TACTICAL GROUND ATTACK: ON THE TRANSFER OF TRAINING FROM FLIGHT SIMULATOR TO OPERATIONAL RED FLAG RANGE EXERCISE

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ABSTRACT

A-10 pilots who rehearsed surface attack skills under high threat conditions in a flight simulator survived a significantly higher proportion of total RED FLAG missions than did pilots who did not receive the simulator training. These data support the notion that simulator training may have a significant influence upon aircrew survivability in high density ground threat environments.

INTRODUCTION

While several studies (Kellogg, Prather, and Castore, 1980; Hughes, Engel, and Lidderdale, 1981) have shown that it is possible to obtain significant improvements in both offensive and defensive skills under conditions of moderate to high threat density in a flight simulator, there exist no data to show that this improved performance transfers to the actual aircraft under realistic combat-like conditions. The present study clearly shows that, for the case of the A-10, training in the Advanced Simulator for Pilot Training (ASPT) can produce significant effects upon survivability in the operational environment. Furthermore, given the constraints of the present study, it might be assumed that the potential benefit of such training may be substantial indeed.

METHOD

SUBJECTS. Twenty-five experienced A-10 instructor pilots from Davis-Monthan AFB, AZ, served as subjects. Subjects had an average of over 700 hours in the A-10 and an average of approximately 1500 overall hours in fighter aircraft.

APPARATUS. The study was conducted on the A-10 configuration of the Advanced Simulator for Pilot Training (ASPT) located at the Operations Training Division of the Air Force Human Resources Laboratory, Williams AFB, AZ. Technical references for the device are found in Gum, Albery, and Basinger (1975) and in Rust (1975). Force cuing was provided through use of a g-suit. G-seat and platform motion cuing were not in effect. A monochromatic, computer generated visual scene of a tactical environment was presented via ASPT's seven cathode-ray tubes placed around the cockpit giving the pilot + 110 degrees to -40 degrees vertical cuing and ± 150 degrees of horizontal cuing.

PROCEDURE. *Prior to participating in RED FLAG* 82-2, eleven of the twenty-five pilots were trained in the ASPT. Following a brief familiarization period, during which time pilots gained practice in operating at low level in the A-10 configuration of the ASPT, each pilot received approximately two hours of practice on both close air support and battlefield interdiction missions.

Simulated close air support and battlefield interdiction missions were practiced in a simulated electronic warfare environment (see Figure 1). The threat array approximates that of a typical Soviet air-defense system at the Forward Edge of the Battle Area (FEBA). Field elevation of the environment was 5500 ft MSL. Temperature was modeled as 30 degrees Centigrade. Unlimited ceiling and visibility were in effect.

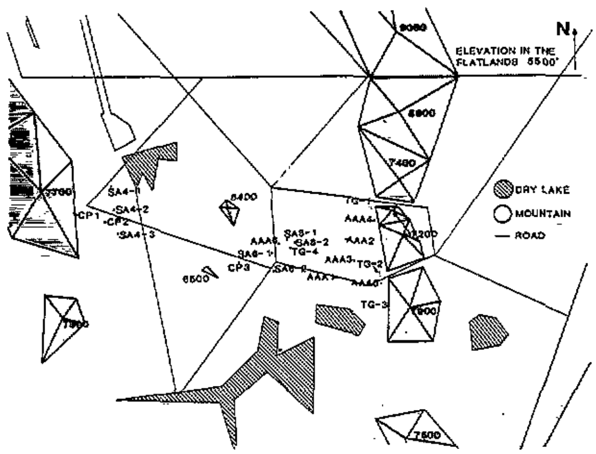

Figure 1. Simulated Hostile Environment

For the close air support (CAS) mission, target arrays in the simulator consisted of three groups of seven tanks each. Tanks were modeled to resemble the size and appearance of T-62s. Targets for the interdiction mission were the two command posts (CPs) located on the *west side of the valley. Each command post* consisted of a group of four vehicles. All elements in both the target and threat arrays were modeled as stationary vehicles/sites. Threat arrays consisted of ZSU-23-4 antiaircraft artillery guns, SA-8, SA-6, and SA-4 surface-to-air missiles. All threats were modeled to operate in an isolated (non-netted) mode and were *modeled as radar controlled.*

Following initialization from a point just outside the northernmost pass leading into the target area, subjects were free to maneuver within the environment and to use whatever tactics they determined to be appropriate. No instruction or direction was provided as to what tactics to use. Prior to entering the environment, each subject was given a verbal "intel" briefing and a map showing the position of suspected threat sites. On each trial, or sortie, the simulated A-10 aircraft was loaded with 1200 rounds of 30mm gun ammunition. A capability to dispense chaff in a manual (as opposed to programmed) mode was provided. Upon the start of each trial, the simulator was reinitialized with the full weapons load described above.

Targets could be "killed" by hits of one or more rounds from the 30 mm gun (simulation of tracers as well as gun sound were provided). When killed, a target would momentarily disappear from the visual scene giving the pilot immediate feedback as to a hit. Although the target reappeared following the brief delay, subsequent hits on the target during a trial were no longer scored. Threat systems responded interactively to the aircraft in terms of the pilot's use of maneuver, direct terrain masking, chaff, etc. A "functional" simulation of a radar warning receiver (RWR) was also present in the simulator cockpit. The RWR symbology differentiated between SAMs and AAA, but did not provide specific symbology for the different types of SAM or AAA. Unclassified simulations of the auditory cues associated with threat status were provided through the pilot's headset. At the time of the study, there was no capability in ASPT for simulating the ALQ-119 electronic countermeasures pod (ECM).

Performance capabilities of the gun and missiles were modeled according to unclassified sources. Independent programs simulated the aerodynamic flyouts of each of the respective missiles. The aircraft was scored as having been killed if the missile passed within 50 ft of the aircraft. A visual image of the missile in flight appeared in the pilot's visual scene. However, no visual launch cues or in-flight smoke trail were associated with missile launches. Muzzle flashes, but no tracers, provided visual cues associated with the activity of the gun threat. In both cases, "kills" by the threat resulted in the immediate termination of the trial. Feedback was given the pilot in each instance as to the conditions of the kill. Terrain crashes also caused a trial to terminate.

Following simulator training in the ASPT, pilots trained in the simulator proceeded to Nellis AFB where they participated in RED FLAG 82-2. Six of these eleven pilots flew the exercise in A-10 aircraft equipped with the ALR-46 Radar Warning Receiver, the ALQ-119 ECM pod, and without a chaff dispensing capability. The remaining five pilots flew A-10 aircraft equipped with the ALR-69 Radar Warning Receiver, the ALQ-119 ECM pod, and <u>with</u> a chaff dispensing capability. Pilots in the non-simulator trained control group were evenly distributed between the two different aircraft configurations. Data from the RED FLAG exercise were collected on a noninterference basis. No changes or alterations to the scheduled range activities, scoring methods, etc., were made for the study.

RESULTS

<u>PRE-RED FLAG SIMULATOR TRAINING.</u> Although both interdiction and close air support were practiced in the simulator, the following data are for close air support only. In terms of survivability, pilots survived approximately 25 percent of the total sorties flown in the one hour of simulated, close air support training. Highly correlated with the percentage of sorties survived was the time each pilot was able to remain in the environment. There were no constraints forcing the pilot to maximize time in the environment. Pilots were free to exit the target area at will. On the average, pilots were able to remain in the environment for between two and three minutes. Since a "trial" was arbitrarily terminated at the end of four minutes, the brief duration of the average sortie indicates that most were terminated either by threat kills or by terrain crashes. Mean time between target kills was approximately 90-seconds with the probability of hitting a target being about 0.50.

Approximately two thirds of all gun engagements occurred at altitudes between 150 and 450 feet AGL at an average range of over 4000 feet from the target. Figure 2 shows aircraft position at the time it was destroyed by a threat in terms of altitude and range to the threat site.

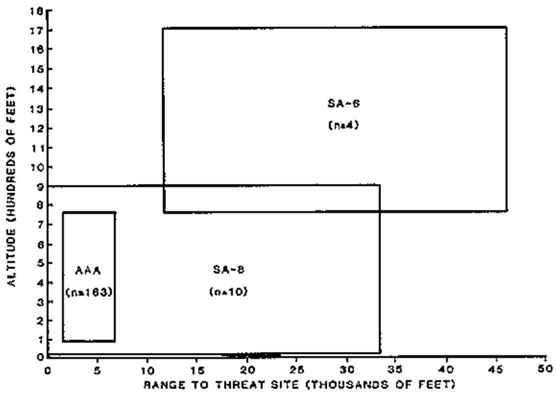

Figure 2. Altitude and Range to Threat Site ($\pm$ 1 s.d.) at Time Aircraft was Destroyed

The figure clearly shows that the majority of all kills were scored by the AAA. The frequency of kills by the AAA in the present simulator study closely matches that observed for the A-10 during the actual EWCAS exercise. The recorded frequency of kills by the SA-8 and SA-6 in the simulator were, on the other hand, low compared to the frequency of Class 1 miss distances recorded for these threats in the actual exercise. This is perhaps due to the 50 ft kill radius employed in the simulator and the 150 ft kill radius used to defined a Class 1 miss in the actual exercise. Figure 3 provides additional data on the bearing of the aircraft to the threat at the time the kill occurred in the simulator. These data clearly show that the aircraft was most often struck from behind.

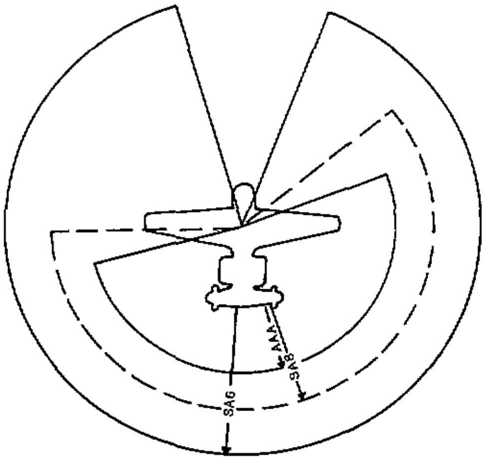

Figure 3. Bearing to Threat (± 1 s.d.) at Time Aircraft was Destroyed

The improvement in performance that characterized one particular pilot over the course of simulator training is shown in Figure 4. The figure shows that following approximately 4-5 trials in the simulator, time in the environment (also significantly correlated with sorties survived) began to show a systematic increase. Figure 4 also shows, for these same trials, a steady decrease in the percent of total time the *aircraft was within the AAA and SAM envelopes.*

Equally as important as those sorties where the aircraft was killed by an air defense threat are those sorties which terminated with terrain crashes. The data in Table 1 show that, aside from the absolute number of crashes that occurred in the simulator, there was a clear increase in crashes as a function of pilot work load. To the extent that a simulator is unable to capture all the potential sources of work load present in the operational environment, these data provide insight into the extent to which the ground, itself, may constitute a significant threat.

EFFECTS OF SIMULATOR TRAINING ON SURVIVABILITY AT RED FLAG. Table 2 shows the percent of total RED FLAG sorties survived as a function of whether or not pilots received simulator training as well as the configuration of the A-10 aircraft flown during the exercise. These data are central to the transfer of training issue for flight simulators. Two clear findings are seen in the data of Table 2. First, those pilots who trained in a simulator configured like that of the aircraft flown during the

CONDITION	NOMINAL VALUE
• FIRING GUN DURING 10-SEC PRIOR TO CRASH	< 1 percent
• *"STRAIGHT-AND-LEVEL" (less than 30° bank: less than 3g's; NO THREATS ACTIVE)*	1 percent
• MANEUVERING (greater than 30° bank; greater than 3g's; NO ACTIVE THREAT)	4 percent
• MANEUVERING/ACTIVE THREAT/S	5 percent
• FIRING/MANEUVERING/ACTIVE THREAT/S	8 percent

CRASHES AS A PERCENTAGE OF TOTAL SORTIES FLOWN = 19 percent

Table 1. Terrain Crash Conditions

AIRCRAFT CONFIGURATION

CONDITION	ALR-46 ALQ-119 *NO CHAFF*	ALR-69 ALQ-119 *CHAFF*	OVERALL MEANS
NO SIM TRAINING	79%	75%	77%
WITH SIM TRAINING	58%	89%	74%
	68%	82%	

Table 2. Percent RED FLAG Sorties Survived as a Function of Aircraft Configuration and Presence/Absence of Simulator Training

subsequent RED FLAG exercise (i.e., ALR-69 and chaff) survived a significantly larger proportion of the total RED FLAG missions flown than did those pilots receiving no simulator training. This represents a clear positive transfer of training effect. The second finding shows equally as clearly that those who trained with the ALR-69 type RWR and chaff in the simulator and who subsequently performed under *combat-like conditions in aircraft not having* these capabilities, performed significantly poorer than their non-simulator trained counterparts. The effect of the ALQ-110 pod upon survivability was not addressed by the present experimental design. While aircraft configuration was not an intended manipulation of this study, it clearly shows the powerful effect of the simulator training upon subsequent operational performance. It also points to the need for training aircrews to operate under worst case, degraded conditions.

PILOT RESPONSES TO QUESTIONNAIRE ITEMS. An extensive questionnaire was completed by pilots following the RED FLAG exercise. A summary of their responses is contained in the following observations.

1. Pilots were uniformly critical of certain aspects of the simulator's visual system, specifically (a) difficulty of acquiring targets at extended ranges, and (b) lack of sufficient cues for flying low level without undue reliance upon cockpit instruments for altitude reference.

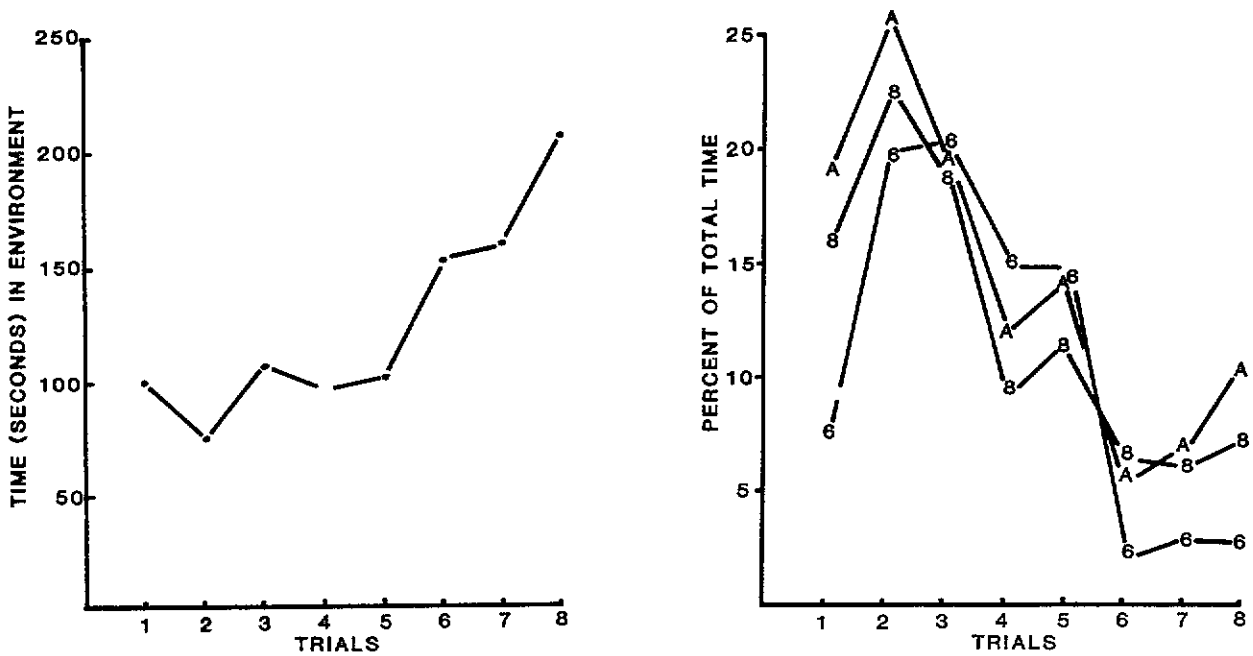

Figure 4. Time in Environment as a Function of Trials (Left Figure)
Percent Time in Threat Envelopes as a Function of Trials (Right Figure)

2. Pilots were in general agreement that the simulated hostile environment contained the critical cues found in the tactical close air support environment.

3. Pilots estimated that this type of simulator training might possibly improve the survivability of the current generation of A-10 pilots (i.e., those with little operational experience and no combat experience) by 20 percent on the average. There was a tendency toward more favorable estimates by those pilots having more overall fighter time and more experience in actual combat or combat-like situations.

CONCLUSIONS

1. These data provide empirical evidence that training under high density ground threat conditions in a flight simulator can improve the survivability of aircrews in a combat-like environment.

2. The fact that positive transfer of training was observed within the constraints of the present study (i.e., no formal training, per se; limited training time in simulator; no control over content or conduct of criterion RED FLAG exercise, etc.) suggests that the real magnitude of this transfer of training effect may be substantial indeed.

3. The occurrence of negative transfer for those simulator-trained crews who flew under no-chaff conditions in RED FLAG strongly indicates the need to train crews for operation under severely degraded or worst case conditions.

4. The unsystematic use of chaff and maneuver and the fact that the majority of all threats struck the aircraft from the rear suggest that serious training deficiencies exist in critical areas of electronic combat training.

5. The high incidence of terrain crashes has serious implications for those concerned with flight safety, especially under combat conditions. The present data suggest that the ground will present a formidable threat under the work load conditions of high threat, low level tactics.

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