F-16 LIMITED FIELD-OF-VIEW VISUAL SIMULATOR TRAINING EFFECTIVENESS EVALUATION

FINAL REPORT

JULY 1987

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

This report covers the F-16 partial Field-of-View (FOV) visual simulator training effectiveness evaluation. An Image IIIT visual system was integrated on the F-16C operational flight trainer at the 58 TTW Luke AFB, AZ. F-16C instructor pilots and students evaluated the ability of a partial field-of-view visual system to support formal school training. Task areas evaluated were conversion, safety-of-flight, emergency procedures, air-to-air and air-to-surface. The results of this evaluation will be used by HQ TAC to determine if a partial FOV visual system can adequately support RTU training. From this a strategy for incorporating additional simulator training into the training syllabi can be developed. This study provided TAC the opportunity to verify F-16 simulator training task analysis.

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FOREWORD

The F-16 Limited Field-of-View Visual System Training Effectiveness Evaluation was managed and conducted by the Directorate of Training, Tactical Air Command, Langley AFB, VA; the Air Force Human Resources Laboratory, Williams AFB, AZ; the 58 Tactical Training Wing, and Detachment 1, 4444 Operations Squadron, Luke AFB, AZ. The evaluation began 1 Jul 86 and ended 31 Dec 86. The evaluation was supported by the F-16 System Program Office, Aeronautical Systems Division (ASD/YWF), Tactical Air Command (TAC) and the Singer-Link Company.

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Personnel from the following organizations contributed greatly to the overall success of the program:

58 TTW F-16 C/D instructor pilots and students
Det 1, 4444 Ops Sq educational specialists
Singer-Link on-site maintenance personnel

SUMMARY

Singer-Link Company offered to loan the USAF a limited field-of-view visual system at no cost for a six-month evaluation. During this evaluation period Singer-Link maintained and installed the visual system on the F-16C operational flight trainer at Luke AFB, AZ. As part of this installation, Singer also provided several special databases to support training at Luke AFB.

The evaluation involved an assessment by instructor and student pilots. All data collected was a subjective evaluation on the training effectiveness of the limited field-of-view visual system. Students and instructor pilots were interviewed one-on-one by a professional research scientist from the Air Force Human Resources Laboratory. Two simulator sorties were developed by training personnel to use the visual system in the current training curriculum.

Pilot acceptance of the visual system was very high. Over 80 percent of the pilots participating in the evaluation indicated the visual system enhanced simulator training. The highest payoff was in the conversion area for emergency and safety-of-flight tasks, especially those tasks involving weather effects. Training effectiveness was also enhanced for air-to-surface and air-to-air tasks. With the addition of this visual system, pilots were able to optimize their instrument/tactical crosscheck thus improving the time sharing between in/out of cockpit duties. Now, with the added capability to train tasks such as transition to land, limited air-to-surface and air-to-air weapons employment, limited BFM, VID, air refueling, VFR navigation, students were able to accomplish much more on the ground prior to their first flight.

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LIST OF ABBREVIATIONS

AFHRL - Air Force Human Resources Laboratory
B COURSE - Basic Course
BFM - Basic Fighter Maneuvers
CRT - Cathode Ray Tube
CX - Conversion Course
DTC - Data Transfer Cartridge
EP - Emergency Procedures
FAA - Federal Aviation Administration
FOV - Field of View
GOR - General Officer Review
HUD - Heads Up Display
HQ TAC - Headquarters Tactical Air Command
HZ - Hertz
IG - Inspector General
INS - Inertial Navigation System
IOS - Instructor Operator Station
IP - Instructor Pilot
OFT - Operational Flight Trainer
OTD - Operations Training Detachment
LATN - Low Altitude Tactical Navigation
RTU - Replacement Training Unit
SMS - Stores Management System
TAC - Tactical Air Command
TFTS - Tactical Fighter Training Squadron
TTW - Tactical Training Wing
TX - Transition Course

SECTION 1

INTRODUCTION

1.1 BACKGROUND.

1.1.1. Previous training system task analysis studies conducted for the F-16 have indicated a potentially high training effectiveness payback for simulators with a visual system. A major recommendation derived from these task analyses was to implement a system that contained a visual and to study actual training effectiveness from the simulator. Previous studies also indicated that a visual system will increase training effectiveness of an Operational Flight Trainer (OFT), F-15 Limited Field-of-View study, (Jul 84). This improvement stems from increasing pilot skill levels and higher pilot acceptance of the simulator.

1.1.2. During an F-16 Aircrew Training Devices General Officer Review (GOR) in 1985, the investigation of implementing a visual capability on F-16 simulators at the schoolhouses was proposed. Det 1, 4444 Operations Squadron provided results of a training requirements task analysis which indicated that visual systems can provide a substantial increase in training capability for operations and training squadrons. The schoolhouse mission and environment would provide the highest payback for the investment required for simulator visual systems.

1.1.3. In Jan 1986 Singer-Link Flight Simulation Division proposed to install and maintain a limited Field-of-View (FOV) visual system on the F-16 OFT at Luke AFB for six months at no cost to the government. The purpose of this loan was to demonstrate the utility of a visual system in an actual training environment. Singer maintains the F-16 OFT contract logistics support at Luke AFB, AZ and maintained the visual system at no cost during the loan period. This is the first implementation of a day/night visual system on a USAF F-16 OFT, and no previous Air Force evaluations of this system have been conducted. The installation of the visual system did not obligate the Air Force to continue use, buy, or lease the system after the six- month loan period.

1.2. PURPOSE.

1.2.1. The purpose of this special project was to evaluate the effectiveness of a limited FOV visual system on an OFT in an replacement training unit (RTU) environment. This study looked specifically at possible enhancements of air-to-air and air-to-surface simulator missions with the proposed visual system. Included in these missions were several conversion, safety-of-flight, and emergency procedures tasks. Other factors examined were pilot acceptance of a visual system and impact of a visual system on training.

1.2.2. The results of this evaluation will be used by HQ TAC to determine if a 36 X 126 degree limited FOV visual system can adequately support RTU training. This study provided TAC the opportunity to verify an F-16 training task analysis and increased understanding of the benefits of simulator visual systems as a training tool.

1.3. **SCOPE AND LIMITING FACTORS.**

1.3.1. This special project was conducted at the 58 TTW, Luke AFB, AZ to access the specific objectives shown in paragraph 1.4. The evaluation used F-16C/D conversion course (CX) students and instructor pilots. Two transition courses (TX), with a total of 11 students, were available to collect subjective data on pilot acceptance of the visual system. Initial (B) course training was not scheduled to begin until Aug 87, therefore these types of students were not available to participate in the study.

1.3.2. The F-16C/D CX course syllabus contains two simulator sessions; air-to-air and air-to-ground. CX students are qualified in the F-16A/B and are transitioning to the F-16C/D. This limited the amount and type of data collected by exposing the evaluation to experienced pilots already trained on the basic weapon system.

1.3.4. The type of analysis performed depended on many factors such as impact on operational training mission, availability of B course students, funding, and equipment. As a result, it was determined that a subjective evaluation would be the only means to gather data.

1.4 **OBJECTIVES.**

The overall objective of this study was to determine if a simulator with a visual system increased the value of training and enabled aircraft time to be more effectively utilized. A collateral objective was to define what additional tasks could be trained effectively in an OFT with the addition of a limited visual system.

1.4.1. Objective 1. Assess training tasks applicable for use with a limited FOV visual simulator for CX course training.

1.4.2. Objective 2. Evaluate the capability of the F-16 limited FOV visual system to support conversion RTU CX training.

1.4.3. Objective 3. Evaluate the capability of the F-16 limited FOV system to support air-to-air RTU CX training.

1.4.4. Objective 4. Evaluate the capability of the F-16 limited FOV system to support air-to-surface RTU CX training.

1.4.5. Objective 5. Evaluate any change in performance level of CX students during first flying sortie.

1.4.6. Objective 6. Evaluate pilot acceptance of the visual system.

1.4.6.1. Subobjective 6-1. Evaluate student pilot acceptance of using a visual simulator for training.

1.4.6.2. Subobjective 6-2. Evaluate instructor pilot acceptance (perceived training benefit) of using a visual simulator for training.

1.4.7. Objective 7. Evaluate the capability of the visual system data base to support RTU training.

1.4.8. Objective 8. Identify additional tasks that could be trained in a simulator with a visual system that are not currently included in the training syllabus.

1.5. DESCRIPTION.

1.5.1. Visual System Description. Link provided the Air Force a microprocessor based IMAGE IIIT visual system with texture. The Image IIIT is a day/dusk/night visual system developed by Singer Link-Miles which meets FAA Phase III advance simulation requirements. The system provided is a three-channel, three-window, wide-angle, collimated zero gap display and an operator repeater display. Integration of the visual system did not interfere with the functioning of the OFT and did not require any permanent modifications. Major components of the visual system are:

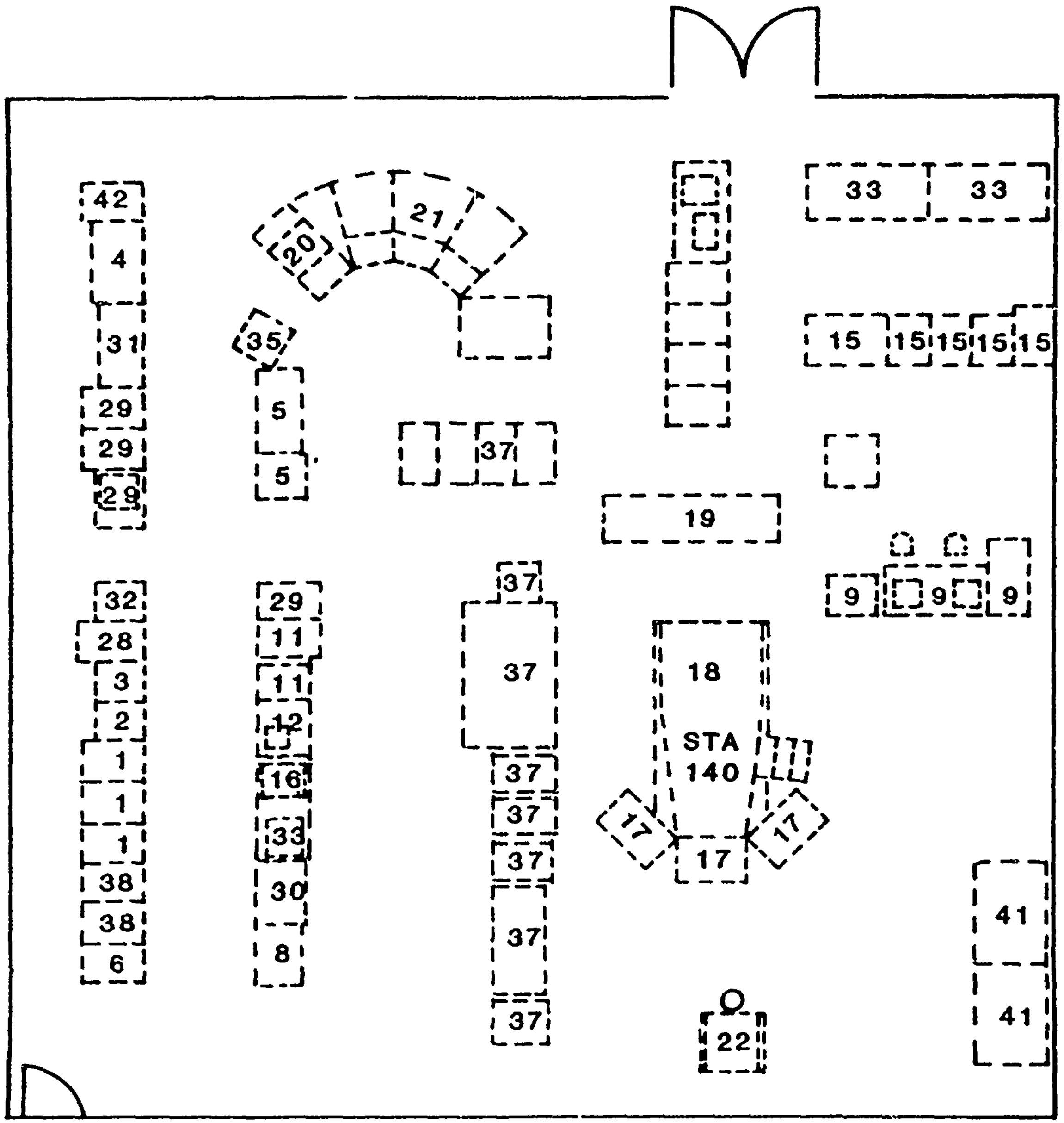
a) Image Generator (IG). This is a three-channel IG electronic system with texture capable of producing up to 250 surfaces simultaneously in each channel. The nominal update/refresh rate is 50 HZ.

b) Display System. Three-window, wide-angle, collimated zero gap display with a 126 degree (+/-63) horizontal FOV and 36 degree (+29, -15) articulated vertical FOV. The displays are a raster/calligraphic, high resolution, shadow-mask color CRT. The resolution (per line) of three arc minutes and 6-foot lamberts of brightness.

c) Instructor Operating Station (IOS). Repeat visual display that optically combines Heads-Up-Display (HUD) with forward visual display. Sample instruction pages for operation of the visual system are provided in Annex A.

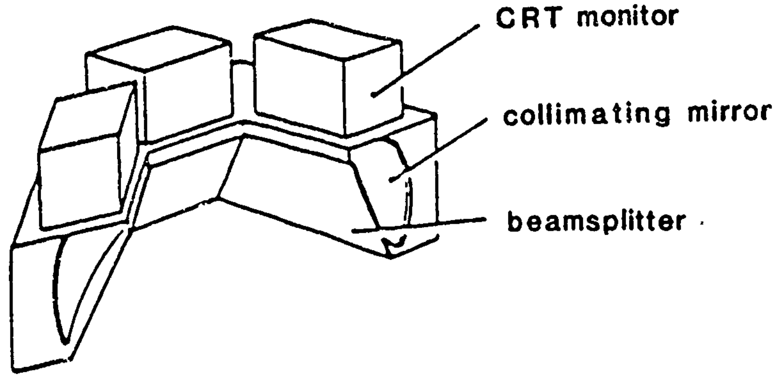
1.5.2. Visual System Capabilities. The IMAGE IIIT visual system produces real-time, out-the-window scenes of colored surfaces and objects representing the actual visual environment. The visual system responds to OFT data defining viewing conditions and presents corresponding updated images to the pilot. The visual system produces successive images at a rate sufficient to give the impression of smooth motion as the observer or a moving scene object changes position and/or altitude.

Figure 1-1
Facility Layout

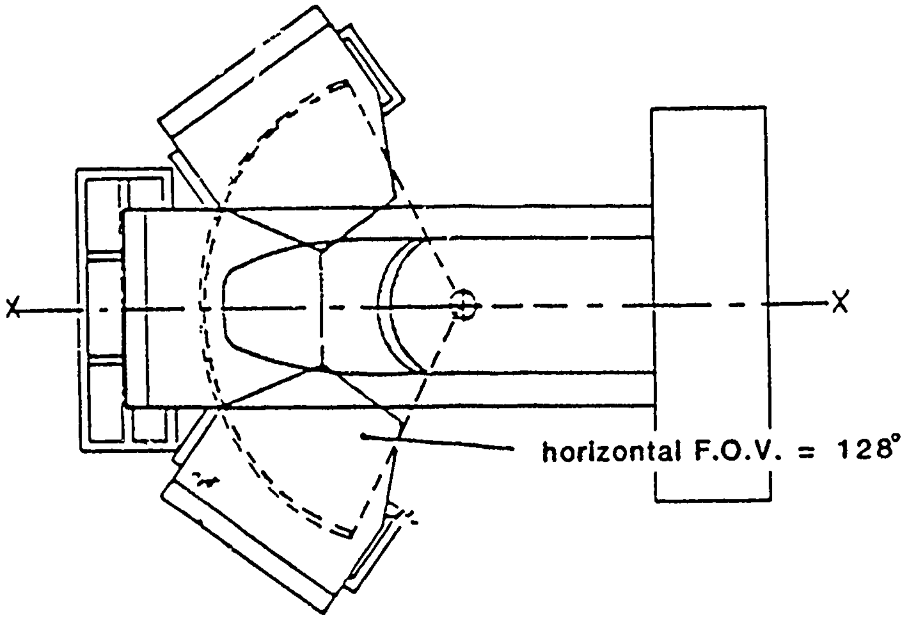


Power Supply Cabinet (Vis Sys)	42
Power Conditioner	41
Computer Floor	40
Fire Barrier	39
Slave Electrical Cab (Vis Sys)	38
ORLMS Cab (by General Electric)	37
Intercom & PWR SW	3[illegible]
FDASS Cab	35
Not Used	34
Table	33
LFI Cab	32
Avionics Cab	31
Versatec PTR	30
EWTD Cab (by AAI Corp)	29
EMS Cab	28
MG set	27
HYD unit	26
Air dryer	25
Air COMPR	24
VAC Pump	23
Cockpit Air Cond	22
INST STA	21
INSTA VIS Display (Vis Sys)	20
Electronics Cab	19
Cockpit	18
Not Used	17
CRT Display	16
Not Used	15
Hard Copy	14
Control Box	13
CRT Display	12
DISC Unit	11
Not Used	10
Not Used	9
Video Terminal (Vis Sys)	8
Line Printer (Vis Sys)	7
Master Electric Cab (Vis Sys)	6
MRCS Cab	5
Power Cab	4
Radar Cab	3
CPU Cab -ND100	2
CPU Cab -ND570	1

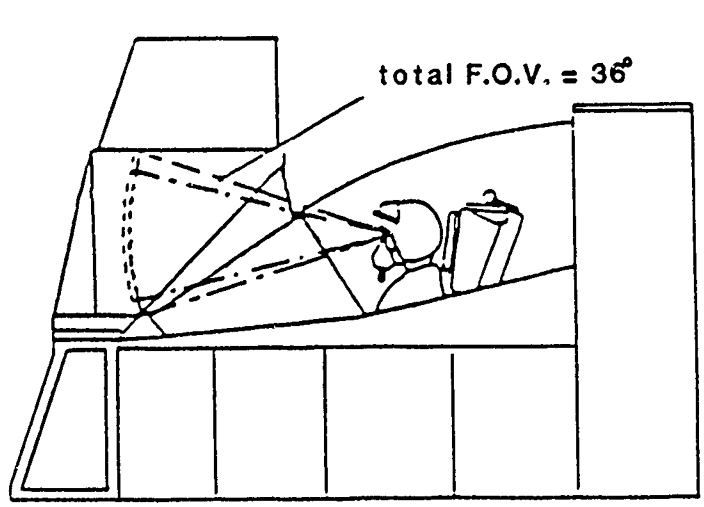
Figure 1-2
3-View Visual Installation Diagram



(A) Typical arrangement of 3 display heads



(B) Plan view of display heads showing horizontal F.O.V.



(C) Cross section through X-X showing vertical F.O.V.

1.5.2.1. The data base utilized during the evaluation was developed by Singer-Link at their facility in Lancing, England. The visual system depicts a variety of scene elements consistent with training requirements. A list of priority scene content features was defined by Det 1, 4444 Ops Sqd, AFHRL, and Singer-Link. This was done to provide the minimum scene content necessary to for effective training based on the known syllabus, and to give Singer-Link a prioritized list which could be used to plan the development of the data base. Available data bases included Luke AFB, air-to-air/air-to-surface ranges, low-level navigation route, Phoenix, and Nap-of-the-Earth. Characteristics of these databases included weather effects, weapons scoring, color, day/night/dusk, and moving models. A complete list is in Annex B. An example of the visual scene is presented in Figure 1-4.

1.5.3. OFT Description. The F-16 OFT consists of a pilot station, IOS, and a computer system. The pilot station is a replica of the F-16C/D cockpit. It consists of a cockpit assembly, environmental control, processor/controller and electronic equipment assemblies, and a G-cuing system. The IOS consists of a control console, a cathode ray tube display system, and a keyboard display system. The IOS is located adjacent the pilot station. The computer system includes the computers and peripherals needed to control inputs, performs a real-time solution of the total system mathematical model, and provides outputs necessary to accurately represent the static and dynamic behavior of the aircraft.

1.6. **OPERATIONAL CONCEPT.**

1.6.1. The limited FOV visual system provided in this evaluation was used by upgrading F-16C/D pilots in air-to-air and air-to-surface tasks at the RTU. Instructor pilots were qualified in simulator instruction on the system prior to student implementation.

1.6.1.1. The limited FOV visual system was used as a full-task trainer to increase proficiency in all normal procedures prior to the students first air-to-air and air-to-surface sorties. This included safety-of-flight tasks, emergency procedures, and instrument approaches and landing.

1.6.1.2. The limited FOV visual system was used to provide familiarization training of air-to-air flying tasks, improve intercept training by providing a visual conclusion to intercepts including visual weapons employment against non-maneuvering and maneuvering targets.

1.6.1.3. The limited FOV visual system was used to train subtasks of air-to-surface weapons employment such as initial pipper placement, target pipper/relationships, and pipper tracking.

1.6.2. Supporting Operations. OFT training sessions were controlled by the IP who was supported by a simulator technician/specialist.

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SECTION 2

METHOD OF ACCOMPLISHMENT

2.1. **INTRODUCTION** This study consisted of three phases of subjective data collection. In Phase I a general questionnaire was given to all pilots flying sorties (except CX course). A training task analysis performed by the Det 1, 4444 Ops Sq was validated during this effort. The second phase consisted of a subjective evaluation by CX course students following air-to-air and air-to-surface simulator sorties and flying sorties. End-of-course critiques submitted by students provided valuable comments on the visual system. A third phase consisted of a questionnaire given to IPs to assess perceived benefit of the visual system and to recommend changes/enhancements that could improve use of the system.

2.2 **SUBJECTS**

2.2.1. This evaluation utilized 93 F-16C CX course students, 11 F-16C TX course students, 25 F-16C IPs, and 14 F-16C line pilots (Phase I only). All pilots, except some involved in phase I, were either IPs or students from the 312th TFTS. F-16C TX course students, F-16C IPs and pilots participated in Phase I of the evaluation. F-16C CX students participated in Phase II and 312th TFTS IPs participated in Phase III (Table 2-1).

Table 2-1. Evaluation Schedule

PHASE	DATA COLLECTION DATES	NO. OF SUBJECTS	SUBJECT TYPE
I	AUG 86 - SEP 86	36	IPS, TX COURSE
II	SEP 86 - JAN 87	93	CX COURSE
III	JAN 87 - FEB 87	15	IPS

2.2.2. All IPs were trained on system operation prior to the beginning of the evaluation and use of the simulator. This included a checkout sortie to ensure IPs were familiar with console operation. Students and other pilots received no formal training on console operation. CX Course students are F-16A/B pilots converting to the F-16C/D. These pilots had previous F-16 experience and received simulator training in an F-16A OFT with a single window night only visual system. TX course students are fighter pilots transitioning to the F-16C/D from a fighter aircraft other than an F-16.

2.3 PROCEDURE.

2.3.1. General Procedure. The evaluation consisted of three phases of subjective data collection as outlined in Table 2-1.

2.3.2. Phase I. The first phase of the evaluation began immediately after the system was operational. Operations Training Detachment (OTD) personnel performed a task analysis to determine appropriate tasks for inclusion in the training syllabus (Objective 1). This consisted of a general questionnaire (see Annex D) given to pilots receiving simulator flights. Pilots filled out the questionnaire immediately upon completion of the sortie. TX students utilized the simulator for eight simulator sessions during scheduled training. They were interviewed for subjective opinion of the capabilities and uses of the simulator (Objectives 1, 2, 3, 4, 6-1, 7, and 8). IPs and line pilots were interviewed for their subjective opinion of the visual system, data base and training potential of the simulator (Objectives 1, 2, 3, 4, and 7). IPs for student training were interviewed after console operation to collect data on ease of console operation (Objective 6-2). Sortie missions evaluated were orientation flights, air-to-air, air-to-ground, emergency procedures, and instruments.

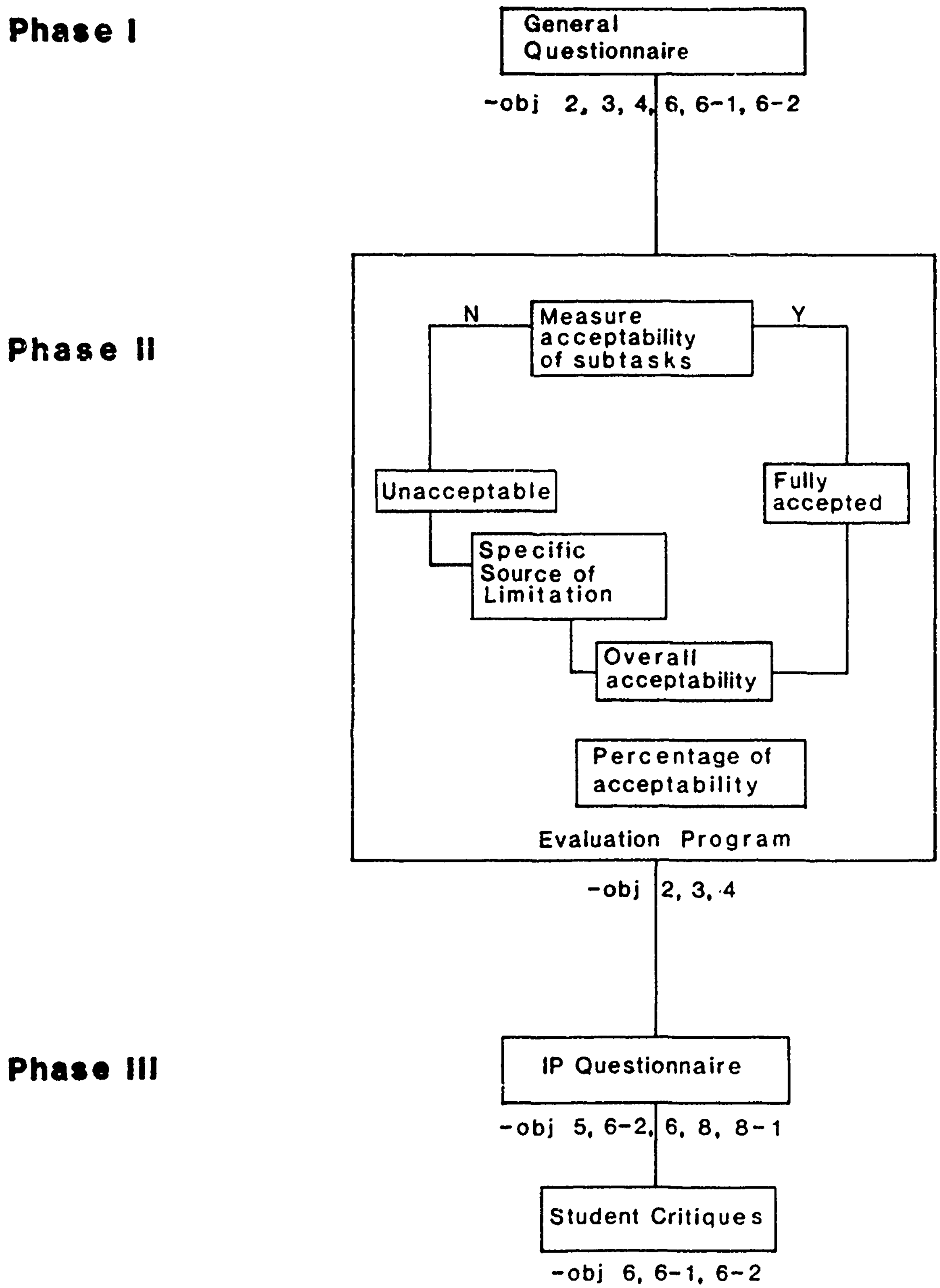
2.3.3. Phase II. The second phase began with students following the schedule of training as prescribed in F16COCXOAL, USAF Conversion Pilot Training Course F16C/D. Each student was interviewed following simulator sorties 0-1 and 0-2. Tasks for sorties 0-1 and 0-2 were evaluated and discrepancies noted by the students were recorded (Objectives 1, 2, 3, 4, and 7). CX students were interviewed after the designated simulator sorties by a research psychologist (AFHRL) to collect the students responses (See Annex D). At the completion of each class students filled out an end-of-course questionnaire that provided student opinion about the OFT. (Objective 6-1).

2.3.4. Phase III. The third phase of the evaluation consisted of an IP questionnaire (See Annex D) administered during the last class of the evaluation. This allowed IPs sufficient use of the system to provide intuitive data concerning how well the simulator visual system supported the various phases of training and what additional tasks could be incorporated into the training syllabus. (Objectives 5, 6-2, and 8).

2.4. **Data Collection.** Data for all phases was collected through subjective questionnaires and analyses of simulator performance and comparison of simulator/aircraft performance. The data was collected in three situations: 1) Subjective interviews with CX students after simulator sorties, 2) Subjective interviews with IPs after simulator training sorties and flying sorties, and 3) Subjective ratings by IPs, pilots, and TX course students on training capability of a limited FOV simulator. During Phase II it became apparent the original data base required refinement; therefore, results are presented as before and after the refinement.

Figure 2-1

Flowchart of Evaluation Method



SECTION 3

RESULTS AND DISCUSSION

3.1. TRAINING EFFECTIVENESS.

3.1.1. Objective 1. Assess training tasks applicable for use with a limited FOV visual simulator for CX course training.

3.1.1.1. Criteria. The F-16 Operations Training Development (Det 1, 4444 Ops Sqd) team evaluated the simulator training tasks for CX training to develop appropriate simulator sorties. Candidate tasks were identified where training could possibly be enhanced by use of a limited FOV visual system. These tasks are listed in Table 3-1.

Table 3-1
Training Tasks Utilizing a Limited Field-of-View for Training

CONVERSION	
Normal Takeoff	Night Approaches
Trail Departure	Overhead Patterns *
Single Ship Landing	Emergency Procedures
Instrument Approach	Low Altitude Navigation
Weather Breakout	Instrument Landing
AIR-TO-AIR	
Weapons Checks	Missile Gun Parameters
Collision Course Intercepts	Air Refueling Rendevous
Stern Intercepts	Offensive BFM *
Non-cooperative Targets *	Low Altitude Intercepts
AIR-TO-SURFACE	
Range Orientation	Strafe *
Bombing Pattern/Recovery *	Offset Aiming Delivery
Nuclear Procedures	Threat Reaction *
Level Bomb	Pop-up Attacks *
Climbing Delivery	Night Range Procedures
Diving Delivery *	

* Limited performance of task

3.1.1.2. Results and Discussion. The task analysis resulted in the development of two simulator sorties (one air-to-air, one air-to-surface). The sorties included conversion, air-to-air and air-to surface tasks used in the overall evaluation. The completed task briefing guides outlining the sorties are listed in Annex C.

3.1.2. Objective 2. Evaluate the capability of the F-16 limited FOV visual system to support Conversion RTU CX training.

3.1.2.1. Measures. The conversion tasks identified in the two simulator sorties included representative emergency procedures, selective jettison procedures, medium altitude electrical system malfunction, simulated minimum fuel (Home) recovery, and instrument approach and landing. Data was collected from questions 3, 4 and 5 of the general questionnaire (Phase I) and through pilot responses immediately after each simulator sortie (Phase II). The responses from the general questionnaire produced a calculated mean score of perceived training improvement. Responses from the student pilot interview (Phase II) produced an overall percentage of pilots who perceived a training enhancement by using the visual system.

3.1.2.2 Results and Discussion. The limited FOV visual system can effectively enhance conversion RTU CX training including emergency procedures and safety-of-flight. Transition training was enhanced with the use of the limited FOV visual system.

3.1.2.2.1. Phase I. Pilot opinion of the ability of the visual system to support conversion training was high. On a scale of one to five, all three tasks rated over 4.0.: Take Off and Departure (4.06), Approach and Landing (4.26), Situational Awareness/EPs (4.18).

3.1.2.2.2. Phase II. The use of the visual was rated very high. Over 90 percent of the students indicated the visual system enhanced training in conversion task areas. This is due to the capability of the visual to support adverse weather effects during approach, landing, and departure procedures. As demonstrated in Phase I results, students also indicated the visual system enhanced training. Data base refinements made during the evaluation had no apparent effect on training effectiveness (Table 3-2). This is to be expected due to the generic nature of conversion tasks.

Table 3-2
Conversion Tasks Analysis

TASK	BEFORE ENHANCEMENTS % (pos/tot)*	AFTER ENHANCEMENTS % (pos/tot)*	OVERALL
Representative Emergency Procedures	92% (35/38)	92% (124/135)	92%
Instrument Approach and Landings	98% (50/51)	96% (123/128)	97%
Trail Departure	91% (10/11)	98% (56/57)	92%

* pos=POSITIVE RESPONSES tot=TOTAL RESPONSES

The majority of those responding that training was not enhanced indicated no deficiency in the visual system, rather that it did not aid or hinder performance. Only one negative response was due to visual system attributes. Other responses indicated problems in operation of the simulator (not the visual system).

3.1.3. Objective 3. Evaluate the capability of the F-16 limited FOV visual system to support air-to-air RTU CX training.

3.1.3.1. Measures. The air-to-air tasks identified in the two simulator sorties included weapon system checks, collision course intercepts, stern conversion from varying intercept geometries, missile and radar mode switchology, missile/gun attack and weapons parameters, and multiple target sorting. Data was collected from question 6 of the general questionnaire and through pilot responses immediately after each simulator sortie. The responses from the general questionnaire (Phase I) produced a calculated mean score of perceived training improvement. The responses from the student pilot interview (Phase II) produced percentages of pilots who perceived a training enhancement.

3.1.3.2 Results and Discussion. The limited FOV visual system can effectively enhance air-to-air RTU CX training.

3.1.3.2.1. Phase I. The calculated mean responses for visual support of air-to-air training was 4.00 on a scale of one to five (five being excellent). This indicated a potential for a simulator with a limited FOV to enhance air-to-air training. However, the tasks tested in this phase were general in nature due to the level of instruction provided in an RTU environment.

3.1.3.2.2 Phase II. Poor responses during initial student pilot evaluations indicated a potential problem area in air-to-air training. A closer look at the air-to-air data base indicated enhancements were required to better support training. These enhancements were accomplished during the evaluation period and are discussed in more detail in Objective 7 (hardware/software). After data base enhancements the visual system was rated very high (Table 3-3). An average of all respondents indicates over 80 percent indicated the limited FOV enhanced air-to-air training. This is well below the perceived benefit for conversion and air-to-ground training. Although several tasks (weapons system checks, switchology, and multiple target sorting) are not "visual intensive" tasks, the last portion of these tasks result in a visual conversion providing reinforcement of correct procedures. The ability to do this task in "real time" allowed students to see the complete task rather than just parts. Due to the limited FOV Basic Fighter Maneuvers (BFM) were not included in the simulator sortie. However, limited BFM was performed on a voluntary basis to provide students an orientation of BFM concepts.

Table 3-3
Air-to-Air Task Analysis

TASK	BEFORE ENHANCEMENTS % (pos/tot)*	AFTER ENHANCEMENTS % (pos/tot)*	OVERALL
Weapons System Checks	65% (13/20)	93% (26/28)	81%
Collision Course Intercepts	44% (11/25)	98% (63/64)	83%
Stern Conversion from varying Intercept Geometries	72% (18/25)	85% (44/52)	81%
Missile & Radar Mode Switchology	84% (21/25)	95% (61/64)	92%
Missile/gun Attack & Weapons Parameters	68% (17/25)	86% (56/65)	81%
Multiple Target Sorting	55% (17/22)	89% (58/65)	86%

* pos=POSITIVE RESPONSES tot=TOTAL RESPONSES

The majority of those responding that training was not enhanced, indicated no deficiency in the visual system, rather that it did not aid or hinder performance. The range for target identification was a problem for collision intercepts, stern conversions, missile parameters, and multiple target sorting. This problem was reduced through data base modifications during the evaluation. Several respondents indicated the missile/gun attack and weapons parameters task was affected by the size of the visual FOV. Remaining negative responses concerned the operation of the simulator, unrealistic radar representations, or computer system malfunctions.

3.1.4. Objective 4. Evaluate the capability of the F-16 limited FOV visual system to support air-to-surface RTU CX training.

3.1.4.1. Measures. The air-to-surface tasks identified in the two simulator sorties included Storage Management System (SMS) air-to-ground programming & Data Transfer Cartridge (DTC) loads, Low Altitude Tactical Navigation (LATN) using Inertial Navigation Systems (INS), nuclear deliveries (radar & visual), and conventional computed deliveries. Data was collected from question 7 of the general questionnaire and through pilot responses immediately after each simulator sortie. The responses from the general questionnaire (Phase I) produced a calculated mean score of perceived training improvement. The responses from the student pilots (Phase II) produced percentages of perceived training enhancement.

3.1.4.2 Results and Discussion. The limited FOV visual system did effectively enhance air-to-surface RTU CX training.

3.1.4.2.1. Phase I. The calculated mean responses of pilots was 4.80 on a scale of one to five (five being excellent). This indicates a very high capability of the visual system to enhance air-to-surface training.

3.1.4.2.2. Phase II. Students did not rate the capability of the visual system to enhance training as high as the IPs and experienced pilots, although ratings were still high. This may be due to the fact experienced pilots require fewer visual cues to perform the task than the novice. Experienced pilots given a few cues (limited FOV) can assess the whole situation. The limited FOV lacks the ability to provide some downwind and base leg visual cues that novice pilots need to more accurately assess their position. However, the presence of a visual system allows these tasks to be performed, even in a limited manner. Without a visual system these tasks could only be practiced through instruments. Table 3-4 illustrates the percentage of CX students indicating a training enhancement.

Table 3-4
Air-to-Surface Task Analysis

TASK	BEFORE ENHANCEMENTS % (pos/tot)*	AFTER ENHANCEMENTS % (pos/tot)*	OVERALL
SMS Air-to-Ground Programming & DTC Loads	81% (22/27)	87% (53/61)	85%
Low Altitude Tactical Nav (LATN) using INS	85% (23/27)	80% (47/59)	81%
Nuclear Deliveries (radar/vis)	100% (25/25)	85% (54/63)	90%
Conventional Computed Deliveries	63% (15/24)	89% (57/64)	82%

* pos=POSITIVE RESPONSES tot=TOTAL RESPONSES

SMS air-to-ground programming and DTC loads are not "visual intensive" tasks; however, the ability to do this task in "real time" allowed students to see the complete task rather than just parts. The deficiencies noted by the remainder of the students were (a) not aided with the addition of the visual, (b) range deficiencies on identifying target, and (c) inadequate horizontal\vertical FOV. The reason for the noted deficiencies were in part due to type of tasks because many pilots rely on instruments to perform the task or could not identify proper outside cues to aid in flying the maneuver. A deficiency is always noted for simulators with less than a full FOV especially when peripheral cues are necessary to complete the task.

3.1.5 Objective 5. Evaluate any change in performance level of CX students during first flying sortie.

3.1.5.1. Measure. IPs were asked to assess the student's performance on initial flying sortie following the applicable simulator sortie. This data was collected on the IP questionnaire (Phase III).

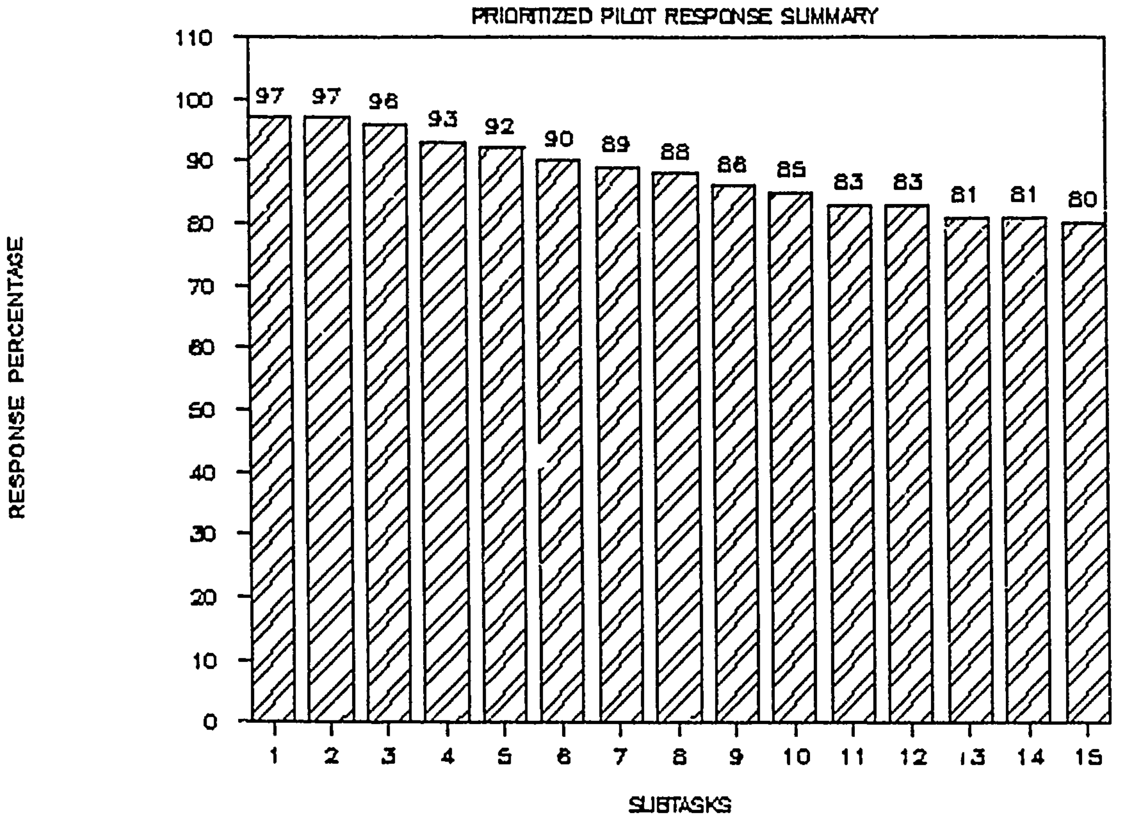
3.1.5.2. Results and Discussion. The 15 IPs interviewed responded that students demonstrated improvement in flying skills since the addition of the visual system for training. The primary areas of improvement are identified in Table 3-5. Emergency Procedures and instrument training showed the highest area of improvement. It is difficult to truly assess the benefit of local area procedures because most of the students received prior training in the Luke AFB area. It should also be noted that the IPs indicated the visual system gave an added dimension of realism that enabled the students to concentrate more on the whole task, thereby increasing their skill level prior to flying the aircraft.

Table 3-5
Areas of Improvement in Performance

AREA IMPROVED	AFTER SIM %	AFTER SORTIE %
Situational Awareness	20%	20%
Local Area Procedures	-	20%
Avionics	-	25%
Emergency Procedures	33%	35%
Instruments	40%	20%
Weapons Employment	27%	27%
Switchology	-	27%
All Areas	53%	40%

3.1.6. Overall Training Effectiveness. The visual system allowed students to realistically practice cockpit management tasks, especially the allocation of in/out of cockpit time. Students tended to fly the simulator more like they would the aircraft. Many tasks that previously could not be practiced in the simulator could now be familiarized to the student before flying the aircraft. Overall, the perceived benefit of using a limited visual system in simulator training was very high. Over 80 percent of the pilots responded the visual system enhanced training in one or more areas. The highest payoff was in the conversion task area followed by air-to-ground and air-to-air, respectively. Figure 3-1 shows a prioritized listing of tasks according to students' perception of training benefit. The enhancements required after initial data base development, indicated the importance of appropriate visual cues in the visual scene.

Figure 3—1



*SUBTASKS

1)INSTRUMENT APPROACH AND LANDING (CONVERSION)
2)TRIAL DEPARTURE (RADAR) AS NO. 4 IN FLIGHT OF FOUR (CONVERSION)
3)SIMULATED MINIMUM FUEL (HOME) RECOVERY (CONVERSION)
4)SELECTIVE JETTISON PROCEDURES (CONVERSION)
5)MISSILE AND RADAR MODE SWITCHOLOGY (AIR-TO-AIR)
6)NUCLEAR DELIVERIES (AIR-TO-SURFACE)
7)LOW ALTITUDE TACTICAL NAVIGATION (LATN) USING INS (TOS,CARA) (AIR-TO-SURFACE)
8)MULTIPLE TARGET SORTING (AIR-TO-AIR)
9)EMERGENCY PROCEDURES (CONVERSION)
10) SMS AIR-TO-SURFACE PROGRAMMING AND DTC LOADS (AIR-TO-SURFACE)
11)COLLISION COURSE INTERCEPTS (AIR-TO-AIR)
12)CONVENTIONAL COMPUTED DELIVERIES (AIR-TO-SURFACE)
13)WEAPON SYSTEM CHECK (AIR-TO-AIR)
14) MISSILE/GUN ATTACK AND WEAPONS PARAMETERS (AIR-TO-AIR)
15) STERN CONVERSION FROM VARYING INTERCEPT GEOMETRIES (AIR-TO-AIR)

3.2 PILOT ACCEPTANCE OF LIMITED FOV SIMULATOR VISUAL SYSTEM

3.2.1. Objective 6. Evaluate pilot acceptance of the visual system.

3.2.1.1. Subobjective 6-1. Evaluate student pilot acceptance of using a visual simulator for training.

3.2.1.1.2 Measures. TX course students answered a general questionnaire (Phase I) and CX course students completed end-of-course critiques. A calculated mean from TX student responses was used to assess their overall impression of the limited FOV visual system. A summary of end-of-course critique responses was used to derive CX course student opinion.

3.2.1.1.3. Results and Discussion. TX and CX course students indicated a very positive attitude towards the use of a limited FOV visual simulator.

3.2.1.1.3.1. TX Course Students. TX Students flew selected types of simulator missions and rated its ability to support these areas of training. TX students were the "test" class to identify potential areas requiring enhancement. Therefore, it was expected these ratings would be lower than CX student critiques. These ratings indicate a training benefit and pilot acceptance before any enhancements were implemented. Students rated each area on a scale of 1 to 5, with 5 being excellent. As seen on Table 3-6 TX course students rated the visual very high. The addition of the visual system to the OFT and the quality of the visual presentation were rated the highest. This indicates the visual scene is somewhat realistic and aids in training.

Table 3-6
TX Student Pilot Opinion

QUESTION	MEAN *
------- Overall Opinion------	
Rating of Visual Presentation	4.92
Ability to Support Flying Sim	4.54
Addition of Visual to Simulator	4.83
------- Areas of Training------	
Take-off and Departure	4.12
Approach and Landing	4.60
Situational Awareness/EP	4.38
Air-to-Air Training	4.58
Air-to-Surface Training	4.69

* Scale: 1 to 5 (1=poor, 5=excellent)

3.2.1.1.3.2. CX Course Students. At the end of the course students are routinely asked to provide feedback on the quality of training they received. No specific request was made to assess the OFT, however a general question is asked as to the adequacy of training devices. In general simulators are usually rated low, and comments to reduce the number of simulator sessions are common. However, several student critiques indicated "The OFT is outstanding," "I hate to suggest it, but another ride, perhaps an extra simulator (intercept)," "Excellent simulator training," "Could get more out of OFT training," "It would be an advantage to have one more simulator prior to first aircraft ride," "Simulator is one of the finest I have seen," "Need more simulator time," "OFT fantastic (for a sim)." Overall, the students indicated the simulator visual system made the OFT training session more enjoyable. A student in class 87-ECL summed it up; The "Simulator is the best I've seen. Not only for A/A, A/G, switchology and procedures, but also for instrument approaches breaking out near minimums. Great training aid. I actually enjoyed the simulator. Without the visual it would be the same as any sim, but the visual display really makes it good."

3.2.1.2. Subobjective 6-2. Evaluate instructor pilot acceptance (perceived training benefit) of using a visual simulator for training.

3.2.1.2.1 Measures. IPs were asked to evaluate the visual system based on their experience as pilots during Phase I (general questionnaire). IPs assessed the value of adding the visual system to a simulator for training enhancement (IP questionnaire) as the evaluation was nearing an end (Phase III). This allowed IPs to formulate an opinion during the six-month period for an overall assessment.

3.2.1.2.2 Results and Discussion. IPs indicated a high acceptance for the use of a simulator with a visual system for training.

3.2.1.2.2.1. Phase I (General Questionnaire). IPs were used to verify the appropriate use of the simulator visual system in the CX course. Therefore, it was expected these ratings would be lower than TX course students. These ratings indicate a training benefit and pilot acceptance of the visual system. Table 3-7 presents IP responses to the general questionnaire. IPs flew selected types of simulator missions and rated its ability to support these areas of training on a scale of 1 to 5, with 5 being excellent.

Table 3-7
Overall Instructor Pilot Opinion

QUESTION	MEAN *
------Overall Opinion--------	
Rating of Visual Presentation	4.15
Ability to Support Flying Sim	4.05
Addition of Visual to Simulator	4.50
------Areas of Training------	
Take-off and Departure	3.96
Approach and Landing	3.95
Situational Awareness/EP	4.0
Air-to-Air Training	3.13
Air-to-Surface Training	3.75

* Scale: 1 to 5 (1=poor, 5=excellent)

3.2.1.2.2.2. Phase III (IP Questionnaire) The calculated mean of the value IPs indicated for the use of a visual system for training was 9.0 (scale of 1-10). This takes into consideration perceived training benefit and ease/difficulty to use. This indicates an increase in IP opinion of the visual system. After being able to use the OFT for training, IPs indicated a higher acceptance of the visual system and identified additional areas where OFT training could be enhanced (see objective 8).

3.2.2. Overall Assessment of Pilot Acceptance. Pilot acceptance of the visual system was extremely high. While the opinion of the IPs was acceptable at the onset of the evaluation, by the end of the evaluation period their acceptance was very high. Discussions with IPs and students further support the collected data on acceptance of the visual system and an increased training effectiveness for the simulator sorties. The comment by several students to add a simulator mission to the syllabus is very unusual and exemplifies the acceptance of a visually oriented OFT.

3.3 VISUAL SYSTEM HARDWARE/SOFTWARE ASSESSMENT

3.3.1. Objective 7. Evaluate the capability of the data base to support RTU training.

3.3.1.1. Measures. An interactive process of feedback from pilots and programmers provided the initial visual data bases. The first data base consisted of preliminary versions of Luke airfield and Range 4. Visual-related comments were gathered throughout the evaluation phase for future reference.

3.3.1.1 Results and Discussion

3.3.1.1.1. Phase I. During the beginning of the evaluation instructor pilots and TX course students assessed the adequacy of the visual data base content (01 Aug -- 10 Nov 86). Recommended refinements are listed in Table 3-8. These refinements were implemented on the system within a two-week period.

Table 3-8
Visual Data Base Refinements

PROBLEM AREA	SUGGESTION
Luke Runways	Adjust Scene Sizes
Air-to-Surface Range	Add Hat Mtn, Pop-up pt Night Flare Pots
Low Level Route	Add Real Offsets
Air-to-Air	Increase Target Range
Luke Airfield Area	Add Caterpillar Parking Lot, Add Section Lines

3.3.1.1.2. Phase II. During student evaluations it became apparent that additional enhancements would increase training effectiveness. This data base revision resulted in a significant increase in positive ratings for the air-to-air sortie tasks (See Table 3-9). This was due to an increased identification range and a flashing beacon positioned on air-to-air targets. Air-to-surface tasks were enhanced by better weapons effects and a complete modeling of the range area. Conversion tasks were adequately modeled in the initial data base and were minimally affected by the data base revision. This indicates a need to have adequate data bases, regardless of the visual system capabilities. Data bases must be continually evaluated for currency and adequacy.

Table 3-9
Task Comparison Assessment
(Acceptance Before/After Data Base Enhancements)

Task Area	Before		After	
	%	No.	%	No.
Air-to-Air Tasks	65%	(92/142)	91%	(308/338)
Air-to-Surface Tasks	83%	(85/103)	85%	(211/247)
Conversion Tasks	95%	(95/100)	94%	(302/320)

3.3.2. Availability of Scheduled Training Hours. The availability of the visual system for training was very high. This indicates Singer-Link was able to maintain the visual system and that simulator missions did not have to be altered due to a lack of visual scene. Table 3-10 shows monthly availability rates for the Image IIIT visual system during the evaluation period.

Table 3-10
IMAGE IIIT Availability Rates

MONTH	AVAILABILITY RATE
July	100%
August	100%
September	91%
October	97%
November	99.4%
December	94%
January	100%
February	100%

Average for 8-month period: 97.7%

3.4 ADDITIONAL OBSERVATIONS

3.4.1. Objective 8. Identify additional tasks that could be trained on a simulator with a visual system that are not currently included in simulator sorties.

3.4.1.1. Criterion. IPs were asked to recommend additional tasks to the student syllabus. These recommendations will be used to revise current syllabi and in the development of a new B Course syllabi. The additional tasks came from the IP questionnaire (Phase III) administered at the end of the evaluation.

3.4.1.2. Results and Discussion. Table 3-11 shows the additional tasks suggested by IPs. The general responses tend to fall into three categories: (a) Emergency procedures, (b) Aircraft restricted tasks, and (c) Night and weather operations. These categories are three areas ideally suited for simulator training and further enhanced with the addition of a visual system. The addition of these and other tasks that are suitable for the limited FOV simulator would allow more effective use of aircraft flight time to develop skills that can only be trained in actual flying.

Table 3-11
Additional Tasks Recommended for the Simulator

ADDITIONAL TASKS	%	No. responding
Low Approach	20%	(3/15)
Vertical Conversions (Night)	15%	(2/15)
Horizontal Conversions (Night)	15%	(2/15)
Tanker Boom For AAR/NAAR	25%	(4/15)
Engine Failure Low Altitude	30%	(5/15)
Tactical Intercepts (Weather)	10%	(1/15)
Moving Target Attacks	40%	(6/15)
Tactical Range Events	10%	(1/15)
Low Level Flight	20%	(3/15)
Simulated Flame Out	30%	(5/15)
None	50%	(8/15)

* % -percentage of those responding
* No.-number responded/total number responded

The main constraint of assigning additional air-to-air tasks is that any limited FOV simulator is limited only to those tasks that can be performed in the forward hemisphere. The student can still gain benefits from a limited FOV simulator for air-to-air tasks in emergency operations, weather tasks, and familiarization with procedures. Other benefits are produced from practicing tasks that are rarely performed due to operational constraints or weather, such as low-level procedures and weather tactical intercepts.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS.

4.1.1. F-16 simulator training on an OFT in an RTU environment is substantially enhanced by the addition of a limited FOV visual system. In an RTU the OFT mission is to familiarize and practice tasks that students have the most difficulty in learning or have safety-of-flight implications. The addition of the visual system enhances the simulator sortie to provide the student with a realistic training environment and visual confirmation of the task.

4.1.2. A limited FOV visual system increases pilot acceptance of simulator training and provides a positive impact on training.

4.1.3. The task analysis and recommended additional tasks provided a basis to develop simulator missions for B Course students to begin training later in the year. This will allow for more productive use of simulator time and flying sorties.

4.1.4. Comments concerning the data base characteristics and training effectiveness illustrated the importance of accurate and appropriate visual cues.

4.1.5. The evaluation process indicated visual data bases can be updated in a timely manner to meet current training needs and objectives and increase training effectiveness.

4.1.6. The visual system reliability indicated it can successfully support a normal training schedule without a decrease in training.

4.2. RECOMMENDATIONS.

4.2.1. To enhance the training of the OFT in an RTU environment a limited FOV system with at least the same capability of the evaluated system should be purchased or retained for long-term use.

4.2.2. Simulator missions developed for the B Course should be evaluated for training effectiveness. The B Course should benefit more with the use of a visual system than advanced (CX/TX) students.

Annex A

IOS INSTRUCTION PAGES

IOS Instructor Controls

- o 5 IOS CRT Pages
  - -3 visual system control
  - -2 visual weather effects

- o Iniatial Condition (IC) Sets
  - -runway 3R arming area
  - -runway 3R before takeoff
  - -inbound to Monti
  - -inbound to Range 4
  - -quick access positions
    - -14 mile final
    - -Range 4 initial pass

- o Repeater Monitor
  - -monitor next to IOS
  - -cabinet with HUD repeater will be available soon

ACTUAL CONTROL PAGES

IMAGE IIIT

VISUAL DATABASE

DATABASE SELECTION

01	LUKE	07	SPARE
02	AIR-AIR/AIR-SURFACE	08	SPARE
03	PHOENIX	09	SPARE
04	VALLEY	10	SPARE
05	MIAMI	11	SPARE
06	DFW	12	SPARE

13 AUTOMATIC DATABASE SELECT ON

CURRENT DATABASE LOADED 1

PAGE ADVANCE FOR IMAGE IIIT VISUAL CONTROL

VISUAL CONTROL

01	BLANK VISUAL DISPLAYS	OFF
02	FIELD OF VIEW	DOWN
03	VISUAL AMBIENCE SETTING	3 (0-5)
04	VISUAL TIME OF DAY	5 (0-5)

0 = BLACK NIGHT
1 = NIGHT
2 = TWILIGHT
3 = DAWN/DUSK
4 = DAY
5 = BRIGHT DAY

AIRFIELD LIGHTING

05	APPROACH LIGHTS	INTENSITY	3	(0-5)
06	TAXIWAY LIGHTS	INTENSITY	3	(0-5)
07	BARRETTES	INTENSITY	3	(0-5)
08	RUNWAY LIGHTING	INTENSITY	3	(0-5)
09	ENVIRONMENTAL LIGHTS	INTENSITY	3	(0-5)

PAGE ADVANCE FOR IMAGE IIIT VISUAL TARGET SELECT

VISUAL TARGET SELECT

TARGET NUMBER	VISUAL MODELS	PROFILE
01	1	2
02	1	2
03	1	2
04	2	7
C5	2	7

VALID MODELS
(1) F-16
(2) MIG-23
(3) TANK
(4) TRUCK
(5) KC-10 TANKER

99 EXPRESS KEY SETUP (SCENARIOS)

SCENARIOS	INTERCEPTS
E RADAR TRIAL DEPARTURE	E 180 HCA
F PINCER	F 135 HCA
G BEAM/DRAG	G 90 HCA
H RESET	H 10 HCA

PAGE ADVANCE TWICE FOR IMAGE IIIT VISUAL DATABASE

Annex A - cont

VISUAL WEATHER EFFECTS

01 Canned Weather Sets: 0 (0-5)

0 = Clear, Unlimited Visibility
1 = 800 Ft Ceiling, Visibility Unlimited
2 = 500 Ft Ceiling, Visibility 5 Miles
3 = 300 Ft Ceiling, Visibility 2 Miles
4 = 200 Ft Ceiling, Visibility 2 Miles
5 = Real Bad Day

PAGE ADVANCE FOR IMAGE IIIT VISUAL WEATHER CONTROL

VISUAL WEATHER CONTROL

01	VISIBILITY	49	(0-49 MILES)
02	RVR MIMIMUM	5	(0-5 MILES)
03	RVR VARIATION IN FOG	0	(0-5000 FT)
04	CLOUD TOP	0	(0-65000 FT)
05	CLOUD BOTTOM	0	(0-65000 FT)
06	FOG TOP	0	(0-32000 FT)
07	CLOUD GRANULARITY	0	(0-7)
08	FOG GRANULARITY	0	(0-7)
09	RAGGED CLOUD	OFF	
10	RAIN	OFF	
11	LIGHTNING	OFF	
12	THUNDERSTROM	OFF	

PAGE ADVANCE FOR IMAGE IIIT VISUAL WEATHER EFFECTS

Annex B

DATABASE FEATURES

O CONTINUOUUS TERRAIN (CT) DATABASE
- -LUKE AIRFIELD
- -LOW LEVEL ROUTE VR245
- -CONVENTIONAL RANGE 4

O CORRELATION WITH RADAR SURFACE TARGETS (RSTs)
- -RANGE 4
  - -10 IP POINT
  - -NUCLEAR CIRCLE
- -RSTs AT EACH STEERPOINT OF VR245

O ARRESTMENT CABLES
- -VISUAL CABLE BOXES AT EACH END OF 3R AND 3L
- -INTEGRATED WITH SIMULATOR FOR PROPER HOOK AND OFF RUNWAY CRASH DETECTION

O F-16S VISIBLE UP TO 4 MILES

O VISUAL SCENE CONTENT LIST

Listing of Prioritized Databases

Priority	Feature
1.	Luke Airfield Area - Dual Runways - Approach Lights - VASI Lights - Taxiway/Ramp Area - Large buildings (selected from base map)
2.	Controlled Air-Surface Range - Nuclear Target with Circles - Nuclear run-in line w/ 45IP, 20IP, 10IP - Conventional Target (left and right) - "Bat Wings" - Range Towers - Strafe Target and Run-in - Offset Aim Point (radar targets) - Radar Target (same as visual nuc target)
3.	Low Level Route (VR245) - Radar Altimeter (+-100 ft accuracy) - Contours for Visual Flight - "Fix" points (2) - ACAL points (can be same as fixed points)

4. Air-to-Air
- Horizon Line
- Enemy Fighters (min 4)

5. Effects
- Missile Fly-out
- Gun Tracers
- Weather
  - Clouds
  - Visibility

6. KC-10 Tanker

7. Luke Airfield Area
- Cattle Pens
- Caterpillar
- Gila Bend AFB (Buckeye)
- Aux 1 Runway
- Section Lines

8. Effects
- Weather (night)
- SAMS/AAA
- Bomb Impact/damage

Annex C

SIMULATOR SORTIE BRIEFING GUIDES

Sortie Syllabus Objectives

OPERATIONAL FLIGHT TRAINER (O)

O-1

1:1 Ratio
1.0 Hours

MISSION OBJECTIVES: Practice using the FCR in the following (sub)modes: RWS, spotlight, TWS AUTO, TWS MAN, ULS, VS, AND ERVA. Practice trial departure. Practice looking on in all the above modes. Practice cruise energy management and intercepts against single and multiple targets. Practice the switchology to change from RWS SST to TWS, and from TWS to SST. Practice use of F-16C/D specific avionics. Accomplish a TACAN penetration and approach, or ILS approach. Accomplish other approaches as time permits.

O-2

1:1 Ratio
1.0 Hours

MISSION OBJECTIVES: Practice using the Nuc Rotary to accomplish a Radar LOFT using the CCRP mode. Practice using GM, FTT, GMT, GMTT, EXP, DBS1, DBS2, and freeze radar (sub)modes. Practice moving the cursors and zeroing the cursors. Practice FCR Fix, FCR Mark , and FCR ACAL. Accomplish a TACAN penetration and approach, ILS, or PAR to minimums. Review F-16C/D avionics as time permits.

AIR-TO-AIR BRIEFING GUIDE
CX COURSE

I. OBJECTIVES

1. Trial departure (RADAR) as No. 4 in flight of four
2. Weapons system checks
3. Collision course intercepts
4. Stern conversion from varying intercept geometries
5. Missile and radar mode switchology
6. Missile/Gun Attack and Weapons Parameters
7. Multiple target sorting
8. Electrical system malfunction (medium altitude) or other appropriate emergency situation
9. Simulated minimum fuel (HOME) recovery
10. Instrument approach and landing

II. ADMINISTRATIVE REQUIREMENTS

MISSION TIME: 1.0 HOUR
BRIEF TIME: 0.3 HOUR
DEBRIEF TIME: 0.3 HOUR
PREREQUISITES: AFT-21
IP/P RATIO: 1:1

MISSION PURPOSE: To familiarize the student with air-to-air procedures and techniques for intercepts against single and multiple targets. Additionally to practice instrument procedures and representative emergency procedures.

III. OFT/MISSION PARAMETERS

A. Initial Conditions
1. Iniatize trainer for Luke Training Mission 2.
2. After iniatilizing, load missiles using Weapons Load Page 2 or the DTC (4 AIM-9L/M, GUN-510).
3. Verify that all targets are activated, no JARMs are required.

B. Operational Requirements

1. Radio Frequencies
   a. Squad Comm....................................Ch 9
   b. Luke SOF......................................Ch 4
   c. Ground Control................................Ch 1
   d. Tower...Ch 2
   e. Phoenix D/A...................................Ch 3
   f. ABQ Center....................................Ch 6
   g. Luke GCA......................................Ch18

2. APP Plates Required
   a. Tiron-Gladden Departure.......................Ch12
   b. HI-TACAN Rwy 03R..............................Ch15
   c. HI-ILS Rwy 03R................................Ch16

3. NAV FACs Required
   a. ILS/GCA 03R...................................Ch77

IV. INSTRUCTOR RESPONSIBILITIES (GENERAL)

1. Start the briefing at least 15 minutes prior to the scheduled takeoff time.
2. Brief student on mission objecties and sequence.
3. Answer questions concerning the mission.
4. Conduct Training Mission.
   a. Monitor performance from IOS
   b. Use local radio procedures.
   c. Act as appropriate communications agency and aircraft crewchief.
5. Electrical malfunction or other appropriate emergency
6. Instrument approach and landing

Remember this is a guide. The IP has the authority to modify the lesson content, based on the student's progress and emphases required upon special subjects. Tasks should be repeated if they are not performed well (time permitting).

VI. OFT MISSION BRIEFING GUIDE

1. Ground procedures
2. Radar Trial Departure
3. Weapons System Check
4. Intercepts
   a. Collision Course geometry
   b. Front quarter and beam intercepts
   c. Stern conversions
   d. Performance in all radar modes
   e. Sorting exercise
5. Emergency
6. Approach and landing

CONVENTIONAL SURFACE ATTACK OFT BRIEFING GUIDE
CX COURSE

I. OBJECTIVES

1. Perform SMS Air-to-Surface Programming and DTC Loads.
2. Perform Low Altitude Tactical Navigation (LATN) using (TOS, CARA).
3. Perform Nuclear Deliveries (Radar and Visual).
4. Perform Convential Computed Deliveries.
5. Perform Representative Emergency Procedures.
6. Perform Selective Jettison Procedures.
7. Perform Instrument Approach and Landing.

II. ADMINISTRATIVE REQUIREMENTS

MISSION TIME:	1.0 HOUR
BRIEF TIME:	0.3 HOUR
DEBRIEF TIME:	0.3 HOUR
PREREQUISITES:	
IP/P RATIO:	1:1

MISSION PURPOSE: To familiarize the student with SMS Air-to-Surface procedures, LATN using INS, nuclear and conventional deliveries on a controlled range, representative emergency, and instrument approaches.

III. OFT/MISSION PARAMETERS

A. Initial Conditions
1. Iniatilize trainer for Luke Training Mission 6.
2. No JARMs required.
3. Aircraft on ground, engine running, wing tanks, 1 SUU-20 with 6 MK-106s and 1 SUU-20 with 6 BDU-33s, 20MM.

B. Operational Requirements

1. Radio Frequencies
   a. Squad Comm....................................Ch 9
   b. Luke SOF......................................Ch 4
   c. Ground Control................................Ch 1
   d. Tower...Ch 2
   e. Phoenix D/A...................................Ch 3
   f. ABQ Center....................................Ch 5
   g. GBN Range Ops.................................Ch10
   h. Range 4.......................................Ch14
   i. Luke GCA......................................Ch18

2. APP Plates Required--41-ILS 03R

3. NAV FACs Required
   a. ILS/GCA 03R...................................Ch77

IV. INSTRUCTOR RESPONSIBILITIES (GENERAL)

1. Start briefing at least 15 minutes prior to the scheduled takeoff time.
2. Brief student on mission objectives and sequence.
3. Answr student questions concerning mission.
4. Conduct Training Mission.
   a. Monitor performance from IOS
   b. Use local radio procedures
   c. Act as appropriate communications agency, aircraft crewchief, and Range Control, and Range Officer.
   d. Simulate emergency
5. Complete AFTO Form 369 before departing OFT.
6. Complete OFT grade sheet following debriefing.

V. OFT MISSION BRIEFING GUIDE

This OFT lesson encompasses the following tasks:

1. Perform before takeoff procedures
   a. SMS Air-to-Surface programming
   b. Verify DTC load change as necessary
2. Perform LATN (Initialize to VR-245 Entry Point)
   a. Fly first two legs (to Dam)
   b. Use INS, TOS, CARA, FIX
3. Perform Nuclear Deliveries (Initialize to Range 4 45 IP)
   a. Fix/ACAL Procedures
   b. Nuclear
      (1) Laydown (Visual and Radar)
      (2) LADD (Visual and Radar)
      (3) Loft (Visual only)
4. Perform Conventional Computed Deliveries
   a. 30 Dive Toss (Roll-out to final only)
   b. 20 LALD CCIP (Roll-out to final only)
   c. Low angle strafe (Roll-out to final only)
5. Perform Representative Emergency
6. Perform Selective Jettison
7. Perform penetration and ILS approach with asymmetric stores (initialize to Luke).

Remember this is a guide. The IP has the authority to modify the lesson content, based on the student's progress and emphases required upon special subjects. Tasks should be repeated if they are not performed well (time permitting).

VI. OFT MISSION DEBRIEFING GUIDE

1. Before takeoff procedures
2. Low altitude tactical navigation (LATN)
3. Avionics operations
4. Nuclear
   a. Laydown
   b. LADD
   c. LOFT
5. Conventional
   a. Dive Toss
   b. CCIP
   c. Strafe
6. Emergency
7. Selective Jettison
8. ILS approach with asymmetric stores

Annex D
Sample Phase I Questionaire

Name:_______________ Rank______ Course_________ Date:__________

Please take a moment of your time to aid in the evaluation of this visual system. You're input is greatly appreciated and will be used to determine the implementation of a visual system.

INSTRUCTIONS: Answer questions A-D and use the rating scale to answer questions 1-8. If Not applicable put 0.

1-----1-----1-----1-----1
1 2 3 4 5
poor adequate excellent

A. Number of Rides in Simulator with visual attached? ___________
Mean IPs=3.3 Mean TXs=1.5
B. Number of Rides in Simulator without visual? ___________
Mean IPs=7.1 Mean TXs=1.07
C. Number of hours in F-16? Mean IPs=751 Mean TXs=119 ___________
D. Identify Purpose of Simulator Flight.
(i.e., Orientation,Air to Air,Ep's,etc) ___________________

1) How would you rate the visual presentation. ___________
IPs:5,2.5,3,4,5,3,5,5,5,5,4,5,2,5,5,5,4,4,5,4, Mean= 83/20=4.15
TXs:5,5,5,5,5,5,5,5,5,5,4,5,5, Mean= 64/13=4.92

2) How well did the visual support your ability to fly the simulator. ___________
IPs:4,3,3,4,4,4,4,5,5,5,5,4,3,4,3,5,4,3,5,4, Mean= 81/20=4.05
TXs:5,4,5,5,3,5,5,4,5,4,5,4,5, Mean= 59/13=4.54

FOR SYLLABUS STUDENTS ONLY (QUESTIONS 3-7)

3) How well did the visual support Take-off and Departure Training._______
IPs:3.5,5,4,5,3,3,4,5,3,3,5,4, Mean= 47.5/12=3.96
TXs:4,3,5,5,3,5,5,5,4,3, Mean= 42/10=4.2

4) How well did the visual support Approach and Landing Training._______
IPs:3.5,5,3,5,1,5,4,5,3,5,4, Mean= 43.5/11=3.95
TXs:4,5,5,4,4,5,5,5,5,4, Mean= 46/10=4.6

5) How well did the visual support Situational Awareness and Aircraft Control during Emergency Procedures Training.________
IPs:4,5,5,4,5,3,5,3,2, Mean= 36/9=4.0
TXs:5,3,5,5,3,5,5,4, Mean= 35/8=4.38

6) How well did the visual support Air-to-Air Training.________
IPs:1.5,3,4,4, Mean= 12.5/4=3.13
TXs:3.5,4,5,5,5,5, Mean= 27.5/6=4.58

7) How well did the visual support Air-to-Surface Training.________
IPs:5,4,4,3,4, Mean= 20/5=4.0
TXs:3.5,45,5,5,5,5,5, Mean= 37.5/8=4.69

8) How would you rate the addition of a visual to this system.________
IPs:4,5,5,4,5,3,5,5,5,5,3,5, Mean= 54/12=4.5
TXs:5,5,5,5,3,5,5,5,5,5,5,5, Mean= 58/12=4.83

9) Additional Comments?
TXs: Great Sim, A/C problem on A/S,Radar package needs updating, Keep it, IPs:Good basic work(Inst,EPs) neg for A/A, more visual the better, need more peripheral vision cues,excellent,tremendous training tool,outstandin visual enhance training 100%,Superb IMC--Need it in Europe.

Annex D

Sample Phase II Evaluation

For each "NO" response given for the subtasks of the Air-to-Surface and Air-to-Air sortie, the computer generated program listed the noted deficiency from the lists below.

DID THE VISUAL AID YOU IN THE PERFORMANCE OF TASKS FOR CONVENTIONAL SURFACE ATTACK CX COURSE IN THE SIMULATOR?

SUBTASK Y/N

1. SMS AIR-TO-GROUND PROGRAMMING & DTC LOADS
2. LOW ALT TACTICAL NAV (LATN) USING INS (TOS,CARA)
3. NUCLEAR DELIVERIES (RADAR & VIS)
4. CONVENTIONAL COMPUTED DELIVERIES
5. REPRESENTATIVE EMERGENCY PROCEDURES
6. SELECTIVE JETTISON PROCEDURES
7. INSTRUMENT APPROACH AND LANDING

DID THE VISUAL AID YOU IN THE PERFORMANCE OF TASKS FOR AIR-TO-AIR CX COURSE IN THE SIMULATOR?

SUBTASK Y/N

1. TRIAL DEPARTURE (RADAR) AS NO.4 IN FLIGHT OF FOUR
2. WEAPONS SYSTEM CHECKS
3. COLLISION COURSE INTERCEPTS
4. STERN CONVERSION FROM VARYING INTERCEPT GEOMETRIES
5. MISSILE AND RADAR MODE SWITCHOLOGY
6. MISSILE/GUN ATTACK AND WEAPONS PARAMETERS
7. MULTIPLE TARGET SORTING
8. MAD ALT ELECT SY MALF OR APPROP EMERGENCY SITUATION
9. SIMULATED MINIMUM FUEL (HOME) RECOVERY
10. INSTRUMENT APPROACH AND LANDING

IDENTIFY THE SPECIFIC DEFICIENCY THAT LIMITED TRAINING

A. VISUAL

A1. SCENE CONTENT
  1. NOT ENOUGH OBJECTS PRESENTED IN VISUAL
  2. THE DISPLAY NOT REPRESENTATIVE OF THE REAL WORLD
  3. OTHER

A2. ALTITUDE CUEING
  1. VISUAL DID NOT PROVIDE PROPER CUES TO JUDGE ALT
  2. VISUAL REPRESENTATION DID NOT MATCH ALT
  3. OTHER

A3. DISTANCE CUEING
  1. VISUAL DID NOT PROVIDE PROPER CUES TO JUDGE DIS
  2. VISUAL REPRESENTATION DID NOT MATCH DISTANCE CUES
  3. OTHER

A4. TARGET IDENTIFICATION
1. UNABLE TO IDENTIFY/DETECT TARGET
2. TARGET UNREALISTIC REPRESENTATION
3. RANGE FOR ID TOO LONG
4. RANGE FOR ID TOO SHORT
5. OTHER

A5. FIELD OF VIEW
1. VERTICAL SIZE OF FOV WAS INADEQUATE FOR TASK
2. HORIZONTAL SIZE OF FOV WAS INADEQUATE FOR TASK
3. OTHER

A6. QUALITY OF VISUAL REPRESENTATION
1. VISUAL WAS NOT REPRESENTATIVE OF REAL WORLD WITH RESPECT TO LUMINANCE
2. VISUAL WAS NOT REPRESENTATIVE OF REAL WORLD WITH RESPECT TO CONTRAST.
3. OTHER

A7. OTHER

B. SIMULATOR/AIRCRAFT CORRELATION

B1. RADAR/VISUAL CORRELATION
1. RADAR WAS NOT REPRESENTATIVE OF ACTUAL RADAR
2. IMPROPER RADAR/VISUAL CORRELATION
3. OTHER

B2. INSTRUMENT/AIRCRAFT CORRELATION
1. INSTRUMENTS DID NOT RESPOND LIKE ACTUAL A/C
2. INSTRUMENTS AHEAD OF VISUAL
3. INSTRUMENTS BEHIND VISUAL SYSTEM
4. IMPROPER INSTRUMENT/VISUAL CORRELATION
5. OTHER

B3. VISUAL RESPONSE TO CONTROL INPUT
1. VISUAL RESPONSE SLOWER THAN REAL WORLD
2. VISUAL RESPONSE FASTER THAN REAL WORLD
3. OTHER

B4. AIRCRAFT HANDLING QUALITIES
1. RESPONSE SLOWER THAN REAL WORLD
2. RESPONSE FASTER THAN REAL WORLD
3. OTHER

B5. OTHER

C. SYSTEM MALFUNCTIONS

C1. INSTRUMENTS
1. INSTRUMENTS DID NOT OPERATE PROPERLY
2. OTHER

C2. MULTI-FUNCTION DISPLAY
1. INSTRUMENTS DID NOT OPERATE PROPERLY
2. OTHER

C3. HEADS-UP DISPLAY
1. HEADS-UP DISPLAY DID NOT OPERATE PROPERLY
2. OTHER

C4. OTHER

D. OTHER DEFICIENCIES WHICH LIMITED TASK TRAINING
1. Did not aid or hinder
2. Did not perform task
3. Other

Annex D

Sample Phase III Questionnaire

Instructor Pilot Evaluation

Name and Rank   Date

Organization

Instructions: Please answer the following questions and return the questionnaire to 2Lt Dixon at your convenience. Your answers will provide input that will be useful in determining the effectiveness of the simulator,

1) Do you feel the addition of the visual to the simulator has increased:

a) Student performance in the simulator? if "yes" in what respect.

Emergency Procedures (4/15)
Situational Awareness (3/15)
Instrument Training (6/15)
Weapons Employment (4/15)
Improved Acceptance (5/15)
All Areas (8/15)

b) Student performance on initial sortie following simulator? if "yes" in what respect.

Emergency Procedures (5/15)
Situational Awareness (3/15)
Local Area Procedures (3/15)
Avionics (4/15)
Instruments (5/15)
Weapons Employment (4/15)
Switchology (4/15)
All Areas (6/15)

2) What changes or additions to the simulator would you make to increase the value of training?

Keep Upgraded (4/15)
Upgrade to Block 30 (5/15)
Upgrade Radar (6/15)
More Realistic Trial Departure (4/15)
More Visual Targets (4/15)
Better Close Formation Mock-up (3/15)
Better Manuevering target (2/15)

3) What additional tasks would you suggest be trained in the simulator with the visual attached?

Low Approach (3/15)
Vertical Conversions (night) (2/15)
Horizontal Conversions (night) (2/15)
Tanker Boom for AAR/NAAR (4/15)
Low Level Flight (3/15)
None (8/15)
Engine Failure Low Alt (5/15)
Tactical Intercepts(weather)(1/15)
Moving Target Attacks (6/15)
Tactical Range Events (1/15)
Simulated Flame out(5/15)

4) On a scale of "1" to "10" (10 being highest) how would you rate the value of the F-16C visual simulator.____________

IPs:7.5,10,7,10,9,10,8.5,10,9.5,10,8.5,9,9,9.5,7.5 Mean=135/15=9.0

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