x
Tuturial		x	x	x	x	x	x	x	x	x	x	x	x	x
Prompts/Cues			x	x	x	x		x	x	x	x	x	x	x

Table C-10. Operating Features and Phase

Feature	Manning						
	OI	SI	O/I	I/O	STUD	PEER	None
Auto Exer	x	x	x	x	x	x	x
Auto Freeze			x	x	x	x	x
Auto Malf	x	x	x	x	x	x	x
Auto Vehicle	x	x	x	x			x
Config Check	x	x	x	x	x	x	x
Crash ORide	x	x					x
Exercise Mod	x	x					
Flag Set	x	x					x
Freeze	x	x	x	x	x	x	
Help	x	x			x	x	
IC Load	x	x	x	x	x	x	x
Inst Sys Check	x	x	x	x	x	x	
Manual Stack	x	x					
Reset	x	x	x	x	x	x	x
Sim Sys Check	x	x	x	x	x	x	
Speech Output	x	x	x	x	x	x	x
Speech Control	x	x	x	x	x	x	
Tuturial	x	x			x	x	
Prompts/Cues	x	x	x		x	x	

Table C-11. Operating Features and Manning

Feature	Strategy		
	Tutor	Interactive	Monitor
Auto Exer	x	x	x
Auto Freeze	x	x	x
Auto Malf	x	x	x
Auto Vehicle	x	x	x
Config Check		x	x
Crash ORide	x	x	x
Exercise Mod	x	x	x
Flag Set	x	x	x
Freeze	x	x	x
Help		x	x
IC Load	x	x	x
Inst Sys Check		x	x
Manual Stack	x	x	x
Reset	x	x	x
Sim Sys Check	x	x	x
Speech Output	x	x	x
Speech Control		x	x
Tuturial			
Prompts/Cues		x	x

Table C-12. Operating Features and Strategy

Feature	Location		
	ROIS	OIOS	O'SH
Auto Exer	x	x	x
Auto Freeze	x	x	x
Auto Malf	x	x	x
Auto Vehicle	x	x	x
Config Check	x	x	
Crash ORide	x	x	x
Exercise Mod	x	x	
Flag Set	x	x	x
Freeze	x	x	x
Help	x	x	
IC Load	x	x	x
Inst Sys Check	x	x	x
Manual Stack	x	x	x
Reset	x	x	x
Sim Sys Check	x	x	
Speech Output	x	x	x
Speech Control	x	x	x
Tuturial	x	x	
Prompts/Cues	x	x	x

Table C-13. Operating Features and Strategy

Function	Operating Feature																	
	ARx	AFrz	AMlf	ACtr	CChk	Crsh	Mod	Flag	Frz	Help	IC	IOS	STI	RSet	SChk	Talk	Lstn	CAI
Prepare																		
Identify																		
Materials																		
Review																		
Dev/Mod																		
Brief																		
Student																		
Staff																		
Initialize																		
Config Tngr					X					X								
Config IOS					X										X			
Init Sim	X		X							X	X							
Verify Ready					X										X			
Train																		
Control Sim	X	X	X	X		X		X	X				X	X				
Simulate																X		
Instruct							X	X	X				X	X				
Monitor																		
Record								X										
Evaluate																		
Peform								X	X					X				
Diagnose																		
Dev Remed							X											
Record																		
Debrief																		
Student								X						X				
Staff								X						X				
Document																		
Stud Rec																		
Trainer Rec																		
Inst Rec																		
Mods																		
Develop																		
New Exer																		
Changes																		
Validate																		

Table C-14. Operating Features and Function

Feature	Phase													
	FAM	PRO	DEC	DET	CLA	STG	RUL	VOI	POS	CRE	MSN	PRO	ADV	SPC
Adap Syll		X	X	X	X	X			X	X		X	X	
Auto Diag		X				X			X	X		X	X	
Auto Syll	X	X	X	X	X	X	X	X	X	X	X	X	X	
Brief/Debrief		X		X	X	X	X			X	X	X	X	X
Cond Capture		X	X	X	X	X	X	X	X	X	X	X	X	X
Comm Record		X						X	X	X	X	X	X	X
Demonstration				X	X	X	X	X	X	X			X	
Environ Mod				X	X	X			X	X		X	X	
Hard Copy		X	X	X	X	X			X	X	X	X	X	X
Param Freeze			X			X			X					
Perf Monitor			X	X	X	X	X	X	X	X	X	X	X	X
Perf Measure			X	X	X	X	X	X	X	X	X	X	X	X
Perf Record		X	X	X	X	X	X	X	X	X	X	X	X	X
Proced Mon		X		X			X		X	X	X	X	X	X
Prog Exercise		X	X	X	X	X	X	X	X	X	X	X	X	X
Replay		X		X	X	X			X	X		X	X	X

Table C-15. Instructing Features and Phase

Feature	Manning						
	OI	SI	O/I	T/O	STUD	PEER	None
Adap Syll		x	x		x	x	x
Auto Diag	x	x	x	x	x	x	x
Auto Syll	x	x	x	x	x	x	x
Brief/Debrief	x	x	x	x	x	x	x
Cond Capture	x	x	x				x
Comm Record			x	x			x
Demonstration	x	x	x	x	x	x	
Environ Mod	x	x	x				
Hard Copy	x	x	x	x	x	x	x
Param Freeze	x	x					x
Perf Monitor	x	x	x	x	x	x	x
Perf Measure	x	x	x				x
Perf Record	x	x					x
Proced Mon	x	x	x	x	x	x	x
Prog Exercise		x	x	x	x	x	x
Replay	x	x	x	x	x	x	

Table C-16. Instructing Features and Manning

Feature	Strategy		
	Tutor	Interactive	Monitor
Adap Syll	x	x	x
Auto Diag	x	x	x
Auto Syll	x	x	x
Brief/Debrie	x	x	x
Cond Capture	x	x	x
Comm Record		x	x
Demonstratio	x	x	x
Environ Mod	x	x	x
Hard Copy	x	x	x
Param Freeze	x	x	x
Perf Monitor		x	x
Perf Measure	x	x	x
Perf Record	x	x	x
Proced Mon		x	x
Prog Exercise	x	x	x
Replay	x	x	x

Table C-17. Instructing Features and Strategy

Feature	Location		
	EICS	OICS	OSHL
Adap Syll	x	x	
Auto Diag	x	x	x
Auto Syll	x	x	x
Brief/Debrief	x	x	
Cond Capture	x	x	x
Comm Record	x	x	
Demonstration	x	x	x
Environ Mod	x	x	x
Hard Copy	x	x	x
Param Freeze	x	x	x
Perf Monitor	x	x	
Perf Measure	x	x	x
Perf Record	x	x	
Proced Mon	x	x	x
Prog Exercise	x	x	x
Replay	x	x	x

Table C-18. Instructing Features and Location

Function	Adap	ADgn	ASyl	BrDe	Capt	CRcd	Demo	Evrn	Copy	PFrz	PMon	PMsr	PRcd	Proc	PrEx	Rply	Cue
								Instructing Feature									
Prepare																	
Identify																	
Materials									x								
Review																	
Dev/Mod								x							x		
Brief																	
Student				x			x		x							x	
Staff				x			x		x				x	x		x	
Initialize																	
Config Tngr																	
Config IOS																	
Init Sim	x		x														
Verify Ready																	
Train																	
Control Sim	x		x		x					x					x	x	
Simulate						x											x
Instruct					x	x	x	x	x	x		x		x	x	x	
Monitor						x			x		x	x	x	x			
Record					x	x			x				x			x	
Evaluate																	
Peform						x			x		x	x	x	x		x	
Diagnose		x							x			x	x	x			
Dev Remed	x						x	x							x	x	
Record						x			x				x			x	
Debrief																	
Student				x	x	x	x		x							x	
Staff				x	x	x			x							x	
Document																	
Stud Rec									x	x	x	x					
Trainer Rec									x								
Inst Rec									x								
Mods				x	x				x								
Develop																	
New Exer																	
Changes					x												
Validate							x						x				

Table C-19. Instructing Feature and Function

Feature	Manning						
	OI	SI	O/I	T/O	STUD	PEER	None
Schedule	x	x					
Stud Rec	x	x	x				x
Inst Rec	x	x	x	x	x	x	x
Trnr Rec	x	x	x	x	x	x	x
Reports	x	x	x	x			
Degraded	x	x	x	x			x
Ex Devel	x	x	x	x			
Evaluate	x	x	x				

Table C-20. Manning and Management Features

Configuration : 2

MANNING: Operational Inst.
STRATEGY: Interactive
LOCATION: Over-the-Shoul. IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
*Auto. Vehicle
Crash Override
Flag Set
*Freeze
IC Load
Manual Stack
*Reset
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Conditions Capture
Demonstration
*Environ. Mod.
Hard Copy
Parameter Freeze
Performance Measure
Procedure Monitor
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 3

MANNING: Operational Inst.
STRATEGY: Monitor
LOCATION: On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
•Auto. Vehicle
Configuration Check
Crash Override
•Exer. Modification
Flag Set
•Freeze
Help
IC Load
Manual Stack
•Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Conditions Capture
Demonstration
•Environ. Mod.
Hard Copy
Parameter Freeze
Performance Monitor
Performance Measure
Performance Record
Procedure Monitor
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 4

MANNING:Operational Inst.
STRATEGY:Monitor
LOCATION:Over-the-Shoul. IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
*Auto. Vehicle
Crash Override
Flag Set
*Freeze
IC Load
Manual Stack
*Reset
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Conditions Capture
Demonstration
*Environ. Mod.
Hard Copy
Parameter Freeze
Performance Measure
Procedure Monitor
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 5

MANNING: Simulator Inst.
STRATEGY: Interactive
LOCATION: On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
*Auto. Vehicle
Configuration Check
Crash Override
*Exer. Modification
Flag Set
*Freeze
Help
IC Load
Manual Stack
*Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Adaptive Syllabus
Auto. Syllabus
Conditions Capture
Demonstration
*Environ. Mod.
Hard Copy
Parameter Freeze
Performance Monitor
Performance Measure
Performance Record
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 6

MANNING: Simulator Inst.
STRATEGY: Interactive
LOCATION: Over-the-Shoul. IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
*Auto. Vehicle
Crash Override
Flag Set
*Freeze
IC Load
Manual Stack
*Reset
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Conditions Capture
Demonstration
*Environ. Mod.
Hard Copy
Parameter Freeze
Performance Measure
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 7

MANNING: Simulator Inst.
STRATEGY: Monitor
LOCATION: On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
*Auto. Vehicle
Configuration Check
Crash Override
*Exer. Modification
Flag Set
*Freeze
Help
IC Load
Manual Stack
*Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Adaptive Syllabus
Auto. Syllabus
Conditions Capture
Demonstration
*Environ. Mod.
Hard Copy
Parameter Freeze
Performance Monitor
Performance Measure
Performance Record
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 8

MANNING:Simulator Inst.
STRATEGY:Monitor
LOCATION:Over-the-Shoul. IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Malfunction
•Auto. Vehicle
Crash Override
Flag Set
•Freeze
IC Load
Manual Stack
•Reset
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Conditions Capture
Demonstration
•Environ. Mod.
Hard Copy
Parameter Freeze
Performance Measure
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Scheduling
Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 9

MANNING: Operator/Instructor
STRATEGY: Interactive
LOCATION: On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Freeze
Auto. Malfunction
•Auto. Vehicle
Configuration Check
•Freeze
IC Load
•Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Adaptive Syllabus
Auto. Syllabus
Conditions Capture
Comm. Record
Demonstration
•Environ. Mod.
Hard Copy
Performance Monitor
Performance Measure
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 10

MANNING:Operator/Instructor
STRATEGY:Monitor
LOCATION:On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Freeze
Auto. Malfunction
•Auto. Vehicle
Configuration Check
•Freeze
IC Load
•Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Adaptive Syllabus
Auto. Syllabus
Conditions Capture
Comm. Record
Demonstration
•Environ. Mod.
Hard Copy
Performance Monitor
Performance Measure
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Student Records
Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development
Training Evaluation

Configuration : 11

MANNING:Technician/Operator
STRATEGY:Monitor
LOCATION:On-board Remote IOS

OPERATING FEATURES :

Auto. Exercise
Auto. Freeze
Auto. Malfunction
•Auto. Vehicle
Configuration Check
•Freeze
IC Load
•Reset
Sim. System Check
Speech Output

INSTRUCTIONAL FEATURES :

Auto. Syllabus
Comm. Record
Demonstration
Hard Copy
Performance Monitor
Procedure Monitor
Prog. Exercise
Replay

MANAGEMENT FEATURES :

Instructor Records
Trainer Records
Reports
Degraded Training
Exer. Development

APPENDIX F

INSTRUCTOR TRAINING REQUIREMENTS

INSTRUCTOR TRAINING REQUIREMENTS

The following list of instructor training requirements was developed from the analysis of functions involved in the training mission utilizing a training simulator.

The specific set of functions and subfunctions to be trained for any specific trainer are developed by the OSBATS model. The related list of training requirements can then developed by accessing the requirements contained in Tables F-1 and F-2. Table F-1 is a list of the requirements for each of the sub-functions or tasks which can be involved in the training mission. Table F-2 is a list of the requirements for the trainer features which can be implemented. They are listed by OSBATS category, i.e., Operating Features, Instructing Features and Managing Features.

The short title for each sub-function or task requirement refers to the title used in the OSBATS function matrices. The manage data function has been included since the instructor training syllabus can include training of the small cadre of instructor or operations staff responsible for training management included scheduling and reporting.

TABLE F-1. List of Sub-Function Training Requirements.

1.0 PREPARE FUNCTION

1.1 IDENTIFY - Identify where and how to access training event information regarding:

a. trainees to be trained,
b. time and duration of training event,
c. trainer to be used and location,
d. training exercise(s) to be conducted,
e. status of the scheduled trainer.

1.2 MATERIALS - Identify location and access to required training materials including:

a. trainee training records,
b. exercise guides,
c. exercise scenario guides,
d. system checklists and guides,
e. data recording forms/files,
f. trainee grade sheets/files,
g. trainer utilization forms/files,
h. system planning forms.

1.3 REVIEW - Develop training session data by reviewing data accessed including:

a. trainee training records to identify trainee performance weaknesses and training problems,

b. exercise materials to identify training objectives, performance criteria, priorities, implementation procedure, contingency options and trainer configuration required.

1.4 DEV/MOD - Plan and modify training materials to meet trainee training requirements including:

a. tailoring or individualizing the training exercise(s) to meet the specific needs of the trainee based on the training record review,

b. modifying exercise initial conditions as required,

c. modifying the exercise scenario to meet the tailored exercise,

d. developing controller functions or modifying automated controller in accordance with the revised scenario,

e. planning performance measurement or if feature incorporated, programming feature as required,

f. developing contingency training and operating plans for:
   - o system catastrophies,
   - o trainee performance failures,
   - o trainer failures,
   - o trainer emergencies (e.g., fire, power failure, communication failure, motion platform malfunction).

g. outlining trainee briefing including:
   - o exercise training objectives,
   - o exercise scenario and tactical situation,
   - o exercise performance standards or criteria,
   - o exercise implementation plan (initialization, use of trainer features),
   - o training emergency procedures (fire, loss of communications, trainer failures).

h. o outlining supporting training staff briefing including:
   - o functions to be performed,
   - o coordination procedures to be employed,
   - o emergency procedures functions.

2.0 BRIEF FUNCTION

2.1 STUDENT - Conduct trainee briefing as planned.

2.2 STAFF - Conduct trainer staff briefing as planned.

3.0 INITIALIZE FUNCTION

3.1 CONFIG TNR - Configure the simulation subsystem and crew station(s) to meet exercise requirements.

3.2 CONFIG IOS - Configure the IOS to the exercise initializing conditions.

3.4 INIT SIM - Initialize the simulation program including entry and initialization including:

a. geographical locations

b. atmospheric environment conditions including weather, ambient conditions and magnetic variation,

c. tactical environment conditions,

d. target locations, characteristics and responses,

e. vehicle configuration,

f. vehicle position and state,

g. programmed malfunctions and emergencies,

h. data monitoring and recording.

3.5 VERIFY - Verify trainer readiness for training including:

a. trainees in position,

b. area secure and safe,

c. supporting materials available such as scripts, scenarios, data sheets, technical manuals.

4.0 TRAIN FUNCTION

4.1 CONTROL SIM - Operate and control the trainer including:

a. activate the training exercise,

b. activate/deactivate manually created malfunctions and emergencies,

c. select and activate demonstrations,

d. set and select replay,

e. freeze training,

f. re-initialize trainer to meet new requirements,

g. monitor safety of operation,

h. deactivate trainer at end of session.

4.2 SIMULATE - Provide manual "simulations" required such as controllers, "missing crew members", enemy actions, other friendly actions.

4.3 MONITOR - Monitor trainee performance relative to training objectives including:

a. operating procedures,

b. operating technique,

c. skill level,

d. trainer performance relative to exercise simulation and IOS features.

4.4 INSTRUCT - Instruct trainee including providing:

a. performance critique,

b. correct operating procedures and techniques,

4.5 RECORD - Record trainee and trainer performance data for:

a. simulation control such as reset, replay, re-initialize,

b. debriefing,

c. student, instructor and trainer records.

5.0 EVALUATE FUNCTION

5.1 PERFORM - Establish if trainee performance is within training objectives performance envelope and that simulation and IOS performance meets exercise requirements.

5.2 DIAGNOSE - Diagnose trainee performance problems,

5.3 DEV REMED - Select instruction technique for remediation, and develop plan and data to implement remediation,

5.4 RECORD - Record and store results of evaluation.

6.0 DEBRIEF FUNCTION

6.1 STUDENT - Prepare debriefing material including:

a. summarize training data collected,

b. assemble debriefing materials such as hard copy, replay files, exercise materials, technical manuals, and debrief trainee including review of:

- o training objectives,
- o trainee performance quality,
- o trainee performance problems,
- o outline of corrective actions to be taken by trainee.

6.2 STAFF - Debrief training staff including review of:

a. exercise implementation objectives and plan,
b. exercise implementation problems,
c. staff performance.

7.0 DEVELOP EXERCISES

7.1 NEW EXER - Identify exercise changes and development required including:

a. modifications required to existing exercises,

b. modifications required by equipment changes,

c. modifications required by tactics changes,

d. modifications required by instructional changes,

e. modifications required by syllabus changes.

f. format the changes to meet:

- o exercise objectives,
- o training implementation requirements,
- o trainer implementation requirements,
- o software implementation requirements.

7.3 CHANGES - Implement the changes.

7.4 VALIDATE - Validate the changes.

8.0 MANAGE DATA FUNCTION

8.1 Complete and store trainee exercise results,

8.2 Complete and store simulator utilization data,

8.3 Complete and store simulator discrepancy data,

8.4 Complete and store exercise change/modification data sheet,

8.5 Complete and store instructional recommendations.

Table 2 lists the instructor training requirements for the IOS features.

TABLE F-2. Features Instructor Training Requirements.

0.0 OPERATING FEATURES

0.1 AUTOMATIC EXERCISE - Access, select, modify, edit, and initialize training exercises using the automatic exercise feature.

0.2 AUTOMATIC FREEZE - Access, set parameters, edit, initialize, override and reset the automatic freeze feature.

0.3 AUTOMATIC MALFUNCTIONS - Access, select, set parameters, edit, initialize, override, cancel and reset the automatic malfunctions/emergencies feature.

0.4 AUTOMATIC VEHICLE - Access, select, set parameters, edit, override and reset the automatic vehicle control feature.

0.5 CONFIGURATION CHECK - Access, interpret, resolve and exit the configuration check feature.

0.6 CRASH OVERRIDE - Access, set and cancel the crash override feature.

0.7 EXERCISE MODIFICATION - Access, select, modify and edit simulation parameters and initialize, override, cancel and save modified exercises.

0.8 FLAG RESET - Access, set, retrieve and cancel the flag reset feature for all options.

0.9 FREEZE - Access, activate and deactivate the freeze feature.

0.10 HELP - Access, select and exit the help feature.

0.11 INITIAL CONDITIONS LOAD - Access, select, modify parameters, edit and activate the initial conditions load feature.

0.12 INSTRUCTIONAL SYSTEM CHECK - Access, interpret, resolve discrepancies an exit the instructional system check feature.

0.13 MANUAL STACK - Access, insert commands, edit, modify sequences, initialize, override and cancel the manual stack feature in all relevant modes of operation.

0.14 PROMPTS/CUES - Recognize, interpret, implement, cancel and exit all prompts and cues provided by the feature.

0.15 RESET - Access, insert parameters, edit, initialize and cancel the reset feature.

0.16 SIMULATION SYSTEM CHECK - Access, interpret, resolve discrepancies and exit the simulation system check feature.

0.17 SPEECH CONTROL - Access, modify, initialize, override and cancel individual messages or deactivate the speech output feature.

0.18 SPEECH CONTROL - Access, initialize, override and deactivate the speech control feature.

0.19 TUTORIAL - Access, utilize and exit the trainer tutorial feature.

I.0 INSTRUCTION FEATURES

I.1 ADAPTIVE SYLLABUS - Access, initialize, modify, edit, override and deactivate the adaptive syllabus feature.

I.2 AUTOMATIC DIAGNOSIS - Access, initialize, interpret, override, implement and deactivate the automatic diagnosis feature.

I.3 AUTOMATIC SYLLABUS - Access, initialize, modify, edit, implement and exit the brief/debrief feature.

I.5 CONDITIONS CAPTURE - Access, initialize, capture parameters, implement, override and cancel the conditions capture feature.

I.6 COMMUNICATIONS RECORD - Access, initialize, activate and deactivate the communications record feature.

I.7 DEMONSTRATION - Access, select, initialize, activate, terminate and reset demonstrations.

I.8 ENVIRONMENT MODIFICATION - Access, edit/modify, initialize and implement environment parameters using the environment modify feature.

I.9 HARD COPY - Access, select and output hardcopy of training displays and parameters.

I.10 PARAMETER FREEZE - Access, select parameters, select state, activate and deactivate parameter freezes using the parameter freeze feature.

I.11 PERFORMANCE MONITOR - Access, select, initialize, reset, exit performance monitor options provided by the performance monitor feature.

I.12 PERFORMANCE MEASUREMENT - Access, select, set parameters, edit, initialize, save/store, reset and exit the performance measurement options provided by the performance measurement feature.

I.13 PERFORMANCE RECORD - Access, select, set parameters, initialize, activate, reset, and exit performance record options provided by the performance record feature.

I.14 PROCEDURES MONITOR - Access, select, initialize, activate, reset, and exit procedures monitoring provided by the procedures monitor feature.

I.15 PROGRAMMED EXERCISE - Access, select, modify, edit, initialize, and activate reset, and cancel programmed exercises provided by the programmed exercise feature.

I.16 REPLAY - Access, select, initialize and activate or cancel simulation reset.

M.0 MANAGING FEATURES

M.1 DEGRADED TRAINING - Input trainer status, identify exercise options with degraded trainer capabilities and select feasible trainer exercise using the degraded training management feature.

M.2 EXERCISE DEVELOPMENT - Access the trainer exercise development module, input exercise data, input required initializing data, edit data, activate and monitor development process and exit exercise development feature.

M.3 INSTRUCTOR RECORDS - Access module, enter instructor training data, edit, save and exit instructor record feature.

M.4 REPORTS - Access module, select report, input required data, edit, save, output/print data and exit at the reports management feature.

M.5 SCHEDULING - Access module, input required data, edit, evaluate options and trial schedules, initialize, sort and print (as necessary) the training schedule developed using the scheduling feature.

M.6 STUDENT RECORDS - Access module, enter student training data, edit, save and exit student feature.

M.7 TRAINING EVALUATION - Access module, select data for analysis, input required data, edit, initialize system, activate evaluation routines, save and print (as required) results using the training evaluation feature.

M.8 TRAINER RECORDS - Access module, input data, review data, edit, format, save and print (as desired) the trainer records using the trainer records feature.

APPENDIX G

BENEFIT DATA

Sample Syllabi Descriptions

1. Phase: Familiarization

   Configurations: # 1 - 3

   Trainer Description:
   - o Mockup of crewstation
   - o Nonfunctional displays and controls
   - o Movable controls related to training tasks
   - o Display of control actions related to training tasks

   Syllabus Description:
   - o Objectives
     1. crew station orientation
     2. static crew station task training
        - o pre-start checks
        - o post shutdown checks
   - o Trials per training session - 2 trials of each of four procedures requiring 2 to 5 minutes each

2. Phase: Part Task - Procedures

   Configurations: # 4 - 47

   Trainer Description:
   - o Mockup of crewstation
   - o Functional displays and controls for procedures to be trained

   Syllabus Description:
   - o Objectives
     1. crew station operating procedures training
        - o normal procedures
        - o emergency/malfunction procedures
   - o Trials per training session - 10 trials, 30 seconds to 5 minutes each

3. Phase: Position

   Configurations: # 48 - 62

   Trainer Description:
   - o Mockup of crewstation subsystem displays and controls
   - o Functional subsystem displays and controls
   - o Simulation of subsystem functions
   - o Simulation of subsystem interface functions related to training tasks
   - o Simulation of related environment

Syllabus Description:

- o Objectives.
  1. crew station subsystem(s) training
     - o normal operation (all modes)
     - o degraded operation (all modes)
- o Trials per training session - 5 trials of 10 minutes each

4. Phase: Crew

Configurations: # 63 - 70

Trainer Description:

- o Mockup of system crewstation(s) with all subsystem and crew interface displays and controls
- o Functional system/subsystem displays and controls
- o Simulation of system/subsystem functions
- o Simulation of all subsystem interface functions related to training tasks
- o Simulation of relevant tactical environment

Syllabus Description:

- o Objectives
  1. crew station subsystem(s) training
     - o normal operation (all modes)
     - o degraded operation (all modes)
- o Trials per training session - 5 trials of 10 minutes each

5. Phase: Mission

Configurations: # 71 - 74

Trainer Description:

- o Mockup of crewstation subsystem displays and controls
- o Functional subsystem displays and controls
- o Simulation of all subsystem functions
- o Simulation of all subsystem interface functions related to training tasks
- o Simulation of complete tactical environment

Syllabus Description:

- o Objectives
  1. system mission training
     - o normal mission (s)
     - o degraded mission(s)
- o Trials per training session - 1 trials of 50 minutes

6. Phase: Proficiency

Configurations: # 75 - 86

Trainer Description:

- o Mockup of crewstation subsystem displays and controls
- o Functional subsystem displays and controls
- o Simulation of all system/subsystem functions
- o Simulation of all subsystem interface functions related to training tasks
- o Simulation of complete tactical environment

Syllabus Description:

- o Objectives
  1. system mission training
     - o normal mission (s)
     - o degraded mission(s)
- o Trials per training session - 1 trials of 50 minutes

7. Phase: Advancement

Configuration # 87 - 103

Identical with phases 1 to 5 as a function of system and job

Importance and Use Time in Minutes of Instructional Support Features

FEATURE USE - AVERAGE SINGLE USE TIME (Minutes)

	Feat.	Manual Time					
OPERATING FEATURES	Time	Fam	Proc	Pos	Crew	Miss	Prof
Auto Exercise	.01	-	C 2.0	C 2.0	C 2.0	S 2.0	S 2.0
Auto Freeze	.01	-	-	C 2.0	-	-	-
Auto Malf	.01	-	S .2	S .1	S .1	S .1	S .1
Auto Vehicle	.01	-	E .5	E .1	S 2.0	S 5.0	S 5.0
Config Check	.2	-	S 1.0	S 1.0	S 1.5	S 1.5	S 1.5
Crash O'Ride	.01	-	-	S .2	S .4	-	-
Exercise Mod	.1	-	E .5	E .3	E .4	S .5	S .5
Flag Set	.01	-	S .2	S .2	S .3	S .3	S .3
Freeze	.01	-	E .01	E .01	E .01	C .01	E .01
Help	.2	-	-	-	-	-	-
Init Condit Load	.05	-	S .3	S 1.0	E 1.5	E 2.0	S 2.0
Inst Sys Check	.1	-	C .2	C .5	C .7	C .7	C .7
Manual Stack	.2	-	S .5	S 1.0	S 1.5	-	S 1.5
Reset	.01	-	E .3	E .5	S 2.0	-	S 2.0
Sim Sys Check	.01	-	C .2	C .2	C .2	C .3	C .3
Speech Output	.01	-	S 1.0	S 2.0	S 3.0	S 5.0	S 5.0
Speech Control	.01	-	-	C .05	S .2	C .1	C .2
Tutorial	-	-	-	-	-	-	-
Prompts/Cues	.01	-	S .1	C .1	S 1.0	S 1.0	S 1.0
INSTRUCTING FEATURES							
Adap Syllabus	.01	C .1	S .5	S .7	S .7	-	S .7
Auto Diagnosis	.01	-	S .2	S .5	S 1.0	-	S 1.0
Auto Syll	.01	-	C .4	C .4	S .4	-	S .4
Brief/Debrief	.5	-	S 1.0	S 2.0	S 5.0	S 7.0	S 7.0
Cond Capture	.01	-	S .2	S .2	S .3	S .3	S .3
Comm Record	.01	-	-	C .5	C .5	C .5	C .5
Demo	.01	-	-	C .5	C .5	-	C .5
Environ Mod	.1	-	-	E .5	E .5	-	-
Hard Copy	.01	-	C .3	S .3	C .3	C .3	S .3
Parameter Frz	.01	-	-	C .1	-	-	-
Perform Measure	.05	-	-	S .2	S 2.0	S 5.0	S 2.0
Perform Monitor	.05	-	-	S .5	S 2.0	S 2.0	S 2.0
Perform Record	.2	-	S .3	S .5	S 1.0	S 2.0	S 2.0
Proced Monitor	.1	-	S .3	S .5	S 2.0	S 2.0	S 2.0
Programmed Exer	.01	-	S .5	S 2.0	C 2.0	E 5.0	S 5.0
Replay	.01	-	C 2.0	S 5.0	S 5.0	-	S 5.0
MANAGING FEATURES							
Degraded Train	.01	-	S .2	S .2	S .4	S .5	S .5
Exercise Dev	1.0	-	S 5.0	S 5.0	E 5.0	E 10.0	S 10.0
Instruct Records	.2	C .4	S .4	C .4	C .4	C .4	C .4
Reports	.2	C .5	C 1.0	C 2.0	C 3.0	C 3.0	C 3.0
Scheduling	.3	S 2.0	S 2.0	S 2.0	S 3.0	S 3.0	S 3.0
Student Records	.2	S .6	S .6	S .6	S .6	S .6	S .6
Trainer Records	.2	-	C .3	S .3	S .3	S .3	S .3
Training Eval	2.0	S 4.0	S 5.0	S 5.0	S 10.0	S 10.0	S 10.0

(Importance code: E=essential, S=significant, C=convenient)

Feature Frequency Of Use For Instruct Phase

	Manual Time					
OPERATING FEATURE	Fam	Proc	Pos	Crew	Miss	Prof
Auto Exercise	x	x	x	x	x	x
Auto Freeze	-	-	-	-	-	-
Auto Malf	-	10	5	5	1	2
Auto Vehicle	-	10	5	5	1	2
Config Check	x	x	x	x	x	x
Crash O'Ride	-	-	5	5	1	1
Exercise Mod	-	2	2	2	-	-
Flag Set	-	5	2	2	5	5
Freeze	-	10	5	5	1	2
Help	-	-	-	-	-	-
Init Condit Load	-	10	5	5	1	2
Inst Sys Check	x	x	x	x	x	x
Manual Stack	-	10	5	5	-	1
Reset	-	5	2	2	-	1
Sim Sys Check	x	x	x	x	x	x
Speech Output	-	10	5	5	1	1
Speech Control	-	-	5	5	1	1
Tutorial	-	-	-	-	-	-
Prompts/Cues	-	10	5	5	1	1
INSTRUCTING FEATURES						
Adap Syllabus	-	1	2	2	-	1
Auto Diagnosis	-	5	5	5	-	1
Auto Syll	-	x	x	x	x	x
Brief/Debrief	-	x	x	x	x	x
Cond Capture	-	5	2	2	5	5
Comm Record	-	-	5	5	1	1
Demo	-	-	1	1	-	1
Environ Mod	-	-	2	2	-	-
Hard Copy	-	5	2	2	5	5
Parameter Frz	-	-	2	-	-	-
Perform Measure	-	-	5	5	1	2
Perform Monitor	-	-	5	5	1	2
Perform Record	-	5	5	5	1	2
Proced Monitor	-	10	5	5	1	2
Programmed Exer	-	10	5	1	1	2
Replay	-	2	2	2	-	1
MANAGING FEATURES						
Degraded Train	x	x	x	x	x	x
Exercise Dev	x	x	x	x	x	x
Instruct Records	x	x	x	x	x	x
Reports	x	x	x	x	x	x
Scheduling	x	x	x	x	x	x
Student Records	x	x	x	x	x	x
Trainer Records	x	x	x	x	x	x
Training Eval	x	x	x	x	x	x

x feature not used in TRAIN function
- feature not used in phase

APPENDIX H

COST FACTORS

FAMILIARIZATION TRAINER FEATURE COSTS DATA
(Thousands of Dollars)

FEATURE	ACQUISITION			PRODUCTION		
	SOFT	HDW	TOTAL	SOFT	HDW	TOTAL
Trainer Record	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1

PART TASK TRAINER FEATURE COSTS DATA
(Thousands of Dollars)

FEATURE	ACQUISITION			PRODUCTION		
	SOFT	HDW	TOTAL	SOFT	HDW	TOTAL
Scheduling	154.2	-	154.2	22.1	-	22.1
Auto Diagnosis	154.2	-	154.2	22.1	-	22.1
Brief/Debrief	154.2	-	154.2	22.1	-	22.1
Exercise Dev	154.2	-	154.2	22.1	-	22.1
Perform Measure	154.2	-	154.2	22.1	-	22.1
Adap Syllabus	154.2	-	154.2	22.1	-	22.1
Tutorial	154.2	-	154.2	22.1	-	22.1
Auto Malf	114.0	-	114.0	16.3	-	16.3
Auto Syllabus	114.0	-	114.0	16.3	-	16.3
Programmed Exer	114.0	-	114.0	16.3	-	16.3
Auto Exercise	114.0	-	114.0	16.3	-	16.3
Replay	114.0	-	114.0	16.3	-	16.3
Perform Monitor	114.0	-	114.0	16.3	-	16.3
Auto Vehicle	114.0	-	114.0	16.3	-	16.3
Speech Control	74.5	3.0	77.5	10.6	3.0	13.6
Demonstration	74.5	-	74.5	10.6	-	10.6
Speech Output	74.5	3.0	77.5	10.6	3.0	13.6
Performance Record	74.5	-	74.5	10.6	-	10.6
Manual Stack	54.9	-	54.9	7.9	-	7.9
Config Check	54.9	-	54.9	7.9	-	7.9
Procedures Check	54.9	-	54.9	7.9	-	7.9
Help	54.9	-	54.9	7.9	-	7.9
Prompts/Cues	54.9	-	54.9	7.9	-	7.9
Exercise Mod	54.9	-	54.9	7.9	-	7.9
Environmental Mod	54.9	-	54.9	7.9	-	7.9
Hardcopy	36.0	2.0	38.0	5.1	2.0	7.1
Auto Freeze	36.0	-	36.0	5.1	-	5.1
Parameter Freeze	36.0	-	36.0	5.1	-	5.1
Crash Override	36.0	-	36.0	5.1	-	5.1
Flag Set	36.0	-	36.0	5.1	-	5.1
Freeze	36.0	-	36.0	5.1	-	5.1
I.C. Load	36.0	-	36.0	5.1	-	5.1
Reset	36.0	-	36.0	5.1	-	5.1
Conditions Capture	36.0	-	36.0	5.1	-	5.1
Comm. Record	36.0	-	36.0	5.1	-	5.1
Trainer Record	36.0	-	36.0	5.1	-	5.1
Degraded Training	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1
Trainer Evaluation	36.0	-	36.0	5.1	-	5.1
Inst Sys Check	36.0	-	36.0	5.1	-	5.1
Sim Sys Check	36.0	-	36.0	5.1	-	5.1

POSITION TRAINER FEATURE COSTS DATA
(Thousand of Dollars)

FEATURE	ACQUISITION			PRODUCTION		
	SOFT	HDW	TOTAL	SOFT	HDW	TOTAL
Scheduling	154.2	-	154.2	22.1	-	22.1
Auto Diagnosis	161.7	-	161.7	23.1	-	23.1
Brief/Debrief	161.7	-	161.7	23.1	-	23.1
Exercise Dev	161.7	-	161.7	23.1	-	23.1
Perform Measure	161.7	-	161.7	23.1	-	23.1
Adap Syllabus	156.1	-	156.1	22.3	-	22.3
Tutorial	156.1	-	156.1	22.3	-	22.3
Auto Malf	114.0	-	114.0	16.3	-	16.3
Auto Syllabus	114.0	-	114.0	16.3	-	16.3
Programmed Exer	119.7	-	119.7	17.1	-	17.1
Auto Exercise	119.7	-	119.7	17.1	-	17.1
Replay	116.8	-	116.8	16.7	-	16.7
Perform Monitor	116.8	-	116.8	16.7	-	16.7
Auto Vehicle	116.8	-	116.8	16.7	-	16.7
Speech Control	74.5	3.0	77.5	10.6	3.0	13.6
Demonstration	76.4	-	76.4	10.9	-	10.9
Speech Output	76.4	3.0	79.4	10.9	3.0	13.9
Performance Record	76.4	-	76.4	10.9	-	10.9
Manual Stack	54.9	-	54.9	7.9	-	7.9
Procedures Check	56.3	-	56.3	8.1	-	8.1
Help	56.3	-	56.3	8.1	-	8.1
Config Check	57.6	-	57.6	8.2	-	8.2
Prompts/Cues	57.6	-	57.6	8.2	-	8.2
Exercise Mod	57.6	-	57.6	8.2	-	8.2
Environmental Mod	57.6	-	57.6	8.2	-	8.2
Hardcopy	36.0	2.0	38.0	5.1	2.0	7.1
Auto Freeze	36.0	-	36.0	5.1	-	5.1
Parameter Freeze	36.0	-	36.0	5.1	-	5.1
Crash Override	36.0	-	36.0	5.1	-	5.1
Flag Set	36.0	-	36.0	5.1	-	5.1
Freeze	36.0	-	36.0	5.1	-	5.1
I.C. Load	36.0	-	36.0	5.1	-	5.1
Reset	36.0	-	36.0	5.1	-	5.1
Conditions Capture	36.0	-	36.0	5.1	-	5.1
Comm. Record	36.0	-	36.0	5.1	-	5.1
Trainer Record	36.0	-	36.0	5.1	-	5.1
Degraded Training	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1
Trainer Evaluation	36.0	-	36.0	5.1	-	5.1
Inst Sys Check	36.9	-	36.9	5.7	-	5.7
Sim Sys Check	36.9	-	36.9	5.7	-	5.7

CREW TRAINER FEATURE COSTS DATA
(Thousands of Dollars)

FEATURE	ACQUISITION SOFT	ACQUISITION HDW	ACQUISITION TOTAL	PRODUCTION SOFT	PRODUCTION HDW	PRODUCTION TOTAL
Scheduling	154.2	-	154.2	22.1	-	22.1
Auto Diagnosis	169.6	-	169.6	24.3	-	24.3
Brief/Debrief	169.6	-	169.6	24.3	-	24.3
Exercise Dev	169.6	-	169.6	24.3	-	24.3
Perform Measure	169.6	-	169.6	24.3	-	24.3
Adap Syllabus	161.7	-	161.7	23.1	-	23.1
Tutorial	161.7	-	161.7	23.1	-	23.1
Auto Malf	114.0	-	114.0	16.3	-	16.3
Auto Syllabus	114.0	-	114.0	16.3	-	16.3
Programmed Exer	125.4	-	125.4	17.9	-	17.9
Auto Exercise	125.4	-	125.4	17.9	-	17.9
Replay	119.7	-	119.7	17.1	-	17.1
Perform Monitor	119.7	-	119.7	17.1	-	17.1
Auto Vehicle	119.7	-	119.7	17.1	-	17.1
Speech Control	74.5	3.0	77.5	10.6	3.0	13.6
Demonstration	82.0	-	82.0	11.7	-	11.7
Speech Output	78.2	3.0	81.2	11.2	3.0	14.2
Performance Record	78.2	-	78.2	11.2	-	11.2
Manual Stack	54.9	-	54.9	7.9	-	7.9
Config Check	60.4	-	60.4	8.6	-	8.6
Prompts/Cues	60.4	-	60.4	8.6	-	8.6
Procedures Check	54.9	-	54.9	7.8	-	7.8
Help	54.9	-	54.9	7.8	-	7.8
Hardcopy	36.0	2.0	38.0	5.1	2.0	7.1
Auto Freeze	36.0	-	36.0	5.1	-	5.1
Parameter Freeze	36.0	-	36.0	5.1	-	5.1
Crash Override	36.0	-	36.0	5.1	-	5.1
Flag Set	36.0	-	36.0	5.1	-	5.1
Freeze	36.0	-	36.0	5.1	-	5.1
I.C. Load	36.0	-	36.0	5.1	-	5.1
Reset	36.0	-	36.0	5.1	-	5.1
Conditions Capture	36.0	-	36.0	5.1	-	5.1
Comm. Record	36.0	-	36.0	5.1	-	5.1
Trainer Record	36.0	-	36.0	5.1	-	5.1
Degraded Training	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1
Trainer Evaluation	36.0	-	36.0	5.1	-	5.1
Inst Sys Check	37.8	-	37.8	5.4	-	5.4
Sim Sys Check	37.8	-	37.8	5.4	-	5.4

MISSION TRAINER FEATURE COSTS DATA
(Thousands of Dollars)

FEATURE	ACQUISITION			PRODUCTION		
	SOFT	HDW	TOTAL	SOFT	HDW	TOTAL
Scheduling	154.2	-	154.2	22.1	-	22.1
Auto Diagnosis	177.3	-	177.3	25.4	-	25.3
Brief/Debrief	177.3	-	177.3	25.4	-	25.3
Exercise Dev	177.3	-	177.3	25.4	-	25.3
Perform Measure	177.3	-	177.3	25.4	-	25.3
Adap Syllabus	165.8	-	165.8	23.7	-	23.7
Tutorial	165.8	-	165.8	23.7	-	23.7
Auto Malf	114.0	-	114.0	16.3	-	16.3
Auto Syllabus	114.0	-	114.0	16.3	-	16.3
Programmed Exer	131.1	-	131.1	18.7	-	18.7
Auto Exercise	131.1	-	131.1	18.7	-	18.7
Replay	122.6	-	122.6	17.5	-	17.5
Perform Monitor	122.6	-	122.6	17.5	-	17.5
Auto Vehicle	122.6	-	122.6	17.5	-	17.5
Speech Control	74.5	3.0	77.5	10.6	3.0	13.6
Demonstration	85.7	-	85.7	12.3	-	12.3
Speech Output	80.1	3.0	83.1	11.5	3.0	14.5
Performance Record	80.1	-	80.1	11.5	-	11.5
Manual Stack	54.9	-	54.9	7.9	-	7.9
Config Check	63.1	-	63.1	9.0	-	9.0
Prompts/Cues	63.1	-	63.1	9.0	-	9.0
Procedures Check	59.0	-	59.0	8.4	-	8.4
Help	59.0	-	59.0	8.4	-	8.4
Hardcopy	36.0	-	36.0	5.1	-	5.1
Auto Freeze	36.0	2.0	38.0	5.1	2.0	7.1
Parameter Freeze	36.0	-	36.0	5.1	-	5.1
Crash Override	36.0	-	36.0	5.1	-	5.1
Flag Set	36.0	-	36.0	5.1	-	5.1
Freeze	36.0	-	36.0	5.1	-	5.1
I.C. Load	36.0	-	36.0	5.1	-	5.1
Reset	36.0	-	36.0	5.1	-	5.1
Conditions Capture	36.0	-	36.0	5.1	-	5.1
Comm. Record	36.0	-	36.0	5.1	-	5.1
Trainer Record	36.0	-	36.0	5.1	-	5.1
Degraded Training	36.0	-	36.0	5.1	-	5.1
Reports	36.0	1.0	37.0	5.1	1.0	6.1
Instructor Record	36.0	-	36.0	5.1	-	5.1
Student Record	36.0	-	36.0	5.1	-	5.1
Trainer Evaluation	36.0	-	36.0	5.1	-	5.1
Inst Sys Check	38.7	-	38.7	5.5	-	5.5
Sim Sys Check	38.7	-	38.7	5.5	-	5.5

INSTRUCTOR COSTS PER HOUR/YEAR

Operational Instructor
Instructor Pilots/Gunners

(0-3 with 6 yrs) & (W-3 with 14 yrs)

MILITARY FACTORS		PER MOS	X12 mos	PER YEAR	÷ 1594 hrs =	COST PER HOUR
Basic Pay	0-3	$2,354		=$28,248		=$17.72
	W-3	2,116		= 25,394		= 15.93
Subsistence Allowance	0-3	115		= 1,380		= 0.87
	W-3	115		= 1,380		= 0.87
Basic Allowance for Quarters (WD)	0-3	455		= 5,460		= 3.43
	W-3	440		= 5,274		= 3.31
Variable Housing Allowance (WD)	0-3	134		= 1,608		= 1.00
	W-3	174		= 2,087		= 1.31
Tax Advantages	0-3	133		= 1,596		= 1.00
	W-3	89		= 1,076		= 0.68
Aviation Incentive Pay	0-3	400		= 4,800		= 3.00
	W-3	400		= 4,800		= 3.00
Total Pay	0-3	$3,591		$46,683		$27.02
	W-3	3,334		40,011		25.10

NOTE:
1. Average Annual Salaries combine/include Basic Pay, Subsistence Allowance, Allowance for Quarters, Variable Housing Allowance, and tax advantages. Basic on "Selected Military Compensation Tables, 1988 Defense Department.

2. WD - with dependents.

INSTRUCTOR COSTS PER HOUR/YEAR

Simulator Instructors

(0-2 with 4 yrs) & (W-2 with 12 yrs)

MILITARY FACTORS		PER MOS	X12 mos	PER YEAR	÷ 1594 hrs =	COST PER HOUR
Basic Pay	0-2	$2,009		=$24,108		=$15.12
	W-2	1,836		= 22,032		= 13.82
Subsistence Allowance	0-2	115		= 1,380		= 0.87
	W-2	115		= 1,380		= 0.87
Basic Allowance for Quarters (WD)	0-2	391		= 4,692		= 2.94
	W-2	411		= 4,932		= 3.09
Variable Housing Allowance (WD)	0-2	133		= 1,596		= 1.00
	W-2	175		= 2,100		= 1.32
Tax Advantage	0-2	51		= 612		= 0.38
	W-2	66		= 792		= 0.50
Aviation Incentive Pay	0-2	206		= 2,472		= 1.55
	W-2	400		= 4.800		= 3.00
Total Pay	0-2	$ 2,905		=$34,860		=$21.86
	W-2	$ 3,003		=$36,036		=$22.60

NOTE:

1. WD- With Dependents

INSTRUCTOR COSTS PER HOUR/YEAR

Operator/Instructor

(W-2 With 12 yrs) & (E-6 with 5 yrs)

MILITARY FACTORS		PER MOS	X12 mos	PER YEAR	÷ 1594 HRS	COST PER HOUR
Basic Pay	W-2	$1,836		=$22,032		=$13.82
	E-6	1,200		= 14,400		= 9.03
Subsistence Allowance	W-2	115		= 1,380		= 0.87
	E-6	173		= 2,076		= 1.30
Basic Allowance For Quarters (WD)	W-2	411		= 4,932		= 3.09
	E-6	366		= 4,392		= 2.76
Variable Housing Allowance (WD)	W-2	173		= 2,076		= 1.30
	E-2	153		= 1,836		= 1.15
Tax Advantage	W-2	68		= 816		= 0.51
	E-6	41		= 492		= 0.31
Total Pay	W-2	$2,603		=$31,236		=$19.59
	E-6	$1,933		=$23,196		=$14.55

NOTE:

1. Not on flight status
2. WD-with dependents

INSTRUCTOR COSTS PER HOUR/YEAR

Technician/Operator

(E-7 with 8 yrs) & (E-5 with 3 yrs)

MILITARY FACTORS		PER MOS	X12 mos	PER YEAR	÷ 1594 hrs	COST PER HOUR
Basic Pay	E-7	$1,458		=$17,496		=$10.98
	E-5	1,016		= 12,192		= 7.65
Subsistence Allowance	E-7	173		= 2,076		= 1.30
	E-5	173		= 2,076		= 1.30
Basic Allowance for Quarters (WD)	E-7	403		= 4,836		= 3.03
	E-5	325		= 3,900		= 2.45
Variable Housing Allowance (WD)	E-7	170		= 2,040		= 1.28
	E-5	134		= 1,608		= 1.00
Tax Advantage	E-7	61		= 732		= 0.46
	E-5	19		= 228		= 0.14
Total Pay	E-7	$2,265		=$27,180		=$17.05
	E-5	$1,667		=$20,004		=$12.54

NOTE:

1. WD-with dependents

INSTRUCTOR COSTS PER HOUR/YEAR

Student Instructor

(W-1 with 10 yrs) & (E-6 with 5 yrs)

MILITARY FACTORS		PER MOS	X12 mos	PER YEAR	÷ 1594 hrs	COST PER HOUR
Basic Pay	W-1	$1,618		=$19,416		=$12.18
	E-6	1,200		= 14,400		= 9.03
Subsistence Allowance	W-1	115		= 1,380		= 0.87
	E-6	173		= 2,076		= 1.30
Basic Allowance for Quarters (WD)	W-1	358		= 4,296		= 2.70
	E-6	366		= 4,392		= 2.76
Variable Housing Allowance (WD)	W-1	147		= 1,764		= 1.11
	E-6	153		= 1,836		= 1.15
Tax Advantage	W-1	50		= 600		= 0.38
	E-6	41		= 492		= 0.31
Total Pay	W-1	$2,288		=$27,456		=$17.24
	E-6	$1,933		=$23,196		=$14.55

INSTRUCTOR COSTS PER HOUR/YEAR

Federal Civil Service Instructors

FACTORS	Operational Instructor	Simulator Instructor	Operator/ Instructor	Technician Operator
	GS-11	GS-10	GS-9	GS-7
Gross Salary				
Per Mos =	$ 2,464	$ 2,242	$ 2,036	$ 1,415
(X12) Per Year =	29,564	26.908	24,435	19.974
(÷1594 Hrs) Per Hour =	18.55	16.88	15.32	12.53
Composite Salary				
Per Mos =	$ 2,595	$ 3,065	$ 2,703	$ 2,208
(X12) Per Year =	31,144	36,776	32,433	26,494
(÷1594 hrs) Per Hour =	19.54	23.07	20.35	16.62

NOTES:

1. Taken from AF Reg 173-13 CH2 of 9 March 88, "Cost Analysis for USAF Cost and Planning Factors."

2. Assume each GS at Step 3.

3. Composite Pay includes Salary and Government Paid Benefits.

INSTRUCTOR COSTS PER HOUR/YEAR

Contractor instructors

Category	Hourly Rate	x	Composite Overhead	=	Hourly Rate	x	Hours Per Year	=	Cost Per Year
Operational Instructor	$12.50		2.15	=	26.88		1594	=	42,847
Simulator Instructor	11.50		2.15	=	24.73		1594	=	39,420
Operator/Instructor	10.50		2.15	=	22.58		1594	=	35,993
Technician/Operator	9.50		2.15	=	20.43		1594	=	32,565
Student Instructor	8.50		2.15	=	18.28		1594	=	29,138

Notes:

1. Hourly rates are based on U.S. Department of Labor Employment Standards (Wage & Hour Div.).

2. Hours per year are based on 7 hours @ day, 22 days @ month, 11.5 months @ year, 90% availability.

3. Composite Overhead includes all overheads, G&A, Profit, COM, etc.

BASELINE

1. Device scheduled for utilization period of 11.5 months a year. (Excluding Christmas 2 weeks vacation period).

2. Assume 8 hours a day minus 1 hour for change-over of crew (7 hours a day).

3. Assume 90% availability of each Device.

4. Calculations assume:

   7 hours a day
   22 days a month
   11.5 months a year
   90% availability
   1594 hours a year

(22 day X 11.5 mos = 253 days X 7 hrs = 1771 hrs X 90% = 1594 hrs a year)

STUDENT COSTS PER HOUR/YEAR

FACTORS

PAY GRADE	YEARS OF SERVICE	BASIC PAY	SUBSISTENCE ALLOWANCE	ALLOWANCE FOR QUARTERS	VAR HOUSING ALLOWANCE	TAX ADVANTAGE	TOTAL	X12 PER YEAR	+1594 HRS = COST PER HOUR
E-3	1	$ 782	$173	$258	$109		=$1,322	=$15,864	= 9.95
E-4	1 1/2	830	173	280	111		= 1,394	= 16,728	=10.49
E-5	2 1/2	969	173	325	134	17	= 1,618	= 19,416	=12.18
E-6	4 1/2	1,200	173	365	153	43	= 1,934	= 23,208	=14.56
E-7	7 1/2	1,412	173	403	170	60	= 2,218	= 26,616	=16.70
W-1	10	1,618	115	356	147	50	= 2,288	= 27,456	=17.22
W-2	12	1,836	115	411	159	82	= 2,603	= 31,236	=19.59
W-3	14	2,116	115	439	174	90	= 2,934	= 35,208	=22.09
	Officers with more than 4 years of Active Duty as Enlisted or Warrant Officer.								
O-1E	6	1,728	115	350	184	72	= 2,449	= 29,388	=18.44
O-2E	8	2,116	115	391	194	110	= 2,926	= 35,112	=22.03
O-3E	10	2,571	115	455	195	144	= 3,480	= 41,760	=26.20
O-1	[illegible]	1,286	115	350	106	4	= 1,861	= 22,332	=14.01
O-2	2	1,518	115	391	133	55	= 2,312	= 27,744	=17.41
O-3	6	2,354	115	455	134	133	= 3,191	= 38.292	=24.02
O-4	13	2,849	115	546	185	193	= 3,888	= 46,656	=29.27
O-5	18	3,585	115	598	198	332	= 4,828	= 57,936	=36.35

NOTES:

1. Factors are quoted "per month."

2. Combines basic pay, allowance for quarters, subsistence allowance, variable housing allowance and tax advantages.

Development of a One-Hour Lesson Utilizing the Computer-Based Training Method of Videodisc

Process

1. Develop the IDO (Instructional Design Outline)

2. Develop the storyboards and write the script.

3. Develop detailed flow-charts.

4. Develop "shot-lists."

5. Shoot the Video on tape.

6. Develop computer-graphics as required.

7. Edit the Video tape.

8. Validate the Video tape.

9. Make frame-accurate layout of the disc (mapping).

10. Accomplish "Videodisc Mastering" (putting Video Tape and Computer-Graphics on Videodisc).

Cost Breakdown for Videodisc

1. It is estimated by SMEs that it would cost approximately $70,000 to produce a one-hour lesson. Any expenses for hardware and software would cost extra. Hardware is estimated at $7000 to $8000 and software is estimated to cost approximately $3000. Assuming the software had to be purchased, the cost would be $73,000 for a one-hour lesson/program.

2. For the above cost estimates, it must be assumed that the producers are using "Authoring Software" to accomplish the computer program. It also assumes this 1-hour lesson has no more than 30 minutes of motion and 30 minutes of stills. The more motion, the greater the expense. (One-hour of stills will handle 54,000 "stills.")

3. To produce the Videodisc, the following items/actions are normally expected:

a. The Instructional Designer would go to the customer's site to conduct a task analysis and develop the IDO (Instructional Design Outline). A follow-up trip is required to verify the tasks.

b. A crew, made up of a Media Producer, Camera-man, Director, and Instructional Director/Designer visits the site to study and plan for the Video-taping.

c. A return trip is made by the above crew to commence actual shooting of the lesson-material. This may include the Narrator at this time.

d. Upon return, the crew will work in a studio/suite which is equipped for videotaping and editing. This Suite usually runs $400 @ hour for rent, which includes technicians and equipment.

e. Other trips will have to be made to the customer's site to shoot, reshoot, modify, etc., the video tape.

f. This becomes an extensive effort to edit and validate the videotape for final approval.

g. Upon final approval, the Master tape is put on the videodisc (Mastering), upon which time no changes can be made. Changes made afterwards result in tremendous expense.

4. A Videodisc on one side only costs approximately $1,800, whereas a two-sided disc will cost $2300.

5. An important consideration in producing Videodiscs is the tremendous expense involved in making changes. Normally 5 to 10% of lesson instructions will be obsolete each year. This must be considered.

Development of a One-Hour Lesson Utilizing Embedded Training

Process:

1. Develop the design
2. Write the Script.
3. Develop detailed flow-charts.
4. Develop scene/situation layouts.
5. Write the Line of Code for the program. (By Computer Programmer).
6. Create/produce the program on the computer.
7. Edit the program.
8. Validate the lesson/program.

Cost Breakdown for Embedded Training

1. To develop the one-hour program/lesson, and perform each of the processes 1. through 8., requires 5 MMs of effort.

2. Included in the 5 MMs is the requirement for five 5-day trips to the customer's site for research, liaison, discussions, computer-programming, and validation.

3. Salaries:

Computer Programmer at $10.77 X 2.15 composite factor =$23.11 @ hour X 160 hrs a mon = $3698 @ mos. $3698 @ mos X 5 MMs = $18,488

4. Travel expenses:

5 Trips to Norva (Ex), 5 days each trip:

Air Fare/RT	= $175.00
Per Diem $80 @ day X 5 days	= 400.00
Car Rental $35 @ day X4 days	= 140.00
Car Parking $5 @ day X 5 days	= 25.00
Mileage (Res to Arpt)	= 8.00
Total	= $748.00

5 Trips X $748 @ trip = $3740

5. Summary:

Salaries for 5 MMs	= $18,488
5 Trips during the 5 MMs	= 3,740
Total	= $22,228

A One-hour lesson costs $22,228 to produce.

6. Assumptions:

a. The software system has been established and accepted prior to adding the Embedded Training capability.

b. If the Instructor were present, you would not need Embedded Training.

c. Want to simulate the Instructor/Supervisor for instructional purposes and feedback.

d. For this discussion, assume there is an Instructor/Operator Station, which is a separate console from the cockpit/s, such as for the T-45 aircraft/simulator program.

e. FORTRAN is the language in usage.

7. There are three situations that may occur with embedded training:

a. The students are simulated.

b. The trainee is the "Instructor-Under-Training" (IUT).

c. The Instructor/Supervisor is not present.

8. Definitions:

Navy

Embedded Training (ET) is defined by the Navy as "training that is provided by capabilities built into or added onto operational systems, subsystems or equipment to enhance and maintain the skill proficiency of fleet personnel."

Air Force

Embedded Training (ET) is instructional software that is part of or interacts with the software of an operational system so that the operational system can be used as a training system. It can be fully integrated with the operational system's software or it can be "strapped on" to the operational system.

Development of a One-Hour Lesson Utilizing the Computer-Based Training Method of Computer-Graphics developed by Authoring Language

Process

1. Develop/modify existing design to some extent.

2. Write script.

3. Develop detailed flow-charts.

4. Write computer program, by Computer Programmer.

5. Produce the program on the computer.

6. Edit the program.

7. Validate the lesson/program.

Cost Breakdown for Authoring Language

1. To develop the one-hour program/lesson, and perform each of the processes, 1. through 7., requires 5 MMs to build a 5 hour program (1 MM for a 1 hour program).

2. Included in the 5 MMs is the requirement for three 3-day trips to the customer's site for research, discussions, and validation.

3. Salaries:

Computer Programmer Class II salary is $10.77.
$10.77 X 2.15 composite factor = $23.11 @ hr.
$23.11 X 160 hours = $3698 @ mos.
$3698 X 5 MMs = $18,488

4. Trip expenses:

3 Trips to Norva (Ex), 3 days each trip.

Air Fare/RT	=	$175.00
Per Diem $80 @ day X 3 days	=	240.00
Car Rental $35 @ day X 2 days	=	70.00
Car Parking fee $5 @ day X 3 days	=	15.00
Mileage (Res to Arpt/RT)	=	8.00
Total	=	$508.00

3 trips X $508 @ trip = $1524

5. Summary:

Salaries for 5 MM		=$18488.00
Trips during 5 MM		= 1524.00
	Total	=$20012.00

$20012 divided by 5 MM =$4002.00 for 1 MM effort to develop a 1-hour program.

Note: A 5 hour lesson requires 5 MMs to produce. Therefore a 1 hour lesson requires 1 MM to produce.

Development of a One-Hour Lesson Utilizing the Computer-Based Training Method of Computer-Graphics by an Authoring System

Progress:

1. Develop the design.

2. Write the script.

3. Develop detailed flow-charts.

4. Produce the program at the computer, utilizing the "Authoring System" already built into the computer program.

5. Edit the program.

6. Validate the program/lesson.

Cost Breakdown for Authoring System

1. To develop the one-hour program/lesson, and perform each of the processes, 1. through 6., requires 2.5 MMs to build a 5 hour program/lesson or .5 MM for a 1-hour lesson.

2. Include in the 2.5 MMs is the requirement for (3) 3-day trips to the customer's site for research, discussions, and validation.

3. Salaries:

Computer Programmer's salary Class II is $10.77.
$10.77 X 2.15 Composite factor = $23.11 @Hr
$23.11 @ Hr X 160 Hrs = $3698 @ mos
$3698 @ mos X 2.5 MM = $9245
(Does not require programming skills but probably developed by a computer-programmer)

4. Trip expenses:

3 Trips to NorVa (Example), 3 days each trip
Same expenses as fro "Authoring Language" = $1524

5. Summary:

Salaries for 2.5 MMs		=$ 9245	
3 trips during 2.5 MMs		= 1524	
	Total	= 10769	(5-Hrs)

A 5 hour lesson requires 2.5 MMs.
A 1 hour lesson requires 0.5 MMs.

$10769 X 1/5 = $2154.00 to develop a one hour lesson

Development of a One-Hour Lesson Utilizing a VCR Tape.

Process:

1. Develop the design.
2. Write the script.
3. Develop detailed flow-charts.
4. Develop scene/situation layouts.
5. Produce the tape:
   On site
   In studio (or both)
6. Edit the tape.
7. Validate the tape/lesson in the field.

Cost Breakdown for VCR Tape

1. To develop a one-hour lesson and perform each of the processes, 1. through 7., requires 1.25 MMs of effort.

2. Included in the 1.25 MMs is the requirement for three 4-day trips to the customer's site for research, liaison, discussions, taping and validation.

3. Salaries
   An Education Specialist/Training Specialist would perform all of the processes above except for No. 5-produce the tape. This would require a type of technician, photographer, or TV Technician.

   Training Specialist @ $9.50 @ hour x 2.15 = $20.43 Hr.
   (Composite factor for Overhead is 2.15)
   $20.43 @ Hr. x (1.25 MM x 160 Hrs.) = 200 Hrs.) = $4086

   Technician/Photographer @ $9.94 @ Hr. x 2.15 = $21.37
   $21.37 @ Hr. x 56 Hrs. = $1197
   (Trip is 4 days/32 hours,plus additional editing/shooting time)

4. Travel Expenses:

3 Trips to NorVa (Example)

Training Specialist - 3 trips x 4 days = 12 days

Photographer/Technician - 1 trip/4 days = 4 days

Training Specialist (each trip/4 days)

Air Fare (RT)	=	$ 175.00
Per Diem $80 @ day x 4 days	=	320.00
Car Rental $35 @ day x 3 days	=	105.00
Car Parking $5 @ day x 4 days	=	20.00
Mileage (Res to Arpt/RT)	=	8.00
Total	=	628.00
3 trips x $628	=	$ 1884.00

Technician/Photographer (1 trip)

Air Fare (RT)	=	$ 175.00
Per Diem $80 @ day x 4 days	=	320.00
(No car rental)		0
Car Parking $5 @ day x 4 days	=	20.00
Mileage (Res to Arpt/RT)	=	8.00
Total	=	$ 523.00

Total for Trips

Training Specialist	=	$ 1884.00
Technician/Photographer	=	523.00
Total	=	$ 2407.00

5. Summary:

Salaries

Training Specialist for 1.25 MM	=	$ 4086.00
Tech/Photographer for 56 Hours	=	1197.00
Total	=	$ 6283.00

Travel

Training Specialist for 3 trips	=	$ 1884.00
Tech/Photographer for 1 trip	=	523.00
Total	=	$ 8690.00
Grand Total	=	$ 8690

It cost $8690 for a one-hour VCR tape.

Development of a Lesson Plan for One Hour of Instruction

Process:

1. Research and Liaison
2. Writing and Editing
3. Typing

Cost Breakdown for Lesson Plan Development

1. To develop a one hour lesson plan and perform each of the processes, 1 through 3, requires 10 man-hours, 8 hours by a training specialist and 2 hours by the typist.

2. Salaries
   Training specialist @ 9.50 @ hour x 2.15 = $20.43 Hr.
   (Composite factor for Overhead is 2.15)
   $20.43 @ Hr x 8 Hrs. = $163.44

   Typing @ 12.75 per hour x 2 = $25.50

3. Total cost = $188.94, rounded to $200

Development of a Job Aid for One Hour of Hands-on Practice

Process:

1. Research and Liaison
2. Writing and Editing
3. Typing

Cost Breakdown for Job Aid for Hands-on Practice

1. To develop materials for one hour of hands-on practice the processes, 1 through 3, requires 18 man-hours, 14 hours by a training specialist and 4 hours by the typist.

2. Salaries

Training specialist @ 9.50 @ hour x 2.15 = $20.43 Hr.

(Composite factor for Overhead is 2.15)

$20.43 @ Hr x 14 Hrs. = $286.02

Typing @ 12.75 per hour x 4 = $51.00

3. Total cost = $337.02, rounded to $350

APPENDIX I

TRAINING GUIDELINES AND PARAMETERS FOR PART TASK TRAINING

APPENDIX I

TRAINING GUIDELINES AND PARAMETER MATRICES FOR PART TASK TRAINING

RULES TRAINING

ACTION VERBS

Choose
Conclude
Deduce
Predict
Propose
Select
Specify
Solve

BEHAVIORAL ATTRIBUTES

1. Choosing a course of action based on applying known rules or regulations.

2. Frequently involving "IF...THEN" situations.

3. Focusing on whether the correct decision rule is being applied and whether the rule is being applied correctly.

EXAMPLES

1. Selecting the appropriate greeting for a foreign dignitary.

2. Solving a problem using Ohm's Law.

3. Choose the proper fire extinguisher for an electrical fire.

4. Specify course of action based on regulations.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training. Relate the objectives and learning activities to operational tasks which the trainee must perform in future real-world assignments.

2. ENSURE PREREQUISITE SKILLS

Make sure that the student can recall and demonstrate the concepts which make up the rule. Then go on to learning the rule.

Require the learner to state the rule verbally. This verbal statement helps the learner recall which concepts make up the rule and how the concepts are arranged. This should usually be an informal statement of the rule in the learner's own words.

3. PROVIDE OPPORTUNITIES FOR PRACTICE IN RECALLING AND APPLYING RULES.

Present examples of when the rule applies, and when it doesn't.

Provide opportunities to apply the rule in a variety of new situations in which the learner has not previously been trained to apply the rule. During practice, practical applications and practice tests provide the student with immediate knowledge of results about his correct and incorrect answers. Provide rewards for correct application of the rule.

Provide practice until the student achieves the desired level of performance: until he learns the rules and learns to apply the rules that he will use in the operational job setting.

Different trainees will have different rates and styles of learning the material. It is better to use techniques which allow students flexibility in learning time.

Reduce forgetting by providing periodic practice or refresher training for infrequently used material.

Where it seems possible, supply students with diagrams, pictures, charts, graphs, rhymes, key words, and other association devices (mnemonics) which the student can use to relate what he already knows to what he is trying to learn. Also encourage students to make up their own mnemonics if they are able and want to do so.

4. TEST TRAINEE UNDERSTANDING OF RULES

To test the learner's understanding of the rule, provide an unfamiliar situation in which the rule can be applied, and then require the learner to tell how the concepts of the rule are related to each other and to this situation in order to show that he is able to state how and why the rule can be applied.

5. ASSOCIATE RULES WITH FEATURES OF JOB ENVIRONMENT

Relate the rules to be learned to operational tasks which the trainee must perform in future real work.

Pick out the features of the real-world job environment which could be used to trigger the trainee's recall of associated materials. Some features of the real-world job setting where the rules will be applied can sometimes trigger the recall of associated material that has not been directly trained that can be used in applying rules.

6. SUPPLY REWARDS APPROPRIATE TO STAGE OF TRAINING

Positive rewards of the student's correct applications of the rules learned is required in the early stages of training. Toward the end of training, the level of positive rewards for correct performance should be reduced to the same level that the student will find on the job.

In order for slower learner to reach the same level of proficiency as faster learners, additional time must be allowed for the slower learner to get as many positive rewards for correct applications of the rules learned as the faster learner.

7. USE DISCOVERY TECHNIQUES FOR DIFFICULT RULES

Where the learner is having a particularly difficult time trying to learn and apply a rule, help him by discover how the concepts are related to each other by using specific questions which will help the learner to state the elements and relationships in the rule. Once the learner has discovered the rule elements by this method, he should be able to (a) recall the rule, (b) state the elements and their relationship in the rule, and (c) be able to apply the rule to job situations.

DECISION MAKING TRAINING

ACTION VERBS

Choose
Decide
Design
Develop
Diagnose
Evaluate
Forecast
Formulate
Organize
Select

BEHAVIORAL ATTRIBUTES

1. Deciding a course of action when alternatives are unspecified or unknown.

2. Deciding a course of action when a successful course of action is not readily apparent.

3. Deciding a course of action when the penalties for unsuccessful courses of action are not readily apparent.

4. Evaluating the relative value of decisions - including possible trade offs.

5. Involving forced decisions made in a short period of time with soft information.

EXAMPLES

1. Choose frequencies to search in an ECM search plan.

2. Decide tactics in combat, with a range of options available.

3. Select a diagnostic strategy when troubleshooting a complex system using schematic diagrams.

4. Decide to abort or commit oneself to land upon reaching the critical point in the glidepath.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training. Relate the learning objectives and learning activities to operational tasks which the trainee must perform in future real-world assignments.

2. ENSURE PREREQUISITE KNOWLEDGE

For the most efficient training of decision making, the student must already have learned the technical knowledge which will allow him to:

a. identify what the problem really is
b. make a list of the most reasonable solutions
c. determine which of the solutions would be best.

3. REDUCE ANXIETY IN EARLY STAGES OF TRAINING.

The student will learn best if ne is not afraid of making incorrect decisions in the training situations; this is particularly true in the early stages of training and in very complex decision making processes. Materials and instructors should, therefore, attempt to decrease student fears to a low level.

4. DESCRIBE CLASSES OF TYPICAL ERRORS.

Give the students examples of these two types of actions which are to be avoided when making decisions:

a. response biases; that is, the tendency to make a "favorite" decision or use a "favorite" solution regardless of the real nature of the problem.
b. perceptual sets; that is, the tendency to generalize problems or view several types of problems as if they were all the same when, in fact, they are quite different.

5. TEACH DECISION MAKING PROCESS.

It is useful to teach the students a set of steps to follow in making decisions. The following 5-step model is suggested:

a. Discover the existence of a problem and define it
b. Identify and collect relevant information
c. Develop reasonable solutions to the problem
   1) compare alternative solutions
   2) combine alternate solutions where desirable
d. Evaluate each of the proposed solutions
   1) How will each solution solve the problem?
   2) Will each solution bring about any additional benefit or problems?
   3) Rank each solution according to the results it would bring.
e. Decide on the best solution and put it into effect.

6. PROVIDE PRACTICE IN MAKING DECISIONS.

Provide the student with a wide variety of decision making experiences. Provide basic problems where there are only a few factors to consider. Solutions to these problems should range from easy to hard. Also provide complex problems which require the student to consider many factors. Again, the solutions should range from easy to hard.

Be sure that the student is provided with enough realistic information and data on which to formulate possible solutions and make final decisions; also, be sure that he makes decisions in the same variety of settings as he will face in carrying out his job.

During the final stages of training, it is important to provide situations which closely duplicate the real world with respect to:

a. amount of data
b. type of data
c. amount of time to complete the decision making problems
d. amount of distraction and "noise" in the working environment.

7. ENSURE OVERLEARNING.

If the trainee will be required to make the decision under stress in the real world, then he must overlearn the decision making skill during training. That is, he must be able to make the correct decision, and he must be able to make the decision efficiently and accurately in distracting surroundings.

8. PROVIDE KNOWLEDGE OF RESULTS RELATIVE TO CHARACTERISTICS OF GOOD DECISIONS.

Provide the learner with knowledge of results (KOR) for each decision he makes. Here is a recommended list of questions to ask about the learner's problem solutions:

a. Was evidence of perceptual sets shown in this solution?
b. Was evidence of response biases shown in this solution?
c. Is this the appropriate time to execute this particular decision?)
d. Did he consider all of the data and information?
e. Is his solution compatible and relevant to the data and the available information?

Give KOR with respect to the above five criteria for each decision and where possible, provide the actual consequences of the learner's decision as compared to his other alternatives.

DETECTION TRAINING

ACTION VERBS

Detect
Distinguish
Monitor

BEHAVIORAL ATTRIBUTES

1. Detecting low threshold cues, especially when the signal-to-noise ratio is very low.

2. Scanning for a wide range of cues for a given "target" and for different types of "targets".

3. Demonstrating skill in vigilance.

EXAMPLES

1. Detect targets on radar scopes, or with ECM.

2. Distinguish between true "targets" and false "targets".

3. Monitor possible malfunctions on a piece of complex equipment.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training. Relate the learning objectives and learning activities to operational tasks which the trainee must perform in future real-world assignments.

2. TRAIN SEARCH PROCEDURES.

Train student to use systematic overall search procedures using whatever senses (sight, hearing, etc.) are appropriate for the task. Provide demonstrations of correct search procedures where appropriate.

3. TRAIN FOR VIGILANCE.

Train the student in techniques of vigilance:

a. train him to establish a mental "set" to search. Use instructions to establish this "set" and provide a positive reward when the student achieves a proper "set."
b. train the student to monitor his own vigilance level by conditioning him to respond to biological conditions (internal cues) which appear when vigilance begins to fade.
c. where appropriate, train the student to use peripheral vision when scanning with the eyes.

4. VARY CONTENT AND STRUCTURE OF PRACTICE ACCORDING TO STAGE OF TRAINING.

In presenting signals, sample from the full range of types of signals. Include the different signal sources to be encountered on the job and the different patterns of each signal source.

Train the student in detection skills according to the following schedule:

a. Early training:
    1) provide a high signal density - more frequent than in operational task.
    2) signals should have high signal-to-noise ratio
    3) use different amounts of time between signal presentations
    4) insure a high frequency of student identifications of the signal
    5) provide student with immediate and continuous knowledge of results
    6) do not teach any vigilance techniques

b. Intermediate training:
   1) use a lower signal density
   2) use lower signal-to-noise ratios
   3) use different amounts of time between signal presentations
   4) provide student with intermittent knowledge of results
   5) introduce vigilance techniques

c. Advanced training:
   1) low signal density; i.e., operational density or minimum number suited to training
   2) decrease signal-to-noise ratio to operational level
   3) use different amounts of time between signal presentations
   4) provide the student with knowledge of results equivalent to what he will receive on the job
   5) require vigilance techniques appropriate to the job setting.

Providing knowledge of results on correct detections can serve as positive reward to encourage vigilance behaviors that will lead to continued correct detections.

Ensure that detections are correct before providing positive reward.

Do not allow a student to leave one phase or level of the learning task until he has achieved the required level of mastery.

5. VERIFY DETECTED SIGNAL WITH A SECOND SENSE WHERE FEASIBLE.

When a student thinks he has detected the signal through one sense, train the student to use the detected signal as a cue. Have the student search for and attempt to verify the existence of the signal in a second sense modality if the signal can be detected with another sense.

CLASSIFICATION TRAINING

ACTION VERBS

Identify
Recognize
Differentiate
Classify

BEHAVIORAL ATTRIBUTES

1. Using the pattern recognition approach to identification - not calculations or problem solving.

2. Classifying nonverbal characteristics.

3. Determining status of a system - ready to start.

4. classifying objects which can be viewed from many perspectives or in many forms.

EXAMPLES

1. Classify a detected target as to the type of target.

2. Visually recognize a flying aircraft as "friend" or "foe".

3. Differentiate a detected noise as a wheel bearing failure, not a water pump failure, by noting the quality of the sound - not by a proceduralized troubleshooting approach.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the training objectives; that is, what the trainee is expected to be able to do by the completion of training. Organize the training material in such a way that the trainee can meet the training objectives at the end of the training. Relate the objectives and learning activities to operational tasks which the trainee must perform in future real-world assignments.

2. ENSURE CUE RECOGNITION.

Call student attention to the important, distinctive features and characteristics of a pattern which distinguish this pattern from other patterns. Be sure that the distinctive features will be present in the student's real-world job environment, for these features are the cues by which the student must recognize the pattern.

Clearly display each of the distinctive features of the pattern under study. Show how these cues differ from each other (pre-differentiation of stimuli). Determine if the trainee can detect these distinctive features in patterns that are not to be classified or recognized in the training task.

Emphasize distinctive features which can be remembered in the form of mental "pictures" instead of abstract words. When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, key words, self instructions, common associations, and other association devices like these to which the student can relate the material he is trying to learn. Also teach students to transform distinctive features of the patterns into items that they can readily recall and make correct actions to.

3. PROVIDE PRACTICE WITH PROBLEMS PROGRESSING FROM SIMPLE TO COMPLEX.

In instructional presentations and practice, many examples and non-examples of the pattern should be presented.

In early training make sure there are few irrelevant features, so that identifying the distinctive characteristics of the pattern is fairly easy. By the end of training, present examples and non-examples that are similar to each other and ensure that the number of irrelevant cues increases to correspond with the real-life situation.

Provide plenty of opportunities for students to practice making recognitions of each pattern being learned.

In practice and practice tests, provide for immediate knowledge of results to help the student meet the learning objectives by making each action of the task correct.

The pause following knowledge of results should be long enough to allow the student time to sort out his errors and pick out distinctive features of the pattern to be classified.

Provide the student with practice in recognizing examples from the full range of patterns produced by a given object. Make the examples more similar as training progresses. At the end of training, the similarities in the examples should be the similarities that exist in the real world.

Provide a variety of examples of the pattern - select examples from the full range of variations in the pattern. Late in the learning stage, include distractions and false cues that might be found in the job setting.

Be sure that students develop a strong tendency to look for certain critical and distinctive patterns and develop the same kind of expectations they will need to have while on the job.

4. REDUCE REINFORCEMENT FREQUENCY AS TRAINING PROGRESSES.

Positive rewards of the students' correct recognizing of patterns is required in the early stages of training. Toward the end of training, the level of positive rewards for correct performance should be reduced to the same level that the student will find on the job.

5. USE SELF-PACED PRACTICE.

Different trainees will have different rates and styles of learning the material. Try to provide flexibility in the time allowed.

6. ENSURE TRAINEE HAS OVERLEARNED CLASSIFICATION SKILLS.

Require the student overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the task has been met. Reduce forgetting by providing periodic opportunity to recall and apply infrequently used material.

In order for slower learners to reach the same level of proficiency as faster learners, time must be allowed for the slower learner to get as many positive rewards for correct answers as the fast learner.

7. TEST WITH NEW EXAMPLES.

To test learning, require the trainee classify new examples of the patterns, and teach recognition of the pattern to someone else.

VOICE PROCEDURES TRAINING

ACTION VERBS

Advise
Answer
Communicate
Direct
Instruct
List
Order
Report
Speak

BEHAVIORAL ATTRIBUTES

1. Speaking and listening in specialized terse messages.

2. Using specific message models, standard vocabulary and format.

3. Using voice clarity, enunciation, and speed.

4. Timing of verbalization is usually critical - when to pass information.

5. Using redundancy in terms of information content.

6. Involving extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns.

7. Communicating even with presence of background noise.

EXAMPLES

1. Radar operator speaking on a communication net.

2. GCA operator directing a pilot in landing an aircraft.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives. Organize the training material in such a way that the trainee can easily identify and meet the learning objectives. Relate the learning objectives and activities to operational tasks which the trainee must perform in future real-world assignments.

Present a brief overview of the activities in which the students will participate during training.

2. BREAK TASK INTO LEARNABLE SEGMENTS.

Break up the material into separate, distinctive types of voice communication that appear on the job.

3. DISCRIMINATE SIMILAR CUES.

Identify similar cues (sounds, words, groups of words, vocal patterns, etc.) that are often confused in communications of this type and test the student to be sure that he can tell the difference between them.

4. DEVELOP APPROPRIATE PERCEPTUAL SET.

Point out critical cues and performances that are different from habitual (everyday type) voice communication.

Teach the student to listen for certain words and phrases (perceptual set).

5. DEMONSTRATE GOOD VOICE TECHNIQUE.

Before demonstrating specific procedures and techniques, teach general voice communication terminology and procedures.

Demonstrate a given voice procedure with examples of correct performance. Be sure the learner observes critical cues and the appropriate responses that he should make to them.

6. PROVIDE PRACTICE IN LISTENING AND SPEAKING IN TYPICAL TACTICAL EVOLUTIONS.

Require enough practice trials for the learner to produce the correct performance; he should especially practice parts he is having difficulty with until he can demonstrate the correct procedure.

During practice, practical applications, and practice tests, provide the student with immediate knowledge of results about his correct and incorrect answers.

Rest periods should be provided during practice sessions (distributed practice) according to:

a. need for rest as judged by the student
b. requirements of the specific learning material as judged by the instructor.

7. INCREASE "NOISE" AND STRESS AS TRAINING PROCEEDS.

Toward the end of training, increase stress and miscellaneous interruptions, distractions, and "noise" to the level that will appear on the job.

Practice voice communication procedures to the level that they will have to be performed in the job setting; this may require some practice in team training with voice communication.

8. OVERLEARN VOICE PROCEDURES.

Require the student to overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the task has been met.

Cross train the learner so that he may perform other voice communication to act as a replacement for other members of his team.

Reduce forgetting by providing periodic practice for infrequently used material.

9. PROVIDE APPROPRIATE SCHEDULE OF REWARDS.

Early in training provide rewards as soon as possible following correct behavior.

Provide a large reward when trainee meets overall training objectives and required overlearning.

PROCEDURES TRAINING

ACTION VERBS

Activate
Adjust
Align
Assemble
Calibrate
Checking
Disassemble
Inspect
Operate
Service

BEHAVIORAL ATTRIBUTES

1. Chaining or sequencing of events.

2. Using both the cognitive and motor aspects of equipment set-up and operating procedures.

3. Using procedural checklists frequently as job aids.

EXAMPLES

1. Assemble and disassemble a piece of equipment.

2. Operate and inspect a piece of equipment (cockpit check lists).

3. Service a piece of equipment (scheduled maintenance).

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives. Organize the training material in such a way that the trainee can easily identify and achieve the learning objectives throughout the training. Relate the objectives and learning activities to on-the-job duties, responsibilities, advancement, or survival.

2. BREAK PROCEDURE INTO EASILY LEARNED SEGMENTS.

Break the procedure into logical sub-units. Then make sure that the procedural steps for each of these sub-units are well organized. The intent is to break the overall learning task down into manageable steps or units, especially when any of the following conditions exist:

a. lower ability students
b. complex material
c. overall task contains many small parts.

3. DEMONSTRATE A SEGMENT BEFORE TRAINEE PRACTICES SEGMENT.

Provide a visual demonstration of how to perform a segment of a procedure just before the trainee attempts to practice the segment.

If the checklist presents the trainee with similar checklist items which in the past have been frequently confused, then be sure that the trainee can explain the differences between these similar checklist items before he is taught which action to take for each one.

4. USE MNEMONIC TECHNIQUES FOR DIFFICULT TO RECALL DATA.

When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, key words, and other association devices (mnemonics) like these to which the student can relate the material he is trying to learn. Also encourage students to make up their own association devices if they can and want to.

When possible, provide students with association devices which will cause an emotional reaction in the student.

5. HAVE STUDENT TALK HIS WAY THROUGH THE PROCEDURE CHECKLIST.

Given a checklist and a view of the equipment (photo mock-up, training device or operational system), have trainee practice describing what to do for each checklist item.

6. ENSURE CERTAIN PRACTICE CONDITIONS ARE USED EARLY IN TRAINING.

Exercises used early in training should contain these characteristics:

a. trainee understands learning objectives.
b. procedure broken down into small, easily learned segments.
c. demonstration of procedure segment before hands-on practice.
c. practice individual segment.
d. practice entire procedure only after segments have been individually practiced.
d. immediate and frequent knowledge of results.
e. immediate and frequent positive reward.
f. few or no distractions.
g. provide guides, prompts, cues, and coaching to aid earning.

7. LATER IN TRAINING USE OTHER PRACTICE CONDITIONS.

After trainee can perform procedure under simple conditions, employ the following practice conditions.

a. occasional, delayed feedback.
b. occasional, delayed reward of students' correct performance.
c. distractions and interference similar to job site.

d. realistic range of conditions (i.e., failures) within procedures.

e. guides or prompts only as found on the job.

8. ENSURE TRAINEE HAS OVERLEARNED PROCEDURE.

Procedural tasks should be overlearned through extensive practice. Later the performance of the first step of a procedure will automatically remind the technician of the entire sequence of steps.

In order for the slower learner to reach the same level of proficiency as the faster learner, time must be allowed for the slower learner to get as many positive rewards for correct answers as the faster learner.

Train the student to the level of proficiency required on the job.

Reduce forgetting by providing periodic practice for infrequently used procedures.

STEERING/GUIDING TRAINING

ACTION VERBS

Control
Guide
Maneuver
Regulate
Steer
Track

BEHAVIORAL ATTRIBUTES

1. Using compensatory movements based on feedback from displays.

2. Demonstrating skill in tracking which requires smooth muscle coordination patterns.

3. Involves estimating changes in positions, velocities, accelerations, etc.

4. Demonstrating knowledge of display-control relationships.

EXAMPLES

1. Maneuver a tank along a road.

2. Track a target in air-to-air gunnery.

3. Guide an aircraft along a predetermined track.

TRAINING GUIDELINES

1. USE ADVANCED ORGANIZERS.

At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives. Relate the learning objectives and activities to operational tasks which the trainee must perform in future real-world assignments. Provide a preview of important, selected motions and movements that the student will learn to make.

2. BREAK MANEUVER INTO LEARNABLE PARTS.

Break the overall learning task down into manageable steps or units when any of the following conditions exist:

a. lover ability students
b. complex material

3. TEACH REQUIRED CUES.

Ensure that the critical cues from which the trainee must get his information for correctly performing the task are realistic and continually available during the performance of the task.

In continuous control task training, a high relationship to real-world conditions is required in:

a. The presentation of the cues to which the trainee must react
b. the actions and reactions which the trainee makes
c. the way that the displays and controls of the system continuously respond to the trainee's control.

4. PRACTICE MANEUVER SEGMENTS.

Highly skilled performance requires extensive practice. This practice should first focus on individual segments of the overall maneuver. Ensure that the students:

a. understand skill objectives - use mental model of good performance
b. observe demonstration of skilled performance of single segment of maneuver
c. practice single segment of maneuver
d. receive knowledge of results
e. continue practice until segment is performed successfully
f. practice other maneuver segments in similar manner

5. CHAIN SEGMENTS TOGETHER INTO A SMOOTH MANEUVER.

Ensure that the students continue practice on the entire maneuver according to the following guidelines:

a. chain maneuver segments together into smooth performance
b. distribute practice

6. TEACH SCAN TECHNIQUE.

Teach the student to scan continuously by specific training of eye movement and where to focus for scanning.

7. SHAPE PERFORMANCE WITH POSITIVE REWARDS.

Positive reward should be provided for performances which are closer to goal than proceeding performances. In this manner, the student's performance will become successively closer to the desired performance.

Positive reward should follow as soon as possible after each correct student performance, initially after each distinct segment of performance and toward the end of training after each maneuver or complete evolution.

8. OVERLEARN MANEUVER.

Have students practice maneuvers under a variety of conditions. Ensure that the students continue to practice beyond the time required to initially perform the set of maneuvers in a correct manner under the typical range of conditions.