DOCUMENT RESUME

ED 068 829 | 08 | AC 012 956

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TITLE Evaluation of a Trainer for Sensor Operators on Gunship II Aircraft.
INSTITUTION Air Force Human Resources Lab., Wright-Patterson AFB, Ohio.
REPORT NO AFHRL-TR-72-27
PUB DATE Sep 72
NOTE 53p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Equipment Evaluation; *Evaluation; *Flight Training; *Simulators; Trainers

ABSTRACT

This report describes the design, development, and evaluation of a training device intended to enable ground-based practice of equipment operation and target-tracking skills that are required by the Forward-Looking Infrared (FLIR) and Low Light Level TV (LLLTV) sensor operators assigned to Gunship II aircraft. This trainer makes use of a relatively unique approach to tracking training by using video tape which is electronically manipulated so as to allow tracking in both simulated wide and narrow-angle fields of view similar to actual equipment. (The complete description of the video equipment is provided in AFHRL-TR-72-41.) In addition, the trainer incorporates both actual and mockup instruments that enable the trainee to practice equipment operation procedures and malfunction isolation and correction. The evaluation of the training effectiveness of this device showed that sensor operators who received practice on this device reached the desired skill levels for both equipment preflight and target tracking sooner than those who had not received such training. As a result of the demonstrated value of this device, the using organization has incorporated it into their formal training curriculum. (Author/NF)

ED 068829

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EVALUATION OF A TRAINER FOR SENSOR OPERATORS ON GUNSHIP II AIRCRAFT

BERTRAM W. CREAM

TECHNICAL REPORT AFHRL-TR-72-27

SEPTEMBER 1972

Approved for public release; distribution unlimited.

ADVANCED SYSTEMS DIVISION
AIR FORCE HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

AC012956

NOTICE

AIR FORCE/56780/20 October 1972 — 100

AFHRL-TR-72-27

EVALUATION OF A TRAINER FOR SENSOR OPERATORS ON GUNSHIP II AIRCRAFT

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FOREWORD

This report represents a portion of the exploratory development program of the Advanced Systems Division, Air Force Human Resources Laboratory (AFHRL), Wright-Patterson AFB, Ohio. This effort is documented by AFHRL under Project 1710, "Training for Advanced Air Force Systems," Task 171003, "Training Implication of New Military Technology." Dr. Ross L. Morgan is the Project Scientist and Mr. Horace H. Valverde is the Task Scientist.

The author wishes to acknowledge the technical advice and assistance of the following personnel:

Lt Col Henry Lang, Tactical Air Command Headquarters (DOST), Langley AFB, Virginia.

Maj Jerome Meyers, 415th Special Operations Training Squadron, Hurlburt Field, Florida.

Special thanks are due to Dr. Theodore E. Cotterman, Mr. Horace H. Valverde and Mr. Robert J. Roettele of the Advanced Systems Division (AFHRL). These individuals rendered invaluable assistance throughout this project in the design, development, and evaluation of the trainer. In addition, Mr. Ned H. Kearns of Systems Research Laboratory, Dayton, Ohio, provided his extremely useful engineering experience in the design and construction of the electronic apparatus used in this effort.

AFHRL-TR-72-27

This technical report has been reviewed and is approved.

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Director, Advanced Systems Division
Air Force Human Resources Laboratory

ABSTRACT

This report describes the design, development, and evaluation of a training device intended to enable ground-based practice of equipment operation and target-tracking skills that are required by the Forward-Looking Infrared (FLIR) and Low Light Level TV (LLLTV) sensor operators assigned to Gunship II aircraft. This trainer makes use of a relatively unique approach to tracking training by using video tape which is electronically manipulated so as to allow tracking in both simulated wide and narrow-angle fields of view similar to actual equipment. (The complete description of the video equipment is provided in AFHRL-TR-72-41.) In addition, the trainer incorporates both actual and mockup instruments that enable the trainee to practice equipment operation procedures, and malfunction isolation and correction. The evaluation of the training effectiveness of this device showed that sensor operators who received practice on this device reached the desired skill levels for both equipment preflight and target tracking sooner than those who had not received such training. As a result of the demonstrated value of this device, the using organization has incorporated it into their formal training curriculum.

SUMMARY AND CONCLUSIONS

PROBLEM

Two problems prompted this effort. One was the need to provide a device that would allow the learning and practice of the target tracking and equipment operation skills required by the Forward-Looking Infrared (FLIR) and Low Light Level Television (LLLTV) sensor operators assigned to Gunship II type aircraft. The second problem, was a need to acquire additional information pertaining to the characteristics of functional part-task trainers. This information will be applied as appropriate to the design of training devices for future Air Force advanced systems.

APPROACH

Based on information obtained from the instructors at the 415th Special Operations Training Squadron, Hurlbut Field, Florida (the users), and on-site observation of the system operation, the trainer was designed to provide target-tracking and equipment-operation practice. Target-tracking practice was provided by using a video tape source displayed on a cathode-ray tube (CRT). The control of the image was provided by a "joy stick" similar to the actual equipment. This stick had the same dynamic control characteristics as the actual equipment. Equipment operation practice was provided by appropriate working mockups of the equipment located at the appropriate aircraft position. An evaluation of the training value of the device was conducted by analyzing the performance of students who had been trained on the device matched against those who had not received such training. A student and instructor evaluation of the value of the device was also obtained.

RESULTS

The student and instructor evaluation of this device and the data analysis performed on the performance ratings indicate that the trainer performed as designed, in that it allowed the practice of the identified tasks in a ground environment. For target tracking, the group that received the training reached the criterion level in their sixth mission while those who had not received the training were unable to do so until their tenth mission. The experimental group (trained on the device) reached the criterion level for equipment preflight on their seventh mission. The control group (normal training) reached it on mission eight. Both of these differences are statistically significant.

CONCLUSIONS

The trainer has fulfilled its design purposes, since it allows the practice of the identified tasks in a ground environment. This practice has positive transfer to the operational flight requirements evidenced by significantly faster learning of the required tasks by those who have used the trainer when compared with those that have not. In addition, it has provided the opportunity to collect valuable information that can be applied to the development of similar devices for future Air Force systems.

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SECTION I

INTRODUCTION

PURPOSE

This report describes an effort to provide a training device which would enable the Forward-Looking Infrared (FLIR) and Low Light Level Television (LLTV) sensor operators assigned to "Gunship II" type aircraft to learn and practice their tracking and equipment operation tasks in a ground environment. One goal was to design, build, and evaluate a ground-based trainer that would be both economical to build and operate as well as providing positive transfer of training to the operational tasks. Another goal was to acquire additional information pertaining to the characteristics of functional part-task trainers. This information will be applied, as appropriate, to the design of training devices for future advanced systems.

PROBLEM

In the Southeast Asia environment of limited war/counterinsurgency the Gunship squadrons have effectively performed in the role of armed reconnaissance and interdiction. They have been one of the most successful night weapon systems deployed in SEA. The eyes of the Gunship are three primary sensor systems, only two of which are discussed in this report (the FLIR and LLLTV). In coordination with the Fire Control Officer (also aboard the aircraft), the sensor operator must be able to track and identify both fixed and moving targets in a hostile environment.

These tracking and identification tasks require a high degree of manual and perceptual skill. At the request of the using organization, the 415th Special Operations Training Squadron, Hurlburt Field, Florida, and Tactical Air Command Headquarters, Langley AFB, Virginia, the multisensor operator trainer was developed to fill this training requirement and to provide a test bed for the acquisition of information and application of new technology in the design of part-task trainers.

BACKGROUND

Since the introduction of the first Gunship (the AC-47, "Puff the Magic Dragon") in Southeast Asia (Figure 1), the concept of transport-type

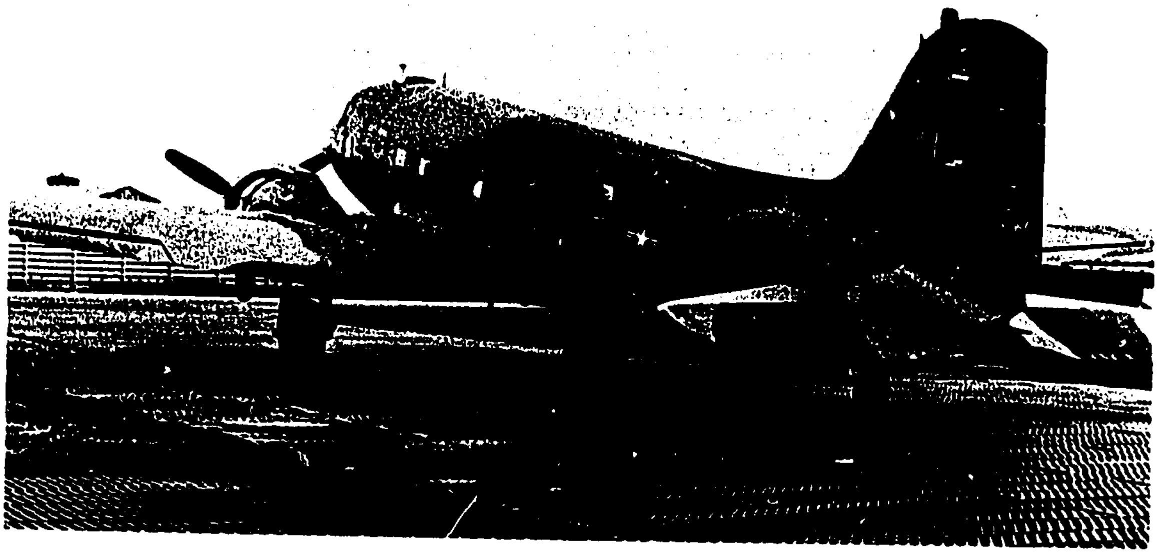

Figure 1. AC-47

aircraft armed with fixed, side-firing guns has proved of great value. The first aircraft of this type (AC-47) were fairly simple in terms of the requirements placed upon crew members. This was due primarily to the absence of sophisticated target acquisition systems. It wasn't until the introduction of the AC-119 (Figure 2) with a Forward-Looking Infrared (FLIR) sensor that a special crew member was designated as solely responsible for its operation. Although the image quality of these early FLIR sensors was poor compared to today's sets, it was apparent that specialized training was necessary. In the early days of this operation, FLIR training was accomplished for new students by a combination of course work and airborne practice. However, because of the unreliable nature

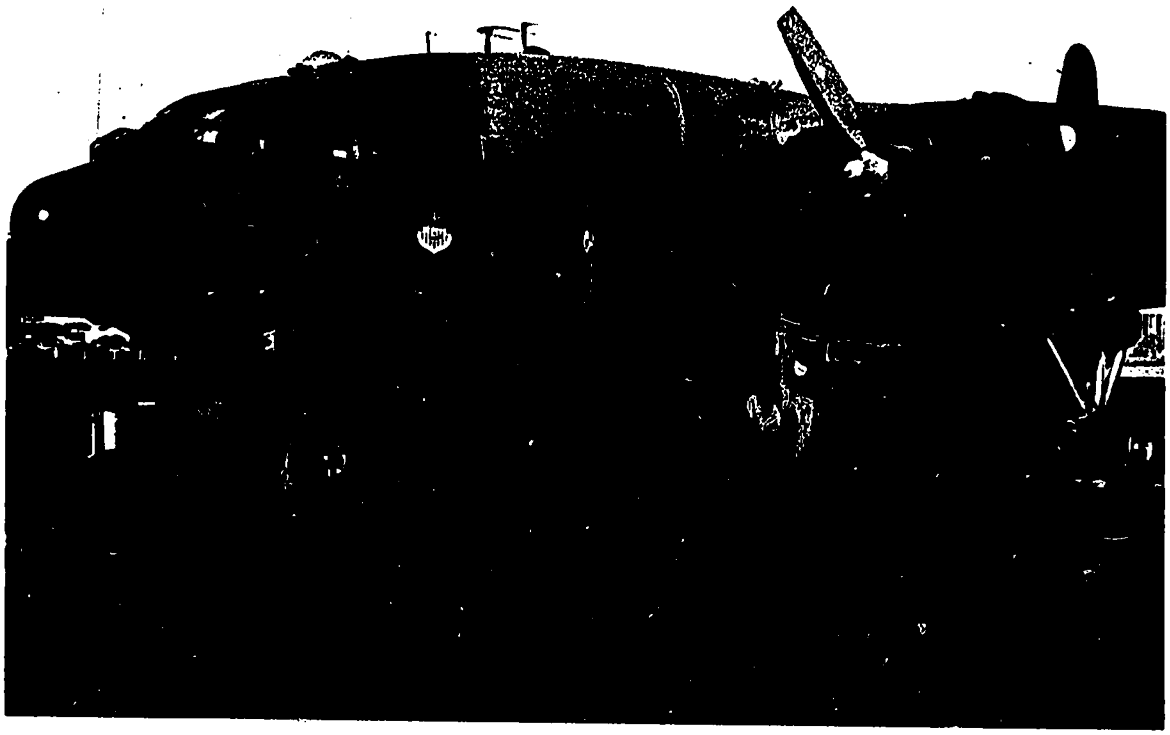

Figure 2. AC-119

of the equipment, small numbers of available aircraft for training and the major differences between the practice terrain and targets compared to those in SEA, the students had to rely upon on-site field training to become proficient. Because of this requirement for on-the-job training (which will always be necessary to some extent), they were not immediately effective when first reaching the combat zone.

As the newer AC-130 Gunships were added to the force (Figure 3), the FLIR sensor was greatly improved and additional sensors were added.

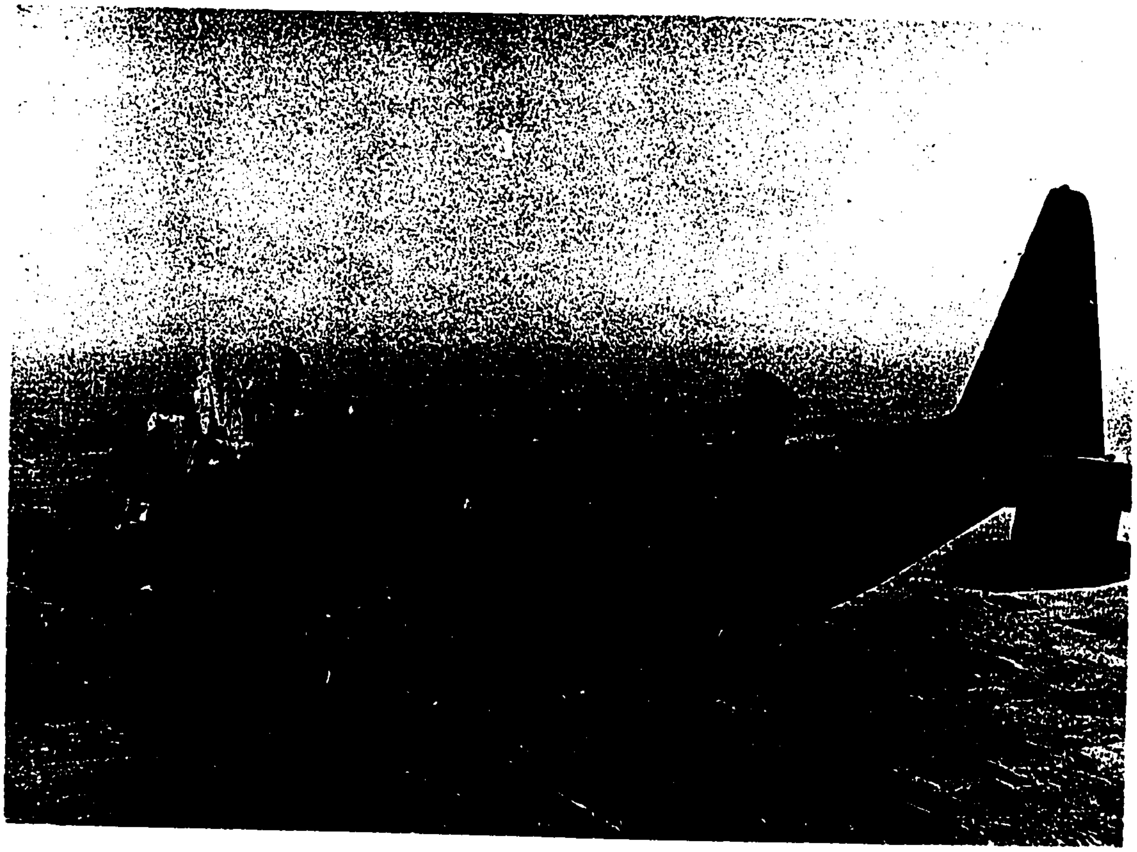

Figure 3. AC-130

One of these was the Low Light Level TV (LLLTV), which can operate with either available light or a slewed light source. The combination of these two sensors coupled to a sophisticated fire control system became a highly effective target destruction system. However, the problem of adequate training for new sensor operators remained. To fill this requirement, various courses and mockups were added to the program with consequent improvement in student preparation. Nevertheless, there remained the need to provide some sort of ground training device to enable the sensor operators to practice their target tracking and equipment operation tasks in a realistic but permissive environment. To fill this need, the sensor operator trainer was designed, constructed, and evaluated.

SECTION II

DESIGN OF THE TRAINER

PRELIMINARY TRAINER CONSIDERATIONS

The multisensor operator trainer was designed to provide a ground-based training device that would provide positive transfer of training for target-tracking and equipment-operation tasks, and in addition, provide additional information pertaining to the characteristics of functional part-task trainers.

It was apparent that because of cost and availability, it would be impractical to use actual infrared or low light level TV equipment in the trainer. Because of this, it was decided to concentrate upon providing faithfully reproduced imagery from these sensors, using technology advances in video signal processing. As in other projects of this type (Reference 8), the emphasis was placed on psychological rather than engineering simulation.

Psychological simulation concentrates on those particular aspects of a task that are both critical to job performance and provide positive transfer of training. Engineering simulation requires a one-to-one duplication of actual equipment and consequently drives the cost of any part-task training device beyond that which can be considered economical. Because psychological simulation places great reliance upon the accurate identification of training objectives, it is necessary to have complete knowledge of the tasks that will be performed in the combat environment. In addition, the trainer should have both appearance and operating

characteristics as close to the actual equipment as necessary to achieve the training objectives. The intention was to provide a useful training device that would fill an actual field requirement; second, to serve as a test-bed for application of new training techniques, and third, to acquire new information about the characteristics of functional part-task trainers that might, in the future, be applied to other advanced systems.

DESCRIPTION OF MULTISENSOR TRAINER

This in-house developed trainer uses an active CRT-type display for image presentation (Figure 4). Video tape provides the image source

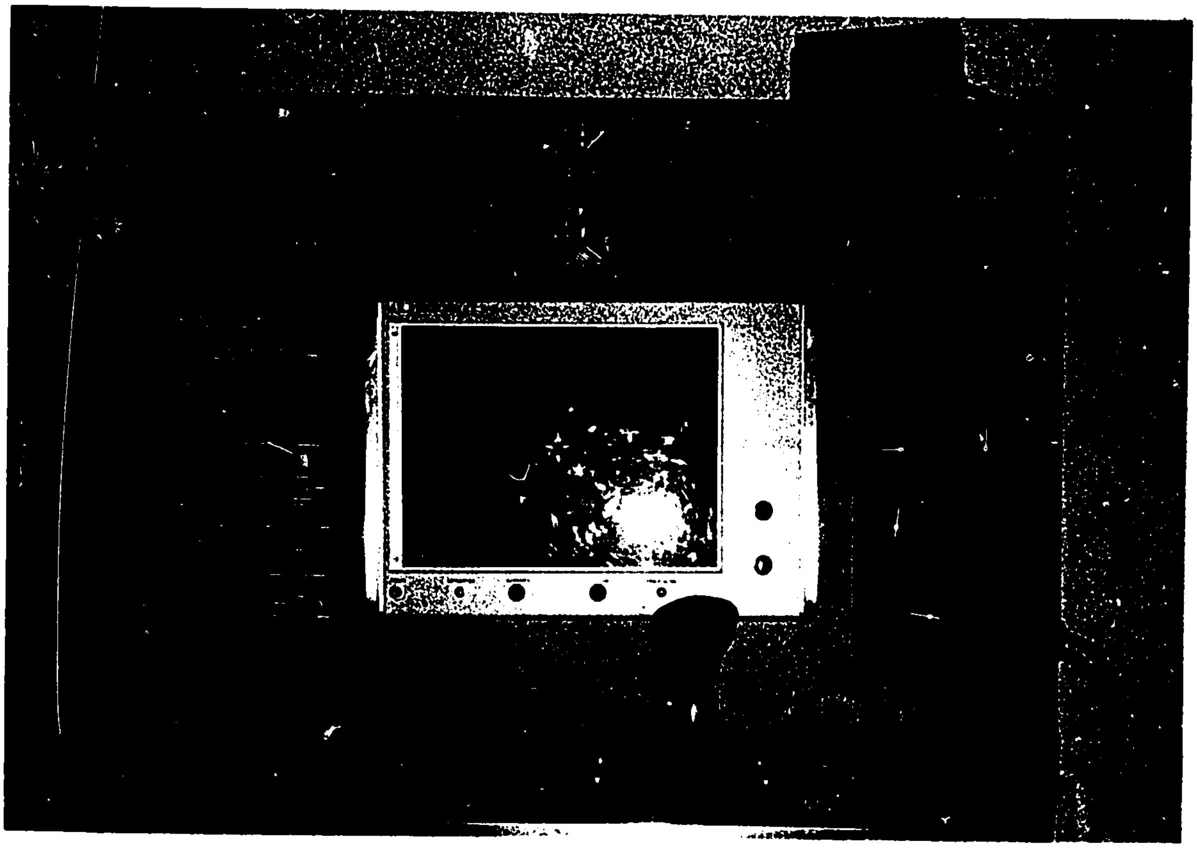

Figure 4. Trainer

and it is relayed through a series of electronic circuits to enable the sensor student to practice tracking. The trainer is also able to expand the imagery in the same scale as that in the actual equipment. (For a full description of the operation of the video distribution system see AFHRL-TR-72-41.) The primary control of the trainer is through the gimbal control and "joy stick" panel (Figure 5).

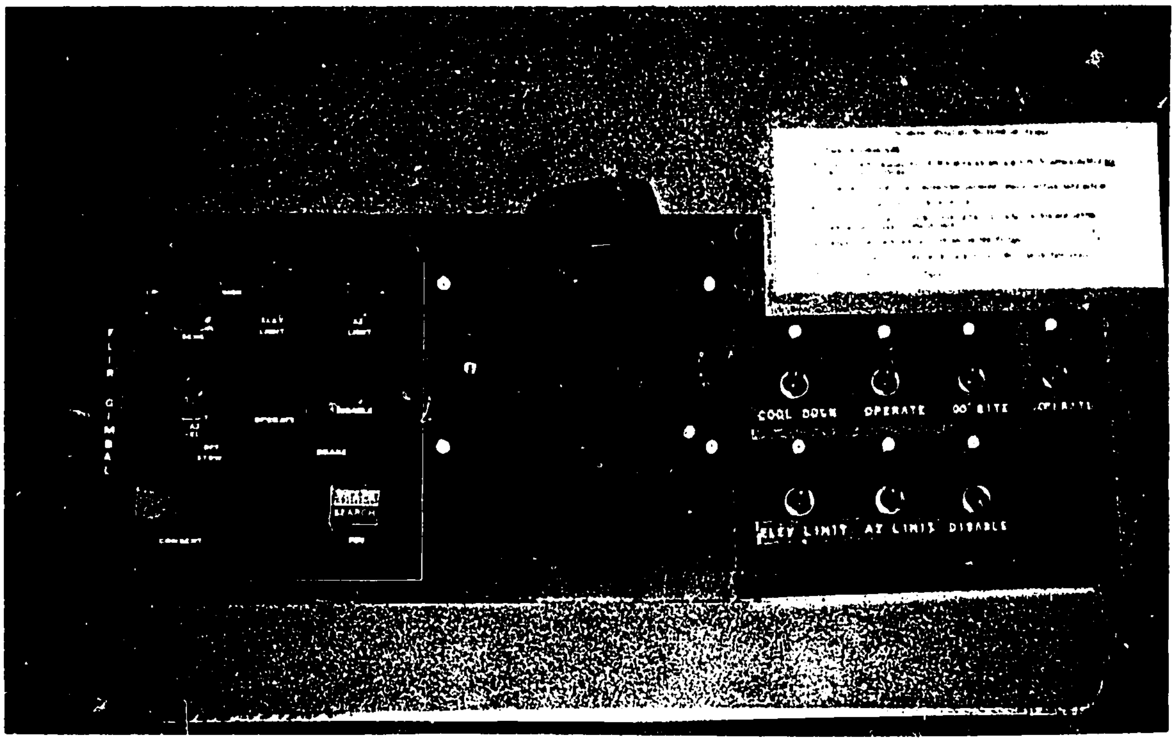

Figure 5. Gimbal Panel, Stick, and Malfunction Control Box

This panel, which is similar to that on the aircraft, incorporates both a drift and sensitivity control as well as other necessary lights and switches. The "joy stick" has a button on top that serves as a slewing control. In the actual equipment, the button slews the sensor

head in both azimuth and elevation to the limits of gimbal travel. In the trainer, this button electronically slews the imagery in both azimuth and elevation in a manner highly similar to the actual equipment.

It is this image-slewing capability that enables the students to practice tracking. Etched on the face of the CRT is a reticle. The task is to identify a potential target in the display imagery and then, by use of the slewing button, center and maintain the target in this reticle regardless of image and target motion. Because the gimbal panel also contains a drift control (which compensates for gimbal drift in azimuth and elevation), the students are able to refine their tracking skills. This is done by using the drift control as the only means of centering and maintaining the target in the reticle.

It was desirable to provide the trainees with actual and simulated accessory equipment panels. First, to familiarize them with approximate locations of the various components, and second, to enable practice of equipment operation. In addition, this allows the instructor to explain operation procedures with visual aids, insert system malfunction indications (Figure 5), and monitor the students' corrective actions. Toward this end, the following associated equipment panels were included:

a. FLIR Control Panel (Figure 6). This panel, along with the gimbal panel, controls the operation of the FLIR sensor. It includes an operating search/track switch, which controls the field-of-view of the sensor optics. In addition, panel lights and press-to-test lights operate. (In this, as in all other panels, the press-to-test lights can be selectively controlled by the instructor to serve as indications of system malfunctions.)

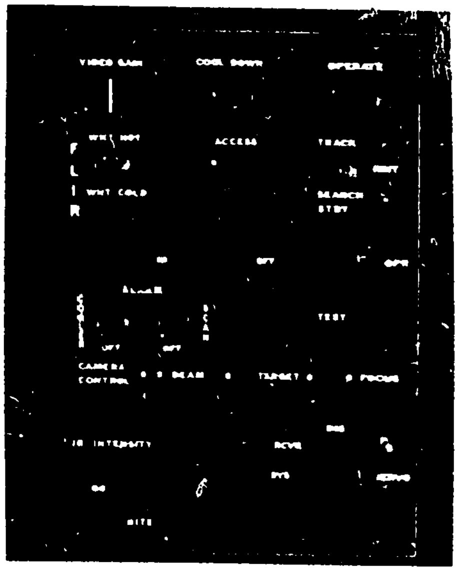

Figure 6. FLIR Panel

b. The Sensor Angle Display Panel (Figure 7). This panel is a working mockup. Its purpose is to indicate to the sensor operator the position of his sensor head in relation to the other sensors. This is done by switch position. These relative angles are displayed in azimuth and elevation. On the trainer, the indicator needles may be positioned by the instructor to provide graphic demonstration of the panel's operation. In addition, it may be used to present problems to the students when discussing firing geometry and target/sensor orientation.

c. In keeping with the distinction previously made between engineering simulation and psychological simulation, the 28 VDC Circuit Breaker panel and Control Switch Unit panel (Figure 7) are represented by engraved plastic panels. Although neither operates, both are useful in providing the students the opportunity to see their placement and to learn their function in relation to the other equipment at the station (Figure 7).

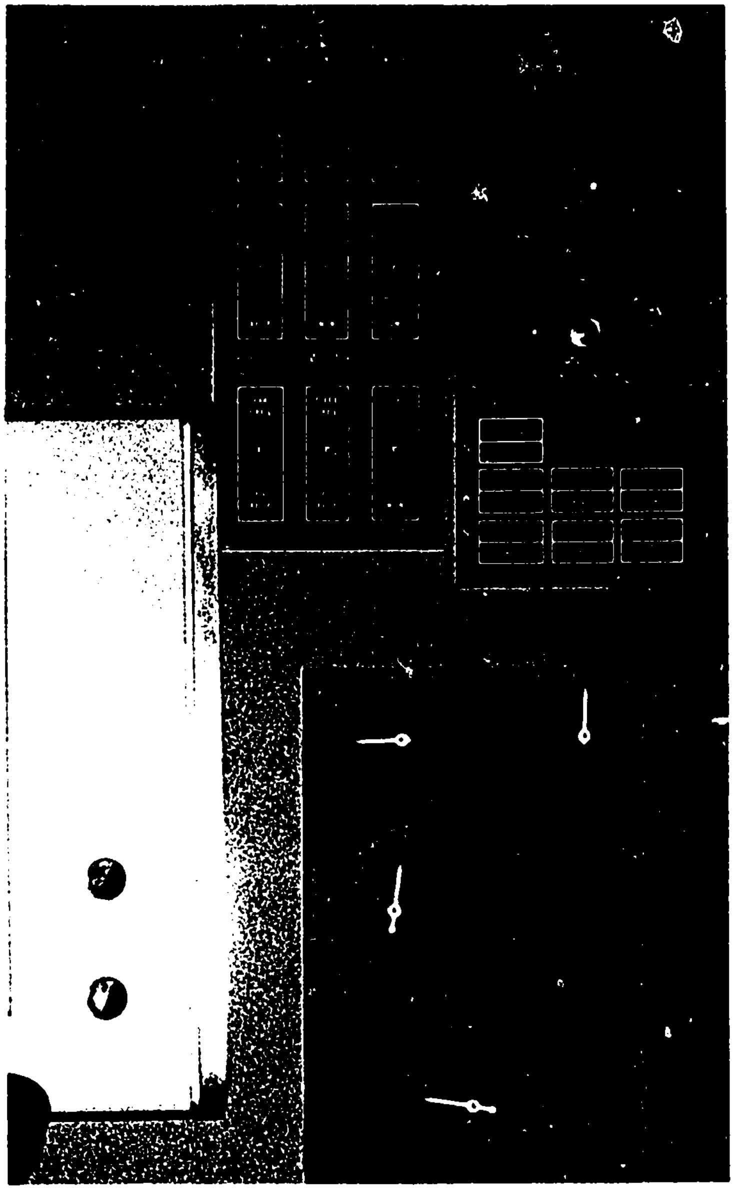

Figure 7. Sensor Angle Display, 28 VDC Panel, Control Switch Panel, Image Recenter Button

d. One addition that was made which is not part of the actual equipment is the image recenter button (Figure 7). Due to the type of display used, it is possible for a student who has maximum gain set on the drift control to actually slew the image so that it leaves the visible portion of the CRT. If this occurs, and if he cannot readily recenter the image, a push on this button will do the recentering for him, thereby saving wasted time on this task.

e. The same rationale used in c. above was continued for the representation of the aircraft instruments located at the FLIR position. In this case, actual-size photographs were mounted in fixed positions (an error we discovered was that the airspeed indicator reads to a maximum of 650K, a speed far beyond the capability of an AC-130 except in unusual circumstances).

f. The Remote Control Unit (RCU) and the Intercom Unit both contain functional panel lights, and follow the rationale of psychological simulation, thereby serving as procedure training devices (Figure 8).

Figure 8. RCU and Intercom Panel

The panels for this trainer were made using three different techniques. The gimbal, FLIR, and RCU panels were photoengraved on adhesive-backed aluminum sheet. The Circuit Breaker, SLADS, and Switch Control units were made of engraved plastic sheets. The Intercom panel was constructed by using press-on lettering over painted plexiglass.

SECTION III

METHOD AND PROCEDURE

INTRODUCTION

To evaluate the device, an experimental methodology was designed that would maximize the control of independent variables, and at the same time cause minimum interruption in the normal training of combat crew members. However, it was necessary to revise these plans, based on operational constraints.

SUBJECTS

Each class assigned to the 415th Special Operations Training Squadron (Hurlburt Field, Florida) for instruction in the AC 130 A/E and AC 119K is composed of six or more crew members. For this study the interest was only in those individuals assigned the duty of FLIR or LLLTV sensor operator on AC 130 A/E aircraft. Each class of students has four to six individuals identified as sensor operators. These individuals, along with the rest of the students in that class, are assigned to two separate crews. This was convenient since the sensor students in one crew were identified as the experimental group and the other crew provided the control. The students themselves represented a wide range of age, experience, and grade. There was commonality, in that all sensor students were rated Navigators and were randomly assigned to crew membership based on the distribution provided by each class population.

PROCEDURE

The treatment of the control and experimental groups was identical (to the extent that training between any two classes is identical), with the exception that the experimental group received training and practice on the device prior to, and during their eleven airborne missions. The control group did not receive training on the device until after their sixth flight. The original plan did not call for any experience on the device by the control group, but the instructors insisted such training be provided to prevent any training deficit on the part of the exempted students. Therefore, the matched sample of experimental and control is maintained for only six of the eleven training missions. The normal crew training includes ground-based instruction followed by the eleven training flights. (Currently, graduating students are assigned directly to Southeast Asia as a crew.)

The introduction to the trainer was provided by the crew sensor instructor. He first went through the formal preflight procedures using the trainer to show switch location and operation. This explanation served to orient students to the position of each separate piece of equipment located at the sensor station. The students asked questions as they occurred and practiced the turn-on procedure. After this introductory phase, the instructor started the display and explained to the students the functions of the slew button by demonstrating its effect on image displacement. The students were then allowed to practice the operation of this control by identifying a target and attempting to center it in the screen reticle by use of the slew button. The instructor monitored this practice and made comments as required. Length of the first session was

about thirty minutes for each sensor student in the crew (experimental). Each succeeding practice session was similar except that the use and purpose of the drift and sensitivity controls were explained and the students' practice then included these and other related items. During each practice session, the instructor inserted simulated equipment malfunctions as he felt appropriate by use of a separate control box. The students were required to remedy these malfunctions. The students were also allowed to practice on the trainer during their free time to refine their skills in areas they felt weak. The students in the control group had no such instruction. Neither were they allowed to practice on the trainer (until after their sixth mission).

The performance of individuals in both groups was rated by the use of TAC Form 88 (Individual Training Mission Grade), which was completed for each student by his instructor after every flight. We were particularly interested in two blocks on the form, target tracking and equipment preflight. The ratings given for these were our performance measures.

The grading criteria definitions used on the TAC form are as follows:

- Unknown - Performance not observed or the element not performed.
- Dangerous - Performance was unsafe.
- Grade 0 - Performance indicates a lack of ability or knowledge. Requires maximum supervision. Additional training is necessary to reach an acceptable standard.

Grade 1 - Performance is safe but indicates limited proficiency. Makes errors of commission or omission which require close supervision. Additional training and practice will be required.

Grade 2 - Performance is essentially correct. Recognizes and corrects errors. Requires normal supervision.

Grade 3 - Performance is correct, efficient, skillful, and without hesitation. Requires minimal supervision.

Grade 4 - Performance reflects an unusually high degree of ability. Further training could not significantly improve his performance.

Each rating for each individual was recorded and the data separated by crews, flight, and group. Analysis of this data is reported in the Results Section.

As part of a subjective evaluation of acceptance by the users of the trainer, a short attitude survey was given to the instructors and students at the completion of the training program (See Appendix).

SECTION IV

RESULTS

The student and instructor evaluation of this device and the data analysis performed on the performance ratings indicate that the trainer performed as designed, in that it allows the practice of equipment operation and target tracking behaviors in a ground environment. The performance rating of 3 was used as the criterion level. The experimental group (based on mean ratings) was able to reach the 3 proficiency level for equipment preflight on its seventh mission, while the control group reached it on mission eight. The task of target tracking showed a greater difference, as evidenced by the fact that the experimental group reached the 3 level on its sixth mission while the control group was unable to do so until its tenth mission (Figures 9 and 10). If we chose to use the performance level of 2 as the criterion, the same relationship between groups exists. For equipment preflight the experimental group reached the 2 level on its second mission, the control on its fourth. For target tracking, the experimental group reached level 2 on its second mission, the control group on its third (Figures 9 and 10). It is felt, however, that the critical skill level is achieved when the performance is accomplished correctly with essentially no supervision. (This would be performance ratings of 3 or 4.) To assess this more meaningful evaluation of performance, the ratings of 1 and 2 were combined to yield a "fail" score and ratings of 3 and 4 for a "pass" score. Using these data, the percent of group membership that achieved a "pass" score for each factor for each mission was computed. As expected the same relationship between control and experimental groups was found (See Figures 11 and 12).

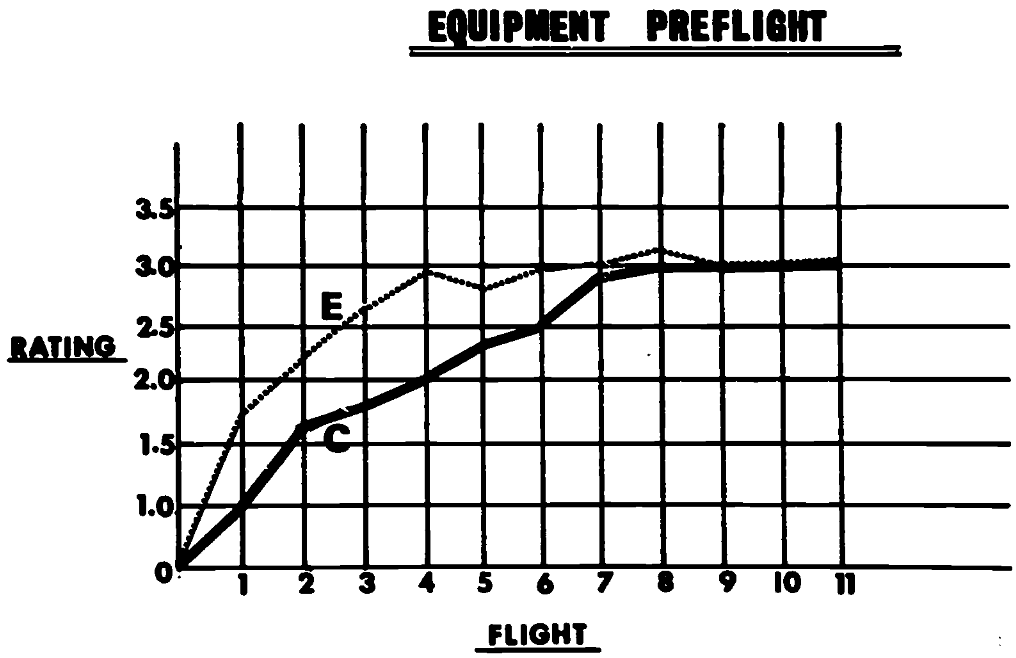

Figure 9. Mean Ratings Equipment Preflight

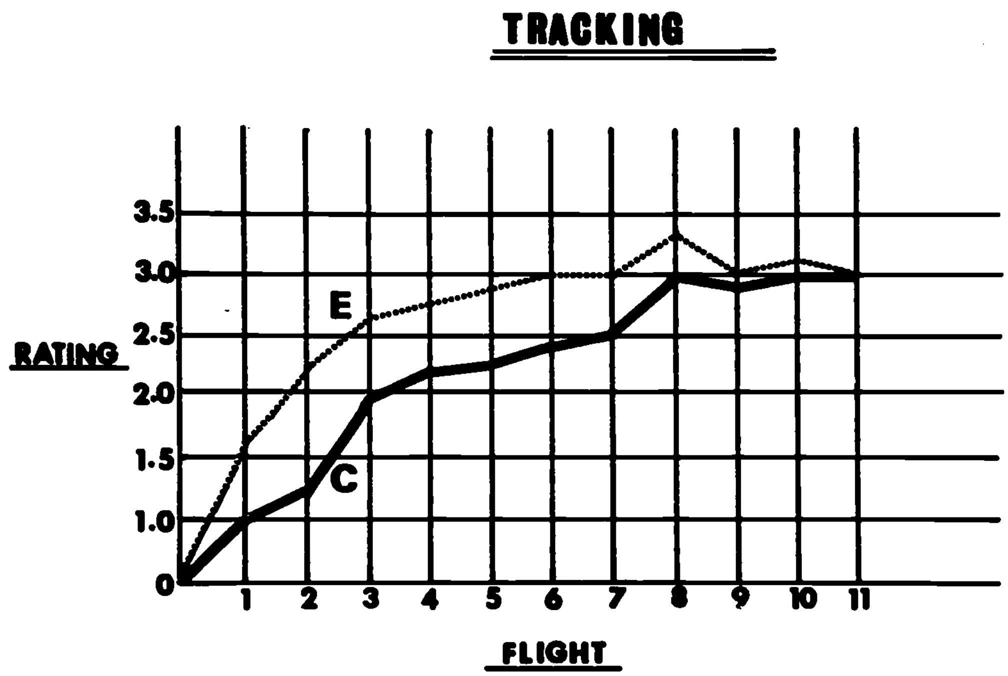

Figure 10. Mean Ratings Target Tracking

EQUIPMENT PREFLIGHT

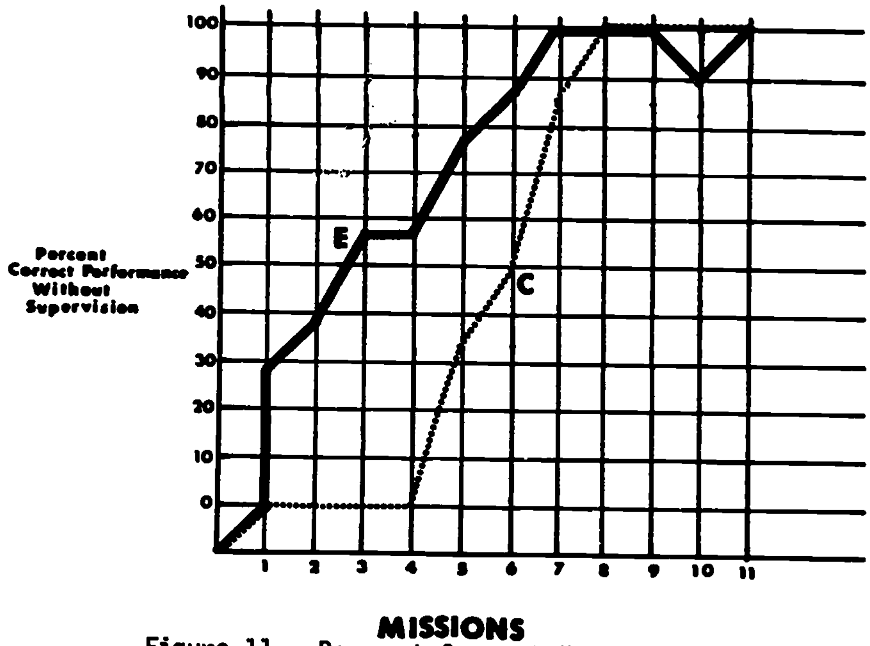

Figure 11. Percent Correct Equipment Preflight

TARGET TRACKING

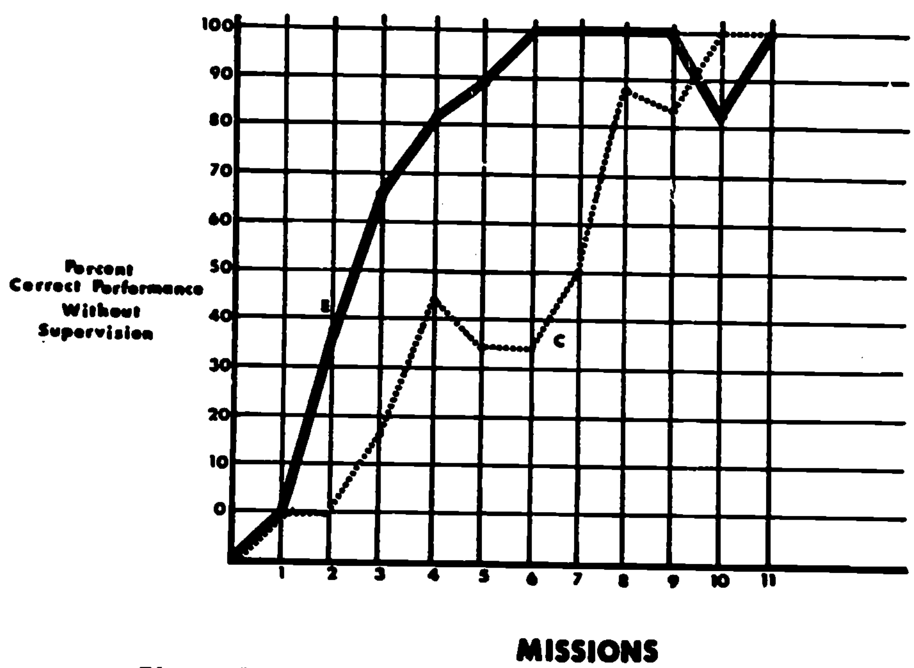

Figure 12. Percent Correct Target Tracking

However, the slopes of the curves are most interesting. The rate of learning is much faster for the experimental than for the control group. It is not surprising that the slope acceleration is greatest during the first six missions. As mentioned previously, the members of the control group were allowed access to the trainer after the sixth mission. The difference between groups on the first six missions for equipment pre-flight and target tracking is significant ($P < .001$) but the difference for missions seven through eleven is not. These significance levels were calculated using the chi-square test (Appendix, Table 4). In addition, from on-site observation of the training and from the comments of the instructors, it is clear that the measured motor skills are acquired early in the training and that further training serves to refine these skills.

In terms of user acceptance, the instructors described the trainer as having either significant or great value and all felt that it had aided student progress. (See Tables 5 through 6 for the survey forms and result.)

If one considers the implications of the evaluation results, it would appear that use of the trainer would make possible the reduction of training flights from eleven to six. In reality this is a misleading interpretation. First, the "Gunship" aircrew is a coordinated team and must perform their duties in unison. Even if the FLIR and LLLTV operators are fully trained during the first seven missions, their presence is required to support the training of the other crew members. Secondly, no attempt was made to measure total performance of the sensor operators,

since the interest focused only on performance variables that might be affected by the training provided by the device. Therefore, not only would it be necessary to provide ground-based training for the rest of the crew but also a structured evaluation of total performance would be necessary before elimination of some number of current training flights is proposed.

From the evaluation and survey it appears that the trainer is performing as designed. It enables the new student to reach his tracking asymptote earlier than was previously possible. Using chi-square, the experimental groups show a significantly greater ability to correctly perform the required tasks than the control groups. In addition to allowing ground-based practice of these two skills, it enables the slower student to receive remedial instruction without the requirement of actual flight. Because it allows the student to reach his required skill level sooner, the remaining flight time may be devoted to the practice of more sophisticated skills, such as image interpretation.

SECTION V

DISCUSSION

The purposes of this project were (1) to provide a ground-based training device that would allow the rehearsal of tasks that previously required actual aircraft flight for practice, and (2) to acquire additional information pertaining to the characteristics of effective functional part-task trainers. This was done in the expectation of applying this information to the design of training devices for future advanced systems. Both of these goals have been achieved. The evaluation of the device gives evidence that it provides positive transfer of training for both target-tracking and equipment-operation tasks. Sensor operators who have received training on the device are able to reach the desired skill-levels significantly sooner than those who have not received this training. Because of this demonstrated value, the 415th Special Operations Training Squadron (Hurlburt Field, Florida) has added the device to its formal training curriculum.

One of the most interesting aspects of this program has been the reaction of the users to the use of part-task trainers for only one segment of the total crew. Initially, the instructors expressed some doubt as to the actual contribution such a device might make. As the program progressed, and it became obvious that the use of the device enabled ground-based practice, the instructors who previously were negative to the project became its strongest supporters. As it turned out, this became a problem because instructors allowed the control group access

to the device after the sixth mission, which consequently made the group comparison invalid after mission six. But more importantly, there was a definite need expressed for similar training for the rest of the crew. This was desired so that the obvious training value of this device could be applied uniformly and the potential of reducing required flight training time realized. Toward this end, TAC Headquarters has established an Instructional System Development team to define the training system for the complete airborne crew.

The idea of combining part-task trainers so that both the individual and crew coordination duties may be practiced is not new. However, this has usually occurred as an afterthought, and great difficulty has usually been encountered as a result of dissimilar engineering of each of the separate units. All of the problems that might be encountered in designing trainers that can be used individually as well as together have not been identified at this date, but the potential of such a trainer(s) is obvious. Using the principle of psychological simulation rather than engineering simulation as the guiding design factor, and basing the capabilities and function on a rigorous task analysis and specified behavioral objectives, it should be possible to provide individual and crew training in the following areas:

1. Equipment location and operation.
2. System functions.
3. Effects of system interaction among crew members.
4. Crew coordination procedures.
5. Emergency and malfunction indications and required actions.
6. Individual and/or crew training.
7. Remedial instruction.

When compared with the usual full mission simulator, this training should be available sooner (in terms of procurement and specifications) and at a lower cost.

One of the problems encountered in the design of most part-task trainers is specifying the correct task difficulty level. As shown by the evaluation, the students who received training practice on the device learned at a faster rate than those who did not. However, a survey showed that the students felt that the training difficulty level was too easy.

Although there are no set rules regarding the exact level of difficulty of a tracking task, maximum and minimum levels can be set on the obvious basis of operator performance. Maximum difficulty should be that which still permits the trainee to perform at some acceptable level. Included in this determination are motivation, measurement, and the "ability of the trainee to gain some insight into the nature of the tracking task and the type of behavior required of him" (Reference 1). The minimum level should require some effort on the part of the trainee to accomplish the task. If he can perform the task correctly from trial one, he will receive little if any value from the training.

Based upon the trainer's use of video tape as the image source, it is possible to vary the difficulty level of the task by varying the tapes themselves. The training squadron using this device already has this capability. Some of the squadron's aircraft are configured so that they can directly record from the on-board sensors. These tapes can then be used on the trainer. In this way the instructors are able to vary

target type, terrain coverage, and general difficulty level of their training media, a flexibility which should provide both tracking and image interpretation training as well as satisfy those who felt the original imagery too "simple." Although the value of the device was confirmed, this additional capability should serve to add to the transfer skills, and thereby enhance tne training worth of the apparatus. In conclusion then, the trainer has fulfilled its design purposes by allowing the practice of equipment operation and target tracking in a ground environment. This practice provides positive transfer to the operational flight requirements as evidenced by significantly faster learning of the required tasks by those who have used the trainer when compared with those that have not. In addition, it has provided the opportunity to collect valuable information that can be applied to the development of devices of this type for future Air Force Systems.

TABLE I

MEANS AND STANDARD DEVIATIONS,

EQUIPMENT PREFLIGHT

Flight	Experimental		Control	
	$\bar{x}$	SD	$\bar{x}$	SD
1	1.71	.9511	1.00	∅
2	2.25	.7071	1.57	.5345
3	2.67	.5000	1.67	.5164
4	2.82	.4045	2.00	∅
5	2.78	.4410	2.33	.5164
6	2.89	.3333	2.50	.5477
7	3.00	∅	2.83	.4052
8	3.20	.4216	3.00	∅
9	3.00	∅	2.83	.4082
10	2.90	.3162	3.00	∅
11	3.00	∅	3.00	∅

TABLE II

MEANS AND STANDARD DEVIATIONS,

TARGET TRACKING

Flight	Experimental		Control	
	$\bar{x}$	SD	$\bar{x}$	SD
1	1.57	.7868	1.00	Ø
2	2.25	.7071	1.43	.5345
3	2.67	.5000	2.00	.6325
4	2.73	.4671	2.13	.8345
5	2.78	.6667	2.17	.7528
6	3.11	.3333	2.33	.5164
7	3.00	Ø	2.50	.5477
8	3.30	.4830	2.83	.4082
9	3.00	Ø	2.83	.4082
10	3.20	.6325	3.00	Ø
11	3.00	Ø	3.00	Ø

TABLE III

PERCENT OF STUDENTS ABLE TO

PERFORM CORRECTLY WITH MINIMAL SUPERVISION

	Target Tracking			Equipment Preflight	
	E %	C %		E %	C %
1	0	0	1	29	0
2	38	0	2	38	0
3	67	17	3	56	0
4	81	43	4	56	0
5	88	33	5	78	33
6	100	33	6	88	50
7	100	50	7	100	83
8	100	88	8	100	100
9	100	83	9	100	100
10	81	100	10	90	100
11	100	100	11	100	100

NOTE: E = Experimental Group

C = Control Group

TABLE IV

CHI-SQUARES FOR EQUIPMENT PREFLIGHT AND TARGET TRACKING MISSIONS ONE THROUGH SIX COMBINED

EQUIPMENT PREFLIGHT

	Fail	Pass	
Experimental	19	34	53
Control	32	5	37
	51	39	90

$$\chi^2 = \frac{9(1\ (19)\ (5) - (34)\ (32)\ 1 - \frac{90}{2})^2}{(53)\ (37)\ (51)\ (39)} = \frac{8088360}{3900429} = HO\chi^2 = 20.737$$

df = 1 $\quad p < .001$

TARGET TRACKING

	Fail	Pass	
Experimental	18	33	51
Control	29	8	37
	47	41	88

$$\chi^2 = \frac{(1\ (18)\ (8) - (29)\ (33)\ 1 - \frac{88}{2})^2}{(51)\ (37)\ (47)\ (41)} = \frac{52039768}{3636249} = HO\chi^2 = 14.31$$

df = 1 $\quad p < .001$

THE X^2 TEST FOR TWO INDEPENDENT SAMPLES

When the data consists of frequencies in discrete categories, the X^2 test may be used to determine the significance of differences between two independent groups.

The hypothesis under this is usually that the two groups differ with respect to some characteristic and therefore with respect to the relative frequency with which group members fall in several categories.

If an observed value of X^2 is equal to or greater than the value given in the appropriate table for a particular level of significance, then the Null hypotehsis (ho) may be rejected at that level.

Formula Used: $df=(r-1)(k-1)$ $X^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij}-E_{ij})^2}{E_{ij}}$

O_{ij} - observed number of cases categorized in the ith row of jth column.

E_{ij} - number of cases expected under ho to be categorized in the ith row of jth column

$\sum_{i=1}^{r} \sum_{j=1}^{k}$ - directs one to sum over all (r) rows and all (k) columns

TABLE V

INSTRUCTOR EVALUATION OF MULTISENSOR TRAINER

	N	%
1. Of what value is the trainer?		
a. Of no value.	∅	∅
b. Some value.	2	16
c. Significant value.	5	42
d. Great value.	5	42
2. This trainer has		
a. hampered student progress.	∅	∅
b. not affected student progress.	∅	∅
c. aided student progress.	6	50
d. greatly aided student progress.	6	50
3. Use of the trainer in time is		
a. too short.	1	1
b. about right.	10	99
c. too long.	∅	∅

4. How much has the trainer helped your students?

a. "There is a definite difference in the initial tracking ability."

b. "Some students are greatly aided by the trainer. Some only need a short time on it."

c. "I have not observed any man-for-man difference. Some students have more of an aptitude for tracking than others. I see it as a significant help for the student who is having problems with basic tracking."

d. "The trainer acquaints the student with the general operation of the sensors before he goes to the aircraft. It is the main and best factor in helping him operate the drift controls. It significantly aids the progress of the student."

e. "The student who has 3 hours of practice and no flight experience can track better in his first flight than the pre-trainer student tracks after 3 flights. Trainer is great!"

f. "I feel the trainer helped the student to become proficient in tracking earlier in training. This allowed him to spend more time learning scope interpretation."

g. "A man who has used the trainer is tracking on II-1 (first flight) as well as a man who has not used it on about II-6 (sixth flight)."

h. "Great on II-1 performance."

i. "It has cut down time to learn tracking greatly."

j. "Very much -- students that have used it have less trouble on the first two missions than the students who did not use it."

5. Could the trainer eliminate any flying training for the sensor operator? Can you foresee replacing some sorties by using trainer time? Be as specific as possible.

a. "I don't feel the trainer will replace any training sorties, but it eliminates the need to waste flying time teaching basic operation of the equipment."

b. "One or two sorties could be cut out as far as physical operation is concerned, but the trainer isn't sophisticated enough for crew coordination."

c. "No" (3 times).

d. "Trainer should be used to complement flight training, not replace it."

e. "The trainer could eliminate about 2 missions, but since the crew trains as an integral unit, this is not possible in the immediate future."

f. "No, I believe under the present conditions the trainer can not replace flight experience."

6. What suggestions do you have to make the trainer more effective?

   a. "Better imagery, good BDA tapes." (2 times)

   b. "Route orientation; wind and gain position determination."

   c. "Additional imagery."

   d. "None" (3 times).

   e. "Use during sensor course will improve student performance on the first part of the flying phase. At least 4-6 hours needed prior to first flight."

7. Should we get more trainers? An EWO trainer?

   a. "I feel we could use an EWO trainer." (4 times).

   b. "Unless we can get a complete simulator, I believe the trainers/simulators/mockups we have are sufficient."

   c. "Presently we do not need more sensor trainers. We could use a trainer for pilots and navigators. It could be used in system malfunction identification and guidance practice."

TABLE VI

STUDENT EVALUATION OF MULTISENSOR TRAINER

	N	%
1. How beneficial do you think this training will be to you as a sensor operator?		
a. Very beneficial.	2	20
b. Helpful.	6	60
c. Of some use.	2	20
d. Little gained from it.	Ø	Ø
e. Benefits gained do not justify its existence.	Ø	Ø
2. How do you feel about taking this training?		
a. It was a waste of my time.	Ø	Ø
b. Sorry I took it.	Ø	Ø
c. Indifferent.	1	10
d. Somewhat glad I took it.	5	50
e. Very glad I took it.	4	40

	N	%
3. How practical was the training for you?		
a. Not practical.	Ø	Ø
b. Should be more practical.	4	44
c. Undecided.	Ø	Ø
d. Quite useful.	4	44
e. Very practical.	1	11
4. How important was this training to the work you expect to do on your next assignment?		
a. Very important.	1	10
b. Quite important.	2	20
c. Of some importance.	4	40
d. Of slight importance.	2	20
e. Of no importance.	1	10
5. How much do you feel you have learned from this training?		
a. A great deal.	Ø	Ø
b. More than average.	5	50
c. About average.	3	30
d. Very little.	2	20
e. Almost nothing.	Ø	Ø

	N	%
6. How interesting was the training?		
a. Very interesting.	Ø	Ø
b. Quite interesting.	5	45
c. Mildly interesting.	5	45
d. Somewhat boring.	1	9
e. Very monotonous.	Ø	Ø
7. How satisfied have you been with this training?		
a. Highly dissatisfied.	Ø	Ø
b. Generally dissatisfied.	1	10
c. Somewhat satisfied - somewhat dissatisfied.	2	20
d. Generally satisfied.	7	70
e. Highly satisfied.	Ø	Ø
8. How do you feel about the difficulty of the content of the training?		
a. Very difficult.	Ø	Ø
b. It gave me some trouble.	1	10
c. Not too difficult - not too easy.	2	20
d. Rather easy material.	7	70
e. Much too simple.	Ø	Ø

9. How do you feel about the length of time spent in the training?

	N	%
a. Much too long.	∅	∅
b. Training time could be shortened.	1	11
c. Present time is just about right.	4	44
d. Would help to add a little more time.	4	44
e. Should have much more instruction.	∅	∅

10. Please write in any other comments you have about the trainer and its utility.

a. "Need more difficult tapes." (Mentioned six times)

b. "I am a believer in this trainer and it should be expanded."

c. "I think this is worthwhile training."

d. "Helpful to Bomb/Nav experienced personnel as tracking control for FLIR and LLLTV is different."

e. "Chief benefit derived from this training was use of gimbal control (drift, sensitivity, etc)."

f. "A definite aid in developing early tracking capability."

g. "This was the only practical application of training received before the first flight."

h. "I think it is worth the time and cost of operation."

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UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Advanced Systems Division Air Force Human Resources Laboratory Wright-Patterson Air Force Base, Ohio 45433	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

EVALUATION OF A TRAINER FOR SENSOR OPERATORS ON GUNSHIP II AIRCRAFT

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Final Report

5. AUTHOR(S) *(First name, middle initial, last name)*

Bertram W. Cream

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
September 1972	40	8

8a. CONTRACT OR GRANT NO. b. PROJECT NO. 1710 c. Task No. 1710-03 d. Work Unit No. 1710-03-032	9a. ORIGINATOR'S REPORT NUMBER(S) AFHRL-TR-72-27 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Advanced Systems Division Air Force Human Resources Laboratory Wright-Patterson Air Force Base, Ohio

13. ABSTRACT

This report describes the design, development and evaluation of a training device intended to enable ground based practice of equipment operation and target tracking skills that are required by the Forward Looking Infrared (FLIR) and Low Light Level TV (LLLTV) sensor operators assigned to Gunship II aircraft. This trainer makes use of a relatively unique approach to tracking training by using video tape which is electronically manipulated so as to allow tracking in both simulated wide and narrow angle fields of views similar to actual equipment. (The complete description of the video equipment is provided in TR-72-41). In addition, the trainer incorporates both actual and mock-up instruments that enable the trainee to practice equipment operation procedures and malfunction isolation and correction. The evaluation of the training effectiveness of this device showed that sensor operators who received practice on this device reached the desired skill levels for both equipment pre-flight and target tracking sooner than those who had not received such training. As a result of the demonstrated value of this device, the using organization has incorporated it into their formal training curriculum.

DD FORM 1 NOV 65 1473

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Gunship Forward Looking Infrared LLLTV Part Task Trainers Tracking Training Training Simulation						

☆U.S.Government Printing Office: 1972 — 759-486/148

UNCLASSIFIED

Security Classification