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TRAINING EVALUATION OF THE F-15 ADVANCED AIR COMBAT SIMULATION

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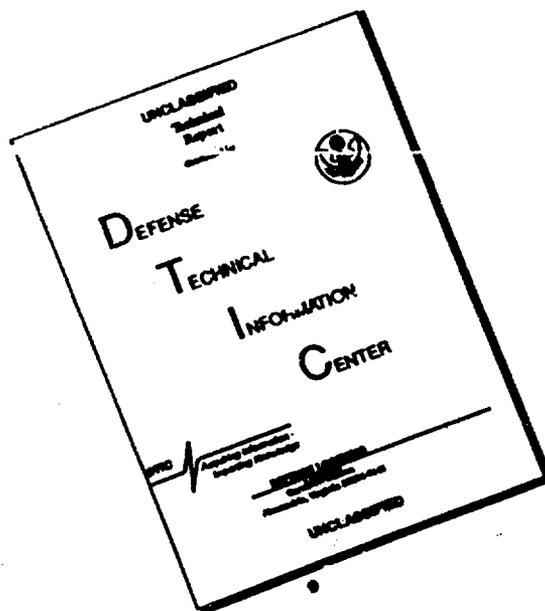
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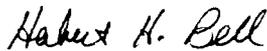
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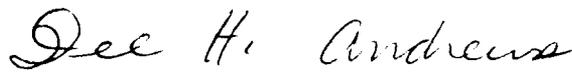
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13. ABSTRACT (Maximum 200 words)

The objective of this investigation was to evaluate the utility of existing multiship simulation for training air combat tasks. Our previous evaluation, based on a limited sample of F-15 pilots, found that such simulator-based training was perceived to supplement existing F-15 continuation training. The present evaluation replicated the prior investigation with a broader subject sample of F-15 pilots. Mission-ready F-15 pilots and air weapons controllers participated in four days of training in simulated air combat missions. The simulation was designed to train two-ship F-15 tactics in an unrestricted combat environment that included multiple air and ground threats, electronic warfare, and real-time kill removal. Participants were surveyed before training to identify combat tasks for which they desired additional training. Following training, the participants rated the value of their continuation training and the simulation for practicing these air combat tasks. The results confirmed the previous evaluation in that pilots identified virtually the same cluster of combat tasks for which they felt the simulation provided desired and valuable training to supplement their continuation training. In summary, both pilots and air weapons controllers perceived that such simulator-based training could enhance their combat proficiency.

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PREFACE

TRAINING EVALUATION OF THE F-15 ADVANCED
AIR COMBAT SIMULATION

SUMMARY

This paper describes an evaluation of the potential value of multiship simulation for United States Air Force (USAF) tactical air combat training. This evaluation was jointly sponsored by the Armstrong Laboratory, Aircrew Training Research Division, and the Tactical Air Command/Directorate of Operations for Training (TAC/DOT). Mission-ready F-15 pilots and air weapons controllers (AWC) from the Tactical Air Forces (TAF) evaluated the training value of the F-15 Advanced Air Combat Simulation (AACS). This simulation was designed to train two-ship F-15 tactics in an unrestricted combat environment. This environment included multiple air and ground threats, electronic warfare, and real-time kill removal. Our previous evaluation of the F-15 AACS focused mainly on F-15A pilots from Air National Guard and TAC air defense units who reported that such simulator-based training could supplement existing F-15 continuation training and improve combat readiness. The present evaluation replicated this previous evaluation with a larger and more diverse sample of F-15 pilots. Additional analyses were conducted to determine whether pilots' ratings were affected by the experience and unit assignment of the rater. The results replicate those of the earlier evaluation, providing further evidence that the F-15 AACS is perceived as enhancing combat training for TAF F-15 pilots and AWCs from units throughout the continental United States.

INTRODUCTION

In modern air combat, fighter aircraft such as the F-15 could encounter a formidable threat environment. This threat environment may include superior numbers of enemy fighters, numerous surface-to-air threats, and the presence of electronic and communications jamming. During peacetime, the Tactical Air Forces (TAF) must provide effective combat training to prepare aircrews for this intense threat environment.

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While aircraft sorties are vital for air combat training, many aspects of actual combat cannot be replicated in the squadron's airborne continuation training environment. The combat realism of existing airborne training for air superiority fighters such as the F-15 is constrained by environmental constraints, resource limitations, and peacetime training rules as well as safety and security restrictions. Therefore, the peacetime training environment provides limited opportunities to practice certain combat tasks that are essential for mission success. For example, most mission-ready F-15 pilots do not routinely practice critical tasks such as flying low altitude, employing classified electronic systems, or firing and evading live missiles. Failure to practice such critical combat tasks can result in shortcomings that reduce training effectiveness and, consequently, combat readiness (Martin, 1984).

Fortunately, these possible training shortcomings have been recognized. In fact, the USAF Fighter Weapons School has identified several combat areas where revision of "training emphasis" or "syllabi content" are warranted "to continue to be responsive to the command's [Tactical Air Command's] needs" (Everts, 1987, p. 1). Also in response to the TAF's training needs, the Armstrong Laboratory, Aircrew Training Research Division and the Tactical Air Command/Directorate of Operations for Training (TAC/DOT) initiated a cooperative training research program to determine the potential value of multiship air-to-air (A/A) simulation for supplementing existing air combat training.

The F-15 Advanced Air Combat Simulation (AACS) was developed to train two-ship F-15 tactical employment in an unrestricted combat environment. This environment was designed to include multiple air and surface threats, electronic warfare, and real-time kill removal (for additional background reading, refer to Bailey, 1989; Houck, Thomas, & Bell, 1989; Kandebo, 1989; McDonald, Broeder, & Cutak, 1989; Thomas, Houck, & Bell, 1990). This training was first implemented in 1988 using McDonnell Aircraft Company's (MCAIR) existing F-15 simulation facility to provide air combat training for mission-ready F-15A pilots and air weapons controllers (AWC). The participants in the first F-15 AACS training evaluation felt that the air combat tasks listed in Table 1 could be better practiced in the simulation than in their squadron continuation training program (Houck et al., 1989; Thomas et al., 1990). In addition, the F-15A pilots desired additional training in these tasks and viewed their squadron continuation training for these tasks as less than adequate. AWCs rated the simulation as providing better training than their units for all F-15 combat tasks. A glossary defining the tasks listed in Table 1 can be found in Appendix A.

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**Table 1. Combat Tasks for which F-15A Pilots Rated the
Previous F-15 AACS as Providing Desired and
Valuable Additional Training**

Multibogey Employment	Missile Employment
Chaff/Flare Employment	Escort Tactics
All-Aspect Defense	Electronic Combat
Tactical Electronic Warfare	Egress Tactics
System Assessment	Radar Lookout
Reaction to Air Interceptors	Radar Sorting
Reaction To Surface-to-Air	Electronic Identification
Missiles	All-Weather Employment
Work with Air Weapons Controller	Low-Altitude Tactics
Communications Jamming	Separation
Beyond-Visual-Range Employment	

Overall, the results of the first F-15 AACS evaluation strongly indicate that aircrews believe that simulation can enhance air combat training. Nevertheless, the generality of these findings across all F-15 pilots throughout the continental United States (CONUS) is uncertain because most participants were F-15A pilots from Air National Guard (ANG) or TAC fighter interceptor squadrons (FIS). Conspicuously absent from this earlier evaluation were active-duty F-15C pilots from TAC's tactical fighter wings (TFW).

The current training utility evaluation was undertaken to confirm the results of the earlier F-15 AACS evaluation (Houck et al., 1989; Thomas et al., 1990) and to extend the evaluation to include F-15C TFW pilots. A larger and more diverse group of CONUS F-15 pilots and AWCs was included to permit us to determine the generality of the previous results throughout the CONUS F-15 community. The present evaluation identified specific air combat tasks for which aircrews desire additional training and determined which of these tasks were perceived as better trained in the F-15 AACS than in typical squadron-level continuation training. In addition, various strengths and weaknesses of this prototype air combat training simulation were identified.

METHOD

Participants

F-15 Pilots

Ninety-four F-15 pilots participated in the present evaluation. Pilots were selected by their squadrons or wings in

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pairs[1] a... flew as two-ship elements (i.e., lead and wingman) throughout training. Each element was led by a pilot with at least a two-ship flight lead qualification. The pilots had a mean of 765 fighter hours, 722 A/A hours, and 577 F-15 flight hours and represented each level of flight qualification from wingman to instructor pilot (IP). Each participant was mission-ready in one of the operational air-to-air variants of the F-15 (i.e., F-15A, F-15C, or F-15C [MSIP][2]). Table 2 shows the number of pilots from each aircraft variant and their respective units.

Table 2. Number of Participating F-15 Pilots by Current Unit Assignment and Unit's F-15 Variant

Pilots	Aircraft	Units	N
'Replication' F-15	F-15A	48 & 318 FIS; 102 FIW; 49 & 116 TFWs; 154 CompGp: 325 & 405 TTWs	53
	F-15C (non-MSIP)	57 FIS	4
F-15C TFW	F-15C (MSIP & non-MSIP)	1 & 33 TFW	37

Eighty-six of the pilots were from active-duty TAC squadrons while the remaining eight were ANG pilots from the 102 Fighter Interceptor Wing (FIW), 116 TFW, and the 154 Composite Group (CompGp). Sixty-six of the active-duty TAC pilots were from fighter squadrons while the remaining 20 were replacement training unit (RTU) IPs from the 325 and 405 Tactical Training Wings (TTW). Thirty-seven active-duty Air Force pilots were from TAC's F-15C TFWs located at Eglin and Langley Air Force Bases. For analysis purposes, the participants were divided into two groups: 'Replication' F-15 pilots and F-15C TFW pilots as shown in Table 2. Pilots assigned to the 'Replication' group were mainly from F-15A squadrons as were the pilots who participated in the previous evaluation (Thomas, et al., 1990). Mean and range of flying hours for pilots by qualification level were computed separately for both groups and appear in Tables 3 and 4.

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[1] One element was composed of pilots from different squadrons.

[2] The F-15C Multistage Improvement Program (MSIP) aircraft is the most recent variant of the air-to-air F-15.

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Table 3. Flying Hours (Mean and Range) of 'Replication' F-15
Pilots by Qualification

F-15 qualification	Fighter hours	Air-to-Air hours	F-15 hours	N
Wingman	270 (150-500)	270 (150-500)	237 (130-350)	11
Two-Ship Lead	831 (420-1700)	774 (420-1700)	485 (150-800)	9
Four-Ship Lead	958 (350-2575)	626 (250-970)	550 (250-970)	7
Mission Commander	1559 (510-2950)	1363 (540-3350)	534 (150-1000)	7
Instructor Pilot	1140 (650-1950)	1140 (650-1950)	1044 (650-1500)	23
All	935	879	682	57

Table 4. Flying Hours (Mean and Range) of F-15C Tactical
Fighter Wing Pilots by Qualification

F-15 qualification	Fighter hours	Air-to-Air hours	F-15 hours	N
Wingman	301 (110-1250)	273 (110-750)	259 (50-550)	19
Two-Ship Lead	586 (400-1390)	586 (400-1390)	491 (400-650)	10
Four-Ship Lead	530 (350-710)	530 (350-710)	530 (350-710)	4
Mission Commander	---	---	---	0
Instructor Pilot	1054 (600-2070)	974 (600-1670)	740 (590-1050)	4
All	505	480	416	3

Air Weapons Controllers

Forty-three mission-ready AWCs from both ground-based and airborne units throughout the CONUS participated in this evaluation. Mean number of intercepts controlled prior to this training was 1108 (range = 100 to 5000).

Multiship Air Combat Simulation System

The simulator system, scenario programming, threat presentations, and engineering support were provided by MCAIR under contract to the Air Force. The simulation used two full-mission F-15C (MSIP) cockpits and an AWC station along with a threat environment that included both computer-controlled and manned adversaries, electronic warfare, communications jamming, surface threats, and manned AWC station. All current F-15C (MSIP) subsystems, including classified subsystems, were programmed in this simulation. Weapons effects were based on real-time missile fly-outs and supported real-time kill removal. The forward hemisphere visual imagery for terrain, weather, and explosions in each F-15 simulator dome was provided by two channels of General Electric Compuscene IV image generators. A point-light source provided the earth/sky horizon in the rear hemisphere. Aircraft and missile images were produced by laser and video target projectors. Audio and video recordings of each engagement were provided for debriefing mission performance and an observation area was available for participants to observe others fly. Details concerning the simulator system and scenario programming can be found in McDonald et al. (1989) and Thomas et al. (1990).

Training Program

Each element was responsible for mission planning, determining specific training objectives, and evaluating and remediating their performance. The flight lead assumed the role of primary instructor for each element. For each training session, TAC/DOT furnished an experienced F-15 IP to serve as training supervisor. The training supervisor monitored the activities to ensure all participants received maximum training value from the simulation.

Training Objectives

Training objectives were established by TAC/DOT. The overall goal was to provide training for "two versus many" engagements in a beyond-visual-range (BVR) combat environment. Training emphasized the following combat functions: (a) maintaining mutual support, (b) using the AWC and a disciplined radar sort to target adversary aircraft, (c) employing effective formations to counter adversary electronic countermeasures (ECM), communications jamming, and intrusion, and (d) employing appropriate tactics, countermeasures, and maneuvers against an all-aspect threat in a multibogey environment. Within-visual-range (WVR) employment was

not emphasized; however, the WVR environment was simulated and engagements were permitted to run to a logical conclusion.

Mission Scenarios and Objectives

Scenarios were designed by TAC/DOT to support the training objectives listed above using offensive counter-air (OCA) and defensive counter-air (DCA) missions. Each mission involved a two-ship F-15 element encountering increasingly more difficult threat scenarios, characteristic of a limited conventional war. Two OCA missions were simulated: a fighter sweep to eliminate enemy aircraft through attrition and an escort to protect a flight of four computer-controlled F-16s from enemy fighters. The objective of the sweep mission was to kill a minimum of two adversary fighters while sustaining no F-15 losses. For the escort mission, the objectives were to detect and target all adversary fighters that threatened the strike package and kill 50% of the adversary fighters beyond visual range. The DCA mission involved defending a fixed surface target from an incoming strike package and the objectives were to (a) detect all adversary aircraft, (b) destroy, disrupt, or drive off escort aircraft, and (c) kill 50% of the strike package beyond visual range.

Each engagement included as many as six adversary aircraft and began with the opposing aircraft initialized 60 to 80 nm apart with appropriate fuel and weapons stores. A brief description of the force composition for each mission appears in Table 5. Each F-15 carried a standard combat load of four AIM-7M radar missiles, four AIM-9M infrared missiles, 940 rounds of 20mm ammunition, and an appropriate combat load of chaff and flares.

Simulated adversary aircraft were either MiG-23, MiG-27, MiG-29, or Su-27 and each carried an appropriate ordnance load. Adversaries could also be programmed to include self-protection jamming or stand-off jamming. Depending upon the specific training scenario, as many as four of these adversary aircraft were flown from manned interactive control stations (MICS), while the others were computer-controlled. The MICS were flown by the same pilots participating in the evaluation. The computer-controlled aircraft either flew as a wingman for the MICS pilots or flew predetermined routes and relied upon programmed tactical maneuvers. Adversary ECM, communications jamming, and ground threats were also computer controlled. More detailed information regarding the programming of adversary aircraft can be found in McDonald et al. (1989) and Thomas et al. (1990).

Training Schedule

The F-15 AACS was conducted over eight four-day sessions between December 1988 and September 1989. Typically, twelve pilots and six AWCs participated in each session. Participants were scheduled for at least one simulator period per day over the four

Table 5. Mission Force Composition

Mission	Friendly	Adversary
OCA (Sweep)	2 F-15s	2 to 6 A/A Fighters (unmanned)
OCA (Escort)	2 F-15s 4 F-16s (unmanned)	4 A/A Fighters (0-4 manned)
DCA (Area Defense)	2 F-15s	2 or 4 A/A Fighters (0-2 manned) 2 or 4 A/S Strikers (unmanned)

consecutive days. Each session was devoted to a single mission: sweep on day 1, area defense on day 2, and escort on days 3 and 4. Within each simulator period, at least three separate engagements were flown. A 'building block' approach was used to individualize training for the specific needs and performance level of each element. The appropriate level of difficulty for each engagement was determined by the training supervisor based upon his assessment of the element's performance. Difficulty was controlled by varying the number and quality of threats and adding various combinations of weather and adversary surface-to-air missile (SAM) sites, ECM, and communications jamming. In addition, the specific adversary tactics and force package were varied for each engagement to prevent predictability.

Each training day began with a mass briefing attended by all training participants, researchers, and simulator support personnel. As part of this briefing, problems identified during the previous day's simulations were addressed, feedback was given concerning employment and tactics of the previous day, and the current day's tactical mission and training objectives were presented. Academic instruction was provided prior to training for pilots unfamiliar with the F-15C (MSIP) avionics simulated for this training.

Data Collection and Analysis

Participants were surveyed on the first and last days of training to evaluate the training value of the F-15 AACS. Questionnaires were based on those used for the previous F-15 AACS. The pretraining questionnaires, shown in Appendices B and C, asked the pilots and AWCs to summarize their operational background and training experience and to ind' ate, using a five-point scale, their desire to obtain additional training in 37 F-15 air combat

tasks.[3] A glossary describing each of these tasks is in Appendix
A. The posttraining questionnaire, shown in Appendices D and E,
asked respondents to rate, using a five-point scale, the value of
their current unit continuation training _and_ the value of the F-15
AACS in supporting 30 of those same combat tasks[4]--seven of the
original 37 combat tasks were eliminated because they were not
emphasized by the training program (i.e., Basic Fighter Maneuvers
[BFM], Air Combat Maneuvers/Air Combat Tactics [ACM/ACT], Night
Tactics, Gun Employment, Safe Passage, Reaction to Anti-Aircraft
Artillery [AAA], and Four-Ship Tactics). Also as part of the
posttraining questionnaire, participants were asked a variety of
open-ended questions intended to elicit opinions regarding system
fidelity and tactical realism, training potential of the
simulation, and the target population for and desired frequency of
such training. Comments regarding each question were categorized
by content and general tone (e.g., favorable or critical).

                              RESULTS

     This section summarizes the major findings of this evaluation.
Readers interested in a more extensive summary and description of
the results and data analyses should refer to Appendix F for pilot
results and Appendix G for AWC results.

                 F-15 Pilot Questionnaire Results

Pilots' Combat Task Ratings

     As in the previous evaluation, a cluster of combat tasks
emerged for which the F-15 AACS was perceived to provide desired
and valuable additional training. The tasks listed in Table 6
received high mean ratings (i.e., 3.5 or greater on a five-point
scale) in desire for additional training. A complete summary of
these results appears in Appendix F (see Table F1). Γ-15 AACS
training for those tasks denoted by a '1' in Table 6 was perceived
as significantly more valuable than unit continuation training. In
addition to being rated as better trained in the F-15 AACS, the
pilots also felt these tasks received _less_ than 'adequate' training
in their current unit.

     F-15 AACS training for the remaining tasks in Table 6 was also
rated highly; however, the simulator training for these tasks was

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     [3] The AWC survey contained 36 combat tasks. AWCs were not
asked to rate 'Work with AWC.'

     [4] The AWC version of this survey contained 29 combat tasks.

Table 6. Combat Tasks for which F-15 Pilots Rated the Current F-15 AACS as Providing Desired and Valuable Additional Training

Combat task	F-15C TFW pilots	'Replication' F-15 pilots
Multibogey, Four or More	1[a]	1
Reaction to SAMs	1	1
Dissimilar Air Combat Tactics	1	1
All-Weather Employment	1	1
ECM/ECCM Employment	1	1
Communications Jamming	1	1
Low Altitude Tactics	1	1
Chaff/Flare Employment	1	1
Escort Tactics	1	1
TEWS Assessment	1	1
Work with AWC	1	1
All-Aspect Defense	2[b]	1
BVR Employment	2	1
Radar Sorting	2	1
Reaction to Air Interceptors	2	1
Missile Employment	2	1
Electronic Identification	---[c]	1
Egress Tactics	2	2

[a] [b] See text for explanation of tasks denoted by a '1' or '2.'

[c] F-15C TFW pilots did not rate Electronic Identification as having high additional training desire.

not perceived to be significantly more valuable than unit continuation training. These tasks are indicated in Table 6 by a '2.' The reason for this outcome was that F-15 AACS and unit continuation training both received high training value ratings. The cluster of F-15 combat tasks for the 'Replication' F-15 pilots summarized in Table 6 parallels the findings of the previous F-15 AACS evaluation shown in Table 1. Furthermore, a similar task cluster emerged for the F-15C TFW pilots, indicating much commonality in their desire for additional combat training and their opinion of the training value of this simulation.

For the most part, these results were unaffected by pilots' current unit type, qualification, or F-15 flying hours. The pilots with the highest amount of experience expressed an equivalent need for additional training in each combat task as did the most inexperienced pilots in our sample. Training value of the F-15 AACS was rated quite uniformly across pilot background variables with the exception of a few tasks which were rated significantly higher by low-time pilots: Visual Identification, Electronic Countermeasures/Electronic Counter-Countermeasures (ECM/ECCM) Employment, and Reaction to SAMs. In summary, the rating data indicate much agreement among CONUS F-15 pilots regarding their perception of their training needs.

Pilots' Open-Ended Questionnaire Responses

Simulator Fidelity. Pilots evaluated the fidelity of the following training system components: cockpits, visual presentations, scenarios, and threat presentations. The most frequent comments regarding simulator fidelity are summarized in Table 7.

Most pilots were pleased with the realism and performance of the simulated cockpits. However, a significant problem was reported in adapting to the F-15E cockpit that had been modified to emulate an F-15C (MSIP) cockpit. The primary problem was the absence of simultaneous display of the horizontal situation indicator (HSI) and attitude director indicator (ADI) in the simulated F-15E cockpit. In the F-15E cockpit for the F-15 AACS, these F-15C mechanical displays were simulated on the center multipurpose color display (MPCD) in the F-15E. Pilots could choose between displaying either the HSI, ADI, or armament display on this single MPCD. During the daily mass briefings, many pilots stated a preference for simultaneous display of the HSI and ADI.

In general, pilots were pleased with the quality of visual presentations. Visual presentation of incoming missiles was especially appreciated for training evasion tactics. Another advantage was the number of threats that could be simultaneously presented in the domes. Nevertheless, certain aspects of the visual presentations limited training value according to several of the pilots. Criticism of the visual presentations most frequently focused on difficulties with aircraft targets produced by the laser and video projectors. For example, several pilots reported

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Table 7. F-15 Pilots' Most Frequent Comments Regarding Simulator Fidelity of the F-15 AACS (total of 87 respondents).

	Comment	Number of comments
Cockpits		
Favorable	Acceptable, good, excellent, etc.	39
Critical	Adapting to modified F-15E cockpit	26
Visual Presentations		
Favorable	Acceptable, good, excellent, etc.; number of simultaneously presented threats; visual display of incoming missiles	38
Critical	Visual accommodation and discrimination of projected target images	15
	Color changes of projected images caused by priority scheme for coordinating target projectors was confusing	32
Mission Scenarios		
Favorable	Acceptable, good, excellent, etc.	65
Critical	None	0
Threat Presentations		
Favorable	Acceptable, good, excellent, etc.	22
Critical	Manned threats were not challenging or credible	10
	Computer-controlled threats were too proficient	9

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that aircraft attitude, aspect angle, and tactical range could not be identified within the distances typical in the air. These pilots indicated that such limitations interfered with tactical formation, visual mutual support, BFM, and ACM/ACT--all tasks requiring substantial visual information. Because this situation was recognized in our previous evaluation, the present F-15 AACS did not emphasize WVR employment.

Even though BVR employment has fewer visual demands than WVR, the limitations of the visual presentations do affect BVR training. Tactical formation and mutual support are essential components of BVR combat employment. In interviews, some pilots admitted that the lack of adequate visual information for formation flying led to unorthodox BVR tactics. Despite this limitation, however, the overall training value of the F-15 AACS received high ratings. Nevertheless, one must remember that the quality of visual presentations is important even for BVR air combat training and that the effectiveness of simulator-based BVR training may be degraded by poor visual presentations.

Another problem identified was the priority scheme used for projecting aircraft images. Images were produced in each simulator dome either by laser projectors producing red outline images, or video projectors producing white contoured images. Because of their better resolution, video projectors were assigned to display the closest aircraft within visual range--initially the wingman. Changing relative ranges among the aircraft could cause a shift to a red laser projector for the wingman, with a threat aircraft becoming a white video image. Pilots felt that this situation caused them to mistake their wingman for enemy aircraft and vice versa, adding undue confusion to the scenarios. In addition, six pilots believed that the red laser images permitted tallies beyond the range possible in the air. Apparently, the brightness and color contrast of the red laser images enhanced visual detection of targets.

Overwhelmingly, pilots thought that the mission scenarios were the key ingredient to the training value of the F-15 AACS. The majority of pilots had positive comments regarding various aspects of the scenarios. For example, pilots praised the ability to repeatedly practice each mission function of the F-15 within a week's time. The scenarios were praised also for being challenging, demanding, realistic, and providing appropriate numbers of air threats for multibogey training.

Criticisms concerning the fidelity of threat presentations, focused on the contrast in realism and accuracy of the computer-controlled versus manned adversaries. Some pilots felt that the simulated maneuvering, radar, and weapons capabilities of the computer-controlled adversaries were better than the actual threat aircraft. In addition, pilots noted the absence of human error in the computer-controlled adversaries. On the other hand, several pilots stated that the manned adversaries did not provide a challenging or credible threat. Most frequently mentioned as an

explanation was that the F-15 pilots, who acted as adversary pilots in addition to training, did not have sufficient practice to employ the MICS. Tactics employed by the MICS pilots were criticized as presenting F-15 tactics rather than realistic adversary tactics.

Recurrent Training. As shown in Table 8, all 87 respondents indicated that repeated exposure to F-15 AACS training was desirable, with 99% desiring at least yearly training. Chi Square tests of significance found no influence of respondents' qualification, F-15 hours, or unit assignment on these data.

Table 8. F-15 Pilots' Preference for Repeated Exposure to F-15 AACS Training (percentage of respondents).

Frequency of Training Per Year

Twice or more	Once	Less than once	None
64%	35%	1%	0%

Target Population. Pilots were asked who would benefit most from this type of simulator training: new wingmen, experienced wingmen, new two-ship leads, experienced two-ship leads, new four-ship leads, or experienced four-ship leads. Pilots of all qualification levels rated the benefit of training for each of these types of pilots using a five-point scale ranging from 'not beneficial' to 'extremely beneficial.' As shown in Table 9, the mean training benefit rating for new wingmen was significantly lower than those for pilots of other experience levels combined.[5]

Table 9. Mean F-15 Pilot Ratings of Training Benefit of F-15 AACS Training for Various Pilot Experience Levels

	Wingmen		Two-ship leads		Four-ship leads	
	New	Experienced	New	Experienced	New	Experienced
Mean Ratings by All Pilots	3.8	4.4	4.3	4.4	4.4	4.2

---

[5] A planned-comparison ANOVA confirmed the significance of this difference, $F(1,412) = 34.9$, $p < .0001$.

Further analyses were undertaken to determine whether the experience level of the pilots affected their ratings. The only significant finding was that four-ship leads rated the benefit of the F-15 AACS training lower for new wingman than did the wingman themselves. This result was further substantiated by several lead pilots who commented that the F-15 AACS training may be too demanding for a new wingman.

Possible Limitations of F-15 AACS Training. Pilots were asked to identify limitations of the simulation that they perceived could potentially result in negative training. Sixty percent of the pilots identified at least one limitation that could possibly be a source of negative training. Keep in mind, however, that the relationship of these perceived simulator limitations to negative training are based solely on pilot opinion, and have not been verified by showing a decrement in actual performance.

Several simulator fidelity problems already discussed were mentioned as limitations and are listed in Table 10. In addition, several pilots thought that the AWCs provided more accurate and more detailed information about the number and altitude of enemy threats than is possible in unit continuation training or actual

Table 10. F-15 Pilots' Most Frequent Comments Regarding Possible Limitations of the F-15 AACS (total of 87 respondents).

Comment	Number of comments
Color changes of projected images caused by priority scheme for coordinating target projectors was confusing	32
Adapting to modified F-15E cockpit	26
Visually accommodating and resolving projected targets	15
Information provided by AWCs was too precise to be realistic	11
Manned threats were not challenging or credible	10
Computer-controlled threats were too proficient	9

combat. Apparently, this artificiality may have prompted pilots to rely excessively on AWC-provided information rather than conducting their own disciplined radar searches.[6]

Advantages of F-15 AACS Training. Possible limitations of the simulation were vastly outnumbered by perceived advantages of F-15 AACS training. Pilots were asked to evaluate this training, relative to continuation training, for helping them fight and win the next war. Out of 87 respondents, 74 provided one or more positive comments regarding the F-15 AACS training. The most frequent response (n = 44) was that the simulation provided valuable training for several combat-essential areas perceived as requiring additional training. These include employment in environments having weather, ECM, and communications jamming; tactical decision making; exposure to multiple air adversaries; reaction to SAMs and A/A missiles; TEWS interpretation; and use of interrogation systems and other "red-guarded" cockpit switches. Eight pilots stated that this type of simulator training would be good preparation for Red Flag and for actual combat.

Air Weapons Controllers' Questionnaire Results

AWCs' Combat Task Ratings

AWCs rated 20 tasks applicable to their combat role. Additional training was perceived to be 'very' or 'highly desired' for 19 of these tasks, listed in Table 11 (All-Weather Employment was the excluded task). Also shown in Table 11, AWCs rated the F-15 AACS significantly more valuable than their unit for providing training for all but five of these F-15 combat tasks (a complete summary of results appears in Appendix G, Table G1). None of the tasks were perceived as better trained in the unit as compared to the F-15 AACS. These results indicate an overwhelming desire for additional combat training and clearly establish that the AWCs perceived that the F-15 AACS provided valuable combat training.

AWCs' Open-Ended Questionnaire Responses

Recurrent Training. Every AWC responding indicated that he or she would benefit from repeated exposures to the F-15 AACS training. These results are summarized in Table 12.

Possible Limitations of F-15 AACS Training. AWCs were asked to identify limitations of the simulation that they perceived could potentially result in negative training. Keep in mind, however, that the relationship of any perceived simulator limitations to negative training are based solely on opinion, and have not been verified by showing a decrement in actual performance.

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[6] This problem has been eliminated in follow-on research with the integration of a new AWC station into the training simulation.

Table 11. Summary of Air Weapons Controllers' Ratings of Relevant Combat Tasks

Combat tasks	Additional training desired	More valuable training in F-15 AACS than unit
Multibogey, Four or More	X	X
Tactics/Mission Planning and Briefing	X	X
Mission Debriefing	X	X
Radar Sorting	X	X
Two-Ship Tactics	X	X
Egress Tactics	X	X
Intraflight Communication	X	X
Tactical Formation	X	X
Escort Tactics	X	X
Mutual Support	X	X
Separation	X	X
All-Aspect Defense	X	X
BVR Employment	X	X
Missile Employment	X	X
Communications Jamming	X	
Dissimilar Air Combat Tactics	X	
Tactical Intercept	X	
Electronic Identification	X	
ECM/ECCM Employment	X	

Table 12. **Air Weapons Controllers' Preference for Repeated Exposure to F-15 AACS Training (percentage of respondents).**

Frequency of Training Per Year

Twice or More	Once	Less than Onc	None
76%	24%	0%	0%

By far, the most frequently mentioned limitation (n = 18) was that the display scopes of the simulated AWC stations provided more precise information regarding the number and altitude of aircraft than does the operational equipment. This limitation was also identified by the pilots. Ten respondents reported that the simulation had no limitations.

Advantages of F-15 AACS Training. AWCs evaluated the value of this training, relative to their current continuation training program, to help them fight and win the next war. The major advantage of the F-15 AACS indicated by 17 AWCs was the ability to brief and debrief "face-to-face" with F-15 pilots, a capability that is rarely available at home units. Discussions with pilots gave AWCs a better understanding of the content and timing of information required by F-15 pilots during air combat engagements. Another advantage mentioned was the opportunity for AWCs to observe F-15 and adversary weapon system capabilities and tactics.

Suggested Improvements. In order to improve the training value of this simulation, 15 of the AWCs recommended replacing the MCAIR AWC station with one that more closely simulates their operational equipment (i.e., UPA-62). Twelve AWCs thought that training would be more valuable if their radar returns and communications were subjected to the simulated ECM and jamming as were the pilots.

CONCLUSIONS

The results of this training utility evaluation confirm those of the previous F-15 AACS evaluation (see Houck et al., 1990 and Thomas et al., 1990). In both evaluations, F-15 pilots identified virtually the same cluster of critical combat tasks for which they perceived that the F-15 AACS had furnished desired and valuable training. Given that the pilots rated their continuation training as less than 'adequate' for these combat tasks, air combat

simulation may function as an important training resource. The value of F-15 AACS training for another cluster of combat tasks was also rated highly; however, simulator training value for these tasks was rated as equivalent to unit continuation training. Nevertheless, since pilots desire additional training for these tasks, simulator-based training offers an additional resource for supplying such training. Overall, the pilots' responses indicate that simulator-based training, like that provided by the F-15 AACS, was perceived as a viable supplement to existing F-15 air combat training.

Pilot opinion was quite uniform regarding these issues. The ratings of the F-15C TFW pilots closely agreed with those of the 'Replication' pilots. The amount of experience of pilots had little influence on their opinions; high-time pilots desired additional combat training to the same extent as their lower-time counterparts. Similarly, pilots' perception of the value of their unit continuation training and of the F-15 AACS was scarcely influenced by amount of previous experience. Together, these results indicate significant commonality among CONUS F-15 pilots in their desire for additional combat training and their favorable opinion of the value of simulation for supplying such training.

The AWC results also closely replicate the previous evaluation and indicate a substantial desire for additional training on a number of combat tasks. AWCs rated the training value of F-15 AACS better than their unit continuation training for nearly all the combat tasks surveyed.

Pilots and AWCs identified a number of strengths and weaknesses of the F-15 AACS training system that provide valuable information for the development and use of future multiship air combat training systems or programs. Most pilots and AWCs expressed a desire to repeat such training at least twice per year. Pilots benefitted greatly from repeated exposures to the same scenarios, and considered the variety of scenarios available in the simulator to be a major advantage. AWCs appreciated the opportunity for "face-to-face" briefing and debriefing with pilots--a rare event in typical AWC continuation training. An especially important advantage of simulator-based training was the availability of immediate performance feedback that is not available in airborne training. Immediate feedback in the form of missile effects and real-time kill removal was repeatedly identified as a major advantage of simulator training over unit training. This feedback allowed pilots to evaluate their performance in employing their weapons system and experimenting with tactics, missile countermeasures, and defensive responses. On the other hand, limitations of the visual presentations precluded optimal employment of tactical formation and visual mutual support. Despite this limitation, however, the overall training value of the F-15 AACS was rated highly.

Because of the positive response of the TAC participants, sponsorship of the F-15 AACS was transitioned to TAC/DOT in FY 90 as a formal training event receiving TAC simulator training credit. To furnish this training, TAC/DOT contracted with MCAIR to provide ten weeks of air combat simulation each in FY 90 and FY 91. For ea.h year of this program, training will have been provided to over 100 CONUS F-15 pilots and over 50 CONUS AWCs (Kandebo, 1989).

Long-term research is needed to develop measures of air combat performance to support training evaluations and instruction. Such measures are needed for simulator training effectiveness research and training cost-effectiveness investigations. This research is required to further determine which combat tasks can be most effectively trained in which training media (i.e., aircraft, simulator, or part-task trainer). Performance measures are also needed to provide pilots with more detailed information on the consequences of their combat decisions for diagnosing the strengths and weaknesses of their decisions.

Future research should also be conducted to identify training strategies that optimize the use of simulation, and to identify methods of tailoring simulator training to the ability levels of incoming pilots. A simulator facility such as that used for the F-15 AACS may be a good test bed for a variety of research efforts. Parameters relevant to combat skill acquisition, retention, and reacquisition can be identified and training transfer experiments from part-task trainers to the air combat simulator can be accomplished. For example, situational awareness measurement tools that have been developed in more controlled environments could be validated in this more complex environment. A simulator facility like that used for the F-15 AACS can supplement existing air combat training and also serve as a valuable research and development test bed.

REFERENCES

Bailey, J. (1989, January). Simulating the battle zone. Flight International, 34-36.

Everts, R.A. (1987). Commandant's corner. USAF Fighter Weapons Review, 35, 1.

Houck, M.R., Thomas, G.S., & Bell, H.H. (1989, October). Training potential of multiplayer air combat simulation. Proceedings of the 33rd Annual Meeting of the Human Factors Society, 1300-1304.

Kandebo, S. (1989, March). USAF controllers, F-15 pilots train for combat using multiship simulation. Aviation Week and Space Technology, 71-79.

Martin, E.L. (1984, October). Practice makes perfect (AFHRL-TP-84-32, AD A147 124). Williams Air Force Base, AZ: Operations Training Division, Air Force Human Resources Laboratory.

McDonald, G.W., Broeder, R.F., & Cutak, R.J. (1989, November). Multi-ship air combat simulation. Proceedings of the 11th Interservice/Industry Training Systems Conference, 148-159.

Thomas, G.S., Houck, M.R., & Bell, H.H. (1990, June). Training evaluation of air combat simulation (AFHRL-TR-90-30, AD B145 631L). Williams Air Force Base, AZ: Operations Training Division, Air Force Human Resources Laboratory.

APPENDIX A

GLOSSARY OF F-15 COMBAT TASKS

APPENDIX A: GLOSSARY OF F-15 COMBAT TASKS

Tactics/Mission Planning and Briefing: The beginning phases of the flight. Flight lead does specific mission planning (e.g., weather, target, tactics, threat, etc.), then briefs other flight members concerning the mission plan.

Mission Debriefing: Postflight discussion of how closely the flight adhered to the briefed game plan, reasons for deviations, suggestions for improvement, etc. Should be used as a learning session.

Escort Tactics: The specific tactics to be used for escorting other aircraft (e.g., bombers, electronic intelligence, radar, photo-reconnaissance), to protect them from any airborne threat. The aircraft being escorted should be briefed concerning the precise mission plan.

Visual Low Level: Low level flight, usually flown approximately 500 feet above ground, using visual references for positioning and turn points.

Night Tactics: Those tactics used for night missions. Usually relies more on radar use and precisely briefed tactics and maneuvers than do daylight missions.

Low Altitude Tactics: Tactics specifically designed for use when your capability to "take it down" is limited or nonexistent.

Visual Lookout: A briefed responsibility of each flight member as to where he is primarily to look for threats. For a single ship it is usually expressed as a percentage of time available, such as 70% visual, 30% radar.

Radar Lookout: The reverse (percentage wise) of visual lookout. More time is spent looking at the radar than outside.

Tactical Formation: The specific place each wingman should fly, with respect to flight lead, and his role designed to accomplish the specific mission, considering the threat, weather, weapons, etc.

Two-Ship Tactics: Specific tactics designed to maximize the offensive and defensive capabilities of a two-ship flight.

Four-Ship Tactics: Specific tactics designed to maximize the offensive and defensive capabilities of a four-ship flight.

Beyond-Visual-Range (BVR) Employment: Tactics designed to operate in a BVR environment, where radar and radar missile capabilities must be considered.

All-Aspect Defense: A defense based upon the premise that the enemy has the ability to fire weapons from anywhere in a 360° circle around the friendly aircraft, as opposed to a guns-only environment, where the enemy must fire from a close-in, stern area.

All-Weather Employment: Employment tactics centered around radar capabilities, where visual weapons may not be able to be used.

Communications Jamming: Tactics designed to minimize the effect of enemy communications jamming.

Tactical Electronic Warfare System (TEWS) Assessment: Use of the onboard TEWS to detect potential threats, primarily via the radar warning receiver.

Electronic Countermeasure/Electronic Counter-Countermeasure (ECM/ECCM) Employment: Use of ECM against a threat, or use of ECCM against enemy ECM.

Chaff/Flare Employment: Use of chaff to defeat enemy radar missiles and flares to defeat enemy infrared missiles, based upon specific tactics.

Reaction to Surface-to-Air Missiles (SAMs): Maneuvers designed to reduce the threat from or to defeat SAMs.

Reaction to Antiaircraft Artillery (AAA): Maneuvers and tactics designed to reduce the threat from ground gunners.

Reaction to Air Interceptors (AIs): Maneuvers and tactics designed to reduce the threat from enemy fighters.

Radar Employment/Sorting: Tactics used for radar search and the sorting of enemy formations and individual formation members.

Visual Identification (VID): Visually determining the identity of another aircraft.

Electronic Identification (EID): Using electronic systems to determine the identity of another aircraft.

Tactical Intercept: An intercept using specific single or multiple ship tactics, using either ground control radar or ownship radar.

Multibogey, Four or More: Tactical employment against multiple enemy air threats.

Intraflight Communications: The communications used between flight members, usually radio #2 and a specific discrete frequency.

Basic Fighter Maneuvers (BFM): Single ship maneuvers (1 v 1) to gain the tactical advantage (i.e., achieve a kill).

Air Combat Maneuvers/Air Combat Tactics (ACM/ACT): Multiship maneuvers (2 v 1, 1 v 2) using BFM as an element of flight to gain the tactical advantage.

Dissimilar Air Combat Tactics (DACT): Multiship tactics used to give pilots practice in fighting different types of aircraft.

Mutual Support: The coordinated efforts of two or more aircraft to provide combined firepower and survivability.

Missile Employment: Tactics used to successfully fire missiles, or to gain the tactical advantage for a missile shot.

Gun Employment: Tactics used to successfully fire the gun, or to gain the tactical advantage for a gunshot.

Separation: Maximize distance between an attacker and a defender to either reattack or to disengage.

Egress Tactics: Tactics used to exit from the battle area without receiving any damage from enemy fire.

Safe Passage: Tactics and electronic procedures designed to safely pass friendly air defenses when exiting the battle area.

Work with Air Weapons Controller (AWC): Using ground-based or airborne control radar to control intercept.

APPENDIX B

F-15 PILOT PRETRAINING QUESTIONNAIRES

F-15 ADVANCED AIR COMBAT SURVEYS

The purpose of this survey is to collect information relating to your flying background and training experience. The Pilot Background Survey will be used to correlate your experience with your ratings of the training you receive this week. The F-15 Combat Training Survey is intended to determine the areas in which you desire additional training. Your careful consideration of responses to this survey is important to the success of the F-15 Advanced Air Combat Simulation Program.

The data you provide for all surveys used this week are confidential and will be coded only with the last four digits of your Social Security Administration Number (SSAN). Enter the last four digits of your SSAN in the blanks provided so that your surveys can be collated throughout the week in an orderly fashion. Please complete this survey prior to leaving the conference room.

Thank you for your cooperation.

PILOT BACKGROUND SURVEY

Team _____   Date _____

Last four digits of your SSAN _____

I. CURRENT STATUS

_____   _____   _____
Squadron No.   Wing or Group No.   Name of Base Location

Check one that applies to your current status:
  ( ) Active USAF   ( ) AFRES   ( ) ANG

Are you a Fighter Weapons School graduate? ( ) Yes   ( ) No

II. FLYING BACKGROUND (flying hours need only be approximations, as best as you recall).

Fighter Hours (list your fighter aircraft experience by primary mission in reverse chronological order beginning with your current UE aircraft):

Air-to-Air			Air-to-Ground		
Aircraft	Hours	Years	Aircraft	Hours	Years
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Total Flying Hours _____   UE IP Hours _____

Combat Hours _____   Type Aircraft Flown in Combat _____

Years Experience in   USAFE _____   PACAF _____   AAC _____

Current Squadron Qualifications (circle the number of the HIGHEST UE qualification that applies to you):

1 Mission Ready Wingman

2 2-Ship Leader

3 4-Ship Leader

4 Mission Commander

5 IP

III. TRAINING EXPERIENCE

Prior to this week, approximately how many ACT or DACT sorties have you flown with the lead or wingman assigned to train with you this week? _____
What live air-to-air missiles have you fired?

( ) AIM-7   ( ) AIM-9   ( ) None

Indicate the major exercises in which you have participated, the number of times you attended each, and the approximate date of your last deployment to each.

Exercise	How Many	Year of Last
( ) Red Flag	_____	_____
( ) Green Flag	_____	_____
( ) Maple Flag	_____	_____
( ) Cope Thunder	_____	_____
( ) NATO Exercises	_____	_____

Others . . .

_____	_____	_____
_____	_____	_____
_____	_____	_____

In what visual air-to-air simulators (e.g., WSTs and OFTs) have you trained?

Simulator	Approximate Year(s)
SAAC - Luke AFB	_____
MCAIR	_____
Other_____	_____

AIR COMBAT TRAINING SURVEY

_____   _____   _____
    Date   Team   Last 4 digits of SSAN

The following is a list of mission elements that have been judged by a group of
F-15 pilots as important for air combat. In terms of preparing YOU for war,
please rate how desirable it is for YOU to receive additional training in each
of the following mission elements. Circle the number corresponding to your
rating for each element and include comments where necessary.

Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5

Comments

1. Tactics/Mission
   Planning and Briefing   1   2   3   4   5

2. Mission Debriefing   1   2   3   4   5

3. Escort Tactics   1   2   3   4   5

4. Visual Low Level   1   2   3   4   5

5. Night Tactics   1   2   3   4   5

6. Low Altitude Tactics   1   2   3   4   5

7. Visual Lookout   1   2   3   4   5

8. Radar Lookout   1   2   3   4   5

9. Tactical Formation   1   2   3   4   5

10. 2-Ship Tactics   1   2   3   4   5

11. 4-Ship Tactics   1   2   3   4   5

	Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5	Comments
12. BVR Employment	1	2	3	4	5	
13. All-Aspect Defense	1	2	3	4	5	
14. All Wx Employment	1	2	3	4	5	
15. Comm Jam	1	2	3	4	5	
16. TEWS Assessment	1	2	3	4	5	
17. Employ ECM/ECCM	1	2	3	4	5	
18. Employ Chaff/Flares	1	2	3	4	5	
19. Reaction to SAMs	1	2	3	4	5	
20. Reaction to AAA	1	2	3	4	5	
21. Reaction to AIs	1	2	3	4	5	
22. Radar Employment/ Sorting	1	2	3	4	5	
23. Visual ID	1	2	3	4	5	
24. Electronic ID	1	2	3	4	5	
25. Tactical Intercept	1	2	3	4	5	
26. Multibogey, 4 or more	1	2	3	4	5	

	Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5
						Comments
27. Intraflight Comm	1	2	3	4	5
28. BFM	1	2	3	4	5
29. ACM/ACT	1	2	3	4	5
30. DACT	1	2	3	4	5
31. Mutual Support	1	2	3	4	5
32. Missile Employment	1	2	3	4	5
33. Gun Employment	1	2	3	4	5
34. Separation	1	2	3	4	5
35. Egress Tactics	1	2	3	4	5
36. Safe Passage	1	2	3	4	5
37. Work with AWACS/GCI	1	2	3	4	5

APPENDIX C

AIR WEAPONS CONTROLLER PRETRAINING QUESTIONNAIRES

F-15 ADVANCED AIR COMBAT SURVEYS
CONTROLLERS

The purpose of this survey is to collect information relating to your controlling background and training experiences. The Controller Background Survey will be used to correlate your experience with your ratings of the training you receive this week. The F-15/Controller Combat Training Survey is intended to determine the areas in which you desire additional training. Your careful consideration of responses to this survey is important to the success of the F-15/Controller Advanced Air Combat Simulation Program.

The data you provide for all surveys used this week are confidential and will be coded only with the last four digits of your Social Security Administration Number (SSAN). Enter the last four digits of your SSAN in the blanks provided so that your surveys can be collated throughout the week in an orderly fashion. Please complete this survey prior to leaving the conference room.

Thank you for your cooperation.

CONTROLLER BACKGROUND SURVEY

Controller No. _____   Date _____

Last four digits of your SSAN _____

I. CURRENT STATUS

    Squadron No.   Wing or Group No.   Name of Base Location

Check all that apply to your current status:

( ) Aggressor School Graduate   ( ) FWS Graduate
( ) Active USAF   ( ) AFRES   ( ) ANG

II. CONTROLLING BACKGROUND

Number of Intercept Events _____ (need only be approximate, as best as you recall).

Years Experience in   USAFE _____   PACAF _____   AAC _____

Current Squadron Qualifications (circle the number of the HIGHEST qualification that applies to you):

1 Mission Ready Weapons Controller (WC)

2 Instructor Weapons Controller (IWC)

3 Weapons Assignment Officer (WAO)

III. TRAINING EXPERIENCE

Indicate the major exercises in which you have participated, the number of times you attended each, and the approximate date of your last deployment to each.

Exercise	How Many	Year of Last
( ) Red Flag	_____	_____
( ) Green Flag	_____	_____
( ) Maple Flag	_____	_____
( ) Cope Thunder	_____	_____
( ) NATO Exercises	_____	_____

Others . . .

_____	_____	_____
_____	_____	_____

AIR COMBAT TRAINING SURVEY
CONTROLLERS

Date	Controller No.	Last 4 digits of SCAN

The following is a list of mission elements that have been judged by a group of F-15 pilots as important for air combat. In terms of preparing YOU for war, please rate how desirable it is for YOU to receive additional training in each of the following mission elements. Circle the number corresponding to your rating for each element and include comments where necessary. Please circle N/A (not applicable) for any mission element that does not apply to you as a weapons controller.

Not Applicable N/A	Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5

Comments

1. Tactics/Mission Planning and Briefing	N/A	1	2	3	4	5
2. Mission Debriefing	N/A	1	2	3	4	5
3. Escort Tactics	N/A	1	2	3	4	5
4. Visual Low Level	N/A	1	2	3	4	5
5. Night Tactics	N/A	1	2	3	4	5
6. Low Altitude Tactics	N/A	1	2	3	4	5
7. Visual Lookout	N/A	1	2	3	4	5
8. Radar Lookout	N/A	1	2	3	4	5
9. Tactical Formation	N/A	1	2	3	4	5
10. 2-Ship Tactics	N/A	1	2	3	4	5
11. 4-Ship Tactics	N/A	1	2	3	4	5

Not Applicable N/A	Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5

<u>Comments</u>

12. BVR Employment	N/A	1	2	3	4	5
13. All-Aspect Defense	N/A	1	2	3	4	5
14. All Wx Employment	N/A	1	2	3	4	5
15. Comm Jam	N/A	1	2	3	4	5
16. TEWS Assessment	N/A	1	2	3	4	5
17. Employ ECM/ECCM	N/A	1	2	3	4	5
18. Employ Chaff/Flares	N/A	1	2	3	4	5
19. Reaction to SAMs	N/A	1	2	3	4	5
20. Reaction to AAA	N/A	1	2	3	4	5
21. Reaction to AIs	N/A	1	2	3	4	5
22. Radar Employment/ Sorting	N/A	1	2	3	4	5
23. Visual ID	N/A	1	2	3	4	5
24. Electronic ID	N/A	1	2	3	4	5
25. Tactical Intercept	N/A	1	2	3	4	5
26. Multibogey, 4 or more	N/A	1	2	3	4	5

Not Applicable N/A	Not Desirable 1	Desirable 2	Very Desirable 3	Highly Desirable 4	Extremely Desirable 5

Comments

27. Intraflight Comm   N/A 1   2   3   4   5

28. BFM   N/A 1   2   3   4   5

29. ACM/ACT   N/A 1   2   3   4   5

30. DACT   N/A 1   2   3   4   5

31. Mutual Support   N/A 1   2   3   4   5

32. Missile Employment   N/A 1   2   3   4   5

33. Gun Employment   N/A 1   2   3   4   5

34. Separation   N/A 1   2   3   4   5

35. Egress Tactics   N/A 1   2   3   4   5

36. Safe Passage   N/A 1   2   3   4   5

APPENDIX D

F-15 PILOT POSTTRAINING QUESTIONNAIRES

F-15 ADVANCED AIR COMBAT SIMULATION
F-15 PILOTS

Date	Team	Last 4 digits of SSAN

      The purpose of this survey is to provide you with an opportunity to critique and evaluate the training you received this past week. Your opinions are a critical part of the analysis of this training system so please answer them as completely as possible. In addition any suggestions for improvements will be helpful in determining the future for this type of training.

      Your comments will be coded only by the last four digits of your SSAN (please enter above). Please complete this survey prior to leaving the conference room.

      Thank you for your cooperation.

1. Evaluate the fidelity of the following training system components:

Cockpit:

Visual:

Scenarios:

Threat Presentations:

2. Would you benefit by recurring exposures to the type of training provided this week? Please check one response.

( ) No, recurring exposures would not be useful.

( ) Yes, twice per year.

( ) Yes, once per year.

( ) Other. Please specify other schedule:

3. Rate the benefit of this type of air combat training for each of the following types of participants. Circle the number corresponding to your rating for each and <u>include comments</u> where necessary.

Not Beneficial 1	Beneficial 2	Very Beneficial 3	Highly Beneficial 4	Extremely Beneficial 5

<u>Comments</u>

New Wingman   1   2   3   4   5

Experienced Wingman   1   2   3   4   5

New 2-Ship Lead   1   2   3   4   5

Experienced 2-Ship Lead   1   2   3   4   5

New 4-Ship Lead   1   2   3   4   5

Experienced 4-Ship Lead   1   2   3   4   5

4. Were there any elements of this week's training that you believe might result in negative training? <u>Please explain</u>.

5. Evaluate the potential of this type of training, relative to your current continuation training program, to help you fight and win the next war.

6. Make any additional comments you have regarding this training.

7. List any comments, suggestions, or criticisms you have regarding billeting, scheduling, meal arrangements, transportation, etc.

F-15 AIR COMBAT TRAINING VALUE SURVEY

Date _____

Last 4 digits of SSAN _____

INSTRUCTIONS: In terms of preparing you for air combat, rate the value of the training received at your current unit and that received during the F-15 Advanced Air Combat Simulation at MCAIR, for each of the following mission elements. Circle the number corresponding to your rating for each mission element for both <u>CURRENT UNIT</u> and <u>MCAIR</u>.

	Not Available N/A	Unacceptable 1	Marginal 2	Adequate 3	Good 4	Excellent 5

<u>COMMENTS</u>

Mission Element	<u>CURRENT UNIT</u>	<u>THIS WEEK</u>
1. Tactics/Mission Planning and Briefing	N/A 1 2 3 4 5	N/A 1 2 3 4 5
2. Mission Debriefing	N/A 1 2 3 4 5	N/A 1 2 3 4 5
3. Escort Tactics	N/A 1 2 3 4 5	N/A 1 2 3 4 5
4. Visual Low Level	N/A 1 2 3 4 5	N/A 1 2 3 4 5
5. Low Altitude Tactics	N/A 1 2 3 4 5	N/A 1 2 3 4 5
6. Visual Lookout	N/A 1 2 3 4 5	N/A 1 2 3 4 5
7. Radar Lookout	N/A 1 2 3 4 5	N/A 1 2 3 4 5
8. Tactical Formation	N/A 1 2 3 4 5	N/A 1 2 3 4 5

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Not Available N/A Unacceptable 1 Marginal 2 Adequate 3 Good 4 Excellent 5 COMMENTS

Item	CURRENT UNIT						THIS WEEK						COMMENTS
9. 2-Ship Tactics	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
10. BVR Employment	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
11. All-Aspect Defense	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
12. All Wx Employment	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
13. Comm Jam	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
14. TEWS Assessment	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
15. Employ ECM/ECCM	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
16. Employ Chaff/Flares	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
17. Reaction to SAMs	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
18. Reaction to AIs	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
19. Radar Employment/Sorting	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
20. Visual ID	N/A	1	2	3	4	5	N/A	1	2	3	4	5	

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	Not Available N/A	Unacceptable 1	Marginal 2	Adequate 3	Good 4	Excellent 5	COMMENTS

CURRENT UNIT   **THIS WEEK**

	CURRENT UNIT						THIS WEEK					
21. Electronic ID	N/A	1	2	3	4	5	N/A	1	2	3	4	5
22. Tactical Intercept	N/A	1	2	3	4	5	N/A	1	2	3	4	5
23. Multibogey, 4 or more	N/A	1	2	3	4	5	N/A	1	2	3	4	5
24. Intraflight Comm	N/A	1	2	3	4	5	N/A	1	2	3	4	5
25. DACT	N/A	1	2	3	4	5	N/A	1	2	3	4	5
26. Mutual Support	N/A	1	2	3	4	5	N/A	1	2	3	4	5
27. Missile Employment	N/A	1	2	3	4	5	N/A	1	2	3	4	5
28. Separation	N/A	1	2	3	4	5	N/A	1	2	3	4	5
29. Egress Tactics	N/A	1	2	3	4	5	N/A	1	2	3	4	5
30. Work with AWACS/GCI	N/A	1	2	3	4	5	N/A	1	2	3	4	5

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APPENDIX E

AIR WEAPONS CONTROLLER POSTTRAINING QUESTIONNAIRES

F-15 ADVANCED AIR COMBAT SIMULATION
CONTROLLERS

The purpose of this survey is to provide you with an
opportunity to critique and evaluate the training you received
this past week. Your opinions are a critical part of the
analysis of this training system so please answer them as
completely as possible. In addition any suggestions for
improvements will be helpful in determining the future for this
type of training.

Your comments will be coded only by the last four digits of
your Social Security Number (please enter above). Please
complete this survey prior to leaving the conference room.

Thank you for your cooperation.

1. Would you benefit appreciably by recurring exposures to the type of training provided this week? If so, approximately how often? Please comment.

2. Evaluate the potential of this type of training, relative to your current continuation training program, to help you fight and win the next war.

3. Were there any elements of this week's training that you believe might result in negative training? Please explain.

4. What changes would you recommend in order to increase training value? Please explain.

5. Make any additional comments you have regarding this training.

6. List any comments, suggestions, or criticisms you have regarding billeting, scheduling, meal arrangements, transportation, etc.

F-15 AIR COMBAT TRAINING VALUE SURVEY
CONTROLLERS

Date _____   Last 4 digits of SSAN _____

In terms of preparing you for controlling in combat, rate the value of the training received at your current unit and that received this week for each of the following mission elements. Circle the number corresponding to your rating for each mission element for both CURRENT UNIT and THIS WEEK.

	Not Available N/A	Unacceptable 1		Marginal 2	Adequate 3	Good 4	Excellent 5	COMMENTS
		CURRENT UNIT			THIS WEEK			
1. Tactics/Mission Planning and Briefing	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
2. Mission Debriefing	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
3. Escort Tactics	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
4. Visual Low Level	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
5. Low Altitude Tactics	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
6. Visual Lookout	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
7. Radar Lookout	N/A 1 2 3 4 5			N/A 1 2 3 4 5				
8. Tactical Formation	N/A 1 2 3 4 5			N/A 1 2 3 4 5				

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	Not Available N/A	Unacceptable 1	2	Marginal 3	4	Adequate 5	Good	Excellent	COMMENTS

CURRENT UNIT / **THIS WEEK**

#	Item	CURRENT UNIT	THIS WEEK
9.	2-Ship Tactics	N/A 1 2 3 4 5	N/A 1 2 3 4 5
10.	BVR Employment	N/A 1 2 3 4 5	N/A 1 2 3 4 5
11.	All-Aspect Defense	N/A 1 2 3 4 5	N/A 1 2 3 4 5
12.	All Wx Employment	N/A 1 2 3 4 5	N/A 1 2 3 4 5
13.	Comm Jam	N/A 1 2 3 4 5	N/A 1 2 3 4 5
14.	TEWS Assessment	N/A 1 2 3 4 5	N/A 1 2 3 4 5
15.	Employ ECM/ECCM	N/A 1 2 3 4 5	N/A 1 2 3 4 5
16.	Employ Chaff/Flares	N/A 1 2 3 4 5	N/A 1 2 3 4 5
17.	Reaction to SAMs	N/A 1 2 3 4 5	N/A 1 2 3 4 5
18.	Reaction to AIs	N/A 1 2 3 4 5	N/A 1 2 3 4 5
19.	Radar Employment/ Sorting	N/A 1 2 3 4 5	N/A 1 2 3 4 5
20.	Visual ID	N/A 1 2 3 4 5	N/A 1 2 3 4 5

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Not Available — N/A
Unacceptable — 1
Marginal — 3
Adequate — 5
Good
Excellent
COMMENTS

	CURRENT UNIT						THIS WEEK						
21. Electronic ID	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
22. Tactical Intercept	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
23. Multibogey, 4 or more	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
24. Intraflight Comm	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
25. DACT	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
26. Mutual Support	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
27. Missile Employment	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
28. Separation	N/A	1	2	3	4	5	N/A	1	2	3	4	5	
29. Egress Tactics	N/A	1	2	3	4	5	N/A	1	2	3	4	5	

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APPENDIX F

DETAILED RESULTS OF PILOTS' COMBAT TASK RATINGS

Additional Training Desire. Mean ratings were computed
separately for F-15C TFW pilots (n = 37) and for the 'Replication'
F-15 pilots (n = 57) and are shown in Table F1. For both pilot
groups, all 37 tasks had mean ratings of 2.6 (on a five-point
scale) or greater indicating that additional training was desired
for every task. Tasks perceived as having a 'high' desire for
additional training were defined as those with a mean rating of 3.5
or higher. F-15C TFW pilots and 'Replication' F-15 pilots rated 24
and 21 tasks, respectively, as having high desire for additional
training. These tasks are indicated by asterisks in Table F1.

There appears to be a high degree of correspondence between
both pilot groups in their relative ratings of additional training
desire for the combat tasks. To confirm this observation, the
combat tasks shown in Table F1 were rank ordered by mean rating
within each pilot group; ranks are shown in Table F1 to the right
of each mean rating. For ease of interpretation, the list of
combat tasks in Table F1 is ordered by the F-15C TFW pilot
rankings. Note the relatively high agreement between rankings of
the F-15C TFW pilots and the 'Replication' F-15 pilots. This
observation was confirmed by a significant Pearson's Product Moment
Correlation, r = .90, df = 35, p < .001, which accounted for 81% of
the variance between the rankings of the two pilot groups.

Because pilots indicated that additional training was highly
desirable for nearly all tasks, their ratings were further examined
to identify those combat tasks where additional training was most
and least desired. Criterion for a difference in additional
training desire was chosen to be greater than or less than one
standard deviation from the grand mean (grand mean and standard
deviation of the mean ratings for both pilot groups are shown in
Table F1). Combat tasks meeting this criterion are indicated in
Table F1. Both pilot groups rated additional training as most
desirable for the following tasks: Multibogey Employment, All-
Aspect Defense, Four-Ship Tactics, Reaction to SAMs, Electronic
Countermeasures/Counter-Countermeasures Employment (ECM/ECCM), and
Reaction to Airborne Interceptors (AI). Similarly, both groups
agreed that additional training is least desired for the following
tasks: Tactical Formation, BFM, Gun Employment, Tactical Intercept,
and Night Tactics.

In a few instances, however, the two pilot groups' ratings
were somewhat different. In addition to the above tasks rated as
most desirable for additional training, the F-15C TFW pilots
included all-weather employment and dissimilar air combat tactics
(DACT). Visual Identification and Mission Debriefing fell in the
'least desired' category for the F-15C TFW pilots. For the
'Replication' F-15 pilots, Chaff/Flare Employment was included in
the 'most desired' category, while Intraflight Communication
and ACM/ACT fell in the 'least desired' category.

Table F1: Pilots' Means and Rank Order of Additional Training Desire Ratings for F-15 Combat Tasks

F-15 Combat Tasks	F-15C TFW Pilots		'Replication' F-15 Pilots	
	Additional training desire	Rank order	Additional training desire	Rank order
Multibogey, Four or more	4.7*M	1	4.6*M	1
All-Aspect Defense	4.4*M	2	4.3*M	4
Reaction to Surface-to-Air Missiles	4.3*M	3.5	4.2*M	5.5
Dissimilar Air Combat Tactics	4.3*M	3.5	4.0*	8.5
Four-Ship Tactics	4.2*M	5	4.4*M	2.5
All-Weather Employment	4.1*M	7	3.8*	11
Reaction to Air Interceptors	4.1*M	7	4.1*M	7
Employ Electronic Countermeasures/ Electronic Counter-Countermeasures	4.1*M	7	4.2*M	5.5
Communications Jamming	4.0*	9	3.7*	13.5
Low Altitude Tactics	3.9*	11	3.6*	17.5
Reaction to Anti-Aircraft Artillery	3.9*	11	4.0*	8.5
Chaff/Flares Employment	3.9*	11	4.4*M	2.5
Egress Tactics	3.8*	13.5	3.5*	20.5

* = High Desire
M = Most Desired
L = Least Desired

Table F1 (continued)

F-15 Combat Tasks	F-15C TFW Pilots		'Replication' F-15 Pilots	
	Additional training desire	Rank order	Additional training desire	Rank order
Safe Passage	3.8*	13.5	3.4	23.5
Missile Employment	3.7*	16.5	3.6*	17.5
Escort Tactics	3.7*	16.5	3.7*	13.5
Tactical Electronic Warfare System	3.7*	16.5	3.9*	10
Work with Air Weapons Controllers	3.7*	16.5	3.7*	13.5
Visual Low Level	3.6*	20	3.2	28.5
Beyond-Visual-Range Employment	3.6*	20	3.5*	20.5
Mutual Support	3.6*	20	3.6*	17.5
Two-Ship Tactics	3.5*	23	3.3	26
Radar Employment/Sorting	3.5*	23	3.7*	13.5
Visual Lookout	3.5*	23	3.4	23.5
Separation	3.4	25.5	3.2	28.5
Radar Lookout	3.4	25.5	3.4	23.5
Intraflight Communication	3.3	27	3.1 L	

* = High Desire
M = Most Desired
L = Least Desired

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Table F1 (concluded)

F-15 Combat Tasks	F-15C TFW Pilots		'Replication' F-15 Pilots	
	Additional training desire	Rank order	Additional training desire	Rank order
Air Combat Maneuvers/Air Combat Tactics	3.2	29	3.1^L	33
Electronic Identification	3.2	29	3.6*	17.5
Tactics/Mission Planning and Briefing	3.2	29	3.4	23.5
Visual Identification	3.1^L	31	3.2	28.5
Basic Fighter Maneuvers	3.0^L	33.5	2.9^L	36
Night Tactics	3.0^L	33.5	3.1^L	33
Mission Debriefing	3.0^L	33.5	3.2	28.5
Tactical Intercept	3.0^L	33.5	3.1^L	33
Gun Employment	2.9^L	36	3.1^L	33
Tactical Formation	2.8^L	37	2.6^L	37
Grand Mean	3.6		3.6	
Standard Deviation	.5		.5	

* = High Desire
M = Most Desired
L = Least Desired

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Unit and F-15 AACS Training Value. Pilots used a six-point rating scale (i.e., 0 = Not Available, 1 = Unacceptable, 2 = Marginal, 3 = Adequate, 4 = Good, and 5 = Excellent) to indicate degree of training value. To simplify analysis, the lower two rating categories (i.e., 'Not Available' and 'Unacceptable') were combined and coded as '1.' Mean ratings of both unit and F-15 AACS training value were computed separately for F-15C TFW pilots and the 'Replication' F-15 pilots and are shown in Table F2.

Students' t tests were computed for each of the 30 F-15 combat tasks to determine significant differences in pilots' ratings of their unit training in comparison to the F-15 AACS. Criterion for a significant difference was determined through the Bonferroni procedure which adjusts the critical alpha value to compensate for the lack of independence between individual tests. The Bonferroni adjusted criterion for a significant difference based on an alpha value of .05 and 30 individual tests is $p < .0017$. Because a few pilots did not provide a rating for every task, the degrees of freedom vary for the t tests.

The F-15C TFW pilots rated the F-15 AACS training significantly more valuable than their continuation training for 11 combat tasks, $ts = 3.7$ to 19.6, $df = 32$ or 33, $p < .0017$. These differences are shown by the right-pointing arrows in Table F2. The F-15 AACS was rated as providing 'Good' to 'Excellent' (i.e., 3.5 or greater) training for all 11 of these tasks, whereas unit training was not rated 'Good' or 'Excellent' for any. In fact, unit continuation training was rated less than adequate (i.e., less than 2.5) for five of these tasks: Multibogey Employment, Reaction to SAMs, All-Weather Employment, Communications Jamming, and Escort Tactics. Reaction to SAMs was the only task for which unit training was rated 'Unacceptable' and over a third of the respondents stated that such training was not available in their units.

Unit training for four tasks was rated by the F-15C TFW pilots as significantly more valuable than F-15 AACS training, $ts = 4.2$ to 9.7, $df = 32$ or 33, $p < .0017$. These differences are shown in Table F2 by the left pointing arrows. The tasks receiving better training in the unit include Visual Lookout, Tactical Formation, Visual Identification, and Mutual Support. Interviews with pilots led to the explanation that each of these tasks has a strong visual component and that the simulator's visual presentations were not adequate to support optimal performance of these tasks. The main criticisms of the visual presentations were that (a) resolution of projected targets was inadequate to determine the aspect angle of aircraft at appropriate ranges, (b) judgment of apparent distance between ownship and wingman was difficult, and (c) rear hemisphere computer-generated imagery is necessary.

Table F2: Pilots' Mean Unit and F-15 AACS Training Value Ratings for F-15 Combat Tasks.

F-15 combat tasks	F-15C TFW Pilots		'Replication' F-15 Pilots	
	Unit training value	F-15 AACS training value	Unit training value	F-15 AACS training value
Multibogey, Four or more	2.4 ----> 4.8		2.6 ----> 4.8	
All-Aspect Defense	4.0	4.6	3.5 ----> 4.7	
Reaction to Surface-to-Air Missiles	1.4 ----> 4.6		1.3 ----> 4.4	
Dissimilar Air Combat Tactics	3.4 ----> 4.3		3.4 ----> 4.3	
All-Weather Employment	2.4 ----> 3.8		2.8 ----> 3.9	
Reaction to Air Interceptors	3.9	4.3	3.3 ----> 4.4	
Employ Electronic Countermeasures/ Electronic Counter-Countermeasure	2.5 ----> 4.4		2.4 ----> 4.5	
Communications Jamming	2.1 ----> 3.9		2.5 ----> 3.6	
Low Altitude Tactics	2.8 ----> 3.6		3.1 ----> 4.0	
Chaff/Flares Employment	2.8 ----> 4.6		1.3 ----> 4.8	
Egress Tactics	3.5	4.0	3.6	4.0
Missile Employment	3.8	4.3	3.8 ----> 4.5	
Escort Tactics	2.4 ----> 4.2		2.5 ----> 4.2	
Tactical Electronic Warfare System Assessment	3.0 ----> 4.4		2.5 ----> 4.5	
Work with Air Weapons Controllers	2.8 ----> 4.5		3.2 ----> 4.3	

Note: Arrows denote significant difference ($p < .0017$) in direction indicated (see text).

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F-15 combat tasks	F-15C TFW Pilots		'Replication' F-15 Pilots	
	Unit training value	F-15 AACS training value	Unit training value	F-15 AACS training value
Visual Low Level	2.8	3.3	3.3	3.2
Beyond-Visual-Range Employment	4.3	4.4	4.1 ---->	4.6
Mutual Support	4.1 <----	3.3	4.1	3.9
Two-Ship Tactics	4.1	4.3	4.0 ---->	4.4
Radar Employment/Sorting	4.4	4.5	3.8 ---->	4.4
Visual Lookout	4.2 <----	3.0	4.0 <----	3.4
Separation	3.7	4.1	3.8 ---->	4.3
Radar Lookout	4.2	4.4	3.9 ---->	4.5
Intraflight Communication	4.2	4.1	3.9	4.1
Electronic Identification	3.6	4.5	3.0 ---->	4.6
Tactics/Mission Planning and Briefing	4.0	3.6	3.5	3.8
Visual Identification	3.9 <----	2.7	3.7 <----	3.0
Mission Debriefing	4.0	4.0	4.1	4.2
Tactical Intercept	4.1	4.1	4.0	4.2
Tactical Formation	4.5 <----	2.6	4.3 <----	3.1

Note: Arrows denote significant difference ($p < .0017$) in direction indicated (see text).

The 'Replication' F-15 pilots rated the F-15 AACS significantly more valuable than unit training for 20 combat tasks, $\underline{t}s$ = 3.9 to 23.8, $\underline{df}$ = 55 to 57, $\underline{p}$ < .0017, as shown in Table F2. These pilots rated the F-15 AACS as providing 'Good' to 'Excellent' training (i.e., 3.5 or greater) for all 20 tasks, while unit training was rated 'Good' to 'Excellent' for only seven. Furthermore, unit training for three tasks was rated less than 'Adequate': ECM/ECCM employment was rated 'Marginal' and Chaff/Flare Employment and Reaction to SAMs were rated 'Unacceptable.' For the latter two tasks, over a third of the respondents indicated that such training was unavailable in their units. As did their F-15C TFW counterparts, the 'Replication' F-15 pilots rated Visual Lookout, Tactical Formation, and Visual Identification as having better training value in their unit, $\underline{t}s$ = 3.4 to 11.3, $\underline{df}$ = 55 or 57, $\underline{p}$ < .0017.

Ratings as a Function of Pilot Background Variables

Pilots' ratings of desire for additional training, value of unit training, and value of F-15 AACS training for each combat task were further analyzed to determine if pilot background or experience influenced these ratings. Data from all F-15 pilots were merged into a single group (n = 94). Task rating data were subjected to a series of one-way, between-groups analyses of variance (ANOVA) to determine whether F-15 hours, type of current unit, or current qualification level influenced the training desire and value ratings for each combat task. Because the F-15 pilots came to this training from various CONUS units having diverse functions, units were collapsed into three types according to similarity: (1) F-15C TFWs (i.e., 37 pilots from the 1 and 33 TFW), (2) F-15A operational units (i.e., 32 pilots from 49 TFW, various FIS, and ANG) and F-15C (non-MSIP) (i.e., 5 pilots from 57 FIS), and (3) F-15A RTU IPs (i.e., 20 pilots from the 405 and 325 TTW). F-15 hours were collapsed into three categories: low-time (i.e., 0 to 500 hours, n = 47), medium-time (i.e., 501 to 1000 hours, n = 32), and high-time (i.e., more than 1000 hours, n = 15). Lastly, pilot qualification was collapsed into three categories: wingmen (n = 29), mid-level pilots composed of two-ship leads, four-ship leads, and mission commanders (n = 37), and IPs (n = 27).

Data on which the ANOVAs were computed were from 94 pilots, although for almost every item a few pilots did not provide a response. As a result the degrees of freedom vary for the error terms. Comparisons having a significant difference were further subjected to Tukey HSD post hoc tests to identify specific differences (critical $\underline{t}$ value = 3.37, $\underline{p}$ < .05).

Additional Training Desire. There were no significant differences in additional training desire attributable to unit type or qualification. For F-15 hours, there was only one significant effect out of 37 combat tasks--Communications Jamming, $\underline{F}(2,91)$ = 3.96, $\underline{p}$ < .05. A Tukey HSD test revealed that this effect was

attributable to a higher mean training desire for high-time pilots compared to both medium-time and low-time pilots, p < .05.

Unit Training Value. Most of the differences in ratings of unit training value were attributable to the ratings of the RTU pilots. Fourteen of 30 combat tasks were rated significantly different as a function of unit type, and most of these differences were a result of RTU IPs rating their continuation training lower than pilots from other unit types. This result is not surprising given that RTU IPs devote the bulk of their flying time to student training sorties at the expense of their own combat training sorties. Interviews with RTU IPs, who had previously been assigned to an F-15 fighter wing, indicated that opportunities for combat training sorties are much fewer in the RTUs as compared to fighter wings.

The analyses involving pilot qualification and F-15 hours were partially confounded by the RTU pilot data since a disproportionate number of RTU pilots made up the IP category (i.e., 20 out of 28 pilots) and the high F-15 hour category (i.e., 12 out of 15 pilots). Unit training value was rated lower by IPs than by wingmen and mid-level pilots for Mission Briefing, Tactical Electronic Warfare System (TEWS) Assessment, Reaction to AIs, Radar Sorting, Electronic Identification, and Mutual Support, p < .05. IPs rated their unit training lower than did wingmen for All-Aspect Defense and Communications Jamming, p < .05. For F-15 time, high-time pilots rated the value of their continuation training lower than low-time pilots for the following combat tasks: TEWS Assessment, Reaction to AIs, Radar Sorting, and Electronic Identification, p < .05. Reaction to AIs also was rated lower by high-time compared to medium-time pilots, p < .05.

With regard to comparisons not involving RTU pilots, F-15C TFW pilots rated their units lower in training value than those from the other units for three combat tasks: Visual Low Level, All-Weather Employment, and Communications Jamming, p < .05. Of these results, only that of Visual Low Level is readily explained. Both TFWs do most of their low level training over water and do not get the desired amount of training over varied terrain. Unit training for Chaff/Flare employment was rated significantly more valuable by TFW pilots than other pilots, p < .05, presumably because fewer F-15s outside the TFWs are equipped with countermeasure dispensers. For qualification, there were no significant differences in ratings between wingman and mid-level pilots. Analyses of F-15 hours found only one significant difference: Low-time pilots rated their unit training higher for Chaff/Flare Employment than did medium-time pilots, p < .05. For the most part, ratings of unit training value by non-RTU pilots differed little as a function of unit type, qualification, or F-15 hours.

F-15 AACS Training Value. Only two out of the 30 combat tasks were rated significantly different as a function of unit type.

Pilots from F-15A and F-15C (non-MSIP) units rated the value of the F-15 AACS training higher for Visual Lookout and Mutual Support than did F-15C TFW pilots, $p < .05$. Likewise, only two combat tasks varied as a result of qualification: wingmen rated training value for Reaction to SAMs significantly higher than did IPs, $p < .05$, and middle-qualification pilots rated Work with AWC higher than did IPs.

Several differences in F-15 AACS training value were found with regard to F-15 hours. Medium-time and low-time pilots rated training value higher for Visual Identification and Work with AWC than did high-time pilots, $p < .05$. In addition, training value for ECM/ECCM Employment and Reaction to SAMs was rated higher by low-time than high-time pilots, $p < .05$; training for Communications Jamming was rated higher by low-time as compared to medium-time pilots, $p < .05$.

APPENDIX G

DETAILED RESULTS OF AIR WEAPONS CONTROLLERS' COMBAT TASK RATINGS

Thirty-eight of the 43 AWCs participating in this training responded to the questionnaires shown in Appendices D and E. Because the AWCs were asked to rate F-15 pilot combat tasks, their training desire ratings were examined, prior to analysis, to identify tasks not applicable to AWC performance. A combat task was excluded from further consideration if 25% or more of the respondents indicated the task was 'Not Applicable.' Tasks considered not applicable to AWCs included Visual Lookout, Visual Identification, Visual Low Level, Low Altitude Tactics, Radar Lookout, TEWS Assessment, Chaff/Flare Employment, Reaction to SAMs, Reaction to AIs, Gun Employment, BFM, and Reaction to AAA. The latter three tasks along with Night Tactics, ACM/ACT, Safe Passage, and Four-Ship Tactics were excluded also because they were not emphasized by this training program. As a result, 20 tasks were determined to be applicable to AWCs.

Mean ratings of desire for additional training, unit training value, and F-15 AACS training value for the 20 applicable tasks are presented in Table G1. For training value ratings, the lower two rating categories (i.e., 'Not Available' and 'Unacceptable') were combined and coded as '1.' Student's t tests were computed for each task to determine significant differences in AWC's ratings of unit training compared to the F-15 AACS. Criterion for a significant difference was again determined through the Bonferroni procedure. The adjusted criterion for a significant difference based on an alpha value of .05 is p < .0017. Because a few AWCs did not provide a rating for every task, the degrees of freedom vary for the t tests.

As indicated by Table G1, AWCs rated additional training for all but one of these applicable F-15 tasks as being 'Very' or 'Highly Desirable.' AWCs also rated the F-15 AACS significantly more valuable than their unit for providing training for all but five of these 20 F-15 combat tasks, ts = 3.6 to 16.9, df = 29 to 37, p < .0017. These differences are indicated in Table G1 by the right-pointing arrows. None of the tasks were perceived as better trained in the unit as compared to the F-15 AACS. These results indicate an overwhelming desire for additional combat training and clearly establish that the F-15 AACS provided AWCs with valuable combat training.

Table G1. Air Weapons Controllers' Mean Combat Task Ratings

Combat tasks	Additional training desire	Unit training value		F-15 AACS training value
Multibogey, Four or More	4.2	2.6	---->	4.4
Tactics/Mission Planning and Briefing	4.3	2.7	---->	4.6
Mission Debriefing	4.2	2.3	---->	4.9
Communications Jamming	4.2	2.6		3.0
Dissimilar Air Combat Tactics	4.1	3.4		4.3
Radar Sorting	4.0	2.7	---->	4.0
Two-Ship Tactics	3.9	2.9	---->	4.5
Egress Tactics	3.7	2.3	---->	3.4
Tactical Intercept	3.6	3.6		4.1
Intraflight Communication	3.2	2.9	---->	4.0
Tactical Formation	3.2	2.6	---->	3.5
Escort Tactics	3.1	2.0	---->	4.5
Mutual Support	3.1	2.6	---->	3.7
Separation	3.1	2.3	---->	3.5
All-Aspect Defense	3.0	2.6	---->	3.7
BVR Employment	3.0	2.4	---->	3.8
Missile Employment	2.8	2.4	---->	3.3
Electronic Identification	2.8	2.0		2.8
ECM/ECCM Employment	2.7	2.3		2.6
All-Weather Employment	2.3	2.0	---->	3.0

Note: Arrows denote significant difference (p < .0017) in direction indicated (see text).

LIST OF ABBREVIATIONS AND ACRONYMS

A/A	Air-to-Air
AAA	Anti-Aircraft Artillery
AAC	Alaskan Air Command
AACS	Advanced Air Combat Simulation
ACM	Air Combat Maneuvers
ACT	Air Combat Tactics
ADI	Attitude Director Indicator
AFB	Air Force Base
AFRES	Air Force Reserves
AI	Airborne Interceptors
ANG	Air National Guard
ANOVA	Analysis of Variance
AWACS	Airborne Warning and Control System
AWC	Air Weapons Controller
BFM	Basic Fighter Maneuvers
BVR	Beyond-Visual-Range
Comm	Communications
Comm Jam	Communications Jamming
CompGp	Composite Group
CONUS	Continental United States
DACT	Dissimilar Air Combat Tactics
DCA	Defensive Counter-Air
DOT	Directorate of Training
ECM	Electronic Countermeasures
ECCM	Electronic Counter-Countermeasures
FIS	Fighter Interceptor Squadron
FIW	Fighter Interceptor Wing
FWS	Fighter Weapons School
GCI	Ground Control Interface
HSI	Horizontal Situation Indicator
ID	Identification, Identify
IP	Instructor Pilot
IWC	Instructor Weapons Controller
MICS	Manned Interactive Control Station
MCAIR	McDonnell Aircraft Company
MSIP	Multistage Improvement Program
MPCD	Multipurpose Color Display
OCA	Offensive Counter-Air
OFT	Operational Flight Trainer
PACAF	Pacific Air Forces
RTU	Replacement Training Unit
SAAC	Simulator for Air-to-Air Combat
SAM	Surface-to-Air Missile
SSAN	Social Security Administration Number
TAC	Tactical Air Command
TAF	Tactical Air Forces
TEWS	Tactical Electronic Warfare System
TFW	Tactical Fighter Wing
TTW	Tactical Training Wing

UDRI	University Of Dayton Research Institute
UE	Unit Equipment
USAF	United States Air Force
USAFE	United States Air Forces in Europe
WAO	Weapons Assignment Officer
WC	Weapons Controller
WST	Weapon System Trainer
WVR	Within-Visual-Range
Wx	Weather