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ABSTRACT

This document consists of an interim report and a final report which describe the second and third phases of a project designed to determine the utility and utilization of sophisticated hardware and software capabilities known as advanced instructional features (AIFs). Used with an aircrew training device (ATD), AIFs permit a simulator instructor to control, monitor, and fabricate simulator training missions. Phase II of the project asked 273 instructor pilots, flight engineers, and radar/navigators from Air Training Command (ATC), Military Airlift Command (MAC), and Strategic Air Command (SAC) to rate each of 16 AIFs on five seven-point rating scales. Phase III extended the survey to 155 electronic warfare and aerial gunnery instructors from ATC, SAC, and TAC training facilities. Based on utility and utilization ratings, the T-5 and T-4 trainers were the most favorably rated by the respondents. They were followed, in order, by the F-4G simulator, B-52 weapon system trainer, and A-10 simulator. The level of AIF use was affected somewhat by hardware and software unreliability, implementation time, functional limitations, and design deficiencies; however, the perceived value of a feature was the most important determiner of its use. It is recommended that: (1) a formal intensive training program be established to teach simulator instructors how to use AIFs more effectively, and (2) future procurement of AIFs be preceded by a detailed front-end analysis that clearly relates AIF capability to training needs. Appendices contain the instructional features, questionnaires, and five data tables. (JB)

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AIR FORCE

HUMAN RESOURCES

AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE II - AIR TRAINING COMMAND, MILITARY AIRLIFT COMMAND, AND STRATEGIC AIR COMMAND)

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An aircrew training device (ATD) is not merely a flight simulator. It is also equipped with sophisticated hardware and software capabilities, known as advanced instructional features (AIFs), that permit a simulator instructor to control, monitor, and fabricate simulator training missions. This report describes the second phase of a three-phase project designed to determine the utility and utilization of AIFs by means of a survey of simulator instructors from the USAF Major Commands. Phase I surveyed instructor pilots and weapons director instructors assigned to principal Tactical Air Command (TAC) ATD training sites. Phase II extended the survey to instructor pilots, instructor flight engineers, and instructor radar/navigators assigned to ATD training sites in the Air Training Command, Military Airlift Command, and Strategic Air Command. In general, Phase II ratings of AIF utility and utilization were considerably higher than those of Phase I. Yet, it was clear that most simulator instructors, regardless of Command, have not yet fully explored the existing instructional capabilities of ATDs. It was recommended that a formal intensive training program be established in order to teach simulator instructors how to use AIFs more effectively.

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SUMMARY

Aircrew training devices (ATDs) are often equipped with sophisticated hardware and software capabilities that permit a simulator instructor (SI) to control, monitor, record, and fabricate flight simulation training missions. These advanced instructional features (AIFs) reflect the primary role of the ATD as a flight trainer. The training value of an ATD is a function of the degree to which it simulates a particular aircraft and the way in which it is used as an instructional device. AIFs are costly to implement. In order to justify these costs, the following questions must be answered: How frequently are AIFs used? How easy are they to use? Are SI's adequately trained to use AIFs? Do AIFs have significant training value?

This report describes the second phase of a three-phase project designed to obtain answers to these questions by surveying SIs from the Air Force Major Commands (MAJCOMs). An on-site survey was administered to 273 SIs assigned to replacement training units (RTUs) and continuation training units (CTUs) at principal Air Training Command (ATC) (T-37, T-38), Military Airlift Command (MAC) (C-5A. C-141, C-130, CH-3, HH-53), and Strategic Air Command (SAC) (FB-111A) ATD sites. The survey requested background information along with five seven-point rating scales for evaluating each of 16 AIFs. Written comments concerning the 16 AIFs or the ATD were solicited. The most striking difference between the Phase I (TAC survey) and Phase II results was in the overall magnitude of the ratings. In comparison to the TAC SIs, the ATC, MAC, and SAC SIs used AIFs more often, found them easier to use, received more training in their use, and considered AIFs to be more important for training. The results suggested that TAC's SI training program is less extensive and less structured than those of the other MAJCOMs.

Features such as freeze, reset, motion, environmental, and crash/kill override were consistently rated high in utility and utilization, whereas features such as automated malfunction insertion, demonstration, record/playback, and hard copy were generally rated lower. The level of AIF use was affected somewhat by hardware and/or software unreliability, implementation time, functional limitations, and design deficiencies. The perceived training value of a feature was the most important determiner of its use.

PREFACE

This research was conducted to satisfy requirements of Air Force Human Resources Laboratory Technical Planning Objective 3, the thrust of which is aircrew training effectiveness. The general objective of this thrust is to identify and demonstrate cost-effective simulator training strategies and systems to develop and maintain the combat effectiveness of Air Force aircrew members. More specifically, the research was conducted under the Air Combat Training Research subthrust, the goal of which is to provide a technology base for training high level and quickly perishable skills in simulated combat environments. Work Unit 1123-02-34, Development and Evaluation of Advanced Instructional Features, addressed a portion of this subthrust. Capt L. Weikhorst was the project monitor and Dr. Donald J. Polzella, under contract to the University of Dayton Research Institute, was the principal investigator.

This effort was jointly coordinated by the Air Force Human Resources Laboratory, Operations Training Division, Williams AFB, Arizona; the Simulator System Program Office (SimSPO) of the Air Force Systems Command, Aeronautical Systems Division (AFSC/ASD), Wright-Patterson AFB, Ohio; Headquarters Air Training Command, Randolph AFB, Texas; Headquarters Military Airlift Command, Scott AFB, Illinois; and Headquarters Strategic Air Command, Offutt AFB, Nebraska. The author gratefully acknowledges the assistance of the following individuals:

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AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE II - AIR TRAINING COMMAND, MILITARY AIRLIFT COMMAND, AND STRATEGIC AIR COMMAND)

I. INTRODUCTION

An aircrew training device (ATD) serves two functions. First, it is a ground-based substitute aircraft that permits student flight crews to fly in a safe and carefully controlled environment. More importantly, an ATD is, as its name implies, a teaching machine that is designed to facilitate the acquisition of flight crew skills. In order to fulfill this second function, an ATD is equipped with sophisticated hardware and software capabilities that permit a simulator instructor (SI) to control, monitor, and in some cases fabricate simulator training missions. These capabilities, which are listed in Table 1, are known as advanced instructional features (AIFs). The list was compiled from several sources, but it was drawn primarily from Semple, Cotton, and Sullivan's (1981) extensive report describing the AIF capabilities of various military and commercial devices.

Table 1. Advanced Instructional Features

BRIEFING FEATURES

Recorded Briefing permits SI to provide a student with information about the simulator and/or a structured training mission through audiovisual media presentation.[a]

Demonstration permits SI to demonstrate optimal flying performance by means of prerecorded standardized segments of simulated flight.[a]

Instructor Tutorial provides SI with self-paced programmed instruction in the capabilities and use of the flight simulator.[a]

Table 1. (Continued)

TRAINING MANAGEMENT FEATURES

Total System Freeze permits SI to suspend simulated flight by freezing all system parameters.[a]

Reset permits SI to return the simulated aircraft to a stored set of conditions and parameters.[a]

Crash and/or Kill Override permits SI to allow simulated flight to continue without interruption following a "crash" or "kill."[a]

Automated Adaptive Training is the computer-controlled variation in task difficulty, complexity, and/or sequence based on student's performance.[a]

Programmed Mission Scenarios are computer-controlled standardized training missions based on pre-programmed event sequences.[a]

VARIATION OF TASK DIFFICULTY FEATURES

Automated Malfunction Insertion permits SI to preprogram a sequence of aircraft component malfunctions and/or emergency conditions.[a]

Environmental permits SI to vary environmental conditions such as wind direction and velocity, turbulence, temperature, and visibility.[a]

Dynamics permits SI to vary flight dynamics characteristics such as stability, system gain, cross-coupling, etc.

Motion permits SI to provide a student with platform motion system cues such as roll, pitch, lateral, and vertical.[a]

Table 1. (Continued)

Flight System Freeze permits SI to simultaneously freeze flight control and propulsion systems, position, altitude, and heading.

Position Freeze permits SI to simultaneously freeze latitude and longitude.

Attitude Freeze permits SI to simultaneously freeze pitch, bank, and heading.

Parameter Freeze permits SI to freeze any one or a combination of flight parameters.[a]

INSTRUCTOR MONITOR AND FEEDBACK FEATURES

Closed Circuit TV permits SI to monitor student's behavior from the instructor console.

Repeaters/Annunciators provide SI with replicas or analog representations of flight instruments and controls at the instructor console.

Instructor Console Displays permit SI to view alphanumeric and/or graphic CRT displays of performance data at the instructor console.[a]

Automated Performance Alert provides SI with visual and auditory signals that indicate specific performance deficiencies.

STUDENT FEEDBACK FEATURES

Record/Playback permits SI to record and subsequently play back a segment of simulated flight.[a]

Table 1. (Concluded)

Automated Performance Feedback provides a student with visual and auditory signals (including verbal messages) that identify performance deficiencies.

Automated Voice Controller is the computer-based technology that simulates the role of a controller by combining speech generation, speech recognition, and situation awareness capabilities.

Hard Copy provides a record of alphanumeric and/or graphic performance data from the automated performance measurement system.[a]

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[a] These features were included in the Phase II questionnaire. (See Appendix.)

It appears that military ATDs are more often treated as substitute aircraft than as teaching machines. A recent report by the United States General Accounting Office (1983) concluded that the Armed Services have not sufficiently analyzed their training requirements for simulators. Nor have they adequately incorporated simulators into their training programs. In justifying the purchase of ATDs, the Services have focussed instead on "duplicating the actual weapon systems and their surroundings . . . with little reference to how the devices could meet training needs" (p. 4).

The present investigation was conducted at the request of the Simulator System Program Office (SimSPO) of the Air Force Systems Command, Aeronautical Systems Division (AFSC/ASD). The objectives of this investigation were:

1. To document and compare the utilization (i.e., frequency and ease of use) of AIFs.

2. To document and compare the utility (i.e., training value) of AIFs.

3. To compare the utility and utilization patterns of AIFs in replacement (e.g., basic, primary, lead-in, initial) and continuation (e.g., advanced, follow-on, refresher, operational) training units.

A broader objective of this investigation was to provide a database that could be helpful both in defining the requirements for ATD procurements and in developing future ATD training programs.

These objectives will be accomplished in several phases by means of a survey of simulator instructors (SIs) from the Air Force Major Commands (MAJCOMs). Phase I has already been completed, and the results of that survey are documented in an earlier report (Polzella, 1983).

The subjects in Phase I were 134 simulator-qualified instructor pilots (IPs) and weapons director instructors (WDIs) assigned to replacement training units (RTUs) and continuation training units (CTUs) at F-4E, F-4G, F-15, A-10, and E-3A Tactical Air Command (TAC) training sites. The results indicated that most TAC SIs received little training in the use of AIFs and that most features were not used very often. Several factors appeared to have contributed to the low usages: (a) hardware and/or software unreliability, (b) time-consuming implementation, (c) functional limitations, and (d) design deficiencies. The results of a multiple regression analysis indicated that ease of use and training value accounted for most of the variability in the frequency-of-use ratings.

The utility and utilization of particular AIFs differed both as a function of ATD and of training unit. For example, features such as freeze and reset were generally used more often during RTU missions, whereas programmed mission scenarios were generally used more often during CTU missions. These differences appeared to reflect differences in the respective training missions. Thus, RTU missions characteristically include a series of discrete procedural exercises, whereas lengthier scenarios are common during CTU missions.

Based on the results of Phase I, it was recommended that future procurement of AIFs be preceded by a detailed front end analysis that clearly relates AIF capability to training needs as well as to any major constraints in the operational environment. During procurement, AIF specifications should be prepared so as to meet user needs and ensure equipment reliability. After operational deployment, the user should provide adequate instructor/operator training in AIF use.

Phase II, which is described in this report, extended the survey to SIs from Air Training Command (ATC), Military Airlift Command (MAC), and Strategic Air Command (SAC).

II. METHOD

Subjects

The subjects in Phase II were 273 instructor pilots (IPs), instructor flight engineers (IFEs), and instructor radar navigators (IRNs) assigned to RTUs or CTUs at the following training sites: Williams AFB (T-50/T-37 and T-51/T-38; RTU), Altus AFB (C-5A and C-141; RTU), Dover AFB (C-5A; CTU), McGuire AFB (C-141; CTU), Little Rock AFB (C-130; RTU, CTU), Kirtland AFB (CH-3 and HH-53; RTU, CTU), Plattsburgh AFB (FB-111A; RTU, CTU), and Pease

AFB (FB-111A; CTU). The distribution of SIs among the various ATDs and training units is shown in Table 2. The SIs' hours of experience as instructors are summarized in Table 3.

Table 2. The Number of SIs Surveyed in Phase II

Command	ATD	Type of SI	Training unit RTU	Training unit CTU
ATC	T-50	IP	29	
	T-51	IP	21	
MAC	C-5A	IP	16	11
		IFE	13	6
	C-141	IP	26	6
		IFE	14	7
	C-130	IP	13	7
		IFE	8	6
	CH-3	IP	3	4
		IFE	3	1
	HH-53	IP	5	6
		IFE	0	6
SAC	FB-111A	IP	6	24
		IRN	11	21
			168	105

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Table 3. Simulator Instructor's Mean (and Standard Deviation) Number of Instructor Hours

Command	ATD	RTU	CTU
ATC	T-50	173.6 (169.5)	
	T-51	129.4 (96.8)	
MAC	C-5A	511.1 (452.1)	454.1 (386.8)
	C-141	582.5 (531.4)	1174.6 (1504.1)
	C-130	126.8 (80.4)	419.8 (189.9)
	CH-3	169.2 (94.4)	263.4 (132.7)
	HH-53	139.2 (149.8)	482.5 (452.1)
SAC	FB-111A	797.1 (693.3)	353.0 (818.4)

Questionnaire

The questionnaire that was used to survey the instructors is shown in the Appendix. It is similar to that used in Phase I. (See Polzella, 1983, Appendix A.) The questionnaire requested background information (i.e., flying and simulator experience), a brief description of a typical training mission, and included a list of 16 AIFs (drawn from the list in Table 1) and their definitions and five questions concerning the utility and utilization of each feature:

1. How often have you used it?
2. How easy is it to use?
3. How much training did you receive in its use?
4. What is its training value?
5. What is its potential training value?

For the fifth question, SIs were asked to assume that they had no prior knowledge of the features and to base their responses on the feature definitions alone. This question was included in order to achieve a common basis for comparison among all SIs. This was not otherwise possible because the various ATDs were not similarly equipped.

Responses to each question were indicated by checking the appropriate interval along a seven-point, successive-category rating scale. (The scales for questions 2 and 4 included a zero-point interval for indicating "no basis for judgment.") The intervals of each scale were labeled with descriptive adjectives in order to facilitate responding and to help interpret the ratings. Additional space was provided for comments.

Procedure

The questionnaire was administered on-site to various sized (N = 2 to 25) groups of SIs. The SIs were briefed on the purpose of the investigation and copies of the questionnaire were distributed and thoroughly reviewed prior to being filled out. The questionnaire could be completed in approximately 30 minutes.

III. RESULTS

Table 4 lists the 16 AIFs that were included in the questionnaire along with their definitions. The table also indicates a mnemonic code for each feature, which will be used in subsequent tables. The AIF capabilities of the various ATDs are shown in Table 5.

Table 4. Advanced Instructional Features Included in the Phase II Questionnaire

Code	Feature
IPT	Instructor Pilot Tutorial - provides the IP with self-paced programmed instruction in the capabilities and use of the flight simulator.
R	Reset - permits instructor to "return" the simulated aircraft to a stored set of conditions and parameters.
TSF	Total System Freeze - permits instructor to interrupt and suspend simulated flight by freezing all system parameters.
RB	Recorded Briefing - permits instructor to provide student with information about a structured training session through audio/visual media presentation.
D	Demonstration - permits instructor to demonstrate aircraft maneuver(s) by prerecording and subsequently playing back a standardized segment of simulated flight.

Table 4. (Concluded)

Code	Feature
RP	Record/Playback - permits instructor to record and subsequently playback all events that occurred during a segment of simulated flight.
E	Environmental - permits instructor to vary environmental conditions such as wind direction and velocity, turbulence, temperature, visibility, etc.
AMI	Automated Malfunction Insertion - permits instructor to preprogram a sequence of aircraft component malfunctions and/or emergency conditions.
PF	Partial Freeze - permits instructor to freeze various flight parameters or parameter combinations such as altitude, heading, position, attitude, flight system, etc.
CKO	Crash and/or Kill Override - permits instructor to allow simulated flight to continue without interruption following a "crash" or "kill."
M	Motion - permits instructor to vary platform motion system cues such as roll, pitch, lateral, vertical, etc.
HC	Hard Copy - provides a record of alphanumeric and/or graphic performance data from the automated performance measurement system for debriefing purposes.
AAT	Automated Adaptive Training - computer-controlled variations in task difficulty, complexity, and sequence based on pilot's performance.
PMS	Programmed Mission Scenarios - computer-controlled standardized training sessions based on pre-programmed event sequences.
PRM	Procedures Monitoring - permits instructor to monitor discrete actions performed by the student in accordance with a procedurally defined checklist.
PAM	Parameters Monitoring - permits instructor to monitor various instrument readings, control settings, aircraft states, or navigational profiles.

Table 5. AIF Capability of Each ATD

Feature	T-50	T-51	C-5A	C-141	C-130	CH-3	HH-53	FB-111A
IPT								
R	X	X	X	X	X	X	X	X
TSF	X	X	X	X	X	X	X	X
RB								
D					X	X	X	X
RP	X	X			X	X	X	X
E	X	X	X	X	X	X	X	X
AMI	X	X			X			
PF	X	X	X	X	X	X	X	X
CKO	X	X	X	X	X	X	X	X
M	X	X	X	X	X	X	X	X
HC					X			X
AAT								
PMS					X			X
PRM					X			X
PAM					X	X	X	X

The raw data included the SIs' descriptions of a typical training mission and their ratings on each question coded as 0 (no basis for judgment) to 7 (maximum rating). The ratings were classified by ATD (T-50, T-51, C-5A, C-141, C-130, CH-3, HH-53, FB-111A), training unit (RTU, CTU), question (1 through 5) and AIF (1 through 16). The resulting data matrix was unbalanced due to the differences in the number of SIs and in the AIF capabilities of the various ATDs (see Tables 2 and 5). This necessitated analyzing the data from each ATD separately, with two exceptions. The C-5A and C-141 data and the CH-3 and HH-53 data were pooled, respectively, before they were analyzed. The pooling of these data was not inappropriate since the respective training missions were highly similar. Moreover, the resulting increase in sample size was statistically desirable, especially in the case of the CH-3 and HH-53 data.

Air Training Command

T-50/T-51 Simulator Training Missions

The T-50 (T-37) and T-51 (T-38) training missions are similar, each lasting approximately 1-1/2 hours. In addition, there are briefing and debriefing periods lasting 20 to 30 minutes each. Although missions may vary from partial task to full mission profile, most missions include takeoffs, instrument and emergency procedures, turns, climbs, descents, course intercepts, penetrations, and multiple approaches. In addition, the T-51 mission emphasizes certain advanced skills that reflect the particular characteristics of the T-38 aircraft, such as steep turns, unusual attitudes, and vertical s maneuvers.

Frequency of AIF Use

The frequency-of-use ratings are summarized in Table 6. Here and in subsequent tables, the features are listed in decreasing order according to the mean ratings. The individual ratings ranged from 1 (never use) to 7 (use most often). The frequency of AIF use appears to be fairly high, with most of the means ranging from 3.5 to 6.5 (i.e., moderately often to very frequently).

Table 6. T-50, T-51 Instrument Flight Simulators: Mean Ratings (and Standard Deviations) of the Frequency of AIF Use

Feature	T-50	T-51	Combined
M	6.6 (1.2)	6.2 (1.9)	6.4
TSF	5.7 (1.4)	6.1 (0.9)	5.9
R	5.6 (1.3)	6.2 (0.8)	5.9
E	5.5 (1.3)	6.3 (0.7)	5.8
**PF	3.9 (1.7)	5.3 (1.4)	4.5
CKO	3.6 (1.4)	3.8 (1.4)	3.7
RP	3.4 (1.3)	3.9 (1.3)	3.6
AMI	3.7 (2.2)	3.1 (1.9)	3.5
*Combined	4.8	5.1	4.9

*$p < .05$.
**$p < .01$.

A two-factor (ATD x AIF) repeated measures analysis of covariance (covariate = number of instructor-hours) was used to analyze the data. The analysis indicated that the T-51 SIs overall mean rating (4.9) was significantly higher than that of the T-50 SIs (4.5), $F(1,47) = 5.26$, $p < .05$. There was also a significant main effect of AIF, $F(7,336) = 42.92$, $p < .001$, and a significant AIF by ATD interaction, $F(7,336) = 3.17$, $p < .01$.

The significant main effect of AIF implies that there are significant differences among the overall ratings of each feature. The Tukey honestly significant difference (HSD) test (Keppel, 1973, p. 138) was used to determine these differences. The results of the test are shown in Table 6 by the placement of brackets around those means that did not differ significantly ($p > .01$). Thus, motion, total system freeze, reset, and environmental received the highest ratings, whereas the remaining features received significantly lower ratings.

The significant interaction implies that the pattern of ratings was different for the two groups of SIs. The Dunn test (Keppel, 1973, pp. 147-149) was used to determine the locus of this interaction by making post hoc comparisons between the various T-50/T-51 adjusted mean pairs. The significant comparisons are indicated in the table by asterisks. Only one significant difference was obtained, that for partial freeze, which was rated significantly higher by T-51 SIs ($p < .01$).

Ease of AIF Use

The ease-of-use ratings are summarized in Table 7. The individual ratings ranged from 1 (most difficult) to 7 (easiest). Ease of use appears to be very high, with most of the means ranging from 4.5 to 6.5 (i.e., easy to very easy). Unlike the frequency of use ratings, the means in Table 7 were based on a variable frequency that reflected the number of SIs who actually used each feature. Consequently, the nonparametric Wilcoxen test was used to compare the T-50 and T-51 ratings, overall, and t-tests were used to make separate T-50/T-51 comparisons for each feature. The significant differences are indicated in Table 7 by asterisks. Thus, the T-51 mean rating of partial freeze was significantly higher than the corresponding T-50 mean rating, $t(47) = -2.84$, $p < .01$.

Training in AIF Use

The amount of training received in AIF use is summarized in Table 8. The individual ratings ranged from 1 (no training received) to 7 (greatest amount received). The mean ratings were fairly high, although not as high as the frequency-of-use and ease-of-use ratings. Most ranged from 3.5 to 5.5 (i.e., moderate to considerable).

A two-factor (ATD x AIF) repeated measures analysis of covariance (covariate = number of instructor-hours) was used to analyze the data. The analysis revealed significant main effects of ATD, $F(1,47) = 5.84$, $p < .025$, and of AIF, $F(7,336) = 11.86$, $p < .001$. The interaction was not significant, $F(7,336) = 1.71$, $p > .05$. It appears that T-51 SIs received more training in the use of AIFs than did T-50 SIs; however, the pattern of use for the two groups was statistically equivalent. The Tukey HSD test was used to determine the significant differences among the combined

Table 7. T-50, T-51 Instrument Flight Simulators: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	T-50	T-51	Combined
TSF	6.7 (0.6)	6.8 (0.4)	6.7
M	6.4 (0.6)	6.4 (0.7)	6.4
R	5.9 (0.8)	6.0 (0.7)	6.0
*PF	5.5 (1.2)	6.4 (0.7)	5.9
CKO	5.7 (1.2)	5.8 (1.3)	5.7
E	5.2 (1.3)	5.1 (1.3)	5.2
AMI	5.2 (1.7)	5.3 (1.0)	5.2
RP	4.9 (1.0)	5.4 (1.1)	5.1
Unweighted Means	5.7	5.9	5.8

*$p < .01$.

ratings of each AIF, and the results of that test are shown in Table 8 by the placement of brackets around the means that did not differ significantly ($p > .01$). The results closely parallel those shown in Table 6. Thus, the features receiving the greatest amount of training were also those features that were most frequently used.

Table 8. T-50, T-51 Instrument Flight Simulators: Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	T-50	T-51	Combined
TSF	4.6 (1.7)	5.6 (1.3)	5.0
M	4.6 (1.6)	4.8 (2.0)	4.7
R	4.2 (1.1)	5.1 (0.9)	4.6
E	4.2 (1.6)	4.7 (1.1)	4.4
RP	3.5 (1.2)	4.6 (0.9)	4.0
PF	3.3 (1.3)	4.5 (1.2)	3.8
CKO	3.7 (1.3)	4.0 (1.3)	3.8
AMI	3.3 (1.7)	3.5 (1.6)	3.4
Combined**	3.9	4.6	4.2

**$p < .025$.

Training Value of AIFs

The training value ratings are summarized in Table 9. The individual ratings ranged from 1 (no training value) to 7 (greatest training value). The ratings were extremely high, with most of the means in the 4.5 to 6.5 range (i.e., considerable to great). Like the ease-of-use ratings, the means in Table 9 were based on a variable frequency that reflected the number of SIs who actually used each feature. Consequently, the nonparametric Wilcoxen test was used to compare the T-50 and T-51 ratings, overall, and t-tests were used to make separate T-50/T-51 comparisons for each feature. There were no significant comparisons ($p > .05$).

Table 9. T-50, T-51 Instrument Flight Simulators: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	T-50	T-51	Combined
E	6.2 (0.9)	6.2 (1.0)	6.2
M	6.1 (1.0)	6.0 (1.0)	6.1
R	5.9 (0.9)	6.3 (0.8)	6.1
TSF	6.0 (0.8)	6.1 (1.0)	6.0
RP	4.9 (1.0)	5.5 (1.3)	5.1
PF	4.8 (1.4)	5.3 (1.1)	5.0
AMI	5.0 (1.6)	4.1 (2.1)	4.6
CKO	4.4 (1.5)	4.4 (1.5)	4.4
Unweighted Means	5.4	5.5	5.4

Potential Training Value of AIFs

The potential training value ratings are summarized in Table 10. The individual ratings ranged from 1 (no potential value) to 7 (greatest potential value). Like the training value ratings, the potential training value ratings were very high, with most means ranging from 4.5 to 6.5 (i.e., considerable to great).

A two-factor (ATD x AIF) repeated measures analysis of covariance (covariate = number of instructor-hours) was used to analyze the data. The analysis revealed a significant main effect of AIF, $F(15,720) = 16.56$, $p < .001$, and a significant ATD by AIF interaction, $F(15,720) = 1.84$, $p < .05$. The main effect of ATD was not significant, $F < 1.00$.

The Tukey HSD test was used to determine the significant differences among the combined ratings of each AIF, and the results of that test are shown in Table 10 by the placement of brackets around the means that did not differ significantly ($p > .01$). Once again the results closely

Table 10. T-50, T-51 Instrument Flight Simulators: Mean Ratings (and Standard Deviations) of the Potential Training Value of AIFs

Feature	T-50	T-51	Combined
E	6.3	6.3	6.3
	(1.0)	(1.0)	
R	6.3	6.2	6.3
	(0.7)	(0.7)	
M	6.3	5.9	6.2
	(1.1)	(1.1)	
TSF	6.1	6.2	6.1
	(1.1)	(0.8)	
RP	5 2	5.9	5.5
	(1.3)	(1.2)	
PF	5.0	5.5	5.2
	(1.7)	(0.8)	
AMI	5.4	4.7	5.1
	(1.5)	(1.8)	
PAM	4.6	5.5	5.0
	(2.2)	(1.4)	
D	4.6	5.5	4.9
	(1.6)	(1.2)	
CKO	4.8	4.9	4.8
	(1.4)	(1.1)	
RB	4.7	5.0	4.8
	(2.0)	(1.5)	
PMS	4.8	4.3	4.6
	(1.8)	(1.0)	
PRM	4.3	5.0	4.6
	(2.0)	(1.5)	
HC	4.5	4.5	4.5
	(2.0)	(1.3)	
AAT	4.1	4.0	4.1
	(2.0)	(1.1)	
IPT	4.0	4.4	4.1
	(1.6)	(1.5)	
Combined	5.1	5.2	5.1

parallel those shown in Table 6. Thus, the features rated highest in potential training value were also those features that were most frequently used.

Despite the indication of a significant interaction, its locus was not revealed by the Dunn test, which was used to make post hoc comparisons between the various T-50/T-51 adjusted mean pairs. The interaction was, therefore, considered to be of minimal importance.

Interrelations Among the Variables

Table 11 shows the intercorrelations among the ratings of each feature on each of the five questions. All the coefficients are positive and significant, $p < .001$. Therefore, a feature's rating on any question can be predicted with greater than chance accuracy given its rating on any other question. For example, it can be generally stated that the more frequently a feature was used, the easier it was to use, the more training was received in its use, and the greater its training and potential training value.

Table 12 summarizes the results of a stepwise multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of the remaining variables. The table indicates that, together, the predictor variables accounted for 53 percent of the variance in the frequency-of-use ratings, the most important predictor being training value followed, in order, by ease of use, potential training value, and training received.

Military Airlift Command

The MAC ATDs that were surveyed included the C-5A, C-141, C-130, CH-3, and HH-53. The same analyses that were performed on the ATC data were used to analyze the MAC data. As discussed previously, C-5A and C-141 and the CH-3 and HH-53 data were pooled, respectively, before they were analyzed.

C-5A/C-141 Flight Simulators

Training mission. The C-5A/C-141 RTU and CTU training missions are similar, each lasting approximately 4 hours. Usually, students will "swap seats" after 2 hours. In addition, there are 2-hour briefing and 1-hour debriefing sessions. Both missions consist of a wide variety of normal and emergency procedures that stress crew coordination. Partial or total real-time scenarios typically provide the training context, especially for the CTU mission.

Frequency of AIF use. The frequency-of-use ratings are summarized in Table 13. Like the ATC ratings, the C-5A/C-141 ratings were fairly high, with most of the means in the 3.5 to 5.5 range (i.e., moderately often to frequently). A two-factor (training unit x AIF) repeated measures analysis of covariance (covariate = number of instructor-hours) revealed a significant main effect of AIF, $F(5,465) = 23.53$, $p < .001$, and a significant AIF by training unit interaction, $F(5,465) = 4.86$, $p < .001$. The main effect of training unit was not significant, $F(1,92) < 1.00$.

Table 11. T-50, T-51 Instrument Flight Simulators: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Training Received, Training Value, and Potential Training Value

	FREQUSE	EASEUSE	TRECD	TVALUE	PTVALUE
FREQUSE	1.00				
EASEUSE	.51	1.00			
TRECD	.49	.38	1.00		
TVALUE	.63	.43	.42	1.00	
PTVALUE	.60	.35	.38	.72	1.00

Note All correlations are significant, $p < .001$.

Table 12. T-50, T-51 Instrument Flight Simulators: Multiple Linear Regression of Frequency of AIF Use on Ease of Use, Training Received, Training Value, and Potential Training Value

Dependent Variable:	Frequency of AIF Use
Multiple R:	.73
Multiple R-Square:	.53
Standard Error of Estimate:	1.29

Analysis of Variance:

	Sum of Squares	DF	Mean Square	F	p
Regression	835.3630	4	208.8408	125.03	< .001
Residual	741.6020	444	1.6703		

Summary of Stepwise Regression:

Step No.	Variable	Multiple R	Multiple RSQ	Increase in RSQ	F-to-Enter
1	TVALUE	.63	.39	.39	288.02
2	EASEUSE	.68	.46	.07	57.33
3	PTVALUE	.71	.50	.04	35.97
4	TRECD	.73	.53	.03	26.72

Table 13. C/5A-C-141 Flight Simulators: Mean Ratings (and Standard Deviations) of the Frequency of AIF Use

Feature	RTU	CTU	Combined
M	5.1 (2.0)	5.7 (2.1)	5.3
CKO*	5.5 (2.1)	4.4 (2.2)	5.2
E	5.1 (1.6)	5.3 (1.7)	5.2
R	4.5 (1.9)	4.3 (1.9)	4.4
PF**	4.3 (1.8)	3.1 (2.1)	3.9
TSF	3.1 (1.4)	3.4 (1.5)	3.2
Combined	4.6	4.4	4.5

*$p < .05$.
**$p < .01$.

A Tukey HSD test revealed that the highest ratings were assigned to motion, crash/kill override, and environmental. A Dunn test indicated that the RTU SIs assigned significantly higher frequency-of-use ratings to crash/kill override and to partial freeze than did the CTU SIs.

Ease of AIF use. The ease-of-use ratings are summarized in Table 14. Ease of use appeared to be extremely high, with most of the means ranging from 5.5 to 6.5 (i.e., very easy). There was no overall difference between the RTU and CTU ratings, $T = 7$, $p > .05$, nor were there any significant RTU/CTU differences for particular features.

Training in AIF Use. The amount of training received in AIF use is summarized in Table 15. Most of the means range from 3.5 to 4.0 (i.e., moderate) and are somewhat lower than the corresponding ATC means. The analysis of covariance revealed a significant effect of AIF, $F(5,465) = 3.49$, $p < .01$. SIs apparently received most training in the use of environmental, reset, and motion. Interestingly, these AIFs were rated lowest in ease of use. Neither the main effect of training unit, $F < 1.00$, nor the AIF by training unit interaction, $F(4,465) = 1.27$, $p > .05$ was significant.

Table 14. C-5A/C-141 Flight Simulators: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	RTU	CTU	Combined
CKO	6.3 (0.9)	6.1 (1.0)	6.2
TSF	6.0 (0.9)	5.9 (0.9)	6.0
PF	5.9 (0.9)	5.7 (0.9)	5.8
M	5.7 (1.0)	5.9 (1.3)	5.8
R	5.4 (0.8)	5.5 (1.0)	5.5
E	5.3 (0.8)	5.2 (0.8)	5.3
Unweighted Means	5.8	5.7	5.8

Table 15. C-5A/C-141 Flight Simulators: Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	RTU	CTU	Combined
E	4.2 (1.3)	3.7 (1.6)	4.1
R	3.7 (1.7)	3.6 (1.8)	3.7
M	3.6 (1.5)	3.8 (1.6)	3.7
TSF	3.7 (1.5)	3.6 (1.5)	3.6
CKO	3.6 (1.6)	3.6 (1.5)	3.6
PF	3.5 (1.5)	3.2 (1.9)	3.4
Combined	3.7	3.6	3.7

Training value of AIFs. The training value ratings are summarized in Table 16. The ratings were quite high, with most of the means in the 4.5 to 5.5 range (i.e., considerable). While there was no overall difference between the RTU and CTU ratings, T = 2.5, $p > .05$, the CTU SIs assigned significantly higher ratings to motion and to total system freeze than did the RTU SIs, $t(91) = -2.38$, $p < .05$, and $t(93) = -2.51$, $p < .05$, respectively.

Table 16. C-5A/C-141 Flight Simulators: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	RTU	CTU	Combined
M*	5.4 (1.3)	6.1 (1.1)	5.6
R	5.2 (1.2)	5.5 (1.1)	5.3
E	5.2 (1.3)	5.3 (1.3)	5.2
PF	5.2 (1.4)	5.0 (1.0)	5.1
TSF*	4.4 (1.4)	5.2 (1.3)	4.7
CKO	4.6 (1.7)	4.8 (1.7)	4.7
Unweighted Means	5.0	5.3	5.1

*$p < .05$.

C-130 Flight Simulator

Training mission. The C-130 RTU and CTU missions are similar to those of the C-5A/C-141. Each training session consists of a 1- to 2-hour prebriefing, a 4-hour mission, and a 1-hour debriefing. Both the RTU and CTU student crews receive extensive practice in normal and emergency procedures during takeoffs, in-flight malfunctions, and full-stop landings. CTU cross-country missions are typically flown under a variety of passenger/cargo configurations and weather conditions.

Frequency of AIF Use. The C-130 frequency-of-use ratings are summarized in Table 17. Although the overall mean rating of 3.9 (i.e., moderately often) was somewhat lower than that of the other ATDs, the

Table 17. C-130 Flight Simulator: Mean Ratings (and Standard Deviations) of the Frequency of AIF Use

Feature	RTU	CTU	Combined
M	6.6 (1.4)	7.0 (0.0)	6.7
E	5.4 (1.0)	6.4 (0.9)	5.8
R	5.7 (1.0)	5.5 (1.3)	5.6
CKO	5.1 (1.4)	5.0 (1.4)	5.1
TSF	4.7 (1.3)	4.6 (1.6)	4.6
PF	4.7 (1.5)	4.1 (1.4)	4.4
PAM	4.2 (1.7)	3.2 (1.9)	3.8
AMI**	3.9 (2.8)	1.5 (0.5)	3.0
PRM	3.0 (1.9)	2.8 (1.4)	2.9
HC	2.6 (1.2)	2.1 (0.8)	2.4
D	1.6 (1.0)	2.4 (1.6)	1.9
RP	1.9 (1.2)	2.0 (0.7)	1.9
PMS	2.0 (1.9)	1.5 (0.7)	1.8
Combined	3.9	3.7	3.9

$^{**}p < .01$.

highest rated features were nevertheless used very frequently. The analysis of covariance revealed a significant effect of AIF, $F(12,384) = 53.23$, $p < .001$, and a significant AIF by training unit interaction, $F(12,384) = 3.25$, $p < .001$. The difference between the overall RTU and CTU ratings was not significant however, $F < 1.00$.

The Tukey HSD test indicated that the highest ratings were assigned to motion, environmental, reset, and crash/kill override. These same features received consistently high ratings at the other sites as well. Procedures monitoring, hard copy, demonstration, record/playback, and programmed mission scenarios received the lowest ratings. The Dunn test revealed only one significant RTU/CTU comparison, that for automated malfunction insertion; it was used significantly more often by RTU SIs.

Ease of AIF Use. The ease-of-use ratings are summarized in Table 18. As was the case for all the ATDs surveyed, ease of use was quite high, with most of the C-130 means in the 4.5 to 6.0 range (i.e., easy to very easy). There was no overall difference between the RTU and CTU ratings, $T = 22.5$, $p > .05$; however, parameters monitoring was rated significantly easier to use by RTU than by CTU SIs, $t(32) = 2.72$, $p < .05$.

Training in AIF use. The amount of training received in AIF use is summarized in Table 19. Most of the means are in the moderate range. The analysis of covariance revealed a significant effect of AIF, $F(12,384) = 15.03$, $p < .001$, but neither the main effect of training unit nor the interaction was significant, $Fs < 1.00$. The results of the Tukey HSD test closely paralleled the results obtained from the frequency-of-use data. Those features that received the most and least amounts of training were used most and least often, respectively.

Training value of AIFs. The training value ratings are summarized in Table 20. The ratings were fairly high, with most of the means in the 4.0 to 6.0 range (i.e., moderate to great). The lowest ratings were generally assigned to the least frequently used features. The overall difference between the RTU and CTU ratings was not significant, $T = 22$, $p > .05$; however, automated malfunction insertion was rated higher by RTU than by CTU SIs, $t(24) = 3.13$, $p < .01$.

CH-3/HH-53 Flight Simulators

Training mission. The CH-3/HH-53 training mission lasts approximately 3 to 4 hours and includes two separate 1-1/2- to 2-hour missions; in addition there are prebriefings and debriefings. Due to the lack of a visual system, instrument flying is emphasized. Student crews practice takeoffs, holding patterns, fix-to-fix, blind landings, and emergency procedures. Malfunctions, which are inserted manually and with great regularity, typically require the crew to respond in a highly coordinated manner. Although the RTU and CTU missions are similar, the CTU mission tends to be somewhat more demanding.

Frequency of AIF use. The CH-3/HH-53 frequency-of-use ratings are summarized in Table 21. The frequency of AIF use appears to be fairly high, with most of the means in the 4.5 to 6.0 range (i.e., frequently to very frequently). Only demonstration was rarely used. The analysis of covariance revealed that, overall, the CTU SIs reported greater AIF use than did the RTU SIs, $F(1,25) = 9.88$, $p < .01$. There was also a significant main effect of AIF, $F(8,208) = 30.76$, $p < .001$. The AIF by training unit interaction was not significant, $F(8,208) = 1.29$, $p > .05$. The Tukey HSD test revealed that, except for record/playback and demonstration, the frequency of AIF use was uniformly high.

Table 18. C-130 Flight Simulator: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	RTU	CTU	Combined
TSF	6.2 (0.9)	6.3 (0.9)	6.2
CKO	6.0 (1.0)	6.3 (0.9)	6.1
M	5.8 (1.1)	6.2 (1.0)	5.9
PF	5.9 (1.2)	5.8 (1.1)	5.9
R	5.5 (1.0)	5.9 (0.8)	5.6
E	5.4 (1.2)	5.9 (1.0)	5.6
AMI	5.0 (1.9)	5.8 (0.9)	5.3
PMS	4.7 (1.1)	5.2 (1.5)	5.0
PAM*	5.3 (1.3)	3.8 (1.7)	4.7
HC	4.7 (1.4)	4.8 (1.6)	4.7
PRM	4.8 (1.3)	4.4 (1.4)	4.7
D	4.1 (1.1)	4.5 (1.1)	4.3
RP	4.1 (0.8)	4.3 (1.6)	4.2
Unweighted Means	5.2	5.3	5.2

*$p < .05$.

Table 19. C-130 Flight Simulator: Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	RTU	CTU	Combined
M	5.0 (1.6)	5.5 (1.1)	5.2
E	4.9 (1.4)	4.8 (0.6)	4.9
CKO	4.7 (1.5)	4.8 (1.0)	4.7
R	4.6 (1.2)	4.8 (0.8)	4.6
TSF	4.6 (1.3)	4.8 (1.0)	4.6
PF	4.4 (1.4)	4.2 (0.9)	4.3
PAM	4.3 (1.2)	4.1 (1.0)	4.2
PRM	3.6 (1.5)	4.2 (1.0)	3.8
AMI	3.8 (2.1)	3.5 (1.5)	3.6
HC	3.4 (1.7)	3.8 (1.0)	3.5
PMS	2.9 (1.8)	3.5 (1.4)	3.1
RP	2.8 (1.4)	3.5 (1.2)	3.1
D	2.4 (1.1)	3.2 (1.2)	2.7
Combined	3.9	4.2	4.0

Table 20. C-130 Flight Simulator: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	RTU	CTU	Combined
M	6.2 (1.3)	6.4 (0.7)	6.2
R	5.5 (1.0)	6.0 (1.2)	5.7
TSF	5.6 (0.9)	5.6 (1.5)	5.6
E	5.4 (1.4)	5.9 (1.0)	5.6
CKO	5.3 (1.1)	5.1 (1.1)	5.2
PF	5.2 (1.2)	4.8 (1.6)	5.1
PAM	4.7 (1.5)	4.1 (1.9)	4.4
AMI**	5.2 (1.8)	3.1 (1.6)	4.3
PMS	4.8 (1.6)	3.7 (1.8)	4.3
PRM	4.2 (1.7)	3.7 (1.8)	4.0
D	3.4 (1.5)	3.4 (1.8)	3.4
RP	3.0 (1.4)	3.4 (1.4)	3.2
HC	3.1 (1.3)	3.2 (1.6)	3.2
Unweighted Means	4.7	4.5	4.6

**$p < .01$.

Table 21. CH-3, HH-53 Flight Simulators: Mean Ratings (and Standard Deviations) of the Frequency of AIF use

Feature	RTU	CTU	Combined
M	5.3 (2.4)	6.6 (0.9)	6.1
E	4.8 (1.2)	6.2 (1.0)	5.7
PAM	4.9 (2.2)	6.0 (1.0)	5.6
TSF	4.5 (1.0)	6.1 (0.7)	5.5
CKO	5.1 (2.0)	5.4 (1.6)	5.3
R	4.3 (1.3)	5.5 (1.1)	5.1
PF	4.3 (1.7)	4.7 (1.9)	4.6
RP	2.2 (1.2)	3.8 (1.4)	3.2
D	1.5 (1.5)	1.6 (1.3)	1.6
Combined**	4.1	5.1	4.7

**$p < .01$.

Ease of AIF use. The ease-of-use ratings are summarized in Table 22. Except for demonstration, all the features received high mean ratings. There was no overall difference between the RTU and CTU ratings, $T = 18.5$, $p > .05$, nor were there any significant differences for particular features.

Table 22. CH-3, HH-53, Flight Simulators: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	RTU	CTU	Combined
TSF	6.6 (0.5)	6.4 (0.6)	6.5
M	6.3 (0.9)	6.2 (1.0)	6.3
CKO	6.5 (0.7)	6.1 (0.8)	6.2
PAM	5.8 (1.4)	5.5 (1.3)	5.6
E	5.3 (0.6)	5.6 (1.0)	5.5
R	5.2 (0.9)	5.6 (0.8)	5.4
PF	5.5 (1.1)	5.1 (1.6)	5.2
RP	4.4	5.2 (1.5)	5.0 (1.0)
D	4.5 (2.1)	3.8 (1.9)	3.9
Unweighted Means	5.6	5.5	5.5

Training in AIF Use. The amount of training received in AIF use is summarized in Table 23. Except for demonstration, it appears that the SIs received at least moderate amounts of training in the use of each feature. The analysis of covariance revealed a significant main effect of AIF, $F(8,208) = 21.98$, $p < .001$. However, neither the main effect of training unit nor the AIF by training unit interaction was significant, $F(1,25) = 2.49$, $p > .05$ and $F(8,208) = 1.62$, $p > .05$, respectively. The Tukey HSD test revealed that, except for record/playback and demonstration, the amount of training received in AIF use was fairly consistent.

Table 23. CH-3, HH-53 Flight Simulators: Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	RTU	CTU	Combined
M	4.7 (2.2)	5.5 (1.9)	5.2
TSF	4.5 (1.2)	5.4 (1.4)	5.0
E	3.9 (1.6)	5.4 (1.4)	4.8
R	4.1 (1.0)	5.0 (1.6)	4.6
PF	3.9 (1.4)	4.9 (1.7)	4.5
CKO	4.1 (1.8)	4.8 (1.8)	4.5
PAM	4.0 (1.5)	4.8 (1.7)	4.5
RP	2.1 (0.9)	4.5 (1.2)	3.5
D	1.5 (1.2)	1.8 (1.2)	1.7
Combined	3.6	4.7	4.3

Training value of AIFs. The training value ratings are summarized in Table 24. The ratings were very high, with most of the means in the 4.5 to 6.5 range (i.e., considerable to great). Only demonstration received a low mean rating. There was no significant overall difference between the RTU and CTU ratings, $T = 7$, $p > .05$, nor were there any significant RTU/CTU differences for particular features.

Table 24. CH-3, HH-53 Flight Simulators: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	RTU	CTU	Combined
M	6.2 (1.4)	6.4 (1.1)	6.4
TSF	6.0 (1.2)	6.2 (0.9)	6.1
E	5.2 (1.5)	5.8 (1.0)	5.5
PAM	5.5 (1.4)	5.5 (1.4)	5.5
R	5.0 (1.3)	5.6 (1.3)	5.4
PF	5.0 (1.4)	5.4 (1.7)	5.2
CKO	5.1 (1.4)	4.8 (1.9)	4.9
RP	4.1 (1.7)	5.0 (1.8)	4.7
D	3.0 (2.3)	2.7 (1.7)	2.8
Unweighted Means	5.0	5.3	5.2

Potential Training Value of AIFs

A three-factor (ATD x AIF x Training Unit) repeated measures analysis of covariance (covariate = number of instructor-hours) was used to analyze the MAC SIs' potential training value ratings. The analysis revealed only two significant effects: a main effect of AIF, $F(15,2265) =$ [illegible] 64, $p < .001$, and an AIF by ATD interaction, $F(30,2265) = 3.00$, $p < .001$. The relevant data are summarized in Table 25.

Table 25. MAC Aircrew Training Devices: Mean Ratings of the Potential Training Value of AIFs

Feature	C-5A/C-141	C-130	CH-3/HH-53	Combined
M	5.7	6.2	6.2	5.9
E	5.6	5.9	6.0	5.7
R	5.6	5.6	5.6	5.6
TSF**	5.0	5.8	6.2	5.4
PF	5.2	5.4	5.2	5.3
CKO	4.9	5.6	5.1	5.1
AMI	4.6	5.3	5.5	4.9
PAM*	4.7	5.0	5.7	4.9
RP**	4.7	4.1	5.4	4.7
PRM	4.8	4.7	4.0	4.6
PMS	4.4	5.0	4.5	4.5
D	4.5	4.3	4.4	4.4
IPT	4.3	3.7	4.1	4.1
RB	4.1	4.0	3.2	3.9
HC	3.7	4.0	4.0	3.8
AAT	3.9	3.6	3.5	3.8
Combined	4.7	4.9	4.9	4.8

*$p < .05$.
**$p < .01$.

The main effect of AIF was analyzed by the Tukey HSD test, which was used to make pairwise comparisons among the combined mean ratings. The results of that test are shown in Table 25 by the placement of brackets around the means that did not differ significantly ($p < .01$). Thus, the features rated highest in potential training value were motion, environmental, reset, total system freeze, and partial freeze, whereas the lowest rated features were demonstration, instructor pilot tutorial, recorded briefing, hard copy, and automated adaptive training.

The AIF by ATD interaction was analyzed by the Dunn test, which was used to make pairwise comparisons among the three mean ratings for each feature. Those features for which there was at least one significant comparison are marked with asterisks. In each case, the CH-3/HH-53 SIs rated that feature significantly higher in potential training value than did other SIs. More specifically, for total system freeze and parameters monitoring, the CH-3/HH-53 means were significantly higher than those of the C-5A/C-141, whereas for record/playback, the CH-3/HH-53 mean was significantly higher than that of the C-130.

Interrelations Among the Variables

Table 26 shows the intercorrelations among the MAC SIs' ratings of each feature on each of the five questions. All the coefficients are positive and significant, *p* < .001, although they are somewhat lower than those obtained from the ATC data. Nevertheless, it can be generally stated that the more frequently a feature was used, the easier it was to use, the more training was received in its use, and the greater was its training and potential training value.

Table 26. MAC Aircrew Training Devices: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Training Received, Training Value, and Potential Training Value

	FREQUSE	EASEUSE	TRECD	TVALUE	PTVALUE
FREQUSE	1.00				
EASEUSE	.41	1.00			
TRECD	.43	.29	1.00		
TVALUE	.57	.36	.42	1.00	
PTVALUE	.41	.22	.37	.67	1.00

Note All correlations are significant, *p* < .001.

Table 27 summarizes the results of a stepwise multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of the remaining variables. The table indicates that, together, the predictor variables accounted for 41 percent of the variance in the frequency-of-use ratings, the most important predictor being training value, followed, in order, by ease of use and training received. (The addition of potential training value did not significantly increase predictability). These results were similar to those obtained from the ATC data except that approximately 12 percent less variability was accounted for.

Table 27. MAC Aircrew Training Devices: Multiple Linear Regression of Frequency of AIF Use on Ease of Use, Training Received, Training Value, and Potential Training Value

Dependent Variable: Frequency of AIF Use

Multiple R:	.64
Multiple R-Square:	.41
Standard Error of Estimate:	1.52

Analysis of Variance:

	Sum of Squares	DF	Mean Square	F	p
Regression	2021.4041	3	673.8013	293.34	< .001
Residual	2937.8682	1279	2.2970		

Summary of Stepwise Regression:

Step No.	Variable	Multiple R	Multiple RSQ	Increase in RSQ	F-to-Enter
1	TVALUE	.57	.33	.33	622.06
2	EASEUSE	.61	.38	.05	98.86
3	TRECD	.64	.41	.03	70.09

Strategic Air Command

FB-111A Simulator Training Mission

The FB-111A mission lasts 3 to 5 hours, including approximately 1 to 2 hours of ground time for prebriefing and debriefing, and 2 to 3 hours of in-flight training. Both peacetime and Emergency War Order (EWO) mission profiles are used. A typical RTU mission consists of various basic skills, such as power on/off, preflight, taxi, takeoff, departure, formation, air refueling, descent to low level, climb, penetration, bombing, and landing. A typical CTU mission includes formation, air refueling, low-level navigation and defensive tactics, emergency-procedure recovery to an unfamiliar airfield, tank rendezvous, weapons delivery, communication procedures, electronic countermeasures, and other tactics that comprise the EWO mission profile. Selected malfunctions are inserted throughout both RTU and CTU missions.

Frequency of AIF Use

The frequency-of-use ratings are summarized in Table 28. Most of the means are above 4.5 (i.e., frequently), which suggests that the frequency of AIF use was generally high. The analysis of covariance revealed a significant main effect of AIF, $F(11,649) = 129.73$, $p < .001$, and a significant AIF by training unit interaction, $F(11,649) = 4.01$, $p < .001$. The overall difference between the RTU and CTU ratings was not significant, $F < .001$.

The Tukey HSD test revealed that parameters and procedures monitoring received significantly higher ratings than did all other features, while record/playback, demonstration, and hard copy received significantly lower ratings than did all other features ($p < .01$). The Dunn test revealed only one significant RTU/CTU comparison: programmed mission scenarios were used more frequently by CTU SIs than by RTU SIs.

Ease of AIF Use

The ease-of-use ratings are summarized in Table 29. Ease of use was high, with most of the means in the 4.0 to 6.5 range (i.e. moderate to very easy). There was no overall difference between the RTU and CTU ratings, $T = 26.5$, $p > .05$, nor were there any significant RTU/CTU differences for particular features.

Training in AIF Use

The amount of training received in AIF use is summarized in Table 30. Most of the means ranged from 3.5 to 5.5 (i.e., moderate to considerable). The analysis of covariance revealed a significant main effect of AIF, $F(11,660) = 53.84$, $p < .001$; however, neither the main effect of Training Unit nor the AIF by Training Unit interaction was significant, $F(1,59) = 1.73$, $p > .05$ and $F(11,660) = 1.79$, $p > .05$, respectively.

The results of the Tukey HSD test were similar to those obtained from the frequency-of-use data. Parameters monitoring and procedures monitoring received significantly higher ratings than all other features, while record/playback, demonstration, and hard copy received the lowest ratings.

Table 28. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Frequency of AIF Use

Feature	RTU	CTU	Combined
PAM	6.8 (0.5)	6.6 (0.8)	6.7
PRM	6.8 (0.5)	6.6 (1.0)	6.6
M	5.8 (1.8)	5.8 (1.5)	5.8
E	5.7 (1.4)	5.8 (1.2)	5.7
CKO	4.9 (0.9)	5.5 (1.3)	5.4
PF	5.4 (1.1)	4.6 (1.6)	4.8
PMS**	3.6 (2.2)	5.3 (1.7)	4.8
R	4.5 (1.3)	4.8 (1.3)	4.8
TSF	4.0 (1.2)	4.4 (1.4)	4.3
RP	2.5 (1.2)	1.7 (0.8)	2.0
D	1.6 (0.8)	1.4 (0.6)	1.5
HC	1.4 (0.6)	1.3 (0.6)	1.3
Combined	4.4	4.5	4.5

**$p < .01$.

Table 29. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	RTU	CTU	Combined
TSF	6.2 (1.0)	6.4 (0.8)	6.3
CKO	6.3 (0.8)	6.3 (0.9)	6.3
PF	6.1 (1.0)	6.2 (1.0)	6.2
M	5.8 (1.3)	6.2 (0.9)	6.1
E	5.5 (0.9)	5.8 (1.0)	5.7
R	5.4 (1.5)	5.7 (1.0)	5.6
PAM	4.9 (1.4)	4.5 (1.4)	4.6
PMS	4.3 (1.6)	4.3 (1.3)	4.3
PRM	4.8 (1.6)	4.1 (1.6)	4 3
RP	3.8 (1.4)	3.3 (1.4)	3.5
D	2.8 (1.5)	2.9 (1.1)	2.9
HC	2.4 (1.4)	2.7 (1.8)	2.6
Unweighted Means	4.9	4.9	4.9

Table 30. FB-111A Operational Flight Trainer: Mean Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	RTU	CTU	Combined
PRM	4.9 (1.4)	5.6 (1.2)	5.5
PAM	4.9 (1.4)	5.5 (1.3)	5.4
M	4.4 (1.2)	4.8 (1.6)	4.6
E	3.9 (1.2)	4.8 (1.2)	4.5
CKO	4.1 (0.9)	4.5 (1.4)	4.4
PF	4.2 (1.3)	4.4 (1.6)	4.4
TSF	4.1 (1.1)	4.3 (1.4)	4.3
R	3.8 (1.3)	4.3 (1.3)	4.2
PMS	3.2 (1.6)	4.0 (1.8)	3.7
RP	2.9 (1.4)	2.2 (1.2)	2.4
D	2.4 (1.4)	2.2 (1.4)	2.2
HC	1.3 (0.6)	1.4 (0.7)	1.4
Combined	3.7	4.0	3.9

Training Value of AIFs

The training value ratings are summarized in Table 31. The ratings were very high, with most of the means in the 4.5 to 6.5 range (i.e., considerable to great). Although there were no significant RTU/CTU comparisons for particular features, the CTU SIs' ratings were significantly higher, overall, than those of the RTU SIs, $T = 11$, $p < .05$.

Table 31. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	RTU	CTU	Combined
PRM	6.3 (1.0)	6.4 (0.9)	6.4
PAM	6.3 (1.0)	6.3 (1.0)	6.3
PF	6.2 (0.8)	5.9 (1.2)	6.0
TSF	5.5 (1.3)	5.9 (1.2)	5.8
E	5.3 (0.8)	5.6 (1.0)	5.5
M	5.5 (1.2)	5.2 (1.8)	5.3
CKO	4.9 (0.6)	5.4 (1.6)	5.2
R	4.9 (1.5)	5.2 (1.4)	5.1
PMS	4.3 (1.9)	5.0 (1.5)	4.9
RP	3.9 (1.3)	3.7 (1.6)	3.7
D	3.3 (1.6)	3.8 (1.7)	3.7
HC	2.0 (0.8)	2.9 (1.3)	2.7
Unweighted Means*	4.9	5.1	5.0

*$p < .05$.

Potential Training Value of AIFs

The potential training value ratings are summarized in Table 32. Like the training value ratings, these ratings were also very high, with most of

Table 32. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Potential Training Value of AIFs

Feature	RTU	CTU	Combined
PRM	6.7 (0.5)	6.8 (0.5)	6.8
PAM	6.6 (0.5)	6.5 (0.7)	6.6
PF	6.2 (1.1)	5.9 (1.2)	6.0
TSF	5.8 (1.1)	6.0 (1.0)	5.9
E	5.9 (0.8)	5.9 (1.0)	5.9
M	5.9 (1.2)	5.6 (1.7)	5.7
CKO	5.5 (1.3)	5.7 (1.4)	5.6
R	5.5 (1.0)	5.6 (1.1)	5.6
PMS	5.3 (1.5)	5.5 (1.4)	5.4
AMI	5.0 (2.0)	4.9 (1.5)	4.9
AAT	4.9 (1.8)	4.5 (1.7)	4.6
RP	5.2 (1.3)	4.4 (1.7)	4.6
D	4.9 (1.8)	4.4 (1.5)	4.5
IPT	4.4 (1.7)	4.3 (1.6)	4.3
HC	4.2 (1.9)	4.1 (1.6)	4.1
RB	3.7 (1.7)	3.8 (1.6)	3.7
Combined	5.4	5.2	5.3

the means in the 4.5 to 6.5 range (i.e., considerable to great). Even the lowest rated feature, recorded briefing, was still considered to have moderate potential training value. The analysis of covariance revealed only one significant effect, that of AIF, $F(15,885) = 25.40$, $p < .001$.

Interrelations Among the Variables

Table 33 shows the intercorrelations among the FB-111A SIs' ratings of each feature on each of the five questions. All of the coefficients are positive and significant, $p < .001$, as they were for the ATC and MAC data. Thus, the more frequently a feature was used, the easier it was to use, the more training was received in its use, and the greater its training and potential training value.

Table 33. FB-111A Operational Flight Trainer: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Training Received, Training Value, and Potential Training Value

	FREQUSE	EASEUSE	TRECD	TVALUE	PTVALUE
FREQUSE	1.00				
EASEUSE	.33	1.00			
TRECD	.53	.29	1.00		
TVALUE	.58	.32	.53	1.00	
PTVALUE	.50	.23	.44	.77	1.00

Note All correlations are significant, $p < .001$.

Table 34 summarizes the results of a stepwise multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of the remaining variables. The table indicates that, together, the predictor variables accounted for 42 percent of the variance in the frequency-of-use ratings, the most important predictor being training value, followed, in order, by training received, ease of use, and potential training value (which contributed relatively little to the overall level of predictability). These results were similar to those obtained from ATC and from MAC.

Table 34. FB-111A Operational Flight Trainer: Multiple Linear Regression of Frequency of AIF Use on Ease of Use, Training Received, Training Value, and Potential Training Value

Dependent Variable: Frequency of AIF Use

Multiple R: .65
Multiple R-Square: .42
Standard Error of Estimate: 1.44

Analysis of Variance:

	Sum of Squares	DF	Mean Square	F	p
Regression	1012.0051	4	253.0013	121.75	< .001
Residual	1371.5435	660	2.0781		

Summary of Stepwise Regression:

Step No.	Variable	Multiple R	Multiple RSQ	Increase in RSQ	F-to-Enter
1	TVALUE	.58	.34	.34	337.56
2	TRECD	.64	.41	.07	77.75
3	EASEUSE	.65	.42	.01	15.04
4	PTVALUE	.65	.42	.00	5.01

IV. DISCUSSION

For purposes of discussion, the 16 AIFs surveyed in Phase II can be organized into four categories.

Briefing AIFs are designed for briefing the student and SI prior to or during a training mission. The purpose is to establish a learning set and to increase learning readiness. These features include

1. Instructor pilot training.
2. Recorded briefing.
3. Demonstration.

Training Management AIFs include various features designed to control the structure and sequencing of tasks within a training mission. These features include

1. Total system freeze.
2. Reset.
3. Automated adaptive training.
4. Programmed mission scenarios.

Variation of Task Difficulty/Fidelity AIFs permit the SI to control the difficulty of simulated flight through variations in ATD fidelity, configuration, or task load demands. These features include

1. Automated malfunction insertion.
2. Partial freeze.
3. Crash/kill override.
4. Environmental.
5. Motion.

Monitor and Feedback AIFs permit the SI to monitor student performance and provide the student with performance feedback. These features include

1. Parameters monitoring.
2. Procedures monitoring.
3. Record/playback.
4. Hard copy.

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Briefing AIFs. None of these features were available on the T-50 and T-51 ATDs. While several SIs considered these features to have significant potential training value in terms of time and manpower savings, most SIs believed that automated briefings would not permit sufficient flexibility. For example, during a "dual" mission, it would simply be easier and more appropriate for SIs to fly demonstrations themselves.

Training management AIFs. Total system freeze and reset were among the most often used, easily used, and highly valued AIFs. These features, which are typically used in succession, permit SIs to temporarily suspend the mission in order to offer instruction and then to rapidly re-initialize the ATD to a particular configuration. Automated adaptive training and programmed mission scenarios were unavailable. Since most SIs preferred to manage training themselves, neither feature received particularly high potential training value ratings.

Variation of task difficulty/fidelity AIFs. Environmental and motion were among the most frequently used and highly valued features. Environmental was especially important for T-37 trainees since it offered them their only experience with instrument flying. Partial freeze was used significantly more often by T-51 SIs. This did not reflect a difference in training value, but rather, was due to a difference in accessibility. Partial freeze could only be activated from the T-50 remote console, whereas T-51 SIs could freeze altitude, position, and heading at the cockpit control panel.

Automated malfunction insertion was used infrequently by both groups. Most instructors preferred to insert malfunctions manually, because this was easier and permitted greater training flexibility. Crash override received only moderately frequent use, but it was an important feature since crashing can cause damage to the terrain model board probe. Otherwise crash override was considered to be a convenient means of avoiding a reset following a crash.

Monitor and feedback AIFs. Of the four monitor feedback features, only record/playback was available on the T-50 and T-51 ATDs. It was used with moderate regularity and was rated relatively high in training value. Parameters monitoring, procedures monitoring, and hard copy were considered to have moderate potential training value; one T-50 SI noted that hard copy might be especially useful for instrument training.

Differences between T-50 and T-51 SIs' ratings. Although there was a significant overall difference between the T-50 and T-51 SIs' frequency-of use-ratings, the significant AIF by ATD interaction suggests that this difference was mostly due to the greater use of partial freeze by T-51 SIs. It is not clear, however, why T-51 SIs also reported receiving more training in AIF use.

Military Airlift Command

Briefing AIFs. Most MAC SIs felt that instructor pilot tutorial and recorded briefing would not enhance simulator training. "Hands-on" training was considered to be superior to instructor pilot tutorial, and "face-to-face" briefings, which afford opportunity for trainees' questions, were preferred over recorded briefings.

Demonstration, which was available on the C-130 and CH-3 ATDs (it had been disabled on the HH-53 ATD), received relatively low ratings. Demonstrations were difficult and time-consuming to use, and the available examples were not sufficiently representative of the mission profiles. C-5A and C-141 SIs felt that demonstrations would probably be unnecessary since "transports do not do maneuvers," and crew coordination, which is of great importance for a successful mission, cannot be "demonstrated."

Training management AIFs. On the C-5A and C-141 ATDs, total system freeze was generally used only during emergencies or following serious errors. At the remaining ATD sites, it was regularly used to correct student procedures and to point out errors. Reset was frequently used by all MAC SIs.

Automated adaptive training was unavailable, and it was rated the lowest of all features in potential training value. One C-5A SI summed up the consensus opinion: "Computers don't know why a student is doing well and might increase complexity before the student is ready." Programmed mission scenarios were available on the C-130 ATD, but they were used the least of all AIFs. Apparently, the available scenarios did not match the mission requirements. Most MAC SIs believed that programmed mission scenarios could be valuable, but not if training flexibility was sacrificed.

Variation of task difficulty/fidelity AIFs. Motion and environmental were among the most frequently used, easily used, and valuable AIFs. Nevertheless, a few C-5A/C-141 and CH-3/HH-53 SIs noted deficiencies in reliability and fidelity. Partial freeze was used with moderate regularity in various situations. On the C-5A/C-141 ATDs, the SIs frequently used position freeze (rather than total system freeze) in order to point out student problems. Several C-130 SIs reported using position and altitude freeze in order to reduce student task load demands. CH-3 SIs used partial freeze to prevent the simulator from "hitting" obstacles and used it during hover checks.

Automated malfunction insertion was available on the C-130 ATD, where it was used moderately often by the RTU SIs but very rarely by the CTU SIs. Apparently, the available malfunctions did not conform to the CTU mission profile. Although automated malfunction insertion was rated relatively high in potential training value, many SIs expressed the opinion that manual insertion was preferable.

Crash override was frequently used and highly valued at each ATD site. On the C-5A/C-141 and CH-3 ATDs, crash override is normally kept in the override position in order to avoid damage to the simulator. C-130 SIs used crash override during "non-visual" missions and during stall training.

Monitor and Feedback AIFs. Parameters and procedures monitoring were only occasionally used by C-130 SIs, many of whom believed it was easier to look at the instruments directly. Several CH-3/HH-53 SIs noted that their existing monitoring capability was not sensitive enough to measure the rapid changes in parameter values that occur during their mission. Several C-5A/C-141 SIs believed that it would be easier to monitor parameters and procedures "over-the-shoulder," while others considered these features to have significant potential value since "we miss a lot now."

Record/playback was among the lowest rated features on the C-130 ATD. It was considered time-consuming and relatively difficult to use. On the CH3/HH-53 ATDs, record/playback was also seldom used, but it was rated much higher in training value, probably because it was easier to use. There was considerable disagreement among the C-5A/C-141 SIs as to the potential training value of record/playback.

Hard copy was seldom used by C-130 SIs. Several instructors referred to it as "unreliable" and "time-consuming." Hard copy was generally considered to have only moderate potential training value; however, a few C-5A/C-141 SIs believed it would be useful for ground track recording and "accident" investigation.

Differences between MAC RTU and CTU SIs' ratings. The RTU and CTU mission profiles for each ATD were similar. It is not surprising, then, that there were relatively few significant differences between the RTU and CTU SIs' mean ratings. The only significant overall difference occurred in the CH-3/HH-53 data; the CTU SIs reported significantly greater use of AIFs than did the RTU SIs. The reason for this difference was not immediately apparent, but it is feasible that the greater complexity of the CH-3/HH-53 CTU mission required more frequent AIF use.

Strategic Air Command

Briefing AIFs. Instructor pilot tutorial and recorded briefing were rated as having only moderate potential training value. Most FB-111A SIs believed that "hands-on" and "face-to-face" instruction would be preferable. The demonstration feat was rarely used. It was sometimes inoperable, and the available demonstrations did not closely conform to the FB-111A mission profile. Nevertheless, some SIs believed that the demonstration feature might be useful for defensive maneuvers and instrument training.

Training management AIFs. The FB-111A SIs used total system freeze and reset with considerable regularity, although the level of use was somewhat less than it was at most of the other ATD sites. Many FB-111A SIs apparently preferred to use position freeze in order to point out student errors.

Automated adaptive training was unavailable and was rated relatively low in potential training value. Programmed mission scenarios, particularly the ECM scenarios, were used moderately often. However, many SIs commented on the need for manual override. Since the CTU mission profile placed greater emphasis on ECM, it seems probable that the significant difference between the RTU and CTU SIs' use of programmed mission scenarios reflected this emphasis.

Variation of task difficulty/fidelity AIFs. As was the case at the other ATD sites, motion and environmental were among the highest rated features on each of the five questions. There were several criticisms of these features, however. Motion was not always operational, and environmental, which was frequently used to vary navigational difficulty, was less appropriate for other purposes.

Partial freeze (i.e., ground position freeze) was frequently used instead of total system freeze (i.e., problem freeze) in order to temporarily suspend the mission and discuss a problem. Crash/kill override was frequently used and was considered to have high training value. The FB-111A SIs, like those at most of the other ATD sites, typically kept this feature in the override mode in order to save time and to protect the simulator from damage.

At the time the survey was conducted, automated malfunction insertion had only recently been implemented on the SATCOM instructor terminal. Automated malfunction insertion was rated as having considerable potential training value because it would ease the SI's workload. Nevertheless, like most of the SIs surveyed, the FB-111A SIs generally believed that manual insertion would permit greater training flexibility.

Monitor and feedback AIFs. Parameters and procedures monitoring were rated highest of all features on frequency of use and training value. The comparable ratings were lower from the other ATD sites at which these features were available. These differences can be accounted for by pointing out that on the FB-111A ATD, parameters and procedures monitoring is done at a remote instructor console. Thus, it is the FB-111A SI's primary means of monitoring the simulated aircraft. In contrast, at the other ATD sites, the instructor console was located "in the box," which permitted SIs to monitor students' performance "over-the-shoulder."

Both record/playback and hard copy were available but were rarely used. Neither feature was always operational. Moreover, record/playback was limited to visual playback only, thus making it unsuitable for student-navigator feedback. Hard copy, which was assigned the lowest ratings of all available features, was said to yield output that was difficult to interpret.

Differences between FB-111A RTU and CTU SIs' ratings. There were very few significant differences between the RTU and CTU SIs' mean ratings. Of all the available features, only one, programmed mission scenarios, was used more frequently by one group (CTU SIs) than by the other (RTU SIs). This finding was discussed previously. The only other significant difference was in the training value ratings. CTU SIs assigned higher training value ratings, overall, than did RTU SIs. The reason for this difference was not apparent. In any case, the magnitude of this effect was rather small.

Predicting the Frequency of AIF Use

The stepwise multiple linear regression analyses of the three sets of data (see Tables 11, 27, 34) indicated that at least 40 percent, and as much as 53 percent, of the variability in the frequency-of-use ratings could be explained by the remaining variables. Training value, alone, accounted for over 30 percent in each data set.

What can be concluded from these facts? Unfortunately, correlational findings do not logically imply causality. Instead, they merely reflect the likely presence of a relationship between variables. In this case, however, it seems reasonable to assume that particular AIFs were used more frequently because they had greater training value. Indeed, assuming that the training value of an AIF did not affect its use is clearly implausible. The remaining variables, i.e., ease of use, amount of training received, and potential training value, together accounted for only 10 percent additional variability (averaged over the three commands) in the frequency-of-use ratings. It seems likely that these variables also influenced the frequency of AIF use but to a much lesser extent than did training value.

Comparisons Between Phase I and Phase II

The most striking difference between the Phase I and Phase II results was in the overall magnitude of the ratings. The ATC, MAC, and SAC SIs consistently rated the features higher on all variables than did the TAC SIs. This suggests that TAC SIs used AIFs less often, found them more difficult to use, received less training in their use, and considered AIFs to be less important for training. As described in Section I of this report, these low ratings were due in part to various problems with the AIFs, such as hardware and software unreliability, time-consuming implementation, functional limitations, and design deficiencies. ATC, MAC, and SAC SIs reported these same problems, but their level of AIF use remained high. Why was this so?

One explanation involves the training received by the SIs. The TAC SIs reported that they received considerably less training in AIF use than did the other MAJCOM SIs. Moreover, the word "informal" was chosen more often by TAC SIs when describing the kind of training they did receive. In contrast, ATC, MAC, and SAC SIs chose "formal" more often when describing their training. These facts suggest that TAC's SI training program is less extensive and less structured than are those of the other MAJCOMs.

There were some similarities in the Phase I and Phase II results. The relative ratings of particular AIFs were fairly consistent across all ATDs. That is, those features rated highest (lowest) by one group of SIs also tended to be rated highest (lowest) by the other groups. This suggests that the overall pattern of AIF use is similar across the MAJCOMs. One notable exception was motion. It was consistently among the highest rated features at ATC, MAC, and SAC ATD sites; however, it was rated lowest of all features in potential training value by the TAC SIs. This difference was probably due to the fact that most ATD motion systems are not capable of high fidelity simulation of fighter aircraft movement.

V. RECOMMENDATIONS AND CONCLUSION

At the end of Phase I, it was recommended that certain AIFs need to be made more reliable and user friendly before their training effectiveness can be ascertained. It was also recommended that a formal intensive training program be established in order to teach TAC SIs how to use AIFs more effectively. These recommendations apply to Phase II as well, for it is clear that most SIs, regardless of command, have not yet fully explored the existing instructional capabilities of ATDs. The principles of effective AIF use still need to be specified, however. Such principles will not be derived from surveys but, rather, from empirical investigations.

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APPENDIX

INSTRUCTIONAL FEATURES QUESTIONNAIRE

ADVANCED INSTRUCTIONAL FEATURES - IP SURVEY

Name____________________________Rank________Squadron______Date_________________

FLYING EXPERIENCE:

Aircraft	Total Hours	IP Hours
____________	________	________

SIMULATOR EXPERIENCE:

Simulator	Total Hours	IP Hours
____________	________	________

BRIEFLY DESCRIBE A "TYPICAL" TRAINING SESSION ON THIS SIMULATOR:

____

____

____

____

____

____

GENERAL COMMENTS AND/OR RECOMMENDATIONS:

____

____

____

____

____

____

Please familiarize yourself with these instructional features and their definitions: For each feature, insert 1 (available) or 0 (unavailable):

(1/0)

_____ Instructor Pilot Tutorial - provides the IP with self-paced programmed instruction in the capabilities and use of the flight simulator.

_____ Reset - permits instructor to "return" the simulated aircraft to a stored set of conditions and parameters.

_____ Total System Freeze - permits instructor to interrupt and suspend simulated flight by freezing all system parameters.

_____ Recorded Briefing - permits instructor to provide student with information about a structured training session through audio/visual media presentation.

_____ Demonstration - permits instructor to demonstrate aircraft maneuver(s) by prerecording and subsequently playing back a standardized segment of simulated flight.

_____ Record/Playback - permits instructor to record and subsequently playback all events that occurred during a segment of simulated flight.

_____ Environmental - permits instructor to vary environmental conditions such as wind direction and velocity, turbulence, temperature, visibility, etc.

_____ Automated Malfunction Insertion - permits instructor to pre-program a sequence of aircraft component malfunctions and/or emergency conditions.

_____ Partial Freeze - permits instructor to freeze various flight parameters or parameter combinations such as altitude, heading, position, attitude, flight system, etc.

_____ Crash and/or Kill Override - permits instructor to allow simulated flight to continue without interruption following a "crash" or "kill."

_____ Motion - permits instructor to vary platform motion system cues such as roll, pitch, lateral, vertical, etc.

_____ Hard Copy - provides a record of alphanumeric and/or graphic performance data from the automated performance measurement system for debriefing purposes.

_____ Automated Adaptive Training - computer-controlled variations in task difficulty, complexity, and sequence based on pilot's performance.

_____ Programmed Mission Scenarios - computer-controlled standardized training sessions based on pre-programmed event sequences.

_____ Procedures Monitoring - permits instructor to monitor discrete actions performed by the student in accordance with a procedurally defined checklist.

_____ Parameters Monitoring - permits instructor to monitor various instrument readings, control settings, aircraft states, or navigational profiles.

1. How often have you used each instructional feature? (Check the appropriate space.)

Feature	never	rarely	occasionally	moderately often	frequently	very frequently	most often
	1	2	3	4	5	6	7
Instructor Pilot Tutorial							
Reset							
Total System Freeze							
Recorded Briefing							
Demonstration							
Record/Playback							
Environmental							
Automated Malfunction Insertion							
Partial Freeze							
Crash and/or Kill Override							
Motion							
Hard Copy							
Automated Adaptive Training							
Programmed Mission Scenarios							
Procedures Monitoring							
Parameters Monitoring							

(Each feature is followed by "Comments:")

2. How easy is it to use each instructional feature? (Check the appropriate space.)

Feature	?	most difficult	very difficult	difficult	moderate	easy	very easy	easiest
Instructor Pilot Tutorial	0	1	2	3	4	5	6	7
Comments:								
Reset	0	1	2	3	4	5	6	7
Comments:								
Total System Freeze	0	1	2	3	4	5	6	7
Comments:								
Recorded Briefing	0	1	2	3	4	5	6	7
Comments:								
Demonstration	0	1	2	3	4	5	6	7
Comments:								
Record/Playback	0	1	2	3	4	5	6	7
Comments:								
Environmental	0	1	2	3	4	5	6	7
Comments:								
Automated Malfunction Insertion	0	1	2	3	4	5	6	7
Comments:								
Partial Freeze	0	1	2	3	4	5	6	7
Comments:								
Crash and/or Kill Override	0	1	2	3	4	5	6	7
Comments:								
Motion	0	1	2	3	4	5	6	7
Comments:								
Hard Copy	0	1	2	3	4	5	6	7
Comments:								
Automated Adaptive Training	0	1	2	3	4	5	6	7
Comments:								
Programmed Mission Scenarios	0	1	2	3	4	5	6	7
Comments:								
Procedures Monitoring	0	1	2	3	4	5	6	7
Comments:								
Parameters Monitoring	0	1	2	3	4	5	6	7
Comments:								

3. How much training did <u>you</u> receive in the use of each instructional feature? (Check the appropriate space. Please comment as to whether the training was <u>formal</u> or <u>informal</u>.)

Feature	/ none /minimal/ some /moderate/considerable/great/greatest/
Instructor Pilot Tutorial	1 2 3 4 5 6 7
Comments:	
Reset	1 2 3 4 5 6 7
Comments:	
Total System Freeze	1 2 3 4 5 6 7
Comments:	
Recorded Briefing	1 2 3 4 5 6 7
Comments:	
Demonstration	1 2 3 4 5 6 7
Comments:	
Record/Playback	1 2 3 4 5 6 7
Comments:	
Environmental	1 2 3 4 5 6 7
Comments:	
Automated Malfunction Insertion	1 2 3 4 5 6 7
Comments:	
Partial Freeze	1 2 3 4 5 6 7
Comments:	
Crash and/or Kill Override	1 2 3 4 5 6 7
Comments:	
Motion	1 2 3 4 5 6 7
Comments:	
Hard Copy	1 2 3 4 5 6 7
Comments:	
Automated Adaptive Training	1 2 3 4 5 6 7
Comments:	
Programmed Mission Scenarios	1 2 3 4 5 6 7
Comments:	
Procedures Monitoring	1 2 3 4 5 6 7
Comments:	
Parameters Monitoring	1 2 3 4 5 6 7
Comments:	

4. Rate the training value of each instructional feature. (Check the appropriate space.)

Feature / ? / none /minimal/ some /moderate/considerable/great/greatest/

Instructor Pilot Tutorial / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Reset / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Total System Freeze / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Recorded Briefing / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Demonstration / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Record/Playback / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Environmental / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Automated Malfunction Insertion / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Partial Freeze / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Crash and/or Kill Override / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Motion / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Hard Copy / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Automated Adaptive Training / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Programmed Mission Scenarios / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Procedures Monitoring / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

Parameters Monitoring / 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 /

Comments:

8. Rate the potential training value of each instructional feature, including those you are not familiar witn. Assume that you have had no experience using any of the features and that all of them are equally easy to u Therefore, base your ratings on the feature definitions alone. (Check the appropriate space.)

Feature	none /minimal/ some /moderate/considerable/great/greatest/
Instructor Pilot Tutorial	1 2 3 4 5 6 7
Comments:	
Reset	1 2 3 4 5 6 7
Comments:	
Total System Freeze	1 2 3 4 5 6 7
Comments:	
Recorded Briefing	1 2 3 4 5 6 7
Comments:	
Demonstration	1 2 3 4 5 6 7
Comments:	
Record/Playback	1 2 3 4 5 6 7
Comments:	
Environmental	1 2 3 4 5 6 7
Comments:	
Automated Malfunction Insertion	1 2 3 4 5 6 7
Comments:	
Partial Freeze	1 2 3 4 5 6 7
Comments:	
Crash and/or Kill Override	1 2 3 4 5 6 7
Comments:	
Motion	1 2 3 4 5 6 7
Comments:	
Hard Copy	1 2 3 4 5 6 7
Comments:	
Automated Adaptive Training	1 2 3 4 5 6 7
Comments:	
Programmed Mission Scenarios	1 2 3 4 5 6 7
Comments:	
Procedures Monitoring	1 2 3 4 5 6 7
Comments:	
Parameters Monitoring	1 2 3 4 5 6 7
Comments:	

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AIR FORCE

HUMAN RESOURCES

AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE III - ELECTRONIC WARFARE TRAINERS)

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The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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Contract Monitor

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An aircrew training device (ATD) is not merely a flight simulator. It is also equipped with sophisticated hardware and software capabilities, known as advanced instructional features (AIFs), that permit a simulator instructor to control, monitor and fabricate simulator training missions. This report describes the third phase of a three-phase project designed to determine the utility and utilization of AIFs by means of a survey of simulator instructors from the Air Force Major Commands. Phase I surveyed 134 instructor pilots and weapons director instructors assigned to principal Tactical Air Command (TAC) ATD training sites. Phase II surveyed 273 instructor pilots, flight engineers, and radar/navigators from Air Training Command (ATC), Military Airlift Command (MAC), and Strategic Air Command (SAC). Phase III extended the survey to 155 electronic warfare and aerial gunnery instructors from ATC, SAC, and TAC training facilities. Based on utility and utilization ratings, the T-5 and T-4 trainers were the most favorably evaluated devices surveyed. They were followed, in order, by the F-4G simulator, B-52 weapon system trainer, and A-10 simulator. The level of AIF use was affected somewhat by hardware and software unreliability, implementation time, functional

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limitations, and design deficiencies. However, the perceived training value of a feature was the most important determiner of its use. It was recommended that future procurement of AIFs be preceded by a detailed front-end analysis that clearly relates AIF capability to training needs.

SUMMARY

Aircrew training devices (ATDs) are often equipped with sophisticated hardware and software capabilities that permit a simulator instructor (SI) to control, monitor, record, and fabricate flight simulation training missions. These advanced instructional features (AIFs) reflect the primary role of the ATD as a flight trainer. The training value of an ATD is a function of the degree to which it simulates a particular aircraft and the way in which it is used as an instructional device.

AIFs are costly to implement and in order to justify these costs, several questions must be answered. How frequently are AIFs used? How easy are they to use? Are simulator instructors adequately trained to use AIFs? Do AIFs have significant training value?

This report describes the third phase of a three-phase project designed to obtain answers to these questions by surveying simulator instructors from the Air Force Major Commands. An on-site survey was administered to 159 SIs assigned to replacement training units and continuation training units at principal Air Training Command (T-5), Strategic Air Command (T-4, B-52 Weapon System Trainer, FB-111A), and Tactical Air Command (F-4G, A-10) ATD facilities. The survey requested background information, along with five seven-point rating scales for evaluating each of 14 AIFs. Written comments concerning the 14 AIFs or the ATD were solicited.

Based on the utility and utilization ratings, the T-5 and T-4 trainers were the most favorably evaluated devices surveyed. They were followed, in order, by the F-4G simulator, B-52 WST, and A-10 simulator. Mission control features (e.g., freeze, reset, and programmed and manual threat control) were generally rated high in utility and utilization. whereas briefing features (e.g., instructor tutorial, recorded briefing, demonstration) and feedback features (e.g., hard copy, record/playback, electronic warfare performance scoring) tended to receive lower ratings.

The level of AIF use was affected somewhat by hardware and/or software unreliability, implementation time, functional limitations, and design deficiencies. The perceived training value of a feature was the most important determiner of its use.

PREFACE

This project was conducted to satisfy requirements of Air Force Human Resources Laboratory Technical Planning Objective 3, the thrust of which is aircrew training effectiveness. The general objective of this thrust is to identify and demonstrate cost-effective simulator training strategies and training equipment capabilities for use in developing and maintaining the combat readiness of Air Force aircrew members at optimum cost. More specifically, the research was conducted under the Air Combat Training Research subthrust, the goal of which is to provide a technology base for training high level and quickly perishable skills in simulated combat environments. Work Unit 1123-02-34, Development and Evaluation of Advanced Instructional Features, addressed a portion of this subthrust. Dr. Wayne Waag (AFHRL/OTU) was the Contract Monitor and Dr. Donald J. Polzella and Dr. David C. Hubbard, under contract to the University of Dayton Research Institute, were the Co-Investigators.

This effort was jointly coordinated by the Air Force Human Resources Laboratory, Operations Training Division, Williams Air Force Base, Arizona; the Simulator System Program Office (SimSPO) of the Air Force Systems Command, Aeronautical Systems Division (AFSC/ASD), Wright-Patterson Air Force Base, Ohio; Headquarters Air Training Command, Randolph Air Force Base, Texas; Headquarters Tactical Air Command, Langley Air Force Base, Virginia; and Headquarters Strategic Air Command, Offutt Air Force Base, Nebraska. The author gratefully acknowledges the assistance of the following individuals:

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Maj Boswell (SAC/DOTP)
Maj Pierce (379 BMW/DOTD)
Maj Dick Bruer (379 BMW/DOTD)
Capt Randy Allen (93 BMW/DO5)
Capt Kevin Court (355 TTW)
Capt Mark Stenger (357 TTS)
CMSG Mlodzik (355 TTW)
TSgt Nunn (355 TTW)
Capt John Trauernicht (37 TFW
MSgt Henry (35 TFW)
SSgt George (35 TTW)
Lt Col Beck (23 TFW)
Maj Bean (23 TFW)
Capt Mark Olson (23 TFW)
Sgt Readtke (23 CRS)
Capt Scott Dortch (320 BMW)
Capt Waddle (320 BMW)
Lt Col McHenry (453 FTS)
Capt Brennan (453 FTS)
SSgt Murphy (453 FTS)
Mr. Merle Goff (AAI Corp.)

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AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE III - ELECTRONIC WARFARE TRAINERS)

I. INTRODUCTION

An Aircrew Training Device (ATD) serves two functions. First, it is a ground-based substitute aircraft that permits student flight crews to fly in a safe and carefully controlled environment. More importantly, an ATD is, as its name implies, a teaching machine that is designed to facilitate the acquisition of flight crew skills. In order to fulfill this second function, an ATD is equipped with sophisticated hardware and software capabilities that permit a simulator instructor (SI) to control, monitor, and fabricate simulator training missions. These capabilities, which are listed in Table 1, are known as advanced instructional features (AIFs). The list was compiled from several sources, but it was drawn primarily from Semple, Cotton, and Sullivan's (1981) extensive report describing the AIF capabilities of various military and commercial devices.

Table 1. Advanced Instructional Features

BRIEFING FEATURES

Recorded Briefing permits simulator instructor to provide a student with information about the simulator and/or a training mission through audiovisual media presentation.[a]

Demonstration permits simulator nstructor to demonstrate optimal aircrew performance by means of prerecording and subsequently playing back segments of simulated flight.[a]

Instructor Tutorial provides simulator instructor with self-paced programmed instruction in the capabilities and use of the simulator.[a]

Table 1. (Continued)

TRAINING MANAGEMENT FEATURES

Total System Freeze permits simulator instructor to suspend simulated flight by freezing all system parameters.[a]

Reset permits simulator instructor to return the simulated aircraft to a stored set of conditions and parameters.[a]

Crash and/or Kill Override permits simulator instructor to allow simulated flight to continue without interruption following a "crash" or "kill."

Automated Adaptive Training is the computer-controlled variation in task difficulty, complexity, and/or sequence based on student's performance.

Programmed Mission Scenarios are computer-controlled standardized training missions based on preprogrammed event sequences.[a]

Manual Mission Control permits simulator instructor to modify programmed scenarios during a training session.[a]

VARIATION OF TASK DIFFICULTY FEATURES

Automated Malfunction Insertion permits simulator instructor to preprogram a sequence of aircraft component malfunctions and/or emergency conditions.[a]

Manual Malfunction Insertion permits simulator instructor to modify preprogrammed malfunctions during a training session.

Table 1. (Continued)

Environmental permits simulator instructor to vary environmental conditions such as wind direction and velocity, turbulence, temperature, and visibility.

Dynamics permits simulator instructor to vary flight dynamics characteristics, such as stability, system gain, cross-coupling, etc.

Motion permits simulator instructor to provide a student with platform motion system cues such as roll, pitch, and yaw.

Flight System Freeze permits simulator instructor to simultaneously freeze flight control and propulsion systems, position, altitude, and heading.

Position Freeze permits simulator instructor to simultaneously freeze latitude and longitude.

Attitude Freeze permits simulator instructor to simultaneously freeze pitch, bank, and heading.

Parameter Freeze permits simulator instructor to freeze any one or a combination of flight parameters.[a]

MONITORING FEATURES

Closed Circuit TV permits simulator instructor to monitor student's behavior from the instructor console.

Repeaters/Annunciators provide simulator instructor with replicas or analog representations of flight instruments and controls at the instructor console.

Table 1. (Concluded)

Instructor Console Displays permit simulator instructor to monitor parameters and procedures at the instructor console by means of alphanumeric and/or graphic CRT displays of performance data.[a]

Automated Performance Alert provides simulator instructor with visual and/or auditory signals that indicate specific performance deficiencies.

FEEDBACK FEATURES

Record/Playback permits simulator instructor to record and subsequently play back a segment of simulated flight.[a]

Automated Performance Feedback provides a student with visual and/or auditory signals (including verbal messages) that identify performance deficiencies.

Automated Voice Controller is the computer-based technology that simulates the role of a controller by combining speech generation, speech recognition, and situation awareness capabilities.

Hard Copy provides a record of alphanumeric and/or graphic performance data.[a]

Performance Scoring provides a metric that summarizes aircrew task performance during a simulated mission.[a]

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[a] These features were included in the Phase III questionnaire.

It appears that military ATDs are more often treated as substitute aircraft than as teaching machines. A recent report by the United States General Accounting Office (1983) concluded that the Armed Services have not sufficiently analyzed their training requirements for simulators. Nor have they adequately incorporated simulators into their training programs. In justifying the purchase of ATDs, the Services have focused instead on "duplicating the actual weapon systems and their surroundings...with little reference to how the devices could meet training needs" (p.4).

By providing AIF capability, simulator manufacturers apparently recognize that the training value of an ATD is determined not only by the degree to which it faithfully mimics a particular aircraft, but also by the way that it is used (Caro, 1973). Previous research suggests that effective AIF-based simulator training is practicable (see Polzella, 1983, p.8). However, instructional features are expensive to implement, especially those features that require the development of complex software. In order to justify these costs, some questions concerning the present and potential utility and utilization of AIFs should be answered: How frequently and easily are AIFs used? Are simulator instructors adequately trained to use AIFs? Do AIFs have significant training value?

The present investigation was conducted at the request of the Simulator System Program Office (SimSPO) of the Air Force Systems Command, Aeronautical Systems Division (AFSC/ASD) in order to answer these questions. The specific objectives of this investigation were:

1. To document and compare the utilization (i.e., frequency and ease of use) of AIFs.

2. To document and compare the utility (i.e., training value) of AIFs.

3. To compare the utility and utilization patterns of AIFs in replacement (e.g., basic, primary, lead-in, initial, transition) and continuation (e.g., advanced, follow-on, refresher, operational) training units.

A broader objective of this investigation was to provide a database that could be helpful both in defining the requirements for ATD procurements and in developing future ATD training programs.

These objectives were to be accomplished in three phases by means of a survey of simulator instructors from the Air Force Major Commands (MAJCOMs). Phases I and II have already been completed, and the results of those surveys are documented in two earlier reports (Polzella, 1983, 1985).

The subjects in Phase I were 134 simulator-qualified Instructor Pilots and Weapons Director Instructors (WDIs) assigned to Replacement Training Units (RTUs) and Continuation Training Units (CTUs) at F-4E, F-4G, F-15, A-10, and E-3A Tactical Air Command (TAC) training sites. The results indicated that most TAC SIs received little training in AIF use and that most features were not used very often. Several factors appeared to have contributed to the low usages: (a) hardware and/or software unreliability, (b) time-consuming implementation, (c) functional limitations, and (d) design deficiencies. The results of a multiple regression analysis indicated that ease of use and training value accounted for most of the variability in the frequency-of-use ratings.

The utility and utilization of particular AIFs differed both as a function of ATD and of training unit. For example, features such as freeze and reset were generally used more often during RTU missions, whereas programmed mission scenarios were generally used more often during CTU missions. These differences appeared to reflect differences in the respective training missions. Thus, RTU missions characteristically include a series of discrete procedural exercises, whereas lengthier scenarios are common during CTU missions.

The subjects in Phase II were 273 simulator-qualified instructor pilots (IPs), instructor flight engineers (IFEs), and instructor radar navigators (IRNs) assigned to Air Training Command (ATC; T-37, T-38), Military Airlift Command (MAC; C-5A, C-141, C-130, CH-3, HH-53) or Strategic Air Command (SAC; FB-111A) ATD training sites.

The most striking difference between the Phase I and Phase II results was in the overall magnitude of the ratings. In comparison to the TAC SIs, the ATC, MAC, and SAC SIs used AIFs more often, found them easier to use, received more training in their use, and considered AIFs to be more important for training. The results suggested that TAC's training program for SIs is less extensive and less structured than those of the other MAJCOMs.

The level of AIF use among ATC, MAC, and SAC SIs was affected somewhat by hardware and/or software unreliability, implementation time, functional limitations, and design deficiencies. However, training value appeared to be the most important determiner of AIF use.

Based on the results of Phases I and II, it was recommended that future procurement of AIFs be preceded by a detailed front end analysis that clearly relates AIF capability to training needs. The analysis should consider all known training applications of the simulator as well as any major constraints in the operational environment. During procurement, AIF specifications should be prepared to meet user needs and to ensure equipment reliability. After operational deployment, the user should provide adequate instructor/operator training in AIF use.

Phase III, which is described in this report, extended the survey to electronic warfare instructors from ATC, TAC, and SAC.

II. METHOD

Subjects

The subjects in Phase III were 155 simulator-qualified electronic warfare instructors (IEW), weapon systems officers (WSOs), aerial gunnery instructors (IAGs), and radar navigator instructors (IRNs). The distribution of SIs among the various ATD sites surveyed is shown in Table 2. Also included in that table are the SIs' mean (and standard deviation) number of hours of instructor experience.

Table 2. Simulator Instructor (SIs) Surveyed in Phase III

Command	ATD	ATD-SITE	Type of training	Type of SI	N	Instructor hours
ATC	T-5	Mather AFB	Basic	IEW	19	287.4 (276.0)
SAC	T-4 (B-52)	Castle AFB	Transition	IEW	20	731.2 (754.6)
		Mather AFB	Operational	IEW	8	188.9 (224.6)
	WST (B-52)	Castle AFB	Transition	IEW,IAG	9	674.9 (747.8)
		Wurtsmith AFB	Operational	IEW,IAG	6	396.2 (231.9)
	FB-111A[a]	Plattsburgh AFB	Transition	IRN	11	677.3 (426.2)
		Plattsburgh AFB	Operational	IRN	9	175.6 (213.8)
		Pease AFB	Operational	IRN	12	210.2 (182.7)
TAC	F-4G	George AFB	Replacement	IEW	13	128.4 (116.1)
		George AFB	Continuation	IEW,IP	19	73.1 (56.4)
	A-10	Davis-Monthan AFB	Replacement	IP	16	98.8 (85.8)
		England AFB	Continuation	IP	17	52.6 (37.4)
					155	

[a]Data from these sites were collected during Phase II.

Questionnaire

The questionnaire that was used to survey the instructors is shown in Appendix A. Although it is similar to those used during Phases I and II (see Polzella, 1983, Appendix A; 1985, Appendix), several important modifications were incorporated.

The first page of the questionnaire requested information concerning flying and simulator experience, the type of training in ATD operations received by the SIs, a description of a typical simulator training session, and general comments and/or recommendations.

The second page of the questionnaire included a list of 14 AIFs (drawn from the list in Table 1) and their definitions, and a space next to each feature that was used to indicate the operational status of that feature (e.g., no such capability, and capability present but unreliable, and capability present and reliable).

On subsequent pages were five questions concerning the utility and utilization of each feature.

1. How often have you used it?

2. How difficult/easy is it to use?

3. How inadequate/adequate was the training you received in its use?

4. As presently implemented, how useful is it?

5. How potentially useful is it?

For the fifth question, SIs were to assume that they had no prior knowledge of the features and to base their responses on the feature definitions alone. This question was included in order to achieve a common basis for comparison among all SIs. This was not otherwise possible because the various ATDs were not similarly equipped.

Responses to each question were indicated by checking the appropriate interval along a seven-point, successive-category rating scale. (On certain questions a 0-interval was included for indicating "not applicable.") The intervals of each scale were labeled with descriptive adjectives in order to facilitate responding and to help interpret the ratings. Additional space was provided for comments.

Procedure

The questionnaire was administered on-site to various sized (N = 5 to 10) groups of SIs. The SIs were briefed on the purpose of the investigation and copies of the questionnaire were distributed and thoroughly reviewed prior to being filled out. For the most part, the questionnaire was self-explanatory. However, Question 3 (How inadequate/adequate was the training you received?) required some additional instruction. For this question, the SIs were asked to rate each feature twice. The first rating assessed the training received in the operation of that feature, whereas the second rating assessed the training received in the <u>effective</u> use of that feature (in terms of student outcome).

The questionnaire could be completed in approximately 30 minutes.

III. RESULTS

Table 3 lists the 14 AIFs that were included in the questionnaire along with their definitions. The table also lists a mnemonic code for each feature, which will be used in subsequent tables. The AIF capabilities of the various ATDs are shown in Table 4.

The Phase III questionnaire yielded the following data from each SI:

1. Number of hours of flying and simulator experience.

2. Type of training received.

3. Description of a typical training session.

4. Assessment of the operational status of each AIF.

5. Ratings of the AIFs on each of the five questions (including the two ratings of Question 3).

6. Comments.

The data were classified by ATD (T-5, F-4G, A-10, T-4 WST, FB-111A), level of training (e.g., transition, operational), Question (1 through 5), and AIF (1 through 14). The resulting data matrix was unbalanced due to differences in the numbers of SIs and in the AIF capabilities of the various ATDs (see Tables 2 and 4). In most cases, this necessitated analyzing the data from each ATD separately.

Descriptive statistics were computed for type of training received by the SIs and for their assessment of the operational status of each AIF. Multivariate analyses of variance were used to analyze the ratings of each feature across the first four questions. The data from Question 5 were analyzed separately. The multivariate model was based on a two-factor mixed design in which level of training was the between-subjects factor, AIF was the within-subjects factor, and the ratings on the first four questions were the dependent variables. Missing data were deleted "list-wise," i.e., subjects who did not rate a feature on all four questions were eliminated from the analyses.

Approximate F-values, derived from Wilks' lambda, were used to test the overall multivariate significance of each effect in the model, i.e., AIF, level-of-training, and the AIF by level-of-training interaction, while univariate <u>F</u>s were used to test the significance of these effects for each of the four questions separately. Tukey honestly significant difference (HSD) values were computed for each univariate analysis. These values were used to determine significant differences between particular ratings, e.g.,

Table 3. Advanced Instructional Features Included in the Phase III Questionnaire

Code	Feature
IT	Instructor Tutorial - provides the instr ctor with self-paced programmed instruction in the capabilities and use of the simulator.
R	Reset - permits instructor to "return" the simulated aircraft to a stored set of conditions and parameters.
TSF	Total System Freeze - permits instructor to interrupt and suspend simulated flight by freezing all system parameters.
PF	Partial Freeze - permits instructor to freeze various flight parameter combinations such as altitude, heading, position, attitude, flight system, etc.
RB	Recorded Briefing - permits instructor to provide student with information about a structured training session through audio/visual media presentation.
D	Demonstration - permits instructor to demonstrate optimal electronic warfare procedures by prerecording and subsequently playing back a simulated engagement.
RP	Record/Playback - permits instructor to record and subsequently playback a segment of simulated flight.
AMI	Automated Malfunction Insertion - permits instructor to preprogram a sequence of aircraft component malfunctions and/or emergency conditions.
HC	Hard Copy - provides a record of alphanumeric and/or graphic performance data for debriefing purposes.
PTC	Programmed Threat Control - computer-controlled standardized training sessions based on preprogrammed event sequences.
MTC	Manual Threat Control - permits instructor to modify threat scenarios during a training session.
PRM	Procedures Monitoring - permits instructor to monitor discrete actions performed by the student in accordance with a procedurally defined checklist.
PAM	Parameters Monitoring - permits instructor to monitor various instrument readings, control settings, aircraft states, or navigational profiles.
EWS	Electronic Warfare Performance Scoring - provides a performance metric that summarizes the outcomes of EW engagements.

Table 4. AIF Capability of Each ATD

Feature	T-5	T-4	WST	FB-111A[a]	F-4G	A-10
IT						
R	X	X	X	X	X	X
TSF	X	X	X	X	X	X
PF			X	X	X	X
RB	X	X				
D						X
RP			X			X
AMI	X	X	X		X	X
HC	X		X	X	X	
PTC	X	X	X	X	X	X
MTC	X	X	X	(X)	X	X
PRM	X	X	X	X		X
PAM	X	X	X	X		X
EWS	X		X	(X)		X

[a]FB-111A data were collected during Phase II using a different version of the questionnaire. Data are not available for those features that are in parentheses. Programmed Threat Control (PTC) was listed as Programmed Mission Scenarios (PMS) on the Phase II questionnaire.

training value of manual threat control vs. training value of programmed threat control, frequency of RTU use of reset vs. frequency of CTU use of reset.

The interrelations among the utility and utilization ratings were determined by means of correlation and regression analyses. First, intercorrelations were computed between the ratings of each feature across the five questions. Second, multiple linear regression analyses were used to determine those variables which significantly predicted the frequency of AIF use. Three potential predictors were evaluated: the ease of AIF use, the adequacy of training received (a composite variable representing the average of the two ratings on Question 3), and AIF usefulness (a composite variable representing the average of the ratings on Questions 4 and 5). Missing data were deleted "list-wise" from these analyses.

Air Training Command

T-5 Trainer

Training mission. The T-5 ATD is a sophisticated generic trainer for primary level electronic warfare skills. The typical training session lasts 3 to 4 hours and includes a 15-minute prebriefing of mission objectives, a 2 1/2-to 3 1/2-hour mission, and a 30-minute debriefing/critique. A complete mission, from takeoff to landing, normally requires the student to search for, identify, and determine the parameters of electronic warfare (EW) signals and select appropriate countermeasures. The instructor's role is to (a) monitor student progress for speed and accuracy, (b) freeze and offer feedback verbally and through demonstration, and (c) reset as required.

Training of SIs. On the average, formal classroom instruction accounted for 28% of the initial training for the T-5 SIs (SD = 29%). Only 11% of the SIs reported having received any refresher training, and nearly all of that training was characterized as informal.

AIFs. The operational status of each AIF on the T-5 trainer is summarized in Table 5. A small percentage of SIs indicated that there are operational problems with recorded briefing and programmed threat control. Otherwise, all available features appear to operate reliably. The table shows that a substantial proportion of SIs apparently have never operated auto malfunction insertion (0.32), manual threat control (0.58), or electronic warfare performance scoring (0.28). (Note: These proportions include those SIs who indicated "no such capability" for these features.)

Utilization and utility ratings. The ratings for the T-5 SIs are summarized in Table 6. Means and standard deviations are listed for available features under Questions 1 to 4 and for all features under Question 5 (potential usefulness). The multivariate analysis of variance revealed a significant overall effect of AIF, $F(45, 463.85) = 4.25$, $p < .001$. Each univariate F ($df = 9,107$) was also significant, $p < .001$.

Table 5. T-5 Trainer: The Number of IEWs Indicating the Operational Status of Each AIF

Feature	No such capability	Never operated	Unreliable	Reliable
IT	16	3	0	0
R	0	0	1	18
TSF	0	0	0	19
PF	12	2	0	4
RB	2	1	3	13
D	15	2	1	1
RP	18	1	0	0
AMI	2	4	0	13
HC	1	2	0	16
PTC	0	1	2	16
MTC	2	9	0	8
PRM	0	1	0	18
PAM	3	1	0	15
EWS	0	4	0	15

Table 6. T-5 Trainer: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(2)	TRECD (2)	TVALUE	PTVALUE
IT						4.2 (1.9)
R	4.5 (1.5)	5.9 (0.5)	6.1 (1.6)	6.1 (1.0)	6.4 (0.8)	6.6 (0.6)
TSF	5.3 (2.1)	6.2 (0.4)	6.7 (0.5)	6.6 (0.5)	6.3 (1.3)	6.5 (0.8)
PF						4.6 (2.2)
RB	4.2 (2.1)	5.8 (1.2)	6.4 (1.0)	6.2 (1.0)	5.6 (1.4)	4.9 (1.8)
D						5.0 (1.4)
RP						5.3 (1.4)
AMI	3.4 (1.6)	5.5 (1.7)	5.2 (2.5)	5.4 (1.9)	4.8 (1.6)	4.9 (1.7)
HC	2.9 (1.7)	6.2 (1.0)	6.0 (1.1)	6.1 (1.3)	6.1 (1.7)	6.6 (1.0)
PTC	6.4 (1.1)	6.2 (1.1)	5.9 (1.7)	6.1 (1.6)	6.6 (0.7)	6.4 (0.9)
MTC	1.6 (0.8)	3.9 (1.1)	2.7 (1.4)	3.8 (1.3)	2.9 (1.6)	4.5 (1.6)
PRM	6.5 (1.4)	6.1 (0.8)	6.5 (0.9)	6.3 (1.2)	6.1 (1.8)	6.5 (1.0)
PAM	6.0 (1.9)	6.2 (0.8)	6.4 (0.9)	5.9 (1.5)	5.6 (2.2)	6.0 (1.5)
EWS	5.3 (2.1)	6.4 (1.0)	6.5 (0.8)	6.6 (0.6)	6.2 (1.5)	6.3 (1.2)
	4.6 (2.2)	5.8 (1.2)	6.0 (1.5)	6.0 (1.4)	5.7 (1.8)	5.6 (1.6)

Frequency of use was highest for programmed threat control, procedures monitoring, and parameters monitoring. These features were used at an average rate of at least five times each mission. Frequency of use was lowest for auto malfunction insertion, hard copy, and manual threat control. These features were used significantly less often than most of the AIFs (Tukey $HSD_{.01} = 2.08$). With the exception of manual threat control, ease of use was uniformly high for all AIFs (Tukey $HSD_{.01} = 1.13$). The training received by the SIs was apparently adequate despite the lack of both formal classroom instruction and refresher training. (See previous section.) This was not the case for manual threat control, however. Training in its operation and in its effective use was not judged to be adequate. Manual threat control received significantly lower ratings on these variables than did all other AIFs ($p < .05$). A similar pattern emerged for the training value ratings. Most of the features were judged to be at least very useful, whereas manual threat control was rated the least useful of all AIFs (Tukey $HSD_{.01} = 1.51$).

The separate analysis of the potential training value ratings (Question 5) also yielded a significant effect of AIF, $F(13,231) = 8.65$, $p < .001$. Every feature was judged to have at least moderate potential usefulness (including manual threat control); however, those features that are presently unavailable (i.e., instructor tutorial, partial freeze, etc.) were generally rated lower than were those AIFs that are already implemented (Tukey $HSD_{.05} = 1.42$).

Interrelations among utilization and utility ratings. Table 7 shows the intercorrelations among the ratings of each feature on each of the five questions. All the coefficients were positive and significant, $p < .01$. Thus, a feature's rating on any question can be predicted with greater than chance accuracy given its rating on any other question. For example, the more useful a feature was, the more frequently it was used, the easier it was to use, the more adequate was the training in its use, and the greater was its potential training value. However, these predictions would not be equally precise. The coefficients of determination (i.e., the squared r values) ranged from .07 (FREQUSE/TRECD(2)) to .64 (TRECD(1)/TRECD(2)) over the entire matrix.

Table 8 summarizes the results of a multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of ease of use, adequacy of training received (a composite variable representing the average of the two ratings on Question 3), and training value (a composite variable representing the average usefulness and potential usefulness). The table indicates that, together, the predictor variables accounted for approximately 30% of the variability in the frequency-of-use ratings. However, the only significant predictor was training value.

Comments. Most of the comments concerning the T-5 ATD were favorable. However, several instructors noted that instructor training and programming support are inadequate; consequently, many of the advanced capabilities of the T-5, such as computer-aided instruction, are not fully utilized. A significant operational deficiency is that the T-5 is too slow to adequately monitor rapidly performed procedural checklists.

Table 7. T-5 Trainer: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
FREQUSE	1.00					
EASEUSE	.31	1.00				
TRECD(1)	.37	.68	1.00			
TRECD(2)	.26	.62	.80	1.00		
TVALUE	.54	.37	.48	.55	1.00	
PTVALUE	.41	.26	.32	.34	.62	1.00

Note All correlations are significant, $p < .01$.

Table 8. T-5 Trainer: Multiple Linear Regression of Frequency of Use on Ease of Use, Adequacy of Training Received, and Training Value

DEPENDENT VARIABLE: Frequency of AI Use

MULTIPLE R: .55 STD. ERROR OF EST.: 1.56

MULTIPLE R-SQUARE: .30

ANALYSIS OF VARIANCE:

	Sum of Squares	df	Mean Squares	F-Ratio	p
REGRESSION	144.2528	3	48.0842	19.844	.000
RESIDUAL	329.5401	136	2.431		

Predictor variable	Coefficient	Standard error	Standard regression coefficient	t	p
EASEUSE	.3095	.1943	.1564	1.593	.1135
TRECD	-.0314	.1437	-.0232	-.218	.8275
TVALUE	.9342	.1574	.4914	5.935	.0000
(CONSTANT)	-2.2552	1.0801			

Strategic Air Command

T-4 Trainer

Training mission. The T-4 ATD provides both transition and operational training for B-52 electronic warfare officers. The typical training session lasts 2 to 3 hours and includes a 15-minute prebriefing of mission objectives and interference checks, a 2-hour mission, and a 15-minute debriefing/critique. The transition and operational missions are highly similar. Both missions require the student to recognize and counteract a series of threats encountered during high-level, low-level, and over-water penetrations into enemy territory. Various malfunctions and emergencies are distributed throughout the mission. Although a mission can proceed under computer control, the T-4 SI can modify mission flow and content through the discretionary use of manual insertions, freezes, and resets.

Training of SIs. The T-4 SIs received both formal and informal instruction. Formal classroom instruction accounted for 38% of T-4 RTU SIs' initial training (SD = 31%), and 70% of T-4 CTU SIs' initial training (SD = 25%). Also, 45% of the RTU SIs and 38% of the CTU SIs reported having received refresher training (approximately once within the preceding year). However, 26% of the RTU refresher training and 80% of the CTU refresher training were characterized as formal classroom instruction.

AIFs. The operational status of each AIF on the T-4 trainer is summarized in Table 9. All available features, except recorded briefing, appear to operate reliably.

Utilization and utility ratings. The ratings by the T-4 RTU and CTU SIs are summarized in Tables 10 and 11, respectively. Means and standard deviations are listed for available features under Questions 1 to 4 and for all features under Question 5 (potential usefulness). The multivariate analysis of variance revealed a significant overall effect of AIF, $F(25,410.13) = 4.34$, $p < .001$. Except for training value, each univariate F (df = 5,114) was also significant, $p < .001$. Neither level of training, nor the AIF by level of training interaction was significant at the multivariate level.

Frequency of AIF use was high overall. The average feature was used at least two to four times a mission. Procedures and parameters monitoring were used most often, threat control (programmed and manual) and freeze, slightly less so. Recorded briefing was used hardly at all (Tukey $HSD_{.01} = .88$). Ease of use was also high overall, although the means were not statistically equivalent (Tukey $HSD_{.01} = .84$). The training received by the SIs (in both the operation and effective use of the features) was judged to be "very adequate." Moreover, each feature (except recorded briefing, as rated by the transition SIs) was judged to be "very useful."

The separate analysis of the potential training value ratings revealed a significant effect of AIF, $F(13,337) = 16.29$, $p < .001$. However, neither the effect of level of training nor the AIF by level of training

Table 9. T-4 Trainer: The Number of IEWs (Transition and Operational) Indicating the Operational Status of Each AIF

Feature	No such capability		Never operated		Unreliable		Reliable	
	T	O	T	O	T	O	T	O
IT	19	7	0	0	0	0	1	1
R	1	0	0	0	0	0	19	8
TSF	0	0	0	0	0	0	20	8
PF	18	7	0	0	0	0	2	1
RB	6	3	6	1	3	0	5	4
D	16	5	1	0	0	0	3	3
RP	16	7	2	0	0	0	2	1
AMI	8	4	0	1	1	0	11	3
HC	20	8	0	0	0	0	0	0
PTC	0	0	0	0	0	0	20	8
MTC	0	0	0	0	0	0	20	8
PRM	4	3	0	0	0	0	16	5
PAM	4	2	0	0	0	0	16	6
EWS	20	8	0	0	0	0	0	0

Table 10. T-4 Transition Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.0 (1.7)
R	5.4 (1.0)	5.7 (0.9)	6.8 (0.5)	6.4 (0.8)	6.3 (1.2)	6.0 (1.1)
TSF	6.0 (0.9)	6.2 (0.5)	6.8 (0.5)	6.4 (0.8)	6.6 (0.8)	6.6 (0.8)
PF						4.0 (2.0)
RB	1.2 (0.4)	4.4 (1.7)	3.9 (2.5)	5.0 (2.2)	2.1 (1.2)	3.0 (1.1)
D						4.6 (1.7)
RP						4.6 (2.0)
AMI	4.5 (1.0)	5.6 (0.5)	5.5 (1.7)	5.6 (1.4)	5.5 (1.5)	4.8 (1.8)
HC						3.2 (1.9)
PTC	5.9 (1.4)	6.0 (1.2)	6.6 (0.8)	6.0 (1.1)	6.4 (0.7)	6.4 (0.7)
MTC	6.0 (1.1)	4.7 (1.1)	6.4 (0.7)	6.0 (1.3)	6.7 (0.6)	6.6 (0.6)
PRM	6.6 (0.9)	4.9 (1.4)	6.1 (0.8)	5.5 (1.5)	6.0 (1.5)	6.0 (1.4)
PAM	6.8 (0.8)	5.2 (0.8)	5.8 (1.2)	5.7 (1.0)	6.0 (1.3)	5.6 (2.2)
EWS						4.2 (1.9)
	5.4 (1.9)	5.4 (1.2)	6.2 (1.3)	5.9 (1.3)	5.8 (1.7)	5.0 (1.9)

Table 11. T-4 Operational Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD (1)	TRECD (2)	TVALUE	PTVALUE
IT						3.8 (1.6)
R	5.5 (1.2)	5.9 (0.4)	6.5 (0.8)	6.5 (0.8)	6.6 (0.5)	6.5 (0.5)
TSF	6.1 (1.1)	6.4 (0.5)	6.9 (0.4)	6.9 (0.4)	6.7 (0.5)	6.4 (0.9)
PF						4.1 (2.5)
RB	2.5 (1.0)	4.8 (1.3)	6.0 (1.4)	7.0 (0.0)	6.0 (0.8)	4.9 (1.4)
D						5.9 (1.2)
RP						6.1 (1.0)
AMI	4.3 (3.1)	4.7 (1.2)	7.0 (0.0)	6.5 (0.7)	6.5 (0.6)	5.5 (1.7)
HC						4.1 (2.2)
PTC	6.2 (1.2)	5.9 (2.1)	6.6 (0.5)	6.4 (1.1)	6.8 (0.5)	6.8 (0.5)
MTC	6.1 (0.8)	6.0 (0.5)	6.4 (0.5)	6.5 (0.5)	6.6 (0.5)	6.9 (0.4)
PRM	6.6 (0.9)	5.2 (1.1)	6.0 (1.0)	5.6 (1.3)	6.3 (1.2)	6.0 (2.1)
PAM	6.7 (0.8)	6.0 (1.3)	6.2 (0.8)	6.0 (0.6)	6.5 (0.8)	5.5 (2.3)
EWS						4.4 (2.1)
	5.5 (1.8)	5.8 (1.2)	6.5 (0.7)	6.4 (0.8)	6.6 (0.7)	5.5 (1.8)

interaction was significant, $F(1,26) = 3.13$, $p > .05$ and $F(13,337) = 1.15$, $p > .05$, respectively. Potential usefulness was fairly high overall. Programmed and manual threat control received the highest ratings, whereas instructor tutorial, partial freeze, recorded briefing, hard copy, and electronic warfare performance scoring received only moderate ratings (Tukey $HSD_{.01} = 1.52$).

Interrelations among utilization and utility ratings. Table 12 shows the intercorrelations among the ratings of each feature on each of the five questions. Most of the coefficients were positive and significant. The matrix suggests, for example, that the more useful a feature was, the more frequently it was used, the easier it was to use, the more adequate was the training in its use, and the greater was its potential training value. It should be noted, however, that not all variables were significantly correlated. For example, although ease of use and adequacy of training received were positively correlated, neither variable was related to frequency of use. The matrix reflects considerable variability in the level of predictability among the variables. The coefficients of determination ranged from .00 (FREQUSE/EASEUSE) to .53 (TVALUE/PTVALUE).

Table 12. T-4 Trainer: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD (1)	TRECD (2)	TVALUE	PTVALUE
FREQUSE	1.00					
EASEUSE	.06	1.00				
TRECD(1)	.13	.32**	1.00			
TRECD(2)	-.05	.36**	.46**	1.00		
TVALUE	.46**	.17*	.40**	.29**	1.00	
PTVALUE	.50**	.16*	.21**	.23**	.73**	1.00

* $p < .05$.
** $p < .01$.

Table 13 summarized the results of a multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of ease of use, adequacy of training received, and training value. The table indicates that, together, the predictor variables accounted for 28% of the variability in the frequency-of-use ratings.

Table 13. T-4 Trainer: Multiple Linear Regression of Frequency of Use on Ease of Use, Adequacy of Training Received, and Training Value

DEPENDENT VARIABLE: Frequency of AIF Use

MULTIPLE R: .53 STD. ERROR OF EST.: 1.28

MULTIPLE R-SQUARE: .28

ANALYSIS OF VARIANCE:

	Sum of Squares	df	Mean Square	F-Ratio	p
REGRESSION	117.9240	3	39.3080	23.954	.0000
RESIDUAL	297.0165	181	1.6410		

Predictor variable	Coefficient	Standard error	Standard regression coefficient	t	p
EASEUSE	.0400	.0934	.0294	.428	.6690
TRECD	-.2972	.1225	-.1757	-2.426	.0163
TVALUE	.7720	.0917	.5679	8.419	.0000
(CONSTANT)	2.5259	.7709			

Training value was clearly the most important predictor. However, adequacy of training also contributed significantly to the equation (even though it was negatively related to the dependent variable). Ease of use did not contribute significantly.

Comments. The T-4 ATD was one of the most highly regarded devices surveyed. In fact, many IEWs preferred it to the more sophisticated B-52 Weapon System Trainer (B-52 WST; see below). One frequent criticism was that modifications in T-4 hardware and software have not kept pace with those of the aircraft.

B-52 Weapon System Trainer - Defensive Stations

Training mission. The B-52 Weapon System Trainer (WST) is one of the most sophisticated ATDs in the Air Force inventory (Stein, 1984). It can provide training for the entire six-man B-52 crew via three separate instructor consoles: the flight instructors console (pilot, co-pilot), the navigation instructors console (navigator, radar navigator), and the defensive avionics systems instructors console (electronic warfare officer, gunner).

The WST can operate in either independent or integrated mode, depending on whether one or all of the crew stations are active at a given time. The integrated capability makes the WST particularly useful for training crew coordination. The typical independent WST training session (defensive) is similar to that of the T-4 except that the WST has more sophisticated threat library, weapons, real-time randomness, maneuvering, monitoring and mission generation capabilities. The integrated session, which includes briefing, mission, and debriefing, may last up to five hours. The independent mission normally lasts up to two hours.

The emergency war order (EWO) mission provides a context for both transition and operational (continuation) training. The integrated EWO mission includes equipment checks and malfunction evaluations, takeoff, air refueling, high-level flight, descent into enemy territory, defense of aircraft in various encounters (airborne interceptors, ships, land-based threats), monitoring of EW equipment, ECM, malfunction analyses, climb and withdrawal, and landing. During independent missions, the instructors use multiple malfunctions, freezes, and resets in order to work on specific problem areas (e.g., malfunction analyses, signal recognition, jamming).

Training of SIs. On the average, formal classroom instruction accounted for only 8% of the initial training for the RTU SIs (SD = 11%) and 25% for the initial training of the CTU SIs (SD = 29%). Only one WST SI reported having received any refresher training.

AIFs. The operational status of each AIF on the B-52 WST is summarized in Table 14. There appear to be operational problems associated with all available features except auto malfunction insertion. The least reliable AIFs (i.e., those AIFs that were called "unreliable" by at least 0.30 of the SIs) were record/playback (0.73), programmed threat control (0.33), procedures monitoring (0.53), and electronic warfare performance scoring (0.53).

Utilization and utility relations. The B-52 WST RTU and CTU SIs' ratings are summarized in Tables 15 and 16, respectively. Means and standard deviations are listed for available features under Questions 1 to 4 and for all features under Question 5 (potential usefulness). The multivariate analysis of variance revealed a significant overall effect of AIF, $F(45,432.53) = 4.85$, $p < .001$. Univariate Fs (df = 9,100) were significant for frequency of use ($p < .001$), ease of use ($p < .001$), and training value ($p < .001$), but not for adequacy of training received ($p < .05$). Although the multivariate effect of level of training was not significant, $F(5,3) = 1.05$, $p < .05$, there was a weak but significant AIF by level of training interaction, $F(45,432.53) = 1.47$, ($p < .05$).

Frequency of AIF use was lower overall than was the case for the T-4. The average feature was used approximately once each mission. Threat control (programmed and manual) and parameters monitoring were used most often (at least two to four times a mission), whereas record/playback (called "unreliable" by 73% of the SIs), hard copy (called "unreliable" by 20% of the SIs), and partial freeze were used significantly less often (Tukey $HSD_{.01} = 2.48$). Ease of use was fairly high overall. Programmed

Table 14. B-52 WST-Defensive Station: The Number of SIs (Transition and Operational) Indicating the Operational Status of Each AIF

Feature	No such capability		Never operated		Unreliable		Reliable	
	T	O	T	O	T	O	T	O
IT	7	6	0	0	1	0	1	0
R	0	0	1	0	2	1	6	5
TSF	0	0	0	0	0	0	9	6
PF	0	0	0	0	1	0	8	6
RB	8	6	1	0	0	0	0	0
D	7	1	1	1	1	1	0	3
RP	2	0	1	0	6	5	0	1
AMI	0	0	0	0	0	0	9	6
HC	1	0	0	0	2	1	6	5
PTC	0	0	0	0	4	1	5	5
MTC	0	0	0	0	3	1	6	5
PRM	2	0	0	0	6	2	1	4
PAM	1	0	0	0	2	2	6	4
EWS	0	0	2	0	4	4	3	2

Table 15. B-52 WST Transition Training: Mean Ratings (and Standard Deviations) of the Frequency of Use Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.3 (1.7)
R	4.0 (1.5)	5.1 (1.1)	4.4 (1.9)	4.6 (1.7)	4.9 (1.8)	6.1 (0.6)
TSF	5.1 (0.6)	6.1 (0.6)	6.6 (0.5)	6.1 (1.3)	6.6 (0.7)	6.7 (0.5)
PF	3.2 (1.3)	5.9 (0.8)	5.5 (1.5)	5.1 (1.5)	6.0 (1.0)	6.4 (0.5)
RB						3.8 (1.6)
D						5.2 (1.3)
RP	1.2 (0.4)	2.8 (1.1)	3.4 (1.8)	3.6 (2.1)	3.2 (2.1)	5.8 (0.7)
AMI	5.1 (1.1)	5.7 (1.3)	4.5 (2.4)	5.6 (1.9)	5.9 (0.9)	6.2 (0.7)
HC	2.2 (0.7)	4.4 (1.8)	5.0 (2.1)	4.6 (1.9)	3.1 (1.5)	5.2 (1.6)
PTC	5.1 (2.1)	6.1 (1.3)	5.8 (1.7)	5.1 (2.0)	5.8 (1.4)	6.8 (0.4)
MTC	5.8 (1.6)	4.1 (0.9)	5.2 (2.0)	4.9 (1.8)	6.6 (0.7)	7.0 (0.0)
PRM	5.0 (3.1)	5.2 (1.6)	5.1 (2.1)	4.6 (2.1)	3.0 (1.7)	4.7 (2.2)
PAM	6.5 (0.9)	4.4 (1.7)	5.7 (1.0)	5.6 (1.4)	4.5 (1.5)	5.2 (2.2)
EWS	2.9 (1.9)	5.1 (1.6)	5.2 (2.0)	4.8 (1.6)	3.8 (1.8)	5.8 (1.3)
	4.3 (2.1)	5.0 (1.5)	5.2 (1.9)	5.0 (1.7)	5.0 (1.8)	5.7 (1.5)

Table 16. B-52 WST Operational Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.8 (1.9)
R	4.2 (1.2)	5.3 (1.4)	6.2 (0.8)	5.7 (2.0)	5.7 (1.8)	6.2 (1.6)
TSF	4.7 (1.4)	6.7 (0.5)	6.7 (0.5)	6.2 (1.2)	6.0 (2.0)	6.7 (0.5)
PF	3.2 (1.5)	6.5 (0.5)	5.8 (1.2)	5.5 (1.4)	4.5 (2.2)	5.5 (2.1)
RB						4.2 (1.8)
D						4.5 (1.9)
RP	1.0 (0.0)	3.2 (1.5)	3.2 (1.8)	3.0 (2.5)	1.7 (1.2)	4.7 (1.8)
AMI	4.0 (2.7)	6.5 (0.8)	6.5 (0.8)	5.5 (2.1)	5.5 (2.0)	6.8 (0.4)
HC	2.0 (1.5)	4.5 (0.8)	5.5 (0.8)	5.0 (1.7)	2.5 (1.5)	4.3 (2.3)
PTC	6.7 (0.8)	6.7 (0.5)	6.2 (1.2)	5.3 (2.0)	6.2 (0.8)	6.7 (0.8)
MTC	5.3 (0.8)	4.3 (1.4)	6.2 (0.8)	6.3 (1.2)	6.5 (0.8)	6.7 (0.5)
PRM	4.7 (2.9)	3.2 (1.8)	5.0 (1.8)	4.3 (2.2)	4.3 (2.4)	6.2 (1.6)
PAM	5.8 (2.0)	4.3 (1.4)	5.7 (1.0)	5.2 (1.2)	6.2 (1.3)	6.3 (1.6)
EWS	4.2 (2.6)	3.8 (1.9)	5.3 (2.3)	5.2 (1.9)	3.0 (2.3)	5.3 (2.3)
	4.2 (1.7)	5.0 (1.8)	5.5 (1.6)	5.1 (2.0)	4.5 (2.3)	5.6 (1.8)

threat control, auto malfunction insertion, and freeze were rated "very easy," whereas record/playback was rated "fairly difficult" (Tukey $HSD_{.01}$ = 1.72). The training received by the SIs was apparently adequate despite the lack of both formal classroom instruction and refresher training. (See previous section.) Threat control (programmed and manual), auto malfunction insertion, and total system freeze were judged to have the most training value, whereas record/playback and hard copy were rated as only "fairly useful" (Tukey $HSD_{.01}$ = 2.00).

The separate analysis of the potential training value ratings revealed a significant effect of AIF, $F(13,169) = 6.72$, $p < .001$. However, neither the effect of level of training nor the AIF by level of training interaction was significant, $F < 1.00$ and $F(13,169) = 1.25$, $p < .05$, respectively. Potential usefulness was fairly high overall. In fact, it was somewhat higher than the usefulness of the AIFs as they are currently implemented (Question 4). Extremely high ratings were assigned to threat control (programmed and manual), auto malfunction insertion, and total system freeze. Even the lowest rated features (e.g., instructor tutorial, recorded briefing) were judged to be at least moderately useful. (Tukey $HSD_{.01}$ = 1.86).

Interrelations among utilization and utility ratings. Table 17 shows the intercorrelations among the ratings of each feature on each of the five questions. Most of the coefficients were positive and significant; the only exceptions were the correlations of potential training value with ease of use and adequacy of training received. The matrix reflects a low, although variable, level of predictability among the variables. The coefficients of determination ranged from .00 (PTVALUE/TRECD(2)) to .23 (TRECD(1)/TRECD(2)).

Table 17. B-52 WST: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
FREQUSE	1.00					
EASEUSE	.22*	1.00				
TRECD(1)	.30*	.50*	1.00			
TRECD(2)	.30*	.45*	.53*	1.00		
TVALUE	.49*	.41*	.32*	.52*	1.00	
PTVALUE	.35*	.16	.13	.06	.45*	1.00

* $p < .01$.

Table 18 summarizes the results of a multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of ease of use, adequacy of training received, and training value. The table indicates that, together, the predictor variables accounted for approximately 29% of the variability in the frequency-of-use ratings. Training value was clearly the most important predictor. However, adequacy of training received also contributed significantly to the equation. Ease of use did not.

Table 18. B-52 WST: Multiple Linear Regression of Frequency of Use on Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

DEPENDENT VARIABLE: Frequency of AIF Use

MULTIPLE R: .53 STD. ERROR OF EST.: 1.82

MULTIPLE R-SQUARE: .29

ANALYSIS OF VARIANCE:

	Sum of Squares	df	Mean Square	F-Ratio	p
REGRESSION	189.0932	3	63.0311	18.932	.0000
RESIDUAL	472.7766	142	3.3294		

Predictor variable	Coefficient	Standard error	Standard regression coefficient	t	p
EASEUSE	-.0724	.1112	-.0561	-.651	.5159
TRECD	.2823	.1222	.2012	2.311	.0223
TVALUE	.6723	.1175	.4496	5.722	.0000
(CONSTANT)	-.4946	.6967			

Comments. It was noted above that many WST AIFs were described as "unreliable." There were several other criticisms of the device: certain threats were said to be "out of date," thereby limiting effective ECM training. Moreover, the WST generates threats probabilistically. Some repeatability will be included with the threat update effort now in progress. Thus, it is not possible to replicate a particular threat scenario exactly. Another apparent problem is that feedback data, which are presented to the SIs on multiple CRT "pages," are not arranged for rapid access during dynamic situations.

FB-111A Operational Flight Trainer

The FB-111A radar navigator instructors' data were collected during Phase II. Those results are summarized in Appendix B (Tables B-1 through B-5). The reader is cautioned that, due to differences between the Phase II and Phase III questionnaires, the FB-111A results and those of Phase III are not directly comparable. See Polzella (1985) for additional information regarding the utility and utilization of the FB-111A Operational Flight Trainer AIFs.

Tactical Air Command

F-4G Simulator

Training mission. The F-4G Advanced Wild Weasel is the ultimate USAF version of the F-4 Phantom II fighter aircraft. In addition to its offensive capabilities, the F-4G carries ECM sensors, jamming pods, chaff dispensers, anti-radiation missiles, and advanced avionics. The typical F-4G simulator mission required students to demonstrate the various system capabilities within a highly dynamic scenario. The RTU and CTU missions are similar; however, CTU missions are characterized by more elaborate threat scenarios, whereas RTU missions tend to stress basic tactical skills.

A typical training session consists of a 15-minute briefing of the planned mission elements, a 1 1/2-hour mission, and 15 to 30 minutes for debriefing and critique. The major mission segments are preflight, takeoff, ingress into EW/target area, egress, and return to base. Mission elements normally include new APR-38 functions, surface-to-air missile (SAM) encounters, air-to-air intercepts, ordnance delivery, and a full spectrum of EW activity. In addition, there are frequent malfunctions, emergencies, and threats. F-4G SIs prefer to insert these manually and use freeze and reset as needed.

Training of SIs. On the average, formal classroom instruction accounted for 36% of the initial training for the RTU SIS (SD = 34%) and 15% of the initial training for the CTU SIs (SD = 22%). Only two F-4G SIs (1 RTU, 1 CTU) reported having received any refresher training.

AIFs. The operational status of each AIF on the F-4G simulator is summarized in Table 19. Except for hard copy, there appear to be few operational problems associated with the F-4G features. However, substantial proportions of SIs apparently have never operated partial freeze (0.47), auto malfunction insertion (0.84), and hard copy (0.53). (Note: The proportions include those SIs who indicated "no such capability" for these features.)

Utilization and utility ratings. The ratings for the F-4G RTU and CTU SIs are summarized in Tables 20 and 21, respectively. Means and standard deviations are listed for available features under Questions 1 to 4 and for

Table 19. F-4G Simulator: The Number of IEWs (Replacement and Operational) Indicating the Operational Status of Each AIF

Feature	No such capability		Never operated		Unreliable		Reliable	
	R	O	R	O	R	O	R	O
IT	12	17	0	1	1	0	0	1
R	3	0	0	0	0	1	10	18
TSF	0	0	0	0	0	0	13	19
PF	8	7	0	0	0	2	5	10
RB	13	19	0	0	0	0	0	0
D	13	18	0	1	0	0	0	0
RP	13	15	0	4	0	0	0	0
AMI	12	12	0	3	0	0	1	4
HC	5	2	4	6	4	5	0	6
PTC	1	1	4	1	0	3	8	14
MTC	0	0	0	0	0	0	13	19
PRM	13	16	0	0	0	0	0	3
PAM	12	16	0	0	1	1	0	2
EWS	12	14	1	2	0	1	0	2

Table 20. F-4G Simulator Replacement Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.4 (1.8)
R	4.0 (1.4)	5.5 (0.9)	5.2 (1.9)	5.2 (1.0)	5.5 (0.9)	6.0 (0.8)
TSF	4.2 (1.5)	6.0 (0.4)	5.8 (1.1)	5.3 (1.0)	5.4 (1.0)	5.8 (1.1)
PF	4.4 (0.9)	5.0 (1.7)	6.0 (0.6)	5.0 (1.7)	5.6 (1.1)	4.6 (2.1)
RB						3.5 (2.0)
D						4.4 (1.8)
RP						5.5 (1.5)
AMI						4.3 (1.7)
HC	2.3 (1.8)	4.2 (1.6)	4.2 (2.1)	4.5 (1.3)	3.6 (1.5)	4.6 (1.1)
PTC	3.0 (1.8)	5.7 (1.2)	5.3 (1.3)	4.7 (1.2)	4.5 (2.0)	5.4 (1.2)
MTC	6.5 (0.7)	4.2 (1.0)	4.9 (1.6)	4.8 (1.4)	6.3 (1.1)	6.4 (0.7)
PRM						4.8 (1.4)
PAM						5.2 (1.2)
EWS						5.0 (2.0)
	4.0 (2.0)	5.2 (1.0)	5.3 (1.5)	5.0 (1.2)	5.2 (1.6)	5.0 (1.6)

Table 21. F-4G Simulator Operational Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.4 (1.4)
R	4.9 (0.9)	6.0 (0.9)	6.5 (0.6)	6.2 (0.9)	6.1 (1.0)	6.4 (0.6)
TSF	4.2 (1.1)	6.3 (0.5)	6.7 (0.5)	6.4 (0.8)	6.3 (0.7)	6.5 (0.7)
PF	3.9 (1.4)	4.9 (1.2)	5.5 (1.8)	5.2 (2.1)	5.1 (1.6)	5.4 (1.5)
RB						2.9 (1.7)
D						4.6 (1.7)
RP						5.3 (1.6)
AMI	2.0 (1.7)	4.8 (2.0)	4.0 (2.3)	4.0 (2.9)	2.8 (2.1)	4.4 (1.8)
HC	2.0 (1.5)	4.1 (2.1)	5.3 (1.9)	3.9 (2.2)	3.7 (1.7)	5.2 (1.3)
PTC	4.1 (1.7)	5.9 (1.1)	5.5 (1.5)	5.6 (1.7)	5.1 (1.4)	5.4 (1.3)
MTC	5.6 (1.2)	4.3 (1.1)	5.5 (1.6)	5.4 (1.8)	6.4 (0.8)	6.5 (0.5)
PRM						4.7 (1.9)
PAM						5.0 (1.7)
EWS						5.2 (1.8)
	4.0 (1.8)	5.1 (1.6)	5.7 (1.7)	5.4 (1.8)	5.2 (1.8)	5.1 (1.7)

all features under Question 5 (potential usefulness). The multivariate analysis of variance revealed a significant overall effect of AIF, $F(25,350.7) = 8.32$, $p < .001$. Each univariate F (df = 5,98) was also significant, $p < .001$. The analysis also revealed a significant overall effect of level of training, $F(5,1) = 1458.03$, $p < .05$; however, none of the univariate Fs were significant in this case, $p < .05$. Finally, there was a significant AIF by level of training interaction, $F(25,350.7) = 1.97$, $p < .01$. Univariate interactions were significant for frequency of use ($p < .05$), and training value ($p < .05$).

A moderate level of frequency of AIF use was observed overall. The average feature was used only once each mission. Manual threat control was used with considerable regularity (five to seven times each mission), whereas hard copy (called "unreliable" by 28% of the SIs) and auto malfunction insertion were rarely or never used (Tukey $HSD_{.01} = 1.30$). The AIF by level of training interaction apparently reflected the fact that RTU SIs used manual threat control more often than they used all other features, whereas CTU (i.e., operational) SIs used manual threat control, programmed threat control, reset, and freeze (total and partial) at statistically equivalent rates (Tukey $HSD_{.05} = 1.93$). While there appeared to be no particular difficulties in using any of the features, some features (e.g., reset, total system freeze) were rated easier to use than others (e.g., hard copy, manual threat control), Tukey $HSD_{.01} = 1.12$. The RTU and CTU SIs rated the training they received (both in the operation and effective use of the features) as adequate (Tukey $HSD_{.01} = 1.19, 1.29$). It is interesting to note that the ratings of the RTU SIs were somewhat lower than those of the CTU SIs, despite the fact that the RTU SIs apparently received more formal training. (See "Training of SIs.") The training value ratings were fairly high overall. The average feature was judged "very useful." The highest ratings were assigned to manual threat control, reset, and total system freeze. Auto malfunction insertion and hard copy received significantly lower ratings than did all other features (Tukey $HSD_{.01} = 1.07$). The significant AIF by level of training interaction was apparently due to a greater degree of variability among the CTU SIs' ratings than among those of the RTU SIs (Tukey $HSD_{.05} = 1.59$).

The separate analysis of the potential training value ratings revealed a significant effect of AIF, $F(13,387) = 13.85$, $p < .001$. However, neither the effect of level of training nor the AIF by level of training interaction was significant, $F < 1.00$ and $F < 1.00$, respectively. Potential usefulness was fairly high overall. Every feature was judged to be at least fairly useful. Manual threat control, reset, and total system freeze received the highest ratings, whereas instructor tutorial, recorded briefing, demonstration, and auto malfunction insertion received significantly lower ratings (Tukey $HSD_{.01} = 1.26$).

Interrelations among utilization and utility ratings. Table 22 shows the intercorrelations among the ratings of each feature on each of the five questions. Most of the coefficients were positive and significant.

Table 22. F-4G Simulator: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
FREQUSE	1.00					
EASEUSE	.04	1.00				
TRECD(1)	.15	.45**	1.00			
TRECD(2)	.28**	.39**	.64**	1.00		
TVALUE	.71**	.19*	.30**	.37**	1.00	
PTVALUE	.52**	.08	.22**	.30**	.70**	1.00

*$p < .05$.
**$p < .01$.

Interestingly, however, neither the adequacy of training received (in operating the features) nor the ease of using the features was related to frequency of use. Overall, the matrix reflects a variable level of predictability among the variables. The coefficient of determination ranged from .00 (FREQUSE/EASEUSE) to .50 (FREQUSE/TVALUE).

Table 23 summarizes the results of a multiple linear regression analysis in which the frequency of AIF use was predicted from a linear combination of ease of use, adequacy of training received, and training value. The table indicates that, together, the predictor variables accounted for approximately 47% of the variability in the frequency-of-use ratings. However, the only significant predictor was training value.

Comments. There were numerous criticisms of the F-4G simulator, most of which related to fidelity and operational reliability. Apparently, most instructors are self-taught, and some are not familiar with the full range of capabilities. Many SIs characterized the simulator as a "procedural trainer" rather than a "full-mission simulator," which it is designed to be. Various recommendations were made: record/playback capability, rear cockpit visual display, electronic warfare and weapons scoring, imaging of electronic missile launches, and better and more structured instructor training.

A-10 Simulator

Training mission. The A-10 is a heavily armed (and armored) close air support attack aircraft. As presently configured, the A-10 pilot also

Table 23. F-4G Simulator: Multiple Linear Regression of Frequency of Use on Ease of Use, Adequacy of Training Received, and Training Value

DEPENDENT VARIABLE: Frequency of AIF-Use

MULTIPLE R: .68 STD. ERROR OF EST.: 1.16

MULTIPLE R-SQUARE: .47

ANALYSIS OF VARIANCE:

	Sum of Squares	df	Mean Square	F-Ratio	p
REGRESSION	173.0386	3	57.6795	43.078	.0000
RESIDUAL	198.1654	148	1.3390		

Predictor variable	Coefficient	Standard error	Standard regression coefficient	t	p
EASEUSE	-.0918	.0788	-.0788	-1.165	.2457
TRECD	.0313	.0824	.0272	.379	.7050
TVALUE	.9677	.0915	.6815	10.575	.0000
(CONSTANT)	-.8718	.5928			

functions as weapon systems officer. In this latter capacity, he is responsible for navigation, ECM operations, and target or threat acquisition and designation.

Because of its extensive capabilities, the A-10 simulator has been used as both part-task trainer and full-mission simulator. A fully integrated mission includes preflight, takeoff, TACAN point-to-point through a programmed series of threats, switchology, operation of radar warning receiver (RWR), threat recognition, evasion, ECM pod operations, chaff/flare usage, weapons delivery, egress, and return-to-base. The major difference between the RTU and CTU missions is that CTU SIs devote more time to the integrated mission than do RTU SIs, whereas RTU SIs devote relatively more time to the training of particular EW techniques.

Training of SIs. On the average, formal classroom instruction accounted for 22% of the A-10 RTU SIs' initial training (SD = 30%) and 11% of the CTU SIs' initial training (SD = 16%). Fifty percent of the RTU SIs and 35% of the CTU SIs reported having received refresher training (within the past 18 weeks and within the past 5 weeks, respectively). More than one-third of that training was characterized as formal classroom instruction.

AIFs. The operational status of each AIF on the A-10 simulator is summarized in Table 24. Apparently there are operational reliability problems associated with all A-10 AIFs except reset and total system freeze. In particular, almost one out of four SIs indicated that electronic warfare performance scoring was unreliable. The table also suggests that a substantial proportion of SIs have never operated demonstration (0.97), record/playback (0.39), auto malfunction insertion (0.52), manual threat control (0.30), (advanced) procedures monitoring (0.48), or (advanced) parameters monitoring (0.52). (Note: The "advanced" monitoring capabilities inform the console operator when aircraft parameters are "out of bounds." Also note that hard copy is available on the A-10 simulator; however, it is not available for copying EW data.)

Utilization and utility ratings. The ratings for the A-10 RTU and CTU SIs are summarized in Tables 25 and 26, respectively. Means and standard deviations are listed for available features under Questions 1 to 4 and for all features under Question 5 (potential usefulness). The multivariate analysis of variance revealed a significant overall effect of AIF, $F(30),446) = 7.40$, $p < .001$. Each univariate F (df = 6,115) was also significant, $p < .001$. The multivariate effect of level of training was not significant, $F(5,1) = 54.69$, $p > .05$; however, there was a significant AIF x level of training interaction, $F(30,446) = 2.31$, $p < .001$. Significant univariate interactions were found for frequency of use ($p < .001$), adequacy of training received ($p < .05$), and training value ($p < .05$).

A relatively low level of frequency of AIF use was observed overall. In fact, it was lower for the A-10 ATD than for any other device surveyed. The average feature was used only once every two to four missions. Demonstration, record/playback, and auto malfunction insertion were rarely or never used; however, total system freeze was used with some regularity by both RTU and CTU SIs (Tukey $HSD_{.01} = 1.52$). Moreover, RTU SIs used procedures monitoring, parameters monitoring, and electronic warfare performance scoring relatively often despite problems in reliability. (See previous section.) CTU SIs used these features significantly less often (Tukey $HSD_{.05} = 2.10$). Ease of use was moderately high for most features. However, significant difficulties in using demonstration, record/playback, auto malfunction insertion, and manual threat control were reported by both RTU and CTU SIs (Tukey $HSD_{.05} = 1.24$). Adequacy of training received (both in the operation and effective use of the features) was rated as "slightly adequate" overall. Training was most adequate for reset and total system freeze and least adequate for demonstration, record/playback, auto malfunction insertion, and manual threat control (Tukey $HSD_{.01} = 1.31$, 1.35). The adequacy of training received in the operation and use of record/playback was significantly lower for RTU SIs than for CIs (Tukey

Table 24. A-10 Simulator: The Number of SIs (Replacement and Operational) Indicating the Operational Status of Each AIF

Feature	No such capability		Never operated		Unreliable		Reliable	
	R	O	R	O	R	O	R	O
IT	14	16	1	1	1	0	0	0
R	1	0	2	0	0	0	13	17
TSF	0	0	0	0	0	0	16	17
PF	3	2	1	2	1	1	11	12
RB	15	17	1	0	0	0	0	0
D	7	5	9	11	0	0	0	1
RP	2	0	10	1	1	0	3	16
AMI	0	4	8	5	1	2	7	6
HC	6	0	4	0	3	1	3	16
PTC	1	2	1	1	3	1	11	13
MTC	5	0	2	3	1	2	8	12
PRM	2	9	1	4	3	1	10	3
PAM	1	13	0	3	1	0	14	1
EWS	0	1	0	1	6	2	10	13

Table 25. A-10 Simulator Replacement Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						4.8 (1.6)
R	3.3 (1.9)	4.7 (1.3)	5.1 (1.9)	5.2 (1.9)	4.1 (1.5)	5.1 (1.8)
TSF	4.9 (0.9)	6.0 (0.7)	6.4 (0.9)	6.2 (0.9)	6.1 (0.9)	6.2 (0.9)
PF	2.1 (1.8)	4.3 (1.6)	4.8 (1.8)	4.7 (1.9)	4.1 (1.6)	4.8 (1.5)
RB						4.1 (1.8)
D	1.0 (0.0)	2.2 (1.0)	2.3 (1.5)	2.0 (0.0)	1.7 (0.6)	3.7 (2.1)
RP	1.1 (0.3)	2.3 (1.0)	3.1 (1.8)	3.3 (2.1)	1.5 (0.5)	3.7 (1.7)
AMI	1.4 (1.0)	3.2 (1.6)	4.1 (2.2)	4.4 (1.9)	2.8 (1.7)	4.2 (1.8)
HC						4.1 (1.8)
PTC	4.3 (2.2)	4.9 (2.0)	5.2 (1.7)	4.8 (1.7)	3.6 (2.1)	5.5 (1.5)
MTC	3.5 (2.4)	2.9 (1.7)	3.7 (1.6)	4.0 (1.8)	4.0 (2.1)	6.2 (0.8)
PRM	4.2 (2.7)	4.8 (1.8)	5.9 (1.2)	5.9 (1.2)	4.3 (2.2)	4.9 (1.9)
PAM	5.9 (1.7)	4.8 (1.8)	5.6 (1.3)	5.3 (1.4)	4.7 (1.9)	5.4 (1.8)
EWS	6.1 (1.7)	4.6 (1.7)	5.7 (1.1)	5.4 (1.4)	3.7 (2.0)	5.9 (0.9)
	3.3 (2.4)	4.2 (1.9)	5.1 (1.8)	5.0 (1.8)	3.8 (2.1)	4.9 (1.8)

Table 26. A-10 Simulator Operational Training: Mean Ratings (and Standard Deviations) of the Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	TRECD(2)	TVALUE	PTVALUE
IT						3.8 (1.7)
R	5.1 (0.6)	5.9 (0.7)	6.2 (1.4)	6.3 (0.8)	5.8 (1.3)	6.2 (0.9)
TSF	5.3 (0.8)	6.1 (0.3)	6.8 (0.4)	6.5 (0.8)	6.6 (0.6)	6.5 (0.9)
PF	2.7 (1.6)	5.1 (1.4)	5.7 (1.1)	4.6 (1.6)	4.0 (1.5)	4.6 (1.4)
RB						2.9 (1.7)
D	1.1 (0.3)	3.0 (1.6)	3.3 (1.7)	3.7 (1.9)	2.2 (1.3)	3.6 (1.6)
RP	2.2 (1.0)	4.6 (1.1)	5.2 (1.5)	4.9 (1.6)	3.7 (1.4)	4.4 (1.5)
AMI	1.5 (1.2)	4.1 (1.5)	4.1 (1.8)	3.8 (2.3)	3.2 (0.9)	4.0 (1.2)
HC						4.3 (1.6)
PTC	3.0 (1.7)	4.5 (1.6)	4.3 (1.6)	3.6 (2.0)	3.2 (1.4)	4.8 (1.4)
MTC	3.1 (2.3)	2.6 (1.0)	2.9 (1.5)	5.0 (1.4)	3.7 (1.8)	5.8 (1.3)
PRM	1.3 (0.5)	4.0 (1.6)	5.3 (1.2)	5.0 (0.7)	2.7 (2.0)	4.1 (1.7)
PAM	2.2 (2.7)	6.0 (0.0)	4.5 (3.5)	5.7 (1.2)	2.5 (2.4)	4.1 (2.0)
EWS	3.3 (2.2)	4.3 (1.6)	4.7 (1.6)	4.4 (1.8)	3.8 (1.8)	4.6 (2.0)
	3.0 (1.9)	4.7 (1.6)	5.1 (1.8)	5.0 (1.8)	4.1 (1.9)	4.5 (1.8)

$HSD_{.05}$ = 1.81,1.87). The AIFs, as presently implemented, were rated "moderately useful" overall. In general, the training value ratings were lower for the A-10 ATD than for any other device surveyed. The most useful features were reset and total system freeze, whereas demonstration, record/playback, and auto malfunction insertion were judged to be significantly less useful (Tukey $HSD_{.01}$ = 1.41). RTU SIs rated parameters monitoring significantly higher in usefulness than did CTU SIs, whereas CTU SIs rated record/playback significantly higher in usefulness than did RTU SIs.

The separate analysis of the potential training value ratings revealed a significant main effect of AIF, $F(13,400) = 13.11$, $p < .001$ and a significant AIF by level of training interaction, $F(13,400) = 2.42$, $p < .01$. The main effect of level of training was not significant, $F(1,31) = 1.57$, $p > .05$. Potential usefulness was moderately high overall. Reset, total system freeze, manual threat control, and electronic warfare performance scoring received the highest ratings, whereas instructor tutorial, recorded briefing, demonstration, record/playback, auto malfunction insertion, and hard copy received significantly lower ratings (Tukey $HSD_{.01}$ = 1.30). The AIF by level of training interaction was apparently due to a greater degree of variability among the CTU SIs' mean ratings than among those of the RTU SIs (Tukey $HSD_{.05}$ = 1.62).

Interrelations among utilization and utility ratings. Table 27 shows the intercorrelations among the ratings of each feature on each of the five questions. Except for the correlation between potential training value and ease of use, all of the coefficients were positive and significant. In general, the level of predictability was moderate. The coefficient of determination ranged from .02 (EASEUSE/PTVALUE) to .45 (EASEUSE/TRECD(1)).

Table 27. A-10 Simulator: Matrix of Intercorrelations Among Frequency of Use, Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

Feature	FREQUSE	EASEUSE	TRECD(1)	RECD(2)	TVALUE	PTVALUE
FREQUSE	1.00					
EASEUSE	.25**	1.00				
TRECD(1)	.25**	.67**	1.00			
TRECD(2)	.31**	.47**	.51**	1.00		
TVALUE	.40**	.55**	.44**	.62**	1.00	
PTVALUE	.48**	.13	.18**	.40**	.51**	1.00

**$p < .01$.

Table 28 summarizes the results of a multiple linear regression analysis in which the frequency of AIF use, adequacy of training received, and training value. The table indicates that, together, the predictor variables accounted for only 25% of the variability in the frequency-of-use ratings. The only significant predictor was training value.

Table 28. A-10 Simulator: Multiple Linear Regression of Frequency of Use on Ease of Use, Adequacy of Training Received, Training Value, and Potential Training Value

DEPENDENT VARIABLE: Frequency of AIF Use

MULTIPLE R: .50 STD. ERROR OF EST.: 1.76

MULTIPLE R-SQUARE: .25

ANALYSIS OF VARIANCE:

	Sum of Squares	df	Mean Square	F-Ratio	p
REGRESSION	223.3051	3	74.4350	24.067	.0000
RESIDUAL	671.1474	217	3.0928		

Predictor variable	Coefficient	Standard error	Standard regression coefficient	t	p
EASEUSE	.0255	.1104	.0181	.231	.8173
TRECD	.0930	.1370	.0585	.678	.4983
TVALUE	.6892	.1077	.4558	6.399	.0000
(CONSTANT)	-.0152	.5672			

Comments. The A-10 simulator was criticized more often than was any other AID surveyed. The most frequent criticisms concerned the device's lack of fidelity to the actual aircraft. Several instructors even believed that transfer of training, from simulator to aircraft, was negative. Many SIs expressed particular frustration at the limited (RTU) or absent (CTU) visual system. Such deficiencies are ironic when considering that the A-10 pilot frequently needs visual contact with targets and threats in order to fulfill his mission.

Several other problems were noted: a lack of instructor confidence in the operational reliability of the device, insufficient instructor training, and difficulty in manually controlling threats. A few SIs stated that the device was useful for procedural training, but many more of the comments were critical.

IV. DISCUSSION

For purposes of discussion the 14 AIFs surveyed in Phase III can be arranged in three categories:

Briefing AIFs are designed for briefing the student and SI prior to or during a training mission. Their purpose is to establish a learning set and increase learning readiness. These features include

1. Instructor tutorial
2. Recorded briefing
3. Demonstration.

Mission Control AIFs include various features designed to control the structure and sequencing of tasks within a training mission. These features include

1. Total system freeze
2. Partial freeze
3. Reset
4. Automated malfunction insertion
5. Programmed threat control
6. Manual threat control.

Monitor and Feedback AIFs permit the simulator instructor to monitor student performance and provide the student with performance feedback. These features include

1. Procedures monitoring
2. Parameters monitoring
3. Electronic warfare performance scoring
4. Hard copy
5. Record/playback.

Briefing AIFs

Operational status. Most of the devices surveyed had no briefing capability. The only exceptions were the T-5 (recorded briefing), T-4 (recorded briefing, audio only), and the A-10 (demonstration). A few T-5 IEWs characterized recorded briefing as "unreliable," and an equal number apparently had never operated the feature. However, most T-5 IEWs considered recorded briefing to operate reliably. It was difficult to assess the operational reliability of recorded briefing on the T-4 trainer and demonstration on the A-10 simulator, since most of the SIs had never operated these features.

Utility and utilization. The briefing features, where available, tended to receive lower utility and utilization ratings than did most of the other features. The potential training value ratings suggested that these features might have some potential usefulness for EW training, but as a group, the briefing AIFs generally received lower potential training value ratings than did most of the other AIFs. Instead of structured briefings, most SIs appeared to prefer informal briefings, which could be adapted to the particular needs of individual students and instructors.

Mission Control AIFs

Operational status. Those features that were manually operated and simple to use (e.g., freeze, reset) appeared to cause few operational problems. This was not the case for the other mission control AIFs. Manual malfunction insertion, although not included in the survey, was apparently preferred by most SIs over auto malfunction insertion. Whereas auto malfunction insertion operated reliably on the B-52 WST, it was either never used or operated unreliably on all other devices surveyed. In addition, approximately one-third of the B-52 WST SIs characterized programmed and manual threat control as "unreliable." Although these features appeared to operate more reliably on the other devices, the only device for which no reliability problems were noted was the T-4 trainer.

Utility and utilization. The ratings of total system freeze and reset were consistently high. The freezing of an ATD (in order to offer feedback) and the subsequent resumption of a training mission appeared to be a critical capability of all ATDs surveyed. Partial freeze, which was available only on the B-52 WST and TAC ATDs, was used less frequently but was nevertheless considered to be at least moderately useful for EW training.

Auto malfunction insertion was used with moderate regularity (averaging about once a mission) during ATC and SAC missions. In contrast, it was considered less important for TAC missions and, consequently, was used less often. Indeed, TAC SIs much prefer the discretionary use of malfunctions. This may be a more appropriate training strategy in their case since the TAC missions are typically more dynamic and less structured than those of ATC and SAC. Consistent with this strategy, the F-4G IEWs generally assigned higher ratings to manual threat control than to programmed threat control, whereas the ATC and SAC SIs generally assigned similar and extremely high ratings to both features.

Monitor and Feedback AIFs

Operational status. The operational status of these features varied greatly across the devices surveyed. The A-10 simulator is the only device that includes a record/playback capability. Most of the A-10 RTU SIs never even operated the feature. However, most of the A-10 CTU SIs did operate the feature, and none reported any problems in reliability. Over 70% of the B-52 WST SIs indicated that their record/playback capability was unreliable. It should be noted, however, that record/playback is not available from the defensive station. During an integrated training session, only aircraft position information is available to the defensive station during a playback. There is no playback of defensive crew actions. These indications appeared to reflect deficiencies in software rather than hardware. As noted in a previous section of this report, many B-52 WST SIs commented that it was impossible to replicate a particular threat scenario on the WST because threats are generated probabilistically.

The operational reliability of the monitor and feedback AIFs appeared to be greatest for the T-5 and T-4 trainers. There were no "unreliable" indications for any of the features. In contrast, the reliability of the monitor and feedback AIFs on the B-52 WST appeared to be especially lacking.

Utility and utilization. In general, record/playback and hard copy, where available, received the lowest utility and utilization ratings. In contrast, procedures and parameters monitoring tended to be among the highest rated of all features surveyed. This generalization did not apply to the A-10 CTU SIs, however, who assigned relatively low frequency-of-use and training value ratings to procedures and parameters monitoring. The low ratings were due in part to the large number of A-10 CTU SIs who indicated "no such capability" for these features, although it is not clear why this was the case. The A-10 CTU SIs also assigned low ratings to electronic warfare performance scoring because of problems in reliability. Overall, the potential usefulness of the monitor and feedback features was relatively high. The means ranged from "moderately useful" to "extremely useful."

Differences Among the ATDs

The survey revealed many differences among the ATDs in terms of AIF utility, utilization, and operational status. Some of these differences were noted in the previous section, but several general observations can also be made. An overview of the operational status data (Tables 5, 9, 14, 19, 24) suggests that the T-5 trainer was the most reliable device, followed, in order, by the T-4 trainer, F-4G simulator, B-52 WST, and A-10 simulator. The devices were similarly ordered with respect to AIF utility and utilization. The T-5 and T-4 trainers tended to receive the highest ratings, whereas the B-52 WST and the A-10 simulator tended to receive lower ratings. Paradoxically, the more sophisticated devices (i.e., those devices with the more extensive instructional support capabilities) received the least favorable evaluations. This paradox may not be characteristic of ATDs in general, but it leads us to ask whether effective EW training might be better achieved through the use of part-task or specialized trainers.

Differences Between the Two Levels of Training

The pattern of AIF utility and utilization was, for the most part, similar across the two levels of training. Some differences were observed among the TAC SIs, however. The F-4G RTU SIs used manual threat control more often than all other features, and the A-10 RTU SIs used procedures monitoring, parameters monitoring, and electronic warfare performance scoring significantly more often than did the A-10 CTU SIs. The A-10 RTU SIs also rated parameters monitoring to be more useful for training than did the A-10 CTU SIs. These differences were consistent with the particular characteristics of the TAC RTU missions, which are less structured and more closely monitored than were the CTU missions. The failure to find RTU-CTU differences within SC probably reflected the fact that these missions were more similar to one another than those of TAC.

Predicting the Frequency of AIF Use

The multiple linear regression analyses (see Tables 8, 13, 18, 23, 28) indicated that at least 25%, and as much as 47%, of the variability in the frequency-of-use ratings could be explained by the remaining variables. Training value was clearly the most significant predictor at every ATD site surveyed. Indeed, it was the only significant predictor at three of the five sites. Adequacy of training received added a small but significant degree of predictability to the T-4 and B-52 WST regression equations.

What can be concluded from these facts? Unfortunately, correlational findings do not logically imply causality; they merely reflect the presence of a relationship between variables. In this case, however, it seems reasonable to assume that particular AIFs were used more frequently because they were more useful. Indeed, assuming that the training value of an AIF did not affect its use is clearly implausible.

How can the fact be explained that the remaining variables (i.e., ease of use, adequacy of training received) did not account for much of the variability in frequency of use? This fact suggests that the SIs would not avoid using a particular feature, even if it were complicated to use, as long as they believed that it would help accomplish mission objectives.

Training Received by the Simulator Instructors

The ratings suggested that the SIs considered their training to be more adequate than inadequate. The T-4 SIs gave the highest ratings, followed, in order, by the T-5, F-4G, B-52 WST, and A-10 SIs. There appeared to be little difference between the adequacy of training received in the operation and effective use of the features.

There was considerable variability in the amount and type of training received by the SIs. The amount of formal initial training appeared to be related to the magnitude of the utility and utilization ratings. For example, the T-4 and T-5 SIs received the greatest amount of formal initial training, and the T-4 and T-5 ATDs were the most favorably evaluated devices. The importance of refresher training was less clear. Thus, the T-4 and A-10 SIs received the greatest amount of refresher training, but the ratings of their respective devices were quite different.

Comparisons Between Phases I, II, and III

Due to the differences between the questionnaires used in Phase III and in Phases I and II, it is difficult to directly compare the ratings. For example, the frequency-of-use ratings obtained from the Phase III questionnaire were considerably higher than those obtained from the previous questionnaires. Nevertheless, it cannot be concluded that electronic warfare SIs use instructional features more often than do other SIs, because the appropriate question and possible answers were worded differently in each case. Thus, in Phase III the SIs were asked in Question 1 "During five typical missions, how often did you use each instructional feature?" The possible answers spanned seven categories ranging from "never" to "8 or more times a mission." In Phases I and II, the SIs were simply asked: "How often have you used each instructional feature?" In this case the possible answers ranging from "never" to "most often." The other questions were also worded differently.

It was possible to make certain valid comparisons, however. For example, within all phases of the survey, the relative ratings of particular AIFs were fairly consistent across all ATDs. That is, those features rated highest (lowest) by one group of SIs also tended to be rated highest (lowest) by the other groups. This suggests that the overall pattern of AIF use is similar across the MAJCOMs. Another valid generalization was that the perceived training value of a feature appeared to be the single most consistent determiner of its use.

V. CONCLUSIONS AND RECOMMENDATIONS

At the conclusion of Phases I and II, it was recommended that certain AIFs need to be made more reliable and user friendly before their training effectiveness can be ascertained. It was also recommended that an intensive training program be established in order to teach SIs how to use AIFs more effectively. These recommendations apply to Phase III as well, for it is clear that many SIs have not yet fully explored the existing instructional capabilities of their ATDs.

The principles of effective AIF use still need to be specified. Such principles will not be derived from surveys but, rather, from empirical investigations. Several reports by R. G. Hughes and his colleagues (Bailey & Hughes, 1980; Bailey, Hughes, & Jones, 1980; Hughes, 1979; Hughes, Hannon, & Jones, 1979; Hughes, Lintern, Wightman, & Brooks, 1981) do provide conceptual models for AIF-based simulator training programs and present experimental evidence aimed at determining the training value of particular features, but much additional work is needed if military ATDs are to be more than mere substitute weapon systems.

It is recommended that future procurement of AIFs be preceded by a detailed front end analysis that clearly relates AIF capability to training needs. The analysis should consider all known training applications of the simulator as well as any major constraints in the operational environment. During procurement, AIF specifications should be prepared so as to meet user needs and ensure equipment reliability. After operational deployment, the user should provide adequate instructor/operator training in AIF use.

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APPENDIX A

PHASE III INSTRUCTIONAL FEATURES QUESTIONNAIRE

ADVANCED INSTRUCTIONAL FEATURES - EWI SURVEY

Name____________________ Rank_______ Squadron_______ Date________________

FLYING EXPERIENCE:

Aircraft	Total Hours	Instructor Hours
__________	________	________

SIMULATOR EXPERIENCE:

Simulator	Total Hours	Instructor Hours
__________	________	________

1. What percent of your initial instruction on simulation training consisted of formal classroom instruction and what percent consisted of informal instruction?

   ______% formal classroom   ______% informal

2. Have you had refresher training on simulation operation? _____ yes _____ no
   (If no, skip next two items.)

   a. How long has it been since you last had refresher training? ______ weeks

   b. What percent of your refresher training was formal and what percent informal?

   ______% formal classroom   ______% informal

BRIEFLY DESCRIBE A "TYPICAL" TRAINING SESSION ON THIS SIMULATOR:

GENERAL COMMENTS AND/OR RECOMMENDATIONS:

Read the definitions of each instructional feature carefully. In the space next to each feature, write the single number corresponding to the statement that best describes the operational status of that feature:

0. The simulator has no such capability.
1. Capability present but I have never seen it operate.
2. Capability present but unreliable.
3. Capability present and reliable.

_____ Instructor Tutorial - provides the instructor with self-paced programmed instruction in the capabilities and use of the simulator.

_____ Reset - permits instructor to "return" the simulated aircraft to a stored set of conditions and parameters.

_____ Total System Freeze - permits instructor to interrupt and suspend simulated flight by freezing all system parameters.

_____ Partial Freeze - permits instructor to freeze various flight parameters or parameter combinations such as altitude, heading, position, attitude, flight system, etc.

_____ Recorded Briefing - permits instructor to provide student with information about a structured training session through audio/visual media presentation.

_____ Demonstration - permits instructor to demonstrate optimal electronic warfare procedures by prerecording and subsequently playing back a simulated engagement.

_____ Record/Playback - permits instructor to record and subsequently playback a segment of simulated flight.

_____ Automated Malfunction Insertion - permits instructor to pre-program a sequence of aircraft component malfunctions and/or emergency conditions.

_____ Hard Copy - provides a record of alphanumeric and/or graphic performance data for debriefing purposes.

_____ Programmed Threat Control - computer-controlled standardized training sessions based on pre-programmed event sequences.

_____ Manual Threat Control - permits instructor to modify threat scenarios during a training session.

_____ Procedures Monitoring - permits instructor to monitor discrete actions performed by the student in accordance with a procedurally defined checklist.

_____ Parameters Monitoring - permits instructor to monitor various instrument readings, control settings, aircraft states, or navigational profiles.

_____ Electronic Warfare Performance Scoring - provides a performance metric that summarizes the outcomes of EW engagements.

1. During five typical missions, how often did you use each instructional feature? (Check the appropriate space.)

	N/A	Never	Once Every 5 Missions or Less	Once Every 2-4 Missions	Once a Mission	2-4 Times a Mission	5-7 Times a Mission	8 or More Times a Mission
Instructor Tutorial	0	1	2	3	4	5	6	7

Comments:

Reset	0	1	2	3	4	5	6	7

Comments:

Total System Freeze	0	1	2	3	4	5	6	7

Comments:

Partial Freeze	0	1	2	3	4	5	6	7

Comments:

Recorded Briefing	0	1	2	3	4	5	6	7

Comments:

Demonstration	0	1	2	3	4	5	6	7

Comments:

Record/Playback	0	1	2	3	4	5	6	7

Comments:

Automated Malfunction Insertion	0	1	2	3	4	5	6	7

Comments:

Hard Copy	0	1	2	3	4	5	6	7

Comments:

Programmed Threat Control	0	1	2	3	4	5	6	7

Comments:

Manual Threat Control	0	1	2	3	4	5	6	7

Comments:

Procedures Monitoring	0	1	2	3	4	5	6	7

Comments:

Parameters Monitoring	0	1	2	3	4	5	6	7

Comments:

Electronic Warfare Performance Scoring	0	1	2	3	4	5	6	7

Comments:

2. How difficult/easy is it to use each instructional feature? (Check the appropriate space.)

Feature	N/A	Virtually Impossible	Very Difficult	Fairly Difficult	Neither Easy Nor Difficult	Fairly Easy	Very Easy	Virtually Automatic
Instructor Tutorial	0	1	2	3	4	5	6	7
Comments:								
Reset	0	1	2	3	4	5	6	7
Comments:								
Total System Freeze	0	1	2	3	4	5	6	7
Comments:								
Partial Freeze	0	1	2	3	4	5	6	7
Comments:								
Recorded Briefing	0	1	2	3	4	5	6	7
Comments:								
Demonstration	0	1	2	3	4	5	6	7
Comments:								
Record/Playback	0	1	2	3	4	5	6	7
Comments:								
Automated Malfunction Insertion	0	1	2	3	4	5	6	7
Comments:								
Hard Copy	0	1	2	3	4	5	6	7
Comments:								
Programmed Threat Control	0	1	2	3	4	5	6	7
Comments:								
Manual Threat Control	0	1	2	3	4	5	6	7
Comments:								
Procedures Monitoring	0	1	2	3	4	5	6	7
Comments:								
Parameters Monitoring	0	1	2	3	4	5	6	7
Comments:								
Electronic Warfare Performance Scoring	0	1	2	3	4	5	6	7
Comments:								

3. How inadequate/adequate was the training you received in the use of each instructional feature? (Check the appropriate space.)

	No Training	Totally Inadequate	Very Inadequate	Slightly Inadequate	Borderline	Slightly Adequate	Very Adequate	Totally Adequate
Instructor Tutorial	0	1	2	3	4	5	6	7
Comments:								
Reset	0	1	2	3	4	5	6	7
Comments:								
Total System Freeze	0	1	2	3	4	5	6	7
Comments:								
Partial Freeze	0	1	2	3	4	5	6	7
Comments:								
Recorded Briefing	0	1	2	3	4	5	6	7
Comments:								
Demonstration	0	1	2	3	4	5	6	7
Comments:								
Record/Playback	0	1	2	3	4	5	6	7
Comments:								
Automated Malfunction Insertion	0	1	2	3	4	5	6	7
Comments:								
Hard Copy	0	1	2	3	4	5	6	7
Comments:								
Programmed Threat Control	0	1	2	3	4	5	6	7
Comments:								
Manual Threat Control	0	1	2	3	4	5	6	7
Comments:								
Procedures Monitoring	0	1	2	3	4	5	6	7
Comments:								
Parameters Monitoring	0	1	2	3	4	5	6	7
Comments:								
Electronic Warfare Performance Scoring	0	1	2	3	4	5	6	7
Comments:								

4. As presently implemented on your system, how useful is each instructional feature? (Check the appropriate space.)

	N/A	Not Useful	Slightly Useful	Fairly Useful	Moderately Useful	Very Useful	Extremely Useful	Indispensable
	0	1	2	3	4	5	6	7
Instructor Tutorial								
Comments:								
Reset								
Comments:								
Total System Freeze								
Comments:								
Partial Freeze								
Comments:								
Recorded Briefing								
Comments:								
Demonstration								
Comments:								
Record/Playback								
Comments:								
Automated Malfunction Insertion								
Comments:								
Hard Copy								
Comments:								
Programmed Threat Control								
Comments:								
Manual Threat Control								
Comments:								
Procedures Monitoring								
Comments:								
Parameters Monitoring								
Comments:								
Electronic Warfare Performance Scoring								
Comments:								

5. Based on the definitions alone and not your experience, how potentially useful is each instructional feature. Rate each feature. Assume each is equally easy to use. (Check the appropriate space.)

	Not Useful	Slightly Useful	Fairly Useful	Moderately Useful	Very Useful	Extremely Useful	Indispensable
Instructor Tutorial	1	2	3	4	5	6	7

Comments:

Reset	1	2	3	4	5	6	7

Comments:

Total System Freeze	1	2	3	4	5	6	7

Comments:

Partial Freeze	1	2	3	4	5	6	7

Comments:

Recorded Briefing	1	2	3	4	5	6	7

Comments:

Demonstration	1	2	3	4	5	6	7

Comments:

Record/Playback	1	2	3	4	5	6	7

Comments:

Automated Malfunction Insertion	1	2	3	4	5	6	7

Comments:

Hard Copy	1	2	3	4	5	6	7

Comments:

Programmed Threat Control	1	2	3	4	5	6	7

Comments:

Manual Threat Control	1	2	3	4	5	6	7

Comments:

Procedures Monitoring	1	2	3	4	5	6	7

Comments:

Parameters Monitoring	1	2	3	4	5	6	7

Comments:

Electronic Warfare Performance Scoring	1	2	3	4	5	6	7

Comments:

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APPENDIX B

FB-111A OPERATIONAL FLIGHT TRAINER: MEAN RATINGS (AND STANDARD DEVIATIONS) OF AIF UTILITY AND UTILIZATION BY RADAR NAVIGATOR INSTRUCTORS

Table B1. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Frequency of AIF Use

Feature	Transition	Operational	Combined
PAM	6.8 (0.6)	6.6 (0.8)	6.7
PRM	6.8 (0.6)	6.5 (0.9)	6.6
PTC**	3.7 (2.1)	5.4 (1.7)	4.8
R	4.0 (1.3)	5.1 (1.0)	4.7
PF	5.3 (1.2)	4.3 (1.7)	4.7
TSF	3.8 (1.1)	4.3 (1.2)	4.1
RP	2.3 (0.8)	1.8 (0.7)	2.0
D	1.6 (0.8)	1.5 (0.6)	1.6
HC	1.5 (0.7)	1.3 (0.7)	1.4
Combined	4.0	4.1	4.1

** $p < .01$.

Table B2. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Ease of AIF Use

Feature	Transition	Operational	Combined
PF	6.3 (0.9)	6.2 (0.9)	6.2
TSF	6.0 (1.1)	6.1 (0.8)	6.1
R	4.9 (1.6)	5.7 (1.0)	5.4
PTC	4.4 (1.3)	4.5 (1.4)	4.5
PAM	5.0 (1.3)	4.1 (1.3)	4.4
PRM	4.6 (1.7)	3.6 (1.6)	4.0
RP	3.9 (1.4)	3.4 (1.1)	3.6
D	3.1 (1.6)	3.3 (1.0)	3.2
HC	2.0 (0.8)	3.0 (1.8)	2.7
Unweighted Means	4.5	4.4	4.5

Table B3. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Amount of Training Received in AIF Use

Feature	Transition	Operational	Combined
PAM	5.3 (1.1)	5.6 (1.2)	5.5
PRM	5.2 (1.1)	5.6 (1.2)	5.5
TSF	4.1 (1.1)	4.4 (1.4)	4.3
PTC	3.1 (1.4)	4.7 (1.6)	4.2
PF	4.2 (1.3)	4.1 (1.7)	4.1
R	3.6 (1.2)	4.3 (1.4)	4.1
D	2.4 (1.4)	2.3 (1.5)	2.3
RP	2.5 (1.3)	2.1 (1.1)	2.2
HC	1.4 (0.7)	1.4 (0.7)	1.4
Combined	3.5	3.8	3.7

Table B4. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Training Value of AIFs

Feature	Transition	Operational	Combined
PRM	6.2 (1.1)	6.7 (0.8)	6.5
PAM	6.2 (1.1)	6.5 (0.9)	6.4
PF	6.0 (0.8)	6.1 (1.0)	6.1
TSF	5.5 (1.1)	5.9 (1.1)	5.8
PTC	4.6 (1.7)	5.5 (1.4)	5.2
R	4.6 (1.6)	5.4 (1.1)	5.2
D	3.3 (1.9)	3.7 (1.4)	3.5
RP	3.8 (1.5)	3.3 (1.4)	3.5
HC	2.2 (0.4)	3.1 (1.4)	2.8
Unweighted Means*	4.7	5.1	5.0

*$p < .05$.

Table B5. FB-111A Operational Flight Trainer: Mean Ratings (and Standard Deviations) of the Potential Training Value of AIFs

Feature	Transition	Operational	Combined
PRM	6.6 (0.5)	6.9 (0.3)	6.8
PAM	6.5 (0.5)	6.7 (0.6)	6.6
PF	6.5 (0.7)	6.0 (1.2)	6.2
TSF	5.9 (1.0)	6.0 (0.9)	6.0
PTC	5.5 (1.5)	5.7 (1.3)	5.6
R	5.3 (0.9)	5.7 (0.9)	5.5
AMI	5.5 (1.7)	5.2 (1.2)	5.3
D	5.5 (1.5)	4.7 (1.6)	5.0
RP	5.2 (1.5)	4.4 (1.7)	4.7
IPT	4.6 (1.5)	4.6 (1.6)	4.6
HC	4.5 (1.9)	4.1 (1.6)	4.3
RB	3.9 (1.8)	4.2 (1.7)	4.1
Combined	5.5	5.4	5.4