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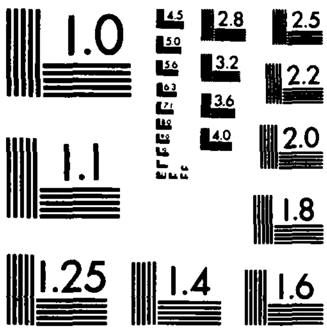

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AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE I – TACTICAL AIR COMMAND)

By

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Williams Air Force Base, Arizona 85224

November 1983

Interim Report for Period March 1982 – December 1982

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

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 flight crew instructor to control, monitor, and record flight simulation training sessions. A survey conducted at five of the principal Tactical Air Command ATD sites revealed that few instructors receive extensive training in AIF use and that most features are not used very often. Several factors appear to have contributed to the low rate of AIF use. These factors include hardware and/or software unreliability, time-consuming implementation, functional limitations, and design

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deficiencies. Although many AIFs were judged to have significant value in replacement and/or continuation training, some features need to be made more reliable and user-friendly before their training effectiveness can be ascertained. It was recommended that a more formalized intensive training program for ATD instructors be established. Such a program would not only teach instructors how to use AIFs but, more importantly, how to use them effectively.

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SUMMARY

Objective

The objectives were (a) to document the utility and utilization of advanced instructional features (AIFs) in aircrew training devices (ATDs), (b) to compare AIF utility and utilization in replacement and continuation training units, and (c) to provide a data base that would be useful both in defining the requirements for future ATD procurements and in developing subsequent training programs using ATDs.

Background/Rationale

ATDs are not merely flight *simulators*. They are also equipped with sophisticated hardware and software capabilities that permit an instructor pilot (IP) to control, monitor, record, and in some cases, fabricate flight simulation training missions. These capabilities, collectively known as AIFs, reflect the ATD's primary role as a flight *trainer*. It is frequently assumed that an ATD's training value is a function of its fidelity or capability for simulation, but in reality the training value of an ATD is determined not only by the degree to which it "simulates" a particular aircraft, but also by the way in which it is used as an instructional device.

Experimental evidence indicates that AIF-based simulator training can be quite effective. However, AIFs are costly to implement, especially those features that require the development of complex software. In order to justify these costs, several questions regarding the utility and utilization of AIFs must be answered: (a) How frequently and easily are AIFs used? (b) Are IPs adequately training to use AIFs? (c) Do AIFs have significant training value?

Approach

A survey on AIF use and training value was developed and administered to 134 qualified instructors assigned to replacement training units (RTUs) and continuation training units (CTUs) at principal Tactical Air Command (i.e., F-4, F-15, A-10, and E-3A) ATD sites. The survey was conducted at the request of the Air Force Systems Command, Aeronautical Systems Division (AFSC/ASD).

Specifics

Method. The survey, which was administered on-site to small groups of instructors (N = 2 to 10), included background information, a list of 17 AIFs and their definitions, and five questions (seven-point successive-category rating scales) regarding the utility and utilization of each feature.

Findings/Discussion. The results of the survey indicated that most instructors receive little training in AIF use and that most features are not used very often. Several factors appear to have contributed to the low usage: (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.

AIF utility and utilization also differed as a function of training unit, this difference being most apparent in the F-15 data. For example, F-15 RTU IPs received more training in the use of the features, used them more frequently, found them easier to use, and rated them higher in training value. Similar tendencies were present for the RTU units at other ATD sites.

However, the relation between AIF utility/utilization and the training unit was not a simple one. Certain features were rated higher by RTU instructors while others were rated higher by CTU instructors. In most cases, these differences reflected the contrast between the kinds of training given in the two training units. For example, RTU training is primarily procedural in nature whereas CTU training places more emphasis on the training of complete mission scenarios.

Conclusions/Recommendations

The survey results constitute a data base on AIF utility and utilization in ATDs that indicated most AIFs are not very often used because of (a) hardware and/or software unreliability, (b) time-consuming implementation, (c) functional limitations, (d) design deficiencies, and (e) the fact that most instructor pilots (IPs) receive little training in their use. The perceived value of a given ATF varied with the kind of training (CTU or RTU).

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 to meet user needs and ensure equipment reliability. After operational deployment, the user should provide adequate instructor/operator training in AIF use.

PREFACE

This research was conducted to satisfy requirements of Air Force Human Resources Laboratory Technical Planning Objective 3, the thrust of which is air combat tactics and training. The general objective of this thrust is to identify and demonstrate cost-effective training strategies and training equipment capabilities for use in developing and maintaining 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 System Division (AFSC/ASD), Wright-Patterson AFB, Ohio; Headquarters Tactical Air Command (HQ TAC/DOT), Langley AFB, Virginia; and the Tactical Air Warfare Center (TAWC/TN), Eglin AFB, Florida. The assistance of Mr. H. Craig McLean (ASD/YWE), Mr. Nat Davis (ASD/YWE), Mr. Jim Brown (TAWC/TNT), Maj. Jim Icenhour (HQ TAC/DOTS), Maj. Mark Nataupsky (HQ TAC/DOTSI), Mr. Richard Greatorex (AFHRL/OTU), and Sgt. Bernadette Hill (AFHRL/OTA) is gratefully acknowledged.

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AIRCREW TRAINING DEVICES: UTILITY AND UTILIZATION OF ADVANCED INSTRUCTIONAL FEATURES (PHASE I - TACTICAL AIR COMMAND)

INTRODUCTION

An Aircrew Training Device (ATD) is a ground-based apparatus that mimics the performance and configuration of a particular aircraft. However, the ATD is not merely a flight simulator. It is also equipped with sophisticated hardware and software capabilities that permit an instructor pilot (IP) to control, monitor, record, and in some cases, fabricate flight simulation training missions. These capabilities, known as advanced instructional features (AIFs), reflect the primary role of the ATD as a flight trainer.

It is frequently assumed that the training value of an ATD is a function of its fidelity or capability for simulation. According to Adams (1972), this assumption could be unwarranted:

> I would not consider the money being spent on flight simulators as staggering if we knew much about their training value, which we do not. We build flight simulators as realistic as possible, ... but the approach is also a cover-up for our ignorance about transfer because in our doubts we have made costly devices as realistic as we can in the hopes of gaining as much transfer as we can. [In the past], the users have been willing to pay the price, but the result has been an avoidance of the more challenging question of how the transfer might be accomplished in other ways, or whether all that complexity (i.e., fidelity) is really necessary. (pp. 616-617)

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 it is used (see Caro, 1973).

Many instructional features have already been provided by ATD manufacturers, and more are being developed. They are listed in Table 1 and grouped according to function. The list was compiled from several sources, but it was drawn primarily from the Semple, Cotton, and Sullivan (1981) report describing the AIF capability of various military and commercial devices.

Instructional features are expensive to implement, especially those features that require the development of complex software, such as <u>automated adaptive training</u> and <u>automated voice controller</u>. In order to justify these costs, some questions concerning the utility and utilization of AIFs must be answered. How frequently are AIFs used? Are IPs adequately trained to use AIFs? Do AIFs have significant training value?

PREVIOUS RESEARCH

The answers to the questions in the preceding paragraph have not been fully provided, but relevant information is available. The most complete discussion of instructional features can be found in the Semple, et al. (1981) report. This report was based on interviews of ATD personnel at 12 Air Force, Navy, Army, Coast Guard, and commercial training sites and is one of seven reports comprising the Air Force Simulator Training Requirements and Effectiveness Study (STRES). The report describes over 20 features and discusses each in terms of its operation, related features, instructional value, observed applications, utility (use-related) information, related research, and design considerations. The interviews were "guided" by a checklist of topics, but they were not highly structured. This approach afforded the investigators flexibility in exploring particular topics, but it precluded systematic analyses of the data.

Relevant information can also be found in several reports describing the automated instructional system on the Advanced Simulator for Pilot Training (ASPT) located at Williams AFB (Faconti, Mortimer, & Simpson, 1970; Knoop, 1973; Faconti & Epps, 1975; Fuller, Waag, & Martin, 1980). The ASPT is a sophisticated research device, which incorporates advanced visual and motion systems, A-10 and F-16 cockpits, extensive AIF capability, and an automated performance measurement system. Notwithstanding the apparent training potential of the ASPT, Gray, Chun, Warner, and Eubanks (1981) found that IPs tended to use the device in a fairly conventional manner. With few exceptions, the instructional features were rarely used.

AIF utility information is available in an important series of reports by R. G. Hughes et al. (Bailey & Hughes, 1980; Bailey, Hughes, & Jones, 1980; Hughes, 1979; Hughes, Hannon, & Jones, 1979; Hughes, Lintern, Wightman, & Brooks, 1981). The reports provide conceptual models for AIF-based simulator training programs and present experimental evidence aimed at determining the training value of particular features. It is clear from these reports that effective AIF-based simulator training is practicable, but systematic analyses of ATD utility and utilization patterns are required before optimal training programs, of the kind envisioned by Knoop (1973), can be designed:

> The software which will comprise flight simulators of the future will consist primarily of sophisticated advanced training programs which automatically and optimally step the student through training, measure his performance at each step, diagnose his problems, and alter the difficulty of various tasks which are commensurate with his skill. (p. 583)

Table 1. Advanced Instructional Features

BRIEFING FEATURES

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

Demonstration permits IP to demonstrate aircraft maneuvers by prerecording and playing back a standardized segment of simulated flight.

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

TRAINING MANAGEMENT FEATURES

Total System Freeze permits IP to suspend simulated flight by freezing all system parameters.

Reset permits IP to return the simulated aircraft to a stored set of conditions and parameters.

Crash and/or Kill Override permits IP 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 pre-programmed event sequences.

Table 1. Advanced Instructional Features (continued)

VARIATION OF TASK DIFFICULTY FEATURES

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

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

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

Motion permits IP to provide student with platform motion system cues such as roll, pitch, lateral, and vertical.

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

Position Freeze permits IP to simultaneously freeze latitude and longitude.

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

Parameter Freeze permits IP to freeze any one or a combination of flight parameters.

Table 1. Advanced Instructional Features (concluded)

INSTRUCTOR MONITOR AND FEEDBACK FEATURES

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

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

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

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

STUDENT FEEDBACK FEATURES

Record/Playback permits IP to record and subsequently play back all events that occurred during a segment of simulated flight.

Automated Performance Feedback provides 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 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.

THE PRESENT INVESTIGATION

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 the investigation were:

1. To document and compare the utilization (i.e., ease and frequency 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 and continuation training units.

A broader objective of the investigation is to provide a data base that would be helpful both in defining the requirements for future ATD procurements and in developing subsequent ATD training programs.

The objectives will be accomplished in two phases by means of a survey of flight instructors from the Air Force Major Commands (MAJCOMS). Phase I is described in this report and includes instructors from principal Tactical Air Command (TAC) ATD sites (F-4, F-15, A-10, and E-3A aircraft). Phase II will include instructors from principal Strategic Air Command (SAC), Military Airlift Command (MAC), and Air Training Command (ATC) ATD sites (FB-111, C-130, C-141, C-5, CH-3, HH-53, T-37, and T-38 aircraft).

METHOD

Subjects

The subjects in Phase I were 134 simulator-qualified IPs and Weapons Director Instructors (WDIs) assigned to replacement training units (RTUs, N=84) or continuation training units (CTUs, N=50) at the following TAC bases: George AFB (F-4E, F-4G; RTU, CTU), Luke AFB (F-15, RTU), Langley AFB (F-15, CTU), Eglin AFB (F-15, CTU), Davis-Monthan AFB (A-10, RTU), Myrtle Beach AFB (A-10, CTU), and Tinker AFB (E-3A; RTU, CTU). The number of IPs and WDIs surveyed at each site is shown in Table 2.

Questionnaire

The questionnaire that was used to survey the instructors is shown in Appendix A. It includes background information (e.g., flying and simulator experience), a brief description of a typical simulator training session, a list of 17 AIFs 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 <u>you</u> receive in its use?
4. What is its training value?
5. What is its <u>potential</u> training value?

Table 2. The Number of Instructors Surveyed at Each ATD Site

ATD Site	Training Unit RTU	Training Unit CTU
F-4E	14	3
F-4G	2	7
F-15	20	19
A-10	26	12
E-3A		
IPs	5	3
WDIs	17	6
	84	50

For the fifth question, instructors were asked to assume that they had no prior knowledge of the features and to base their answers on the feature definitions alone. This question was included in order to achieve a common basis for comparison among all instructors. 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 scale. (A zero-point interval was included for indicating that a particular feature was never used or was unavailable. Subjects were instructed to "consider a feature to be available as long as it is incorporated on the simulator and regardless of whether it is fully operational.") In order to facilitate responding, the intervals of each scale were labeled with descriptive adjectives. Additional space was provided for comments.

Procedure

The questionnaire was administered on-site to small groups of instructors (2 to 10). The instructors 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 20 minutes.

RESULTS

The raw data included the instructors' flying and simulator experience in number of hours, their descriptions of a typical training session, and their responses to each question, coded as 0 to 7. (Except as noted, responses of 0, which indicated that a particular feature was unavailable or never used, were not included in the analyses.)

The raw data were classified by ATD (F-4, F-15, A-10, E-3A Flight Simulator, E-3A Mission Simulator), training (RTU, CTU), question (1 through 5), and AIF (1 through 17). Due to the unequal number of instructors and the different features-capability at each site (see Appendix B), the data matrix was unbalanced. Therefore, the data for each ATD were analyzed separately. The data were then pooled and reanalyzed in order to assess the general pattern of results. All analyses were computed on a Univac 1100/81 system using BMDP statistical software (Dixon, 1981).

Sample Size

A sample of 134 instructors (84 RTU and 50 CTU) were surveyed in this study. In analyzing the data, this sample was treated as though it had been randomly drawn from an infinite population of flight instructors. In fact, the sample was drawn from a finite population and, moreover, constituted a large proportion of that population. Thus, the parametric analyses described in this section (ANOVAs, t-tests) are conservatively biased, and the resulting inferences are made with considerable confidence.

Instructors' Flying and Simulator Experience

The instructors' flying and simulator experience is summarized for each ATD site in Tables 3 to 7 and for the pooled data in Table 8. The RTU-CTU means for each type of experience were compared using t-tests. The significant comparisons are indicated on the tables with asterisks.

The RTU and CTU means were statistically equivalent at the F-4 and E-3A sites. However, there were several significant differences at the other sites. Table 8 shows that, overall, RTU instructors reported significantly more simulator flying time and simulator instruction time, $\underline{t}(126) = 2.44$, $p < .05$ and $\underline{t}(128) = 2.17$, $\underline{p} < .05$, respectively. There were no significant overall differences in aircraft time.

The "Typical" Training Session

The typical simulator training session varies by ATD and by type of training unit. For example, a typical F-4 RTU session consists primarily of preflight, inflight, and postflight procedural training with particular emphasis on instrument and emergency procedures. The session may also include practice in certain tactical skills such as intercepts, air-to-ground attack, and the use of radar warning systems. In contrast, tactical skills are emphasized in the typical F-4 CTU session, which frequently centers around a highly structured tactical scenario. The F-15 RTU and CTU training sessions are similar to those of the F-4.

The A-10 RTU and CTU training sessions do not markedly differ. In both cases, the emphasis is on procedural training. Apparently, this emphasis is one of necessity. The RTU ATD (Davis-Monthan AFB) has only a dusk/night visual system, while the CTU ATD (Myrtle Beach AFB) has no visual system at all. Without a sophisticated visual system, neither ATD can effectively simulate the principal A-10 tactical capability, air-to-ground attack.

The size and functional characteristics of the typical Airborne Warning and Control System (AWACS) crew necessitates the use of two E-3A ATDs. E-3A flight training is carried out by IPs in the Flight Simulator, while E-3A aircrew mission training is carried out by WDIs in the Mission Simulator. Training sessions on either ATD may last several hours.

RTU and CTU Flight Simulator sessions are similar and consist primarily of emergency procedural training. E-3A Mission Simulator sessions are, as one WDI described them, "designed to train students within a high density, multiple event scenario." Both RTU and CTU sessions emphasize crew coordination, procedural training, and fighter intercept monitoring and control. CTU sessions are typically based on formalized scenarios (Red Flag, Blue Flag), and CTU students may be required to "play" various roles, such as pilot, ground monitor, senior weapons director.

Student preflight and postflight briefings are common across all ATDs. However, they occur more often at RTU training sites.

Table 3. F-4 IPs: Experience in Mean Number of Hours

	RTU	CTU
Aircraft		
Flying experience	1152.4	1090.0
IP experience	382.5	282.5
Simulator		
Flying experience	437.6	330.0
IP experience	242.2	171.5

Table 4. F-15 IPs: Experience in Mean Number of Hours

	RTU	CTU
Aircraft		
Flying experience	747.5	694.2
* IP experience	287.5	153.7
Simulator		
Flying experience	229.5	206.6
IP experience	171.2	115.3

* $p < .025$.

Table 5. A-10 IPs: Experience in Mean Number of Hours

		RTU	CTU
Aircraft			
	Flying experience	645.4	503.8
*	IP experience	256.9	56.7
Simulator			
	Flying experience	27.9	26.2
	IP experience	21.9	21.2

* $p < .01$.

Table 6. E-3A IPs: Experience in Mean Number of Hours

	RTU	CTU
Aircraft		
Flying experience	1570.0	1266.7
IP experience	382.0	260.0
Simulator		
Flying experience	516.0	466.0
IP experience	362.4	332.7

Table 7. E-3A WDIs: Experience in Mean Number of Hours

	RTU	CTU
Aircraft		
Flying experience	1069.1	838.3
WDI experience	400.6	212.5
Simulator		
* Flying experience	1244.1	591.7
WDI experience	529.4	217.7

* $p < .05$.

Table 8. Pooled Data: Instructors' Experience in Mean Number of Hours

	RTU	CTU
Aircraft		
Flying experience	907.1	779.3
IP or WDI experience	324.6	169.6
Simulator		
* Flying experience	429.1	249.8
* IP or WDI experience	222.4	129.3

* $p < .05$.

Frequency of AIF Use

Ratings of the frequency of AIF use are summarized for each ATD site in Tables 9 to 13 and for the pooled data in Table 14. The individual ratings ranged from 1 (never use) to 7 (use most often). (Note: Ratings of 0, i. e., unavailable, were transformed to ratings of 1, i.e., never use, before the data were analyzed. The tabled means incorporate these transformed ratings.)

The frequency of AIF use appears to be generally low. Except for the E-3A IP data, most of the means range from 1.5 to 3.5 (i.e., rarely to occasionally) with an overall mean of 2.8. This is partly due to the high percentage of instructors who indicated that particular features were unavailable for use. This percentage was 25.7% overall and was as high as 76% for recorded briefing.

A two-factor (Training x Available AIFs) repeated measures analysis of variance (for unequal N) was used to analyze the data from each ATD. A significant main effect of AIF was found in every case, $p < .001$, indicating that the various AIFs are not used equally often. In most cases, reset, environmental, the various freezes, and crash override, if available, were used significantly more often than recorded briefing, demonstration, record/playback, hard copy, automated adaptive training, and programmed mission scenarios. In contrast, demonstration, hard copy, and programmed mission scenarios were among the features used most often on the E-3A Mission Simulator. (Note: these differences were determined by the Dunn test, Keppel, 1973, pp. 147-149.)

The main effect of training was significant for the F-15 ATD, $F(1,37) = 6.41$, $p < .025$, and for the A-10 ATD, $F(1,36) = 4.29$, $p < .05$. In both cases, the RTU ratings were significantly higher than the CTU ratings.

The interaction of training and AIF was significant for the F-15 ATD, $F(8,296) = 8.61$, $p < .001$, the A-10 ATD, $F(12,432) = 3.21$, $p < .01$, and the E-3A flight simulator, $F(9,54) = 4.71$, $p < .001$. A significant interaction implies that the pattern of AIF use is different for the two training groups. In order to determine the locus of this interaction, the Dunn test was used to make post-hoc comparisons between the various RTU/CTU mean pairs. The significant differences are indicated in Tables 10, 11, and 12 by asterisks. For example, Table 10 shows that reset and flight system freeze are used more frequently by F-15 RTU IPs, $p < .01$, while programmed mission scenarios are used more frequently by F-15 CTU IPs, $p < .01$.

Table 9. F-4 Simulator: Mean Rated Frequency of AIF Use

Feature	RTU	CTU	Mean
Reset	5.2	5.0	5.1
Environmental	4.1	3.8	4.0
Auto Malfunction Insertion	1.4	1.0	1.2
Flight System Freeze	3.5	3.5	3.5
Position Freeze	3.1	3.3	3.2
Parameter Freeze	2.8	3.4	3.0
Crash Override	6.4	6.5	6.4
+ Auto Performance Feedback	1.5	1.7	1.5
Hard Copy	1.8	1.8	1.8
+ Auto Adaptive Training	1.4	2.7	1.6
Programmed Mission Scenarios	2.1	3.3	2.5
Grand Mean	3.1	3.4	3.2

+ Note: These AIFs are available only on the F-4E simulator.

Table 10. F-15 Simulator: Mean Rated Frequency of AIF Use

Feature	RTU	CTU	Mean
* Reset	4.8	2.8	3.9
Environmental	4.2	3.1	3.7
Auto Malfunction Insertion	3.0	3.7	3.4
* Flight System Freeze	6.3	3.9	5.1
Crash Override	5.6	5.1	5.3
Motion	2.5	1.5	2.0
Hard Copy	1.2	2.1	1.6
* Programmed Mission Scenarios	2.1	4.1	3.1
Grand Mean	3.7	3.3	3.5

* $p < .01$.

Table 11. A-10 Simulator: Mean Rated Frequency of AIF Use

	Feature	RTU	CTU	Mean
	Reset	5.0	4.3	4.8
*	Total System Freeze	4.5	3.0	4.0
	Recorded Briefing	1.2	1.0	1.1
	Demonstration	1.8	1.2	1.6
	Record/Playback	1.6	1.3	1.5
*	Environmental	4.5	3.0	4.0
	Auto Malfunction Insertion	2.6	2.6	2.6
**	Flight System Freeze	1.9	3.5	2.4
	Position Freeze	3.0	2.3	2.8
	Parameter Freeze	2.9	2.0	2.6
	Crash Override	4.6	3.8	4.3
	Hard Copy	2.6	1.6	2.3
	Programmed Mission Scenarios	1.0	1.5	1.2
	Grand Mean	2.9	2.4	2.7

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

Table 12. E-3A Flight Simulator: Mean Rated Frequency of AIF Use (IPs)

	Feature	RTU	CTU	Mean
	Reset	6.2	4.7	5.6
	Environmental	6.0	6.3	6.1
	Auto Malfunction Insertion	5.4	4.3	5.0
	Flight System Freeze	6.4	4.0	5.5
	Position Freeze	6.4	5.3	6.0
	Parameter Freeze	4.8	5.0	4.9
	Crash Override	4.6	5.0	4.8
	Motion	6.4	7.0	6.6
	Hard Copy	1.0	1.0	1.0
*	Programmed Mission Scenarios	1.4	6.0	3.1
	Grand Mean	4.9	4.9	4.9

* $p < .01$.

Table 13. E-3A Mission Simulator: Mean Rated Frequency of AIF Use (WDIs)

Feature	RTU	CTU	Mean
Total System Freeze	1.3	1.2	1.3
Recorded Briefing	1.5	1.8	1.6
Demonstration	3.3	3.0	3.2
Record/Playback	1.2	1.3	1.3
Environmental	1.9	2.3	2.0
Crash Override	3.1	3.0	3.1
Auto Performance Feedback	3.4	2.7	3.2
Hard Copy	2.6	2.8	2.7
Programmed Mission Scenarios	3.4	3.5	3.4
Grand Mean	2.4	2.4	2.4

Table 14. Pooled Data: Mean Rated Frequency of AIF Use

	Feature	RTU	CTU	Mean
**	Reset	5.1	3.9	4.6
	Total System Freeze	3.2	2.4	3.0
	Recorded Briefing	1.3	1.3	1.3
*	Demonstration	2.4	1.8	2.2
	Record/Playback	1.4	1.3	1.4
	Environmental	3.9	3.3	3.7
	Auto Malfunction Insertion	2.7	2.8	2.7
	Flight System Freeze	3.9	3.7	3.8
	Position Freeze	3.4	3.1	3.3
	Parameter Freeze	3.1	2.9	3.0
	Crash Override	4.9	4.8	4.8
	Motion	3.3	2.3	2.8
	Auto Performance Feedback	2.5	2.3	2.5
	Hard Copy	2.0	1.9	2.0
*	Auto Adaptive Training	1.4	2.7	1.6
**	Programmed Mission Scenarios	2.0	3.3	2.5
	Unweighted Grand Mean	2.9	2.7	2.8

* $p < .05$.
** $p < .001$.

The pooled data, summarized in Table 14, must be interpreted cautiously, since the pooled data matrix was unbalanced. The nonparametric Wilcoxen test was used to compare the RTU and CTU ratings overall, while t-tests were used to make separate RTU-CTU comparisons for each feature. The significant differences are indicated in Table 14 with asterisks. Thus, reset and demonstration are used more frequently by RTU instructors, $t(70) = 3.75$, $p < .001$ and $t(97) = 2.47$, $p < .025$, respectively, while auto adaptive training and programmed mission scenarios are used more frequently by CTU instructors, $t(15) = -2.14$, $p < .05$ and $t(87) = -4.23$, $p < .001$, respectively. There was no overall difference between the two groups' ratings, $T = 31.5$, $p > .05$.

Ease of AIF Use

Ratings of the ease of AIF use are summarized for each ATD site in Tables 15 to 19 and for the pooled data in Table 20. The individual ratings ranged from 1 (most difficult) to 7 (easiest). Most of the means are in the 4.0 to 6.0 range suggesting that most AIFs are at least moderately easy to use. The features were rated similarly at each site, with certain exceptions. For example, reset, environmental, the various freezes, motion, and crash override (those features used most frequently) are apparently easy to use wherever available. On the other hand, record/playback, auto performance feedback, hard copy, and programmed mission scenarios were rated differently across some of the sites. For example, A-10 IPs rated record/playback as moderately easy to use, whereas E-3A WDIs rated it as very difficult. F-4 IPs rated auto performance feedback as difficult to use, whereas E-3A WDIs rated it as very easy. Finally, hard copy and programmed mission scenarios are moderately easy to implement on all ATDs except the E-3A mission simulator (WDIs) and A-10 simulator, respectively.

Unlike the frequency of use data, the means in Tables 15 to 20 are based on a variable frequency that reflects the number of instructors who actually used each feature. Thus, all the data matrices were unbalanced. Consequently, for each ATD and for the pooled data, the nonparametric Wilcoxen test was used to compare the RTU and CTU ratings, overall, and t-tests were used to make separate RTU-CTU comparisons for each feature.

The overall comparison was significant only for the F-4 and F-15 data. The F-4 CTU IPs tended to give higher ratings than did the F-4 RTU IPs, $T = 1.5$, $p < .01$, while F-15 RTU IPs gave higher ratings than did F-15 CTU IPs, $T = 0$, $p < .01$. The significant comparisons for each feature are indicated in Tables 15 and 16 by asterisks. Thus, parameter freeze was rated higher by F-4 CTU IPs (Table 15), $t(17) = -2.54$, $p < .025$, while environmental, flight system freeze, and crash override were rated higher by F-15 RTU IPs (Table 16), $t(35) = 3.00$, $p < .01$, $t(15) = 2.42$, $p < .05$, $t(36) = 3.51$, $p < .01$, respectively. Although the pooled data revealed no overall difference between the RTU and CTU ratings, $T = 41.5$, $p > .05$, flight system freeze was rated easier to use by RTU instructors, $t(78) = 2.19$, $p < .05$.

Table 15. F-4 Simulator: Mean Rated Ease of AIF Use

Feature	RTU	CTU	Mean
Reset	5.9	6.0	5.9
Environmental	5.1	5.3	5.2
Auto Malfunction Insertion	3.0	5.0	3.3
Flight System Freeze	5.9	5.8	5.9
Position Freeze	5.2	5.4	5.3
* Parameter Freeze	5.0	6.4	5.5
Crash Override	6.5	6.5	6.5
+ Auto Performance Feedback	2.1	3.0	2.2
Hard Copy	3.3	3.5	3.4
+ Auto Adaptive Training	2.4	3.5	2.7
Programmed Mission Scenarios	2.9	4.1	3.4
Unweighted Grand Mean	4.3	5.0	4.5

+ Note: These AIFs are available only on the F-4E simulator.
* $p < .025$.

Table 16. F-15 Simulator: Mean Rated Ease of AIF Use

	Feature	RTU	CTU	Mean
	Reset	5.3	4.7	5.1
**	Environmental	5.4	4.1	4.8
	Auto Malfunction Insertion	4.9	4.4	4.6
*	Flight System Freeze	6.9	6.3	6.7
**	Crash Override	6.7	5.8	6.3
	Motion	5.4	4.4	4.9
	Hard Copy	4.8	4.1	4.3
	Programmed Mission Scenarios	4.9	4.7	4.8
	Unweighted Grand Mean	5.5	4.8	5.2

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

Table 17. A-10 Simulator: Mean Rated Ease of AIF Use

Feature	RTU	CTU	Mean
Reset	5.1	5.4	5.2
Total System Freeze	5.7	5.8	5.7
Recorded Briefing	5.0	---	5.0
Demonstration	3.6	4.5	3.7
Record/Playback	3.5	4.7	3.7
Environmental	4.3	4.8	4.4
Auto Malfunction Insertion	3.5	2.6	3.2
Flight System Freeze	5.8	5.1	5.5
Position Freeze	5.1	5.4	5.2
Parameter Freeze	4.8	4.9	4.8
Crash Override	5.9	5.6	5.8
Hard Copy	4.6	5.2	4.7
Programmed Mission Scenarios	1.0	2.8	2.2
Unweighted Grand Mean	4.5	4.7	4.5

Table 18. E-3A Flight Simulator: Mean Rated Ease of AIF Use (IPs)

Feature	RTU	CTU	Mean
Reset	6.4	5.7	6.1
Environmental	5.4	6.0	5.6
Auto Malfunction Insertion	4.2	4.0	4.1
Flight System Freeze	5.8	5.3	5.6
Position Freeze	6.0	5.3	5.8
Parameter Freeze	5.5	6.3	5.9
Crash Override	5.8	5.3	5.6
Motion	6.2	6.3	6.3
Hard Copy	2.0	---	2.0
Programmed Mission Scenarios	3.0	5.0	4.3
Unweighted Grand Mean	5.0	5.5	5.1

Table 19. E-3A Mission Simulator: Mean Rated Ease of AIF Use (WDIs)

Feature	RTU	CTU	Mean
Total System Freeze	4.7	2.7	4.0
Recorded Briefing	4.6	3.5	4.3
Demonstration	4.8	4.0	4.6
Record/Playback	2.3	1.5	2.1
Environmental	4.6	4.5	4.6
Crash Override	5.8	6.0	5.9
Automated Performance Feedback	6.3	6.0	6.2
Hard Copy	5.6	5.6	5.6
Programmed Mission Scenarios	3.7	4.2	3.8
Unweighted Grand Mean	4.7	4.2	4.6

Table 20. Pooled Data: Mean Rated Ease of AIF Use

	Feature	RTU	CTU	Mean
	Reset	5.4	5.4	5.4
	Total System Freeze	5.8	5.6	5.7
	Recorded Briefing	4.6	4.0	4.4
	Demonstration	4.1	4.3	4.2
	Record/Playback	3.1	3.6	3.2
	Environmental	4.8	4.7	4.8
	Auto Malfunction Insertion	4.2	3.9	4.1
*	Flight System Freeze	6.2	5.7	6.0
	Position Freeze	5.2	5.2	5.2
	Parameter Freeze	5.0	5.6	5.2
	Crash Override	6.2	5.9	6.1
	Motion	5.5	4.8	5.2
	Auto Performance Feedback	4.4	4.5	4.5
	Hard Copy	4.5	4.4	4.4
	Auto Adaptive Training	2.5	3.5	2.7
	Programmed Mission Scenarios	3.8	4.3	4.0
	Unweighted Grand Mean	4.7	4.7	4.7

* $p < .05$.

Training in AIF Use

The amount of training received in AIF use is summarized for each ATD site in Tables 21 to 25 and for the pooled data in Table 26. The individual ratings ranged from 1 (none) to 7 (greatest). As was the case for the frequency-of-use data, ratings of 0 were transformed to ratings of 1 before the data were analyzed. The tabled means incorporate these transformed ratings.

Except for the E-3A IP data, most of the means range from 1.5 to 4.5 (i.e., minimal or moderate) and are similar to those obtained from the frequency-of-use data. It appears that most instructors do not receive extensive training in AIF use.

A two-factor (Training x Available AIFs) repeated measures analysis of variance (for unequal N) was used to analyze the data from each ATD. The main effect of AIF was significant in every case, $p < .001$. The differences between features, determined by the Dunn test, were similar to those revealed in the frequency of use data. In most cases, reset, environmental, the various freezes, and crash override, the same features that were frequently used, received significantly more training than did infrequently used features, such as recorded briefing, demonstration, record/playback, automated adaptive training, and programmed mission scenarios.

The main effect of training was significant only for F-15 IPs, $F(1,37) = 5.90$, $p < .025$. F-15 RTU IPs received more training than did F-15 CTU IPs. (This effect was also present in the frequency of use data.) In most cases, then, RTU and CTU instructors received comparable amounts of training overall.

The interaction of training and AIF was significant for the F-15 ATD, $F(8,296) = 6.63$, $p < .001$, and the A-10 ATD, $F(12,432) = 2.12$, $p < .05$. In the case of the F-15 data, RTU IPs received more training in the use of reset, environmental, and flight system freeze, whereas CTU IPs received more training in the use of hard copy. In the case of the A-10 data, the locus of the interaction was not revealed by post-hoc comparisons. However, the relative differences between the means are similar to those in the A-10 frequency-of-use data. (Compare Tables 11 and 23.)

The analysis of the pooled data revealed no overall difference between the RTU and CTU ratings, $T = 47.5$, $p > .05$. However, RTU instructors received more training in reset, $t(76) = 3.08$, $p < .01$, whereas CTU instructors received more training in automated adaptive training and programmed mission scenarios, $t(15) = -2.29$, $p < .05$ and $t(132) = -2.23$, $p < .05$, respectively. (Note: automated adaptive training was not available on most ATDs. Therefore, this difference may not generalize.)

Table 21. F-4 Simulator: Mean Amount of Training Received in AIF Use

Feature	RTU	CTU	Mean
Reset	3.7	4.0	3.8
Environmental	2.8	3.2	2.9
Auto Malfunction Insertion	1.2	1.2	1.2
Flight System Freeze	3.1	3.3	3.2
Position Freeze	3.2	3.8	3.5
Parameter Freeze	2.6	2.8	2.7
Crash Override	3.2	3.8	3.5
+ Auto Performance Feedback	1.6	1.3	1.6
Hard Copy	2.0	1.8	1.9
+ Auto Adaptive Training	1.3	2.7	1.5
Programmed Mission Scenarios	1.8	2.6	2.1
Grand Mean	2.4	2.9	2.6

+ Note: These AIFs are available only on the F-4E simulator.

Table 22. F-15 Simulator: Mean Amount of Training Received in AIF Use

	Feature	RTU	CTU	Mean
**	Reset	4.0	1.9	3.0
*	Environmental	4.0	2.9	3.5
	Auto Malfunction Insertion	3.2	3.6	3.4
*	Flight System Freeze	4.4	3.2	3.8
	Crash Override	4.3	3.8	4.1
	Motion	3.4	2.4	2.9
*	Hard Copy	1.3	2.5	1.9
	Programmed Mission Scenarios	3.0	2.8	2.9
	Grand Mean	3.4	2.9	3.2

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

Table 23. A-10 Simulator: Mean Amount of Training Received in AIF Use

Feature	RTU	CTU	Mean
Reset	4.3	4.2	4.3
Total System Freeze	4.5	3.8	4.2
Recorded Briefing	1.2	1.3	1.2
Demonstration	2.2	1.3	1.9
Record/Playback	2.3	1.7	2.1
Environmental	4.2	3.4	3.9
Auto Malfunction Insertion	3.3	3.6	3.4
Flight System Freeze	2.0	3.2	2.4
Position Freeze	3.2	2.8	3.1
Parameter Freeze	3.2	2.9	3.1
Crash Override	4.2	3.8	4.1
Hard Copy	3.3	2.8	3.1
Programmed Mission Scenarios	1.3	2.3	1.7
Grand Mean	3.0	2.9	3.0

Table 24. E-3A Flight Simulator: Mean Amount of Training Received in AIF Use (IPs)

Feature	RTU	CTU	Mean
Reset	4.4	4.3	4.4
Environmental	5.2	5.0	5.1
Auto Malfunction Insertion	4.0	4.3	4.1
Flight System Freeze	5.2	3.7	4.6
Position Freeze	5.2	3.3	4.5
Parameter Freeze	4.0	3.0	3.6
Crash Override	5.4	3.3	4.6
Motion	5.4	6.0	5.6
Hard Copy	1.0	1.0	1.0
Programmed Mission Scenarios	2.2	3.7	2.8
Grand Mean	4.2	3.8	4.1

Table 25. E-3A Mission Simulator: Mean Amount of Training Received in AIF Use (WDIs)

Feature	RTU	CTU	Mean
Total System Freeze	1.5	2.0	1.7
Recorded Briefing	1.3	2.2	1.5
Demonstration	3.0	3.7	3.2
Record/Playback	1.1	1.3	1.2
Environmental	1.8	2.7	2.0
Crash Override	2.8	2.7	2.8
Automated Performance Feedback	2.4	2.2	2.3
Hard Copy	3.3	4.0	3.5
Programmed Mission Scenarios	2.9	4.0	3.2
Grand Mean	2.2	2.7	2.4

Table 26. Pooled Data: Mean Amount of Training Received in AIF Use

	Feature	RTU	CTU	Mean
**	Reset	4.1	3.2	3.7
	Total System Freeze	3.3	3.2	3.3
	Recorded Briefing	1.2	1.6	1.3
*	Demonstration	2.5	2.1	2.4
	Record/Playback	1.8	1.6	1.7
	Environmental	3.4	3.2	3.4
	Auto Malfunction Insertion	2.8	3.1	2.9
	Flight System Freeze	3.2	3.2	3.2
	Position Freeze	3.4	3.3	3.4
	Parameter Freeze	3.1	2.9	3.0
	Crash Override	3.8	3.6	3.8
	Motion	3.8	2.9	3.4
	Auto Performance Feedback	2.0	1.9	2.0
	Hard Copy	2.4	2.5	2.5
*	Auto Adaptive Training	1.3	2.7	1.9
*	Programmed Mission Scenarios	2.2	2.8	2.4
	Unweighted Grand Mean	2.8	2.7	2.7

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

AIF Training Value

The training value ratings are summarized for each ATD-site in Tables 27 to 31 and for the pooled data in Table 32. The individual ratings ranged from 1 (none) to 7 (greatest). Most of the means range from 3.5 to 5.5 (i.e., moderate to considerable). Not surprisingly, the frequently used features were also those rated relatively high in training value. A notable exception was programmed mission scenarios, which was rated high in training value by all instructors except the A-10 RTU IPs, but was not used often. Another exception was hard copy, which was only occasionally used, but was considered by most instructors to have at least moderate training value. An interesting contrast occurred in the case of motion. F-15 IPs considered it to have only moderate training value, whereas E-3A IPs rated it highest of all features.

Like the ease-of-use data, the training value data were a function of the frequency with which each feature was used. Thus, RTU-CTU overall comparisons were made with the nonparametric Wilcoxen test, whereas comparisons for each feature were made with t-tests. Among the various ATDs, the only significant overall comparison occurred in the F-15 data. In this case, RTU IPs gave significantly higher ratings than did CTU IPs, $T = 3$, $p < .05$. Significant individual comparisons included reset, $t(16) = 4.02$, $p < .001$, flight system freeze, $t(32) = 3.06$, $p < .01$, and motion, $t(27) = 2.34$, $p < .05$. The only other significant differences occurred in the A-10 and E-3A IP data: Environmental was rated higher by A-10 RTU IPs, $t(35) = 2.56$, $p < .05$, programmed mission scenarios was rated higher by A-10 CTU IPs $t(12) = -2.25$, $p < .05$, and position freeze was rated higher by E-3A RTU IPs, $t(6) = 2.74$, $p < .05$.

The analysis of the pooled data revealed a significant overall difference between the RTU and CTU ratings, $T = 21$, $p < .05$. Apparently, there was a general tendency for RTU instructors to rate AIFs higher in training value. This tendency was strongest in the case of environmental, $t(116) = 2.72$, $p < .01$, and flight system freeze, $t(84) = 2.27$, $p < .05$.

AIF Potential Training Value

A 2 (training) by 5 (ATD) by 17 (AIF) repeated measures analysis of variance (for unequal N) was used to analyze these data. The individual ratings ranged from 1 (none) to 7 (greatest). Like the training value data, described previously, most of the means range from 3.5 to 5.5 (i.e., moderate to considerable). The analysis revealed several significant effects.

There was a slight but significant overall difference between the RTU ($\bar{x} = 4.5$) and CTU ($\bar{x} = 4.3$) ratings, $F(1,117) = 4.67$, $p < .05$. The main effect of ATD was not significant, however, $F(4,117) = 1.77$, $p > .05$. This reflects the fact that the overall mean rating was similar at each ATD site. The interaction of training and ATD was also not significant, $F(4,117) = 2.41$, $p > .05$. This reflects the fact that the difference between the RTU and CTU ratings was fairly consistent across ATDs.

Table 27. F-4 Simulator: Mean Rated AIF Training Value

Feature	RTU	CTU	Mean
Reset	5.4	5.4	5.4
Environmental	4.9	4.1	4.6
Auto Malfunction Insertion	4.2	2.5	3.8
Flight System Freeze	5.1	4.5	4.9
Position Freeze	4.1	4.2	4.1
Parameter Freeze	4.4	4.6	4.5
Crash Override	5.4	4.8	5.2
+ Auto Performance Feedback	3.1	3.3	3.2
Hard Copy	4.0	4.7	4.2
+ Auto Adaptive Training	4.0	4.3	4.1
Programmed Mission Scenarios	4.4	5.0	4.7
Unweighted Grand Mean	4.5	4.3	4.4

+ Note: These AIFs are only available on the F-4E simulator.

Table 28. F-15 Simulator: Mean Rated AIF Training Value

Feature	RTU	CTU	Mean
** Reset	5.6	3.8	4.9
Environmental	4.2	3.6	3.9
Auto Malfunction Insertion	4.9	4.0	4.4
** Flight System Freeze	6.4	5.1	5.9
Crash Override	5.3	4.6	5.0
* Motion	3.6	2.3	3.1
Hard Copy	3.6	3.7	3.7
Programmed Mission Scenarios	4.9	5.4	5.2
Unweighted Grand Mean	4.8	4.1	4.5

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

Table 29. A-10 Simulator: Mean Rated AIF Training Value

	Feature	RTU	CTU	Mean
	Reset	5.2	5.3	5.3
	Total System Freeze	5.2	5.0	5.1
	Recorded Briefing	5.3	2.5	4.3
	Demonstration	3.8	3.3	3.7
	Record/Playback	4.1	3.4	4.0
**	Environmental	5.1	4.0	4.8
	Auto Malfunction Insertion	3.6	4.5	3.9
	Flight System Freeze	5.0	4.6	4.8
	Position Freeze	4.6	4.5	4.6
	Parameter Freeze	4.4	4.1	4.3
	Crash Override	4.9	5.0	4.9
	Hard Copy	4.0	3.0	3.8
*	Programmed Mission Scenarios	2.8	4.2	3.6
	Unweighted Grand Mean	4.5	4.1	4.4

* $p < .05$.
** $p < .025$.

Table 30. E-3A Flight Simulator: Mean Rated AIF Training Value (IPs)

Feature	RTU	CTU	Mean
Reset	5.8	5.0	5.5
Environmental	5.4	6.0	5.6
Auto Malfunction Insertion	5.6	4.7	5.2
Flight System Freeze	6.2	4.7	5.6
* Position Freeze	6.0	4.7	5.5
Parameter Freeze	4.5	5.3	4.9
Crash Override	5.4	4.7	5.1
Motion	6.8	6.3	6.6
Hard Copy	1.0	---	1.0
Programmed Mission Scenarios	4.0	4.7	4.5
Unweighted Grand Mean	5.1	5.1	5.0

* $p < .05$.

Table 31. E-3A Mission Simulator: Mean Rated AIF Training Value (WDIs)

Feature	RTU	CTU	Mean
Total System Freeze	3.2	3.3	3.2
Recorded Briefing	3.6	3.3	3.5
Demonstration	5.3	5.0	5.2
Record/Playback	4.6	2.3	3.8
Environmental	3.3	3.3	3.3
Crash Override	4.7	4.3	4.6
Automated Performance Feedback	4.1	5.0	4.3
Hard Copy	3.7	3.2	3.6
Programmed Mission Scenarios	4.6	5.0	4.8
Unweighted Grand Mean	4.1	3.9	4.0

Table 32. Pooled Data: Mean Rated AIF Training Value

Feature	RTU	CTU	Mean
Reset	5.3	4.8	5.1
Total System Freeze	4.6	4.8	4.7
Recorded Briefing	3.8	2.9	3.5
Demonstration	4.4	3.9	4.3
Record/Playback	4.4	3.9	4.2
** Environmental	4.7	4.0	4.4
Auto Malfunction Insertion	4.2	4.2	4.2
* Flight System Freeze	5.5	4.8	5.2
Position Freeze	4.5	4.4	4.5
Parameter Freeze	4.3	4.5	4.3
Crash Override	5.1	4.7	5.0
Motion	4.3	3.4	3.9
Auto Performance Feedback	4.0	3.8	3.9
Hard Copy	3.8	3.6	3.8
Auto Adaptive Training	3.7	3.6	3.7
Programmed Mission Scenarios	4.4	5.0	4.7
Unweighted Grand Mean	4.4	4.2	4.3

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

There was a significant main effect of AIF, $F(16,1872) = 8.01$, $p < .001$, and a significant interaction of Training and AIF, $F(16,1872) = 2.25$, $p < .01$. The relevant data are summarized in Table 33. The Dunn test was used to analyze the main effect by comparing the mean ratings of all pairs of features. Four groups of features were identified as a result. The highest ratings were assigned to reset, record/playback, and programmed mission scenarios. Significantly lower ratings ($p < .05$) were assigned to total system freeze, demonstration, auto malfunction insertion, position freeze, parameter freeze, auto performance feedback, hard copy, and auto adaptive training. The lowest ratings ($p < .01$ relative to those in the highest group, $p < .05$ relative to those in the intermediate group) were assigned to recorded briefing and motion. The remaining features (i.e., instructor pilot tutorial, environmental, flight system freeze, and crash override) were rated between those in the highest and intermediate groups. These features differed only from those in the lowest group, $p < .01$. It is especially interesting to note that of the three highest rated features, only reset was frequently used.

The Dunn test was also used to determine the locus of the Training x AIF interaction. Only one significant comparison was obtained, that for auto performance feedback. Apparently, neither the main effect of training nor its interaction with AIF was very robust.

The strongest effect obtained (omega squared = .07) was the interaction between ATD and AIF, $F(64,1872) = 4.63$, $p < .001$. Notwithstanding the absence of a significant main effect of ATD, this interaction suggests that there might be significant differences among the ATD instructors' ratings of certain features. The relevant data are summarized in Table 34. Significant differences, determined by the Dunn test, were revealed for those features marked with an asterisks. The probability value applies to the largest observed difference. For all features except reset, the mean rating for the E-3A WDIs was significantly lower than the highest observed mean rating. In the case of reset, the mean rating for the F-4 IPs was significantly lower than that for the A-10 IPs, and in the case of motion, the E-3A IPs rating of 6.9 was significantly higher than all others.

Finally, there was a significant triple interaction, $F(64,1872) = 2.10$, $p < .001$, which suggests that the pattern of RTU-CTU differences, shown in Table 33, was not consistent across all ATDs. It is unlikely that this effect is very important since its magnitude is quite small (omega squared = .02). The relevant data are summarized in Tables C1 to C5 in Appendix C.

Interrelations Among the Variables

Table 35 shows the intercorrelations among the ratings of each feature on each of the five questions. All the coefficients are positive and significant, $p < .001$. Thus, a feature's rating on any question can be predicted with greater than chance accuracy given its rating on any other question. However, these predictions will not be equally precise. The respective proportions of variance accounted for (indicated by the squared coefficients) range from 5% to 42%. Since the coefficients are positive, it can be generally stated that

Table 33. Potential Value of AIFs: Mean Ratings by RTU and CTU Instructors

Feature	RTU	CTU	Mean
Instructor Pilot Tutorial	4.8	4.7	4.7
Reset	5.0	5.3	5.1
Total System Freeze	4.2	4.7	4.3
Recorded Briefing	3.9	3.2	3.6
Demonstration	4.6	4.1	4.4
Record/Playback	5.1	5.2	5.1
Environmental	4.8	4.2	4.6
Auto Malfunction Insertion	4.4	4.4	4.4
Flight System Freeze	4.6	4.7	4.6
Position Freeze	4.5	4.4	4.5
Parameter Freeze	4.3	4.3	4.3
Crash Override	4.8	4.6	4.8
Motion	3.5	3.4	3.5
* Auto Performance Feedback	4.4	3.6	4.1
Hard Copy	4.5	3.8	4.3
Auto Adaptive Training	4.4	3.7	4.1
Programmed Mission Scenarios	5.1	5.2	5.1
Grand Mean	4.5	4.3	4.5

* $p < .05$.

Table 34. Potential Value of AIFs: Mean Ratings by ATD Instructors

Feature	F-4 IPs	F-15 IPs	A-10 IPs	E-3A IPs	E-3A WDIs
Instructor Pilot Tutorial	4.8	4.5	5.0	5.1	4.5
* Reset	5.5	5.1	5.4	5.7	4.0
** Total System Freeze	3.1	4.6	5.2	4.6	3.7
Recorded Briefing	3.4	3.3	3.6	4.0	4.6
Demonstration	4.2	4.1	4.5	4.1	5.3
Record/Playback	4.8	5.5	4.9	4.4	5.7
** Environmental	5.0	4.4	5.3	5.3	2.7
** Auto Malfunction Insertion	4.2	4.7	4.6	5.6	3.6
** Flight System Freeze	5.1	5.6	4.3	5.6	2.7
* Position Freeze	4.9	4.2	4.7	5.6	3.7
Parameter Freeze	5.1	4.0	4.4	4.9	3.6
* Crash Override	5.4	5.0	4.7	5.0	3.7
** Motion	3.4	3.3	4.0	6.9	1.8
Auto Performance Feedback	4.4	3.8	3.8	4.0	5.0
Hard Copy	4.6	4.3	4.1	3.9	4.2
Auto Adaptive Training	4.6	3.9	3.9	3.4	4.7
Programmed Mission Scenarios	5.0	5.4	4.5	5.3	5.8
Grand Mean	4.6	4.5	4.5	4.9	4.1

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

Table 35. 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	.43	.40	1.00		
TVALUE	.55	.38	.43	1.00	
PTVALUE	.42	.23	.33	.65	1.00

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

the greater training value a feature has, the more frequently it is used, the easier it is to use, the more training was received in its use, and the greater its potential training value.

Table 36 summarizes the results of a multiple linear regression analysis in which the frequency of AIF use is predicted from a linear combination of the remaining variables. The table indicates that, together, the predictor variables account for over 42% of the variance in the frequency-of-use ratings, the most important predictors being ease of use and training value.

Table 37 summarizes the results of a multiple linear regression analysis in which AIF training value is predicted from a linear combination of the remaining variables. The table indicates that, together, the predictor variables account for over 53% of the variance in the training value ratings, the most important predictor being potential training value, followed, in order, by frequency of use, training received, and ease of use.

DISCUSSION

This section briefly discusses the utility and utilization ratings of each AIF. The features are grouped by function, just as they were in Table 1. The discussion incorporates the instructors' comments as well, since in many cases, these comments help explain the ratings.

Briefing Features

These features are designed for briefing the student and/or instructor prior to or during a simulator training session. The purpose is to establish a learning set and to increase learning readiness.

Recorded Briefing. The recorded briefing feature is available only at two ATD sites and it is used very rarely. On the A-10 ATD recorded briefing is available only for student IPs as part of simulator checkouts. Audio visual media are limited. E-3A WDIs indicated that recorded briefing is too difficult to use and is only available at the students discretion. Recorded briefing apparently has greater utility for RTU training, although its potential training value is relatively low. Several instructors feel this feature is unnecessary and prefer to brief the students themselves.

Demonstration. Like recorded briefing, the demonstration feature is used infrequently and is presumed to have greater utility for RTU training. However, it is rated as having somewhat greater training potential than recorded briefing. (One A-10 IP stated, "There's nothing better than a good demo.") In comparison to other AIFs, demonstration is time consuming to implement on both the A-10 and E-3A mission simulators, which may explain its infrequent use.

Table 36. 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: .6545 STD. ERROR OF EST.: 1.3796

MULTIPLE R-SQUARE: .4283

ANALYSIS OF VARIANCE:

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P
REGRESSION	1431.6965	4	357.9241	188.059	.0000
RESIDUAL	1910.8638	1004	1.9033		

PREDICTOR VARIABLE	COEFFICIENT	STD. ERROR	STD. REG COEFFICIENT	t	P
INTERCEPT	-1.03064				
EASEUSE	.38496	.03308	.314	11.639	.0000
TRECD	.17546	.03534	.137	4.965	.0000
TVALUE	.35176	.04082	.291	8.617	.0000
PTVALUE	.16036	.04197	.120	3.821	.0001

Table 37. Multiple Linear Regression of AIF Training Value on Frequency of Use, Ease of Use, Training Received, and Potential Training Value.

DEPENDENT VARIABLE: AIF Training Value

MULTIPLE R: .7312 STD. ERROR OF EST.: 1.0292

MULTIPLE R-SQUARE: .5346

ANALYSIS OF VARIANCE:

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO	P
REGRESSION	1221.8385	4	305.4596	288.362	.0000
RESIDUAL	1063.5305	1004	1.0593		

PREDICTOR VARIABLE	COEFFICIENT	STD. ERROR	STD. REG COEFFICIENT	t	P
INTERCEPT	.16897				
FREQUSE	.19578	.02272	.237	8.617	.0000
EASEUSE	.10005	.02610	.099	3.834	.0001
TRECD	.14171	.02631	.134	5.387	.0000
PTVALUE	.53017	.02673	.479	19.832	.0000

Instructor pilot tutorial. Most instructors receive some formal training in AIF use. Typically, this training is included as part of the instructor pilot training course. However, over 80% of the comments reveal that most of the training in AIF use tends to be informal. Instructor pilot tutorial is not currently available at any of the surveyed ATD-sites, but it was consistently rated high in potential training value. (One instructor felt it was unnecessary and stated, "Hands-on training is best.")

Training Management Features

These include various features designed to control the structure and sequencing of tasks within a training session.

Total system freeze. Total system freeze is available on only two ATDs. If given a choice, most instructors apparently prefer to use flight system freeze to suspend simulated flight. A total system freeze on the E-3A mission simulator results in the simultaneous freezing of all student consoles, thereby interrupting the entire mission. As a result, E-3A WDIs especially dislike this feature and many consider it unavailable for use. In contrast, on the A-10 ATD total system freeze is easiest of all freezes to use, and A-10 IPs use the feature frequently.

Reset. Reset is among the most frequently used and highly valued features at each ATD site. It is typically used in conjunction with flight system freeze and permits instructors to rapidly re-initialize the ATD to a particular configuration so that a student can repeat a particular maneuver or mission segment. Not surprisingly, reset is used especially frequently by RTU instructors. Reset is used least often by F-15 IPs, who commented that it requires numerous switch actions.

Crash and/or kill override. Used mainly for convenience, crash override is typically left "on" at all times so that an instructor can avoid losing data or having to reset the ATD following a crash. The ratings of this feature were high at most sites, although 39% of the E-3A WDIs considered crash override to be unavailable. In fact, crash override is frequently used on the E-3A mission simulator. However, it must be inserted during sim start-up, and WDIs will not normally insert it themselves.

Automated adaptive training. Automated adaptive training is available only on the F-4E simulator, where it is used mainly by CTU IPs. It was rated as difficult to use, with only moderate training value. Manual override of automated adaptive training is not possible. In commenting on its potential, several instructors doubted its training effectiveness, remarking that "it takes the IP out of the loop."

Programmed mission scenarios. Programmed mission scenarios are available at all sites and are apparently an important part of CTU training. Although they were rated high in utility (highest, with reset and record/playback, in potential training value), they are used less often than might be expected. Instructors' comments indicate that programmed mission scenarios are extremely "cumbersome to build" and relatively difficult to use. In the E-3A flight simulator, programmed scenarios are limited to programmed malfunction blocks, which helps explain the large proportion of IPs who presumed the feature was unavailable. Many CTU instructors would like to have a greater number and variety of scenarios available, whereas a few RTU instructors felt the feature leaves the IP with nothing to do.

Variation of Task Difficulty Features

This group of features permits an instructor to control the difficulty of simulated flight through variations in ATD fidelity, configuration, or task load demands.

Automated malfunction insertion. Automated malfunction insertion is available on four of the five ATDs surveyed. In most cases, it is seldom used, and many instructors prefer to insert malfunctions manually. Their comments indicate that automated insertion is sometimes unreliable and can be difficult to implement. On the other hand, manual insertion is easy and immediate. Automated malfunction insertion may be desirable in certain situations. For example, the typical E-3A flight simulator training session emphasizes emergency procedural training and E-3A IPs use the feature moderately often.

Environmental. Some capability for varying environmental condition is present at each ATD site. It is used moderately often by most instructors, very often by E-3A IPs, but very rarely by E-3A WDIs. The E-3A mission simulator, which can only simulate winds aloft, has the most limited environmental capability of all ATDs surveyed. This helps explain why a relatively large proportion of WDIs reported that this feature is unavailable. Other instructors expressed the need for increased fidelity and ease of use. Environmental was rated as having moderately high training value, especially for RTU training.

Motion. Motion is available on the F-15 ATD, where it is rarely used, and on the E-3A flight simulator, where it is frequently used. This difference apparently reflects a difference in fidelity. The training value ratings suggest that motion may have greater utility in RTU training, but its overall potential training value is relatively low. (E-3A WDIs rated motion lowest of all AIFs.)

Flight system, position, and parameter freeze. The purpose of these features is to permit the instructor to selectively freeze parts of the ATD system and thereby control the student's task load. The various freezes may be viewed on a continuum bounded by total system freeze, in which the entire ATD ceases to function, at one end, and parameter freeze, in which a single parameter such as altitude is held constant, at the other. At most sites, the freezes, particularly flight system freeze, are used frequently and are rated high in training value. However, they are used not so much to reduce task load but, rather, to suspend temporarily the training session so that the instructor can offer feedback and/or re-configure the ATD for another task. Not surprisingly, the utilization and utility of freeze tend to be lower in CTU training because of the extended scenarios that characterize CTU training sessions.

Instructor Monitor and Feedback Features

Although none of these features were included in the survey, several instructors stressed the importance of instructor feedback in the form of repeaters/annunciators and real-time situational displays.

Student Feedback Features

Student feedback is one of the most important determiners of effective learning. These features are designed to provide this feedback in various ways. Ironically, the features are among those used least often.

Record/Playback. Record/Playback is available on the A-10 ATD and the E-3A mission simulator. It is rarely used at both sites and, compared to other AIFs, is relatively difficult to use. For example, on the A-10 ATD record/playback must be implemented by, first, accessing a particular CRT page and, second, entering playback and select time modes by means of a light pen. On the E-3A mission simulator, record/playback was rated most difficult of all AIFs to use. Many WDIs did not consider it to be fully operational. Paradoxically, record/playback is among those features rated highest in potential training value.

Automated performance feedback. Automated performance feedback is available on the F-4E ATD and the E-3A mission simulator. Although 45% of the instructors indicated that automated performance feedback was unavailable, the other instructors reported using it moderately often. It apparently has greater potential utility for RTU training. A few instructors commented that this is a useful feature only if manual override is possible.

Hard copy. While a potentially useful feature, hard copy is seldom used at most sites. It has not been operational on the E-3A flight simulator for several years and is rarely operational on the F-15 ATD. Several instructors at other sites noted problems in reliability and ease of implementation, and one instructor commented on the need to protect classified information. Graphic situational displays are apparently preferable to numeric summaries.

AIF Utilization

The results of this survey indicate that many AIFs are not used extensively. Several factors appear to have contributed to the low rate of use. First, training in AIF use tended to be minimal. As a result, some instructors were not fully familiar with the AIF capability of their respective devices. Second, several features were not always operational due to hardware and/or software unreliability. This applied, for example, to recorded briefing on the A-10 ATD and E-3A mission simulator, auto malfunction insertion on the F-4 ATDs and hard copy on the F-15 ATD and E-3A flight simulator. Many instructors considered these features to be unavailable for use. Third, some of the more complex features, such as demonstration, record/playback, and programmed mission scenarios, took relatively longer to implement. Due to the limited amount of simulator time that was available to train students, these features could not be used extensively. The fact that these features were nevertheless rated high in training value suggests that infrequently used AIFs can be effective training aids. Finally, there were some features, such as environmental and total system freeze on the E-3A mission simulator, that were either too limited in capability or deficient in design to justify frequent use.

The multiple regression analysis (Table 36) suggests that ease of use and training value are the most important factors that determine AIF use. However, as with all correlational data, cause-effect relationships have not been established. Many other factors are doubtlessly involved.

RTU-CTU Differences

The results also indicate that AIF utility and utilization differs as a function of training unit. This difference was most apparent in the F-15 data. The F-15 RTU IPs used the features more frequently, found them easier to use, received more training in their use, and rated them higher in training value. Similar tendencies were present at the other ATD sites, and the analyses of the pooled data suggest that AIFs have greater utility for RTU training in general.

The relationship between AIF utility/utilization and training unit is not a simple one, however. Certain features were rated higher by RTU instructors while others were rated higher by CTU instructors. In most cases these differences reflect the contrast between the procedural-based RTU training session and the scenario-based CTU training session.

CONCLUSIONS AND RECOMMENDATIONS

A broad objective of this investigation was to provide a data base that would help in defining the requirements for future TAC ATD procurements and help in developing subsequent ATD training programs. The data suggest that certain AIFs need to be made more reliable and user-friendly before their training effectiveness can be ascertained. Some of these features may eventually prove unnecessary. It is clear, however, that most instructors have not yet fully explored the existing instructional capabilities of ATDs.

It is recommended that formal intensive training programs be established for ATD instructors. These programs should not only teach instructors how to use AIFs, but more importantly, how to use them effectively - that is, when and why to use them. (Interestingly, this recommendation is implicit in the high potential training value ratings of instructor pilot tutorial.) 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 A

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:

____

____

____

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____

Please familiarize yourself with these instructional features and their definitions:

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 maneuvers 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, and visibility.

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

Flight System Freeze - permits instructor to simultaneously freeze flight control and propulsion systems, latitude, longitude, altitude, and heading.

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

Parameter Freeze - permits instructor to freeze any one or combination of flight parameters.

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, and vertical.

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

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.

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

	unavailable	never	rarely	occasionally	moderately often	frequently	very frequently	most often
Feature								
	0	1	2	3	4	5	6	7

Comments:

...

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

	never used or unavailable	most difficult	very difficult	difficult	moderate	easy	very easy	easiest
Feature								
	0	1	2	3	4	5	6	7

Comments:

...

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

unavailable/ none /minimal/ some /moderate/considerable/great/greatest/

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

Comments:

...

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

never used or/
unavailable/ none /minimal/ some /moderate/considerable/great/greatest/

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

Comments:

...

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

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

Feature / / / / / / /
1 2 3 4 5 6 7

Comments:

...

APPENDIX B

AIF CAPABILITY OF EACH ATD

Table B-1. AIF Capability of Each ATD

Feature	F-4 ATD	F-15 ATD	A-10 ATD	E-3A FS	E-3A MS
Instructor Pilot Tutorial					
Reset	X	X	X	X	
Total System Freeze			X		X
Recorded Briefing			X		X
Demonstration			X		X
Record/Playback			X		X
Environmental	X	X	X	X	X
Auto Malfunction Insertion	X	X	X	X	
Flight System Freeze	X	X	X	X	
Position Freeze	X	X	X	X	
Parameter Freeze	X		X	X	
Crash Override	X	X	X	X	X
Motion		X		X	
Auto Performance Feedback	X				X
Hard Copy	X	X	X	X	X
Auto Adaptive Training	X				
Programmed Mission Scenarios	X	X	X	X	X

APPENDIX C

AIF POTENTIAL TRAINING VALUE AT EACH ATD

Table C-1. F-4 Simulator: Potential Training Value of AIFs

Feature	RTU	CTU	Mean
Instructor Pilot Tutorial	4.6	5.2	4.8
Reset	5.5	5.4	5.5
Total System Freeze	2.6	4.2	3.1
Recorded Briefing	3.3	3.6	3.4
Demonstration	4.1	4.5	4.2
Record/Playback	4.5	5.5	4.8
Environmental	5.0	5.1	5.0
Auto Malfunction Insertion	4.6	3.4	4.2
Flight System Freeze	5.1	5.2	5.1
Position Freeze	4.7	5.2	4.9
Parameter Freeze	5.1	5.2	5.1
Crash Override	5.5	5.2	5.4
Motion	3.2	3.8	3.4
Auto Performance Feedback	4.4	4.5	4.4
Hard Copy	4.7	4.4	4.6
Auto Adaptive Training	4.6	4.8	4.6
Programmed Mission Scenarios	4.9	5.0	5.0
Grand Mean	4.5	4.7	4.6

Table C-2. F-15 Simulator: Potential Training Value of AIFs

	Feature	RTU	CTU	Mean
	Instructor Pilot Tutorial	4.9	4.1	4.5
	Reset	5.4	4.8	5.1
*	Total System Freeze	4.0	5.3	4.6
	Recorded Briefing	3.9	2.7	3.3
	Demonstration	4.5	3.6	4.1
	Record/Playback	5.4	5.5	5.5
	Environmental	4.8	3.9	4.4
	Auto Malfunction Insertion	4.8	4.5	4.7
*	Flight System Freeze	6.2	4.8	5.6
	Position Freeze	4.4	3.9	4.2
	Parameter Freeze	4.4	3.6	4.0
	Crash Override	5.4	4.7	5.0
**	Motion	4.2	2.4	3.3
	Auto Performance Feedback	4.3	3.3	3.8
	Hard Copy	4.5	4.2	4.3
	Auto Adaptive Training	4.2	3.6	3.9
	Programmed Mission Scenarios	5.2	5.6	5.4
	Grand Mean	4.7	4.1	4.5

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

Table C-3. A-10 Simulator: Potential Training Value of AIFs

Feature	RTU	CTU	Mean
Instructor Pilot Tutorial	5.0	4.8	4.9
Reset	5.2	5.8	5.4
Total System Freeze	5.3	4.9	5.2
Recorded Briefing	3.7	3.3	3.6
Demonstration	4.5	4.5	4.5
Record/Playback	4.7	5.3	4.9
Environmental	5.6	4.6	5.3
Auto Malfunction Insertion	4.4	4.9	4.6
Flight System Freeze	3.9	5.2	4.3
Position Freeze	4.5	5.1	4.7
Parameter Freeze	4.2	4.9	4.4
Crash Override	4.6	4.8	4.7
* Motion	3.5	5.1	4.0
Auto Performance Feedback	3.8	3.8	3.8
Hard Copy	4.4	3.5	4.1
Auto Adaptive Training	4.0	3.7	3.9
Programmed Mission Scenarios	4.3	5.0	4.5
Grand Mean	4.4	4.7	4.5

* $p < .05$.

Table C-4. E-3A Flight Simulator: Potential Training Value of AIFs (IPs)

Feature	RTU	CTU	Mean
Instructor Pilot Tutorial	4.6	6.5	5.1
Reset	5.8	5.5	5.7
** Total System Freeze	5.6	2.0	4.6
** Recorded Briefing	5.0	1.5	4.0
** Demonstration	5.2	1.5	4.1
** Record/Playback	5.6	1.5	4.4
Environmental	5.8	4.0	5.3
Auto Malfunction Insertion	5.8	5.0	5.6
Flight System Freeze	5.8	5.0	5.6
Position Freeze	5.6	5.5	5.6
Parameter Freeze	4.4	6.0	4.9
Crash Override	5.4	4.0	5.0
Motion	6.8	7.0	6.9
** Auto Performance Feedback	5.0	1.5	4.0
Hard Copy	4.0	3.5	3.9
* Auto Adaptive Training	4.4	1.0	3.4
Programmed Mission Scenarios	5.8	4.0	5.3
Grand Mean	5.3	3.8	4.9

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

Table C-5. E-3A Mission Simulator: Potential Training Value of AIFs (WDIs)

Feature	RTU	CTU	Mean
Instructor Pilot Tutorial		4.8	4.5
Reset	3.6	5.4	4.0
Total System Freeze	3.6	3.8	3.6
Recorded Briefing	4.6	4.4	4.6
Demonstration	5.1	5.6	5.2
Record/Playback	6.0	4.8	5.7
Environmental	2.8	2.4	2.7
Auto Malfunction Insertion	3.5	4.0	3.6
Flight System Freeze	2.7	2.4	2.6
Position Freeze	4.1	2.4	3.7
Parameter Freeze	3.7	3.4	3.6
Crash Override	3.8	3.4	3.7
Motion	1.9	1.2	1.8
Auto Performance Feedback	5.3	3.8	5.0
Hard Copy	4.6	2.8	4.2
Auto Adaptive Training	5.0	3.8	4.7
Programmed Mission Scenarios	6.1	4.8	5.8
Grand Mean	4.2	3.7	4.1

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