U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1604

Training Effectiveness of the AH-64A Combat Mission Simulator for Sustaining Gunnery Skills

David B. Hamilton
Anacapa Sciences, Inc.

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A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

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This research evaluated the effectiveness of the AH-64A Combat Mission Simulator (CMS) for sustaining crew gunnery proficiency. Although the research was originally designed to be conducted over a 12-month period, the time period was shortened to 6 months to overcome problems with crew attrition and to meet project deadlines. Baseline gunnery performance was measured both on the live-fire gunnery range and in the CMS for 30 AH-64A crews from an operational cavalry brigade. Subsequently, the crews were divided into two groups. The control group continued normal unit training but was restricted from gunnery practice in the CMS. Each crew in the simulator group received five scenario-based gunnery training sessions in the CMS and normal unit training but was restricted from live-fire practice in the aircraft. Six months after the baseline measures, crew gunnery performance was again evaluated on the live-fire gunnery range and in the CMS for the 18 crews that remained in the experiment. The results failed to indicate CMS gunnery training effectiveness: Gunnery skill enhancement was not detected in the simulator group's performance and gunnery skill.
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decay was not found in the control group. The failure to demonstrate the training effectiveness of the CMS is probably due to the high initial skill levels of the aviators and the lack of skill decay in the control group over a 6-month period.

Research Report 1604

Training Effectiveness of the AH-64A Combat Mission Simulator for Sustaining Gunnery Skills

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Training Simulation

FOREWORD

This research was performed within the Training Research Laboratory by the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA), Fort Rucker, Alabama, and was sponsored by the Standards in Training Commission (STRAC). The research was conducted in response to two taskings: One from the U.S. Army Aviation Center (USAAVNC) and one from the Department of the Army. It was accomplished as an annex to the Memorandum of Agreement between ARIARDA and the Directorate of Training and Doctrine, dated 15 March 1984.

Over the past two decades, the Army has made a significant investment in rotary-wing aviator training with the development and acquisition of motion-based visual flight simulators. One example of this type of simulator is the AH-64A Combat Mission Simulator (CMS). With the high expense of aircraft operations and the decreased availability of live munitions, AH-64A gunnery training in the CMS has been viewed as a safe, cost-effective alternative to aircraft training.

High-fidelity flight and weapons simulators have been deployed to support aircrew training in operational aviation units. However, little empirical data exist to document the training effectiveness of the simulators. To support the Army deployment of the CMS, a research approach was designed to generate empirical data on the effectiveness of the AH-64A CMS for sustaining gunnery skills. The research was designed to test the effectiveness of simulator gunnery training in live-fire gunnery exercises. This document reports the results of that research.

This report will serve as a source of information about the training effectiveness and capabilities of the AH-64A CMS. Results were briefed to representatives of STRAC in December 1990 and USAAVNC in January 1991. Other briefings to operational personnel were conducted from January through March 1991. The information in this report was used to rewrite the Gunnery Manual TC 1-140 and will be effective for developing simulator training strategies for aerial gunnery.

EDGAR M. JOHNSON
Technical Director

ACKNOWLEDGMENTS

The author wishes to express appreciation to a number of persons for their contributions to this research.

Several individuals from ARIARDA contributed to this project. Charles A. Gainer, Chief, ARIARDA, Fort Rucker, Alabama, served as the Contracting Officer's Technical Representative. Dennis Wightman (Technical Team Leader, Simulation Research Program) and Captain Dale Weiler (Research and Development Coordinator) provided administrative assistance. Joan Blackwell (Research Psychologist) provided advice and participated in the initial research effort of the project. Larry Murdock (Data Processing Manager) was responsible for running the initial statistical analyses.

Members of the Anacapa Sciences, Inc., staff also contributed to this project. Most notably, Catherine R. Kjellsen (Aviation Research Technician) was invaluable in the on-site data collection effort. D. Michael McAnulty consulted on the design, analyses, and presentation of the data.

The leadership and support of Colonel Thomas J. Konitzer (Commander, 6th Cavalry Brigade, Air Combat), made this research project possible. Although they cannot all be acknowledged individually, the author thanks the other unit commanders, operations officers, instructor pilots, and aviators who provided the leadership, coordination, instruction, and participation necessary to complete the research.

TRAINING EFFECTIVENESS OF THE AH-64A COMBAT MISSION SIMULATOR FOR SUSTAINING GUNNERY SKILLS

EXECUTIVE SUMMARY

This report describes the methods and results of an experiment designed to measure the effectiveness of the AH-64A Combat Mission Simulator (CMS) for sustaining gunnery skills in Army aviators. The research was conducted by the U.S. Army Research Institute Aviation Research and Development Activity.

Requirement:

The Army has made a significant investment in the development and acquisition of motion-based, visual flight and weapons simulators for training rotary-wing aviators. Most of the simulators have been deployed to operational units to help reduce the training cost of sustaining flight and gunnery skills in proficient aviators. However, the effectiveness of flight simulators in augmenting unit gunnery training has not been demonstrated. Empirical data are required to demonstrate that flight simulators are effective in sustaining gunnery skills and to determine the extent that simulator training can be used to conserve resources such as aircraft flight time and live ammunition.

The research objectives of this experiment were (a) to determine the effectiveness of the CMS for sustaining crew gunnery skills and (b) to provide information on the optimum combination of aircraft and CMS training for sustaining those skills.

Procedure:

An operational cavalry unit participated in a forward transfer-of-training experiment designed to meet the research objectives. An initial evaluation of AH-64A crew gunnery performance was conducted both during a live-fire exercise and during a CMS test scenario. Subsequently, crews were assigned to one of two groups. The simulator group crews continued normal unit training and received scenario-based CMS gunnery training but were restricted from live-fire training. The control group crews received the normal unit training but were restricted from CMS gunnery training. The training phase of the research, originally scheduled for a year, was shorted to 6 months to meet project schedules and to minimize crew attrition. Crew gunnery performance was measured again during a final live-fire exercise and in the CMS.

Findings:

Analysis of the initial and final performance tests in the CMS showed that after five gunnery training sessions in the CMS performance was consistently but not significantly improved in the experimental group. However, the skill improvement did not transfer to the live-fire range. The simulator group's performance was not significantly better than the control group crew's performance during the final live-fire exercise. In addition, neither group showed any indication of gunnery skill decay over the course of the experiment. Because the results did not demonstrate the effectiveness of the CMS for sustaining gunnery skills over 6 months, no conclusion can be drawn about the optimum combination of CMS and aircraft training.

Utilization of Findings:

The costs of AH-64A gunnery training resources (e.g., flight and range time, ammunition) have increased the Army's dependence on flight simulators for training that was previously accomplished in the aircraft. However, the Army has not had empirical data about the training effectiveness of the CMS for sustaining gunnery skills to determine the optimal utilization of the flight simulator. Although the data are limited by the relatively short experimental period, two recommendations are presented on the basis of the research. First, if aircraft hours and other forms of gunnery training continue at the levels observed in this research, CMS gunnery training may be required only on a semiannual or quarterly basis. If the support for aircraft hours and other gunnery training is reduced, gunnery skills may decay in less than 6 months and additional CMS training will be required to maintain gunnery skills. Second, further research is required to investigate gunnery skill decay in proficient aviators over a 12- to 18-month period.

TRAINING EFFECTIVENESS OF THE AH-64A COMBAT MISSION SIMULATOR FOR SUSTAINING GUNNERY SKILLS

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TRAINING EFFECTIVENESS OF THE AH-64A COMBAT MISSION SIMULATOR FOR SUSTAINING GUNNERY SKILLS

Introduction

During the past two decades, the U.S. Army has committed hundreds of millions of dollars to the development and acquisition of motion-based visual flight simulators to augment helicopter pilot training. The simulator cockpits are constructed from the same components used to build the aircraft and consequently produce high-fidelity simulations of the controls and displays in the aircraft. The hardware environments are supported with powerful mainframe computer systems capable of generating and displaying the results of aircraft, aerodynamic, meteorological, geographic, tactical, and weapons modeling.

Flight simulators are a means of obtaining operational readiness at an acceptable cost. Relatively inexpensive simulator training is used as a cost-effective alternative to more expensive aircraft training. In fact, the primary justification for the Army's Synthetic Flight Training System (SFTS) has been the economy of simulator-for-aircraft substitution (see Hopkins, 1979).

There are at least two other benefits of simulator-based training. One is increased safety. A large number of emergency procedures that are inherently dangerous in the aircraft can be practiced in the simulator (e.g., engine or tail-rotor failures). Aviator proficiency in these procedures translates into saved lives and equipment. Day-to-day aircraft operations are not likely to provide the practice in these maneuvers that simulators can.

The second major benefit of simulators is that scenarios can be created that model the danger and complexity of the modern battlefield. A realistic force-on-force training scenario is difficult (or impossible) to accomplish in the aircraft during peacetime. By necessity, training at Army gunnery ranges arrays a maximum of firepower against only the semblance of a threat and consists of regimented procedures designed to maximize the safety of the participants and the surrounding community. In contrast, Army tacticians foresee the modern battlefield as dynamic and dangerous. With an interactive threat, unlimited ammunition, and unrestricted firing opportunities, flight simulators can potentially train Army aviators to fight and survive in a realistic wartime environment.

The Army has acquired 39 high fidelity flight simulators to support aviator training for the AH-1 Cobra, UH-60 Black Hawk, CH-47 Chinook, and AH-64 Apache aircraft. The majority, including 7 AH-1 Flight and Weapons Simulators (AH1FWSs), 15 UH-60 Flight Simulators (UH60FSs), 5 CH-47 Flight Simulators (CH47FSs), and 5 AH-64A Combat Mission Simulators (CMSs), have been delivered to operational aviation units for unit training. The remainder, consisting of 2 AH1FWSs, 2 UH60FSs, 1 CH47FS, and 1 CMS, are used for institutional training at the U.S. Army Aviation Center (USAAVNC).

With the acquisition of these resources, the Army has committed simulators to accomplish two different types of training: institutional and unit. Institutional training refers to the initial flight and weapon systems training given to Army aviators. Unit training refers to the training given to Army aviators after they have completed institutional training and have been assigned to an operational unit. The primary goal of institutional training is the acquisition of individual skills. In contrast, the primary goal of unit training is the acquisition of crew and team skills and the sustainment of all skills (i.e., individual, crew, and team).

With the acquisition of the simulators, the Army initiated research to address questions about the effectiveness of the rotary wing simulators and about the tasks that can be trained in the simulators. Previous research had demonstrated the value of simulators for the acquisition of basic flight and procedural skills in fixed wing aircraft (see Jacobs, Prince, Hays, & Salas, 1990, and Valverde, 1973, for reviews). However, the number of experiments conducted on rotary wing simulators was small by comparison (Holman, 1979; Bridgers, Bickley, & Maxwell, 1980; Luckey, Bickley, Maxwell, & Cirone, 1982). Unfortunately, the experiments that demonstrated the effectiveness of existing simulators had not also identified the characteristics of the simulators that mediate the effective transfer of skills (Orlansky & String, 1977). Without a clear understanding of the mechanisms of successful skill acquisition in fixed wing simulators, the Army could not assume that the fixed wing results would generalize to rotary wing simulators.

Another theoretical and practical question of concern to the Army is whether skills that can be acquired in the simulator can also be sustained in the simulator. The effectiveness of simulators has not been as thoroughly researched for skill sustainment as for skill acquisition. In the study of skill sustainment, the proficient aviator can be assumed to have learned the environmental stimuli that determine the appropriate actions and reactions in the aircraft. However, once skills are refined in the aircraft, the simulator may not provide the necessary stimuli to maintain the skill. Thus, without specific knowledge about the mechanisms of successful transfer-of-training, questions of the effectiveness of a particular simulator for the acquisition or sustainment of skills must be answered empirically.

Background

The research described in this report was initiated as a result of three administrative events, which are described in the following three sections.

Flight simulation plan audits. Almost all the resources expended by the Army on the SFTS program have been for the development and acquisition of the simulators. The resources devoted to research on how to use the simulators effectively have been small by comparison. Thus, the specific effects that flight simulators are capable of accomplishing in Army aviator training have not been empirically determined.

In two audits of the SFTS, first in 1981 and again in 1984, the Army Audit Agency (AAA) recognized the lack of research documenting the effectiveness of simulators for sustaining helicopter flight and gunnery skills. The AAA reports (U.S. Army Audit Agency, 1982, 1985) stated that, although flight simulators had reduced the training costs and improved training at the USAAVNC, the Army had not determined the effects that flight simulators have on unit training. Specifically, both reports admonished the Army for the operational tests conducted on the SFTS and concluded that the Army had not adequately quantified the return on its investment in flight simulators procured for unit training.

DA tasking. In 1986, the Department of the Army (DA) tasked the Army Research Institute Aviation Research and Development Activity (ARIARDA), through the Training and Doctrine Command (TRADOC), to plan and initiate postfielding training effectiveness analyses (TEAs) of each of the Army's flight simulator systems. The TEAs were intended to investigate the utilization and training effectiveness of Army flight simulator systems in operational field units and to provide a basis for developing effective unit training strategies. In response to the tasking, ARIARDA developed a research plan comprising a series of related research projects (U.S. Army Research Institute Aviation Research and

Development Activity, 1986; Cross & Gainer, 1987). Each project was designed to investigate the effectiveness of a flight simulator system for training a set of specific tasks (e.g., contact and emergency flight tasks, weapons tasks) in an operational environment. Four of the projects have subsequently been completed with the AH1FWS (Kaempf, Cross, & Blackwell, 1989; Kaempf & Blackwell,1990; McAnulty & Kaempf, 1991).

Gunnery manual revisions. Concurrent with the DA tasking, the Department of Tactics and Simulation (DOTS; formerly the Department of Gunnery and Flight Systems) proposed revisions to the helicopter gunnery training manual (FM 1-140; Department of the Army, 1986). FM 1-140 defines the training requirements and performance standards for the Army's aerial gunnery training program. In response to increasing pressure to reduce the requirements for training ammunition, DOTS proposed significant changes to the crew gunnery training requirements and standards for the AH-64A aircraft in the coordinating draft of the revised helicopter gunnery manual (TC 1-140; USAAVNC, 1988). For example, DOTS proposed to conduct all AH-64A crew gunnery training and qualification in the CMS. No ammunition was provided for crew training and qualification; ammunition was provided only for training attack helicopter teams and conducting combined arms live-fire and joint air attack team (JAAT) exercises. While considering the substitution of simulator gunnery training for live-fire gunnery training, DOTS personnel identified a need for information on the effectiveness of the CMS for gunnery training.

Twenty-two months later, DOTS released the approved draft of the helicopter gunnery manual (TC 1-140; USAAVNC, 1990). In this version of TC 1-140, the proposal that all AH-64A crew gunnery be conducted in the CMS was dropped and the available training ammunition was redistributed among the gunnery tables, this time with more for the crew tables and less for the team tables. The document continued to predict that "reductions in service ammunition for training are inevitable" and suggested that unit commanders use the CMS and AH-1 simulator to "help aircrews maintain their proficiency between live-fire exercises and reduce the need to use live ammunition for certain tasks" (p. B-1).

CMS Effectiveness for Sustaining Gunnery Skills

Operational unit commanders are faced with increasing pressure to reduce training ammunition requirements and use the most efficient and effective mix of simulator and aircraft training. There is little empirical data to demonstrate the effectiveness of flight simulators in augmenting unit gunnery training. Empirical data are required to demonstrate that flight simulators can effectively train gunnery skills and to determine the extent that training conducted in simulators can be used to conserve training resources such as aircraft flight time and live ammunition.

This report describes research on the training effectiveness of the AH-64A CMS for sustaining gunnery skills. It is one of a group of projects planned by ARIARDA in response to the DA tasking for TEAs on each of the Army's simulators. In addition, ARIARDA agreed to focus the initial TEAs on the effectiveness of the CMS for training and sustaining crew gunnery skills at the request of the Army Standards in Training Commission (STRAC) and DOTS. Therefore, the research was designed to meet two major objectives:

- determine the effectiveness of the CMS for the sustainment of crew gunnery skills, and
- provide data to establish an optimum combination of aircraft and flight simulator training for the sustainment of crew gunnery skills.

In addition to the objectives described above, STRAC and DOTS requested an evaluation of the ammunition requirements and gunnery standards for AH-64A crew qualification published in the revised helicopter gunnery manual. The research addressing these issues is published in a separate report (Hamilton, 1991).

Design Considerations

The value of any training experience depends upon how effectively training transfers to the operational task. In the case of flight simulators, the amount of aircraft training that can be conserved as a function of simulator training is a direct measure of the training effectiveness of the simulator. The transfer of skills, facts, and attitudes can be positive or negative. Positive transfer occurs when learning simulator skills facilitates the acquisition of aircraft skills. Negative transfer occurs when learning simulator skills interferes with the acquisition of aircraft skills.

The methods for quantifying the transfer of training and training effectiveness of aircraft simulators are well developed and quantitative (Roscoe & Williges, 1980; Roscoe, 1971), especially for skill acquisition. Basically, the method uses a simple ratio to quantify the value of training time in the simulator in terms of the aircraft time saved. At a minimum, some measurable difference must exist between the performance of the experimental and control groups to demonstrate training effectiveness. If the information obtained from training research is sufficiently detailed, the ratio can be calculated for incremental amounts of time in the simulator to describe an entire function called the incremental transfer effectiveness function. The function is described as being negatively decelerated, meaning that the effectiveness of any training experience decreases with exposure to that experience. The hypothetical shape of the function is demonstrated by the curve labeled "training effectiveness" in Figure 1.

The design of research that demonstrates skill sustainment is different from research that demonstrates skill acquisition. The differences are illustrated by the learning curve labeled "skill" in Figure 1, which demonstrates how skills are typically acquired. Initially, with no skill level present, training is highly effective in increasing skill levels. As skill is acquired, increasing amounts of training produce less skill acquisition and, at some point, becomes skill sustainment. Research to quantify skill acquisition assumes that both the experimental and control groups are on the initial, accelerating part of the curve with low skill levels and that training effectiveness can be demonstrated as soon as the simulator is effective in transferring skills to the experimental group.

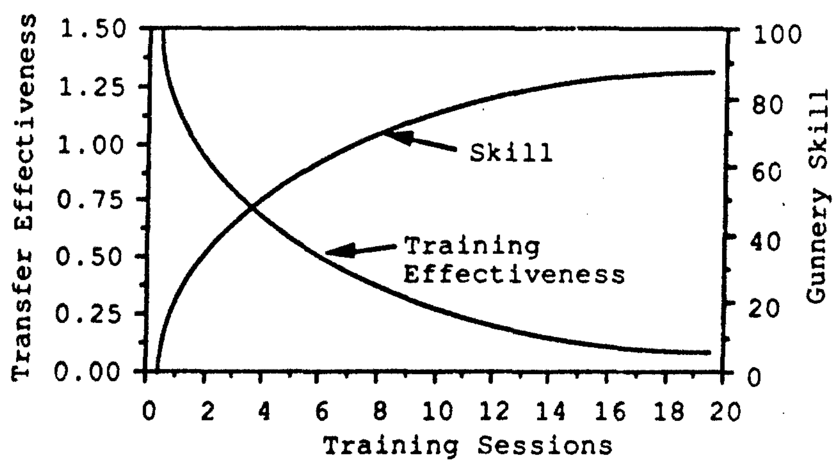

Figure 1. Hypothetical relationships between the acquisition of skill and training effectiveness.

In contrast, research to quantify skill sustainment assumes that both the experimental and control groups are on the asymptotic part of the curve. Training effectiveness is difficult to demonstrate by transferring skills to the experimental group when both groups already have high levels of skill, simply because very little further learning can occur. If skills are sufficiently well developed before the initiation of the research, the only way to bring about the difference in performance needed to demonstrate training effectiveness is to allow the control group's skills to decay. If the simulator is effective in maintaining the experimental group skills while the control group skills decay, then training effectiveness is demonstrated. If the simulator is not effective in sustaining the experimental group skills, they will decay along with the control group.

Thus, the question of how long it takes for AH-64A gunnery skills to decay is critical to the design of this research project. Ruffner and Bickley (1983) and Ruffner, Wick, and Bickley (1984) studied the decay of procedural and psychomotor flight skills in active duty and reserve Army aviators. Ruffner et al. stated that skill decay may have a critical period between 6 and 12 months. Before this period, little proficiency loss is expected; after the period, operationally important loss occurs, followed by a very long period where additional loss is relatively small.

Initial Research Effort

The research described in this report was preceded by an unsuccessful attempt to conduct a CMS TEA project. The initial research design proposed that AH-64A crew gunnery skills be measured during a pretest live-fire gunnery exercise. Subsequently, each crew would be assigned to one of three different training groups: a control group and two experimental groups. All groups would receive the normal program of instruction for the unit. One experimental group would receive CMS gunnery training; the other group would receive dry-fire gunnery training in the aircraft; and the control group would be restricted from gunnery training in either the CMS or in the aircraft. The gunnery training would be controlled in each group for 1 year. At that time, crew gunnery skills would again be evaluated during a posttest live-fire exercise. The effectiveness of the CMS would be evaluated by comparing the differential performance of the three groups between the pretest and posttest exercises.

The research was begun as described above when live-fire performance data were collected on 15 crews. The Army unit participating in the research was unable to assign other crews to the project because of anticipated personnel turnover. Consequently, live-fire data were collected 3 months later for an additional 12 crews. By that time, 4 of the original crews were unable to participate in the research because at least one of the crewmembers was assigned to another unit. At the initiation of the training phase of the research, there were 9 crews in the control group, 8 crews in the aircraft training group, and 6 crews in the simulator training group.

Within 1 month, crew attrition was so high that the research design was reevaluated. Several factors contributed to the attrition of crews. A major storm damaged many of the operational aircraft at the participating installation. Because of the lack of aircraft, some aviators were transferred to other units or types of aircraft. In addition, some crewmembers were transferred to another unit because of a high priority training mission. Finally, crew attrition was exacerbated because the loss of either crewmember constituted the loss of the entire crew. The possibility of conducting the research over the course of an entire year was eventually precluded by the attrition of participating crews. Therefore, an alternative research plan was developed and the current research effort was initiated.

Method

General Procedures

The revised research plan was divided into three phases (see Figure 2). During Phase 1, an initial evaluation of AH-64A crew gunnery performance was conducted during a live-fire exercise and during a CMS test scenario. During the live-fire exercise, the crew fired a set of crew gunnery engagements developed by the participating unit and referred to as Table VIII. During the CMS test, the crews fired against targets designated in a mission scenario developed by the researchers and the unit standardization instructor pilots (SIPs). The primary measures of gunnery performance collected during the live-fire exercises and the CMS test scenario were target effect and engagement time. In addition, the participating aviators completed a demographic survey describing their skill and training at the initiation of the research.

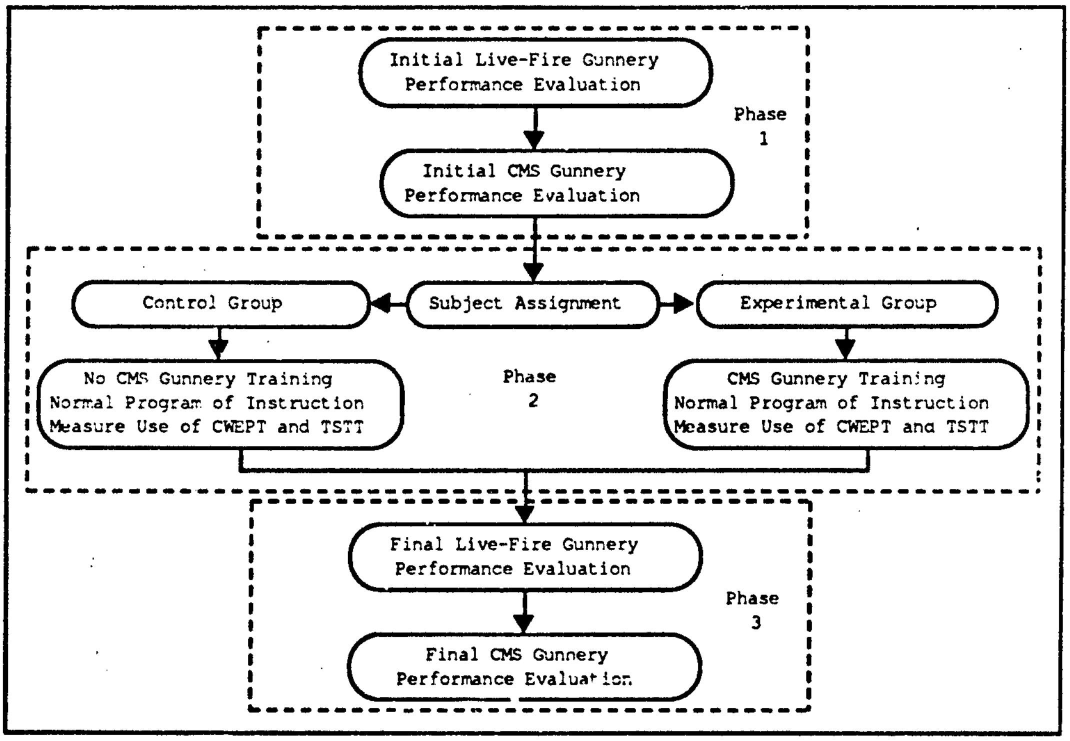

Figure 2. Flow chart of principal phases in the experimental design.

In Phase 2, crews were assigned to one of two groups: an experimental group that received scenario-based gunnery training in the CMS and a control group that was restricted from gunnery training in the CMS. The training phase of the research was shortened to only 6 months to achieve project schedules and to minimize crew attrition. The frequency of other non-CMS gunnery training activities was also recorded during this period.

In Phase 3, crew gunnery performance was measured during a final live-fire exercise and in the CMS. The effectiveness of the CMS was evaluated by measuring the differential performance of the training groups between the pretest and posttest in the CMS and during the live-fire exercises.

Apparatus

Two flight systems (the AH-64A aircraft and the AH-64A CMS) and a scoring system were used during this research. Each of these systems is described in the following sections.

AH-64A aircraft. The AH-64A (see Figure 3) is a twin engine, four-bladed helicopter with a maximum gross weight of 17,650 pounds and an approximate height, width, and length (excluding the rotor system) of 15 ft, 17 ft, and 49 ft, respectively. The two crewmembers, a pilot (PLT) and a copilot/gunner (CPG), are seated in tandem with the PLT behind and above the CPG. The AH-64A is a weapons platform equipped with point target (Hellfire missile), area weapon (30 mm chain gun), and aerial rocket (2.75-inch folding-fin type) systems. The helicopter is equipped with a laser range finder/designator (LRF/D), a pilot night vision system (PNVS), and a CPG target acquisition and designation system (TADS) that allow the crew to operate the helicopter at night and under adverse weather conditions. The AH-64A can acquire and fire on targets in a large number of different operating modes. Additionally, an on-board video recorder subsystem (VRS) can record the imagery and symbology being displayed by either the PNVS or TADS. The operation of the aircraft is described in the Operator's Manual for the AH-64A Helicopter (Department of the Army, 1984).

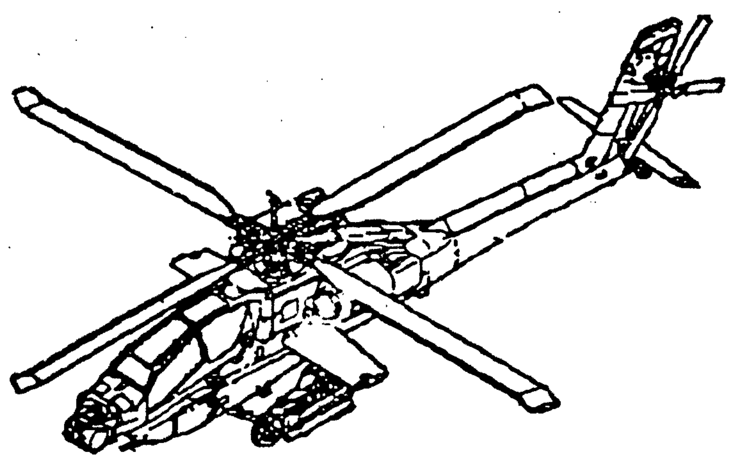

Figure 3. Diagram of the AH-64A aircraft.

AH-64A CMS. The evaluation of the gunnery training effectiveness of the AH-64A CMS was the primary focus of this research. The AH-64A CMS is a flight and weapons simulator designed for training aviators in the use of the AH-64A Apache helicopter. The CMS consists of two flight simulator compartments (PLT and CPG), each having a six-degree-of-freedom motion base. Each compartment simulates the helicopter environment using a multichannel digital image generator, three pairs of loudspeakers, a subwoofer, and a seat vibrator. The simulator is operated in an integrated mode for crew training or in an independent model for individual training. Additionally, each compartment has an instructor/operator (I/O) station and an observer station. The operation and capabilities of the CMS are fully described in the Operator's Manual for the AH-64A (Apache) Combat Mission Simulator (Department of the Army, 1988).

Area Weapons Scoring System. The Army has sponsored the development of a scoring system for attack helicopter live-fire training and evaluation designated the Area Weapons Scoring System (AWSS). The AWSS was used during the initial and final live-fire exercises for objective scoring of AH-64A gunnery performance. Although the Army plans to acquire a number of the systems, the AWSS used in this research was the proof-of-principle system installed on the Dalton-Henson Multipurpose Range Complex at Fort Hood, Texas.

The AWSS consists of the Ballistic Scoring Subsystem (BSS) for 30 mm projectiles, the Detonation Scoring Subsystem (DSS) for rockets, and the Computer Scoring Subsystem (CSS) for score calculation, display, and hard-copy production. The BSS (see Figure 4) uses special purpose, Doppler radar sensors to detect the rounds that penetrate a 15 m radius fan in front of each target. The 30 mm rounds that penetrate the Doppler fan are counted as hits; those outside the fan are counted as misses. No information about the exact location of the hits or misses is provided by the BSS, but AWSS personnel could detect when the target was struck by a burst.

The DSS (see Figure 5) is an acoustical system that determines the geographic location of rocket impacts. It consists of 10 microphone sensors placed within 1000 m of the target. During a rocket engagement, each sensor transmits the acoustical signal that it receives to the CSS. Using the known position of the sensors and the physics of sound propagation, the CSS analyzes the signals from several sensors to compute the impact point, cross range miss distance, and down range miss distance for each rocket. The system reliably determines the location of rocket impacts up to approximately 350 m from the target. Rockets falling

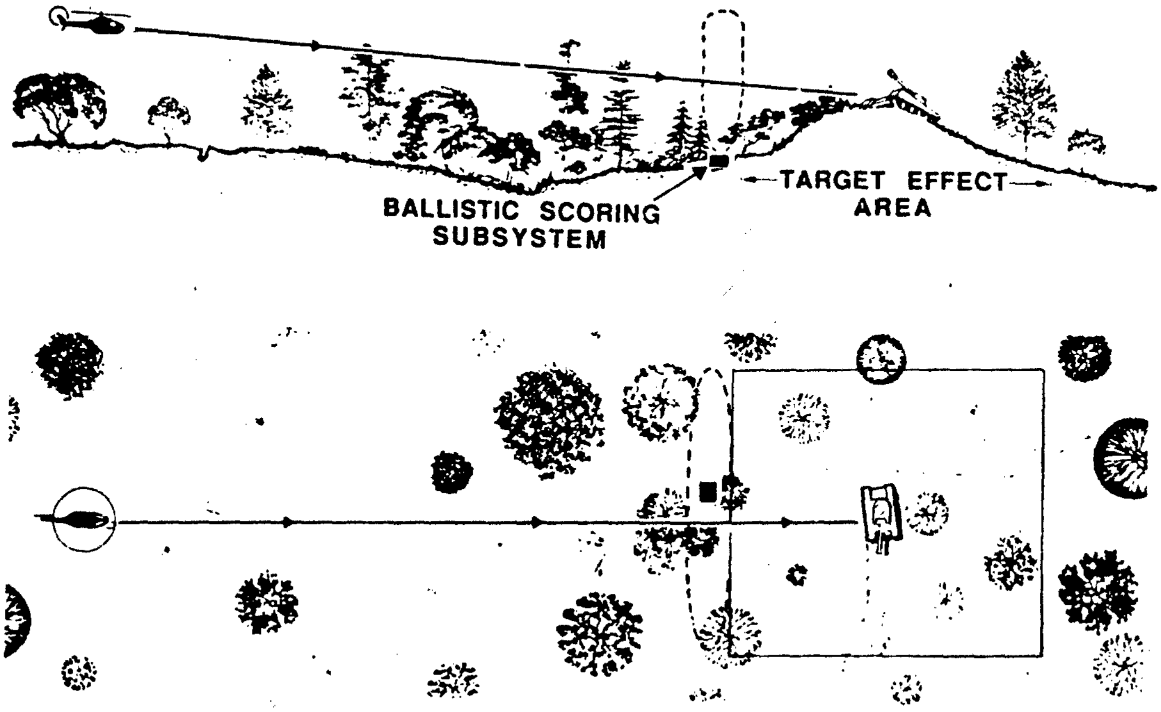

Figure 4. Diagram of the Ballistic Scoring System of the Area Weapons Scoring System.

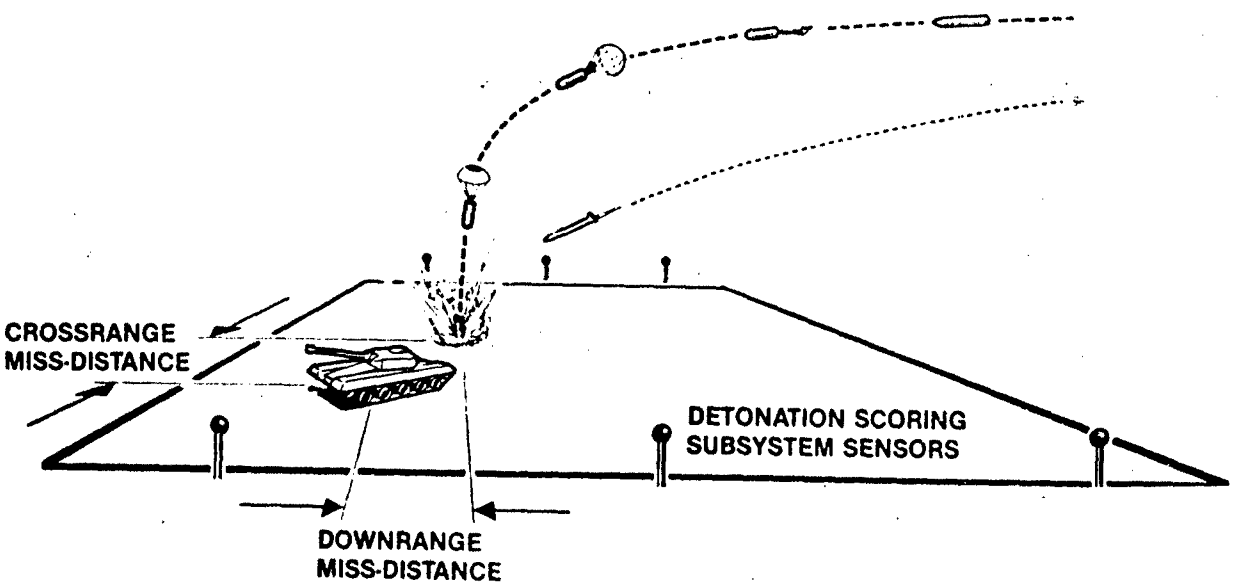

Figure 5. Diagram of the Detonation Scoring System of the Area Weapons Scoring System.

beyond the range of 350 m are not detected or have a large location errors.

The proof-of-principle AWSS had three notable limitations associated with the DSS. First, at the initiation of the project, the system was not reliably scoring Multi-Purpose Submunition (MPSM) rocket engagements. MPSM rockets were not used during the live-fire exercises. Second, the system was not reliably scoring multiple rocket engagements. Third, the acoustically based DSS was susceptible to interference from any other loud events such as the 30 mm gun firing. Because of these limitations, the four rockets that made up each engagement were fired individually with approximately 30 to 60 seconds between launches, and no engagements were fired simultaneously.

Materials

Data forms. Two types of data forms were developed and used to collect information from participating aviators: an AH-64 CMS Gunnery Research Program Demographic Survey and a Postflight Debriefing form. The AH-64 Demographic Survey (see Appendix A) was designed to collect personal, training, flight, and gunnery range experience that was used to characterize the experience of the aviators who participated in the research. As noted in the general procedures, the survey was completed by all aviators during the initial live-fire exercises.

The Postflight Debriefing form (see Appendix B) was designed to collect information about the specific gunnery tasks performed during the training phase of the research. Each aviator was instructed to complete the form after each flight in the AH-64A aircraft, the CMS, or Cockpit, Weapons, and Emergency Procedures Trainer (CWEPT).

Live-fire crew gunnery table. The unit crew qualification table used in the experiment was designed for the Dalton-Henson Multipurpose Range Complex (see Table 1). The table contains 2 calibration and 18 normal engagements employing all three AH-64A weapon systems. It was used for both day and night training. The engagements were fired from seven firing points toward 13 targets (see Figure 6). The distance from the firing points to the targets ranged from 975 m to 2575 m for the 30 mm gun, from 3450 m to 4500 m for the rockets, and from 2100 m to 4620 m for the missiles. All engagements were fired from a stationary hover with the exception of the two 30 mm engagements that were fired from a

Table 1

Initial and Final Live-Fire Gunnery Table

Firing Point	Weapon System	Target Number	Target Distance	Rounds
1[a]	30 mm	1-7A,B	975	20
	Rockets	R3	3700	4
1	30 mm	1-7A,B	975	20
	Rockets	R3	3700	4
	Hellfire	R4	3835	1
2	30 mm	9A	1066	20
	Rockets	R2	3450	4
	Hellfire	R2	3450	2
3	30 mm	1-5A,B	1700	20
	Rockets	R3	4500	4
	Hellfire	R2	4350	1
4	30 mm	8A	1645	20
	Rockets	R2	4400	4
	Hellfire	R3	4620	1
5	30 mm	8B	1400	20
6	30 mm	9B	1100	20
7	Hellfire	43	3775	1
	Hellfire	32	2350	1
	Hellfire	31	2100	1
	30 mm	34	2575	20

Note. The 30 mm engagements employed target practice (TP) rounds and the rocket engagements employed target practice point detonating (TP/PD) warheads with Mark 66 motors; the Hellfire engagements were simulated.

[a]calibration

moving hover at firing points 5 and 6. The arrows in Figure 6 indicate the direction of movement of the targets and aircraft, if any occurred.

CMS scenario. A single gunnery scenario was developed to test and train crew gunnery performance in the simulator. The I/O situation and target handover sheet used to implement the scenario are presented in Appendix C. The scenario exercised all weapons systems (30 mm, rockets, and missiles), target modes (moving and stationary), and aircraft modes (stationary and moving hover) at a variety of target ranges. The scenario contains engagements similar to those in

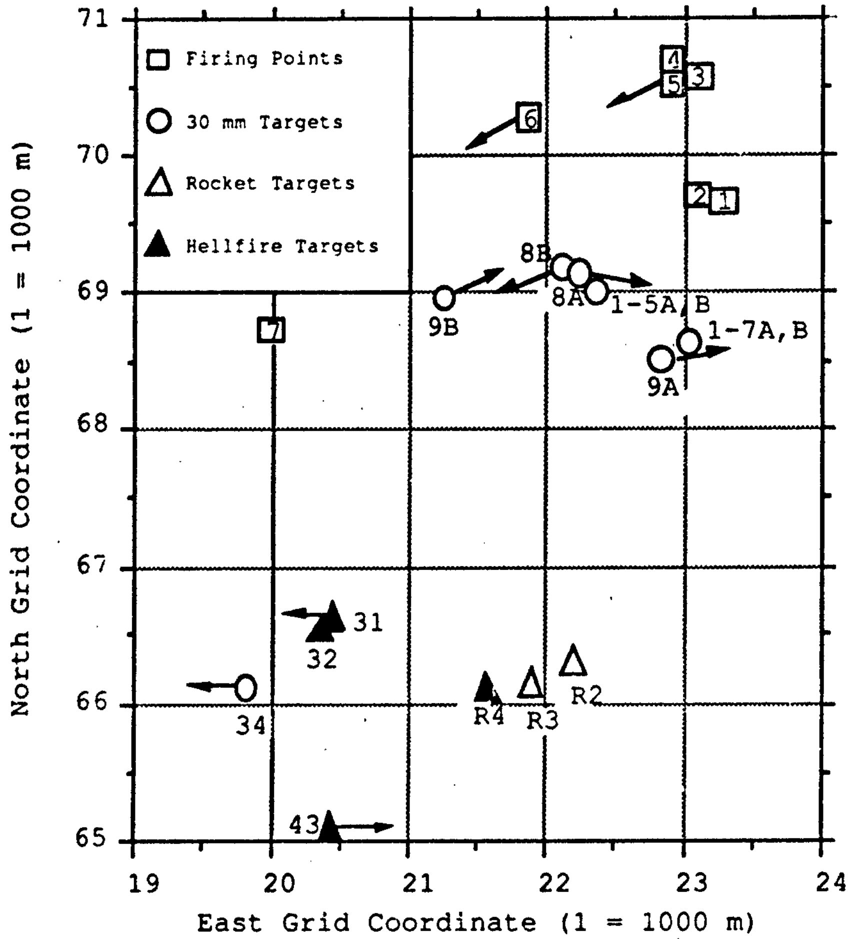

Figure 6. Configuration of the firing points and targets at the Dalton-Henson Multipurpose Range Complex, Fort Hood, Texas.

Table 1, but 30 mm target distances are greater than in Table 1 because engagements shorter than 2000 m are difficult to create in the simulator. Additionally, the missile engagement distances in the simulator are longer than in Table 1 because engagements longer than 5000 m are difficult to create on the live-fire range.

The tactical scenario was conducted with a temperature of 15°, a visibility of 7600 m, a ceiling of 3000 ft, a wind of 5 kts at 300°, and a barometric pressure of 29.92 in. The CMS threat lethality was set to 5 with hostility interrupt on. The visual mode (VM) and scene illumination (SI) were changed to simulate day and night (Day: VM = 2, SI = 5; Night: VM = 1, SI = 11).

Personnel

The three types of personnel participating in this research (AH-64A aviators, CMS I/Os, and range scoring personnel) are described in the following sections.

AH-64A aviators. Initially, 30 qualified and current AH-64A crews (60 aviators) were selected to serve as subjects for the study. All crews from three squadrons of an operational cavalry brigade who were scheduled to remain in the unit for at least 6 months were selected to participate. Because Army policy restricts females from gunship operations, all aviators were male. The experimenter, with the assistance of brigade and squadron SIPs, formed two matched groups on the basis of qualitative estimates of aviator experience and skill. Fifteen crews were assigned to the experimental (simulator) group and fifteen crews were assigned to the control (no simulator) group.

Before U.S. troop deployment to the Persian Gulf, crew attrition was minimal (3 crews) and unrelated to crew performance (i.e., permanent change of station, medical grounding). An additional 9 crews were lost to operational units of the Central Command before the final performance tests. Fortunately, crew loss was equal between the groups. At the conclusion of the research, 18 crews participated in the final live-fire exercises, 9 in each group. After completing the day run, however, one crew in the control group was unable to complete the night run or CMS test because of an off-duty injury to one crewmember.

During the initial live-fire exercises, demographic and flight experience information was obtained from the participating aviators using the AH-64 CMS Gunnery Research Program Demographic Survey (see Appendix A). The demographic data obtained from the survey indicate a range of experience that is typical of AH-64 operational units. Namely, the units consist of aviators with two distinctly different backgrounds: those with previous career experience in other helicopters (predominantly the AH-1) and those who proceeded from initial entry rotary wing training to the AH-64 Aviator Qualification Course (AQC). Analysis of the demographic data for the aviators who completed the research indicate that the training groups were similar when the research began (see Table 2). The differences that were found between the

Table 2

Aviator Demographic Data at the Initial Live-Fire Exercise

Measure	Quantity	Pilot Control (n = 9)	Pilot Simulator (n = 9)	Gunner Control (n = 9)	Gunner Simulator (n = 9)
Age (years)	median range	30 (23-40)	31 (25-47)	30 (26-34)	26 (22-40)
Months of Active Duty	"	118 (20-213)	120 (37-267)	78 (46-153)	80 (18-216)
Months Since AQC	"	27 (3-34)	30 (9-60)	18 (5-30)	6 (2-22)
AH-64A Flight Hours	"	541 (229-622)	434 (148-788)	288 (149-638)	218 (149-518)
Total Flight Hours	"	1230 (386-4360)	1168 (313-5940)	761 (382-2011)	416 (314-1727)
Readiness Level	mean SD	1.2 (0.44)	1.2 (0.67)	1.1 (0.33)	1.8 (0.83)
Range Experience	"	3.1 (1.90)	2.8 (1.79)	1.4 (1.24)	0.7 (1.41)

Note. AQC = AH-64A Aviator Qualification Course. Readiness Level (RL) progresses from RL3 (new assignment to unit) to RL1.

simulator and control groups are small, especially when compared to the differences between the crew seat position. However, the AH-64A flight hours, readiness levels, and previous Dalton-Henson range experience indicate that the simulator group was somewhat less experienced than the control group.

CMS instructors. The gunnery instruction and console operation for crew testing and training in the CMS was conducted by seven civilian Flight Simulator Facility AH-64A CMS Instructor Pilots (IPs). All seven were retired Army IPs and were highly experienced in the CMS operation and instruction. The I/Os were briefed on the purpose, design, and procedures of the research project and participated in designing the tactical CMS gunnery scenario.

Scoring personnel. Target effect measures of gunnery performance were obtained during the live-fire exercises by nine individuals: four AWSS operators, three squadron SIPs, and two researchers. Two civilian contract personnel operated the AWSS during the day exercises and another two during the night exercises; on each shift, one scorer operated the BSS and one operated the DSS. The missile target effect performance was evaluated by each squadron's SIP. The researchers monitored the range activities, collected the performance information from the BSS and DSS operators, and entered the data into the project computer, one during the day exercises and the other during the night exercises. The researchers obtained engagement time measures for the live-fire exercises and the CMS tests from the VRS videotapes. They also obtained target effect measures for the CMS tests from computer-generated printouts.

Detailed Procedures

Live-fire exercises. The initial and final live-fire exercises were conducted at the Dalton-Henson Multipurpose Range Complex at Fort Hood, Texas. The initial live-fire exercises were conducted at two different times. Two squadrons from the participating unit completed the initial exercises over a 9-day period. The last squadron completed the initial exercises over a 5-day period approximately 2 months later. All squadrons completed the final live-fire exercises over a 15-day period 6 months after the first initial live-fire exercise. During both the initial and the final live-fire exercises, only one squadron occupied the range at a time. The experimental protocol for the live-fire exercises was similar for the initial and final exercises.

The gunnery exercises were controlled from the range operating tower. Each squadron provided one range safety officer and one communications (COM) officer. The range operations office provided one civilian to operate the automated range. All targets were raised and lowered under the computer control of the range operator in the tower.

Each squadron established a forward arming and refueling point (FARP) within one mile of firing point 1. For the entire period that the squadron occupied the range, unit personnel manned the bivouac for rearming, refueling, maintaining, and staging aircraft. Aircraft began and ended each run at the FARP. Each crew contacted the tower COM officer when they were ready to start a run. When the range was clear of preceding aircraft, the aircraft were cleared by the COM officer to move from the FARP to the first firing point.

Typically, a crew arrived on the range at firing point 1 and proceeded through firing point 7 in sequential order. If equipment malfunction or other problems occurred, the crews were instructed to return to the FARP to obtain aircraft maintenance or replacements. Subsequently, the crews returned to the range to complete all engagements. Performance of all the gunnery tasks in Table 1 and, consequently, progress through all seven firing points was referred to as a run. Each crew completed one run under day conditions and one run under night conditions. During the initial exercises, crews were allowed to complete multiple runs to pass unit standards for gunnery performance. Shortages of range time and ammunition during the final exercises limited each crew to a single day and a single night run.

All aircrews followed standard out-front boresight procedures before firing the aircraft laser or weapons. Upon arriving at each firing point, the COM officer acknowledged the aircraft's arrival at the firing position, cleared the crew to arm the weapon systems, instructed the crew to activate the VRS, and randomly selected one of the target engagements defined for that firing point. For each engagement, the COM officer performed the following activities:

- requested that the range operator raise the target;
- requested that the aircraft establish the minimum safe altitude of 50 ft above ground level (AGL); and
- delivered a standard target handover including bearing, description, mode (stationary or moving), and weapon.

After receiving the target handover, the crew performed the following activities:

- established an altitude of 50 ft AGL,
- acknowledged the target handover,
- positioned switches for the engagement,
- unmasked the aircraft,
- acquired the target,
- delivered the ordinance,
- masked the aircraft, and
- called "weapons clear" to the COM officer.

When the crew called weapons clear, the COM officer instructed the crew to deactivate the VRS and to place the weapon systems in the safe mode; he then cleared the crew to proceed to the next firing position.

During the initial and final live-fire exercises, each crew was allowed to choose the weapon mode used to engage each target. However, the crews consistently used the same mode, which probably represented the consensus on the optimal weapon system mode for each engagement. The 30 mm engagements were conducted by the CPG using the TADS and LRF/D. Rocket engagements were conducted in the cooperative mode: The CPG tracked the target with the LRF/D and TADS and the PLT maneuvered the aircraft to align the rocket symbology and fire the weapon. Missile engagements were conducted using the aircraft's simulated Hellfire training missiles by the CPG using the TADS and LRF/D in a normal lock-on-before-launch mode with autonomous target designation.

AH-64A CMS test procedures. The CMS scenario was used to test the gunnery performance of all crews after the initial live-fire exercises and again after the final live-fire exercises. The CMS was used in the integrated mode both for testing and training gunnery performance. The CMS gunnery performance test was conducted for both day and night conditions during a 1.5-hour simulator period.

Each crew arrived at the simulator facility 30 to 40 minutes before the scheduled simulator session. When the crew arrived, the I/O gave them a copy of the situation sheet, a tactical map, a contour chart, and a communications frequency list. The crews were then allowed to plan the mission before the simulator session began; they could obtain assistance from the I/O, if necessary.

Each crew began the scenario in a holding area and flew to the first firing position under the direction of the scout, who was played by the I/O. From the first firing position, the crew fired missiles, rockets, and 30 mm rounds at different targets. The scout then directed the crew to move to another firing position, where the crew engaged other targets using the missiles and rockets. Subsequently, the scout directed the crew to move to a grid point. When the crew arrived at the grid point, the scout directed the crew to proceed cautiously in the direction of another grid point to assist in locating a downed friendly aircraft. As the aircraft traveled through the lowland route, the scout called for the crew to suppress a target using the 30 mm gun. When the aircraft arrived at the second grid point, the scout instructed the crew to turn around and make another reconnaissance pass over the lowland route and to engage the target again using the 30 mm gun. After completing the engagement, the scout directed the crew to proceed to another highland battle position, where a final missile target was engaged.

After the crews completed the scenario under day conditions, they repeated it under night conditions. When the test session was completed, the crew reviewed their performance with the I/O and returned the test materials. The time required for each test session was approximately 2.5 hours.

The CMS VRS was used during the test to record all engagements. During each test, the I/O directed the crews through the scenario by acting as the scout. He did not provide any instruction or performance feedback to the crews during the CMS test. As each target was engaged, the summary of the ownship gunnery performance, generated by the CMS, was printed by the researcher.

Experimental group training procedures. After the initial live-fire exercise and CMS test, the squadron and brigade SIPs were instructed to continue the normal unit training of the simulator group aviators, with the following three exceptions. First, the simulator group aviators were restricted from participating in any live-fire gunnery practice in the aircraft. Second, they were instructed to complete the Postflight Debriefing form after each flight in the aircraft, CMS, or CWEPT and to submit the completed forms periodically to the on-site researcher. Third, they were required to attend five gunnery training sessions in the CMS before the final live-fire exercise.

The experimental group's gunnery training was conducted exclusively in the CMS. The procedures for training crews in the CMS were similar to those used in the CMS gunnery tests with two exceptions. First, the VRS was not used during CMS training. Second, the I/O aided and instructed the crewmembers as necessary during the mission.

Control group training procedures. After the initial live-fire exercise and CMS test, the squadron and brigade SIPs were instructed to continue the normal unit training of the control group aviators, with the following two exceptions. First, the control group aviators were restricted from gunnery practice in the CMS, but they were allowed to use the CMS for instrument and emergencies procedures training. Second, they were instructed to complete the Postflight Debriefing form after each flight in the aircraft, CMS, or CWEPT and to submit the completed forms periodically to the on-site researcher. Except for the initial and final gunnery tests, the researchers had no direct contact with the control group aviators.

Monitoring Procedures

The use of the CMS was the only training activity under the experimental control of this research. However, there are several other training activities that could significantly affect crew gunnery performance. Differential use of other forms of gunnery training by the two groups could confound the results of the research. Therefore, participation in JAAT training exercises and the use of the aircraft, the CWEPT, and the TADS Selected Task Trainer (TSTT) were monitored over the course of the research to aid in the interpretation of the results. Squadron operations officers provided information about major gunnery training activities (e.g., JAATs). The Army aviator flight records (Form 759) were reviewed after the initial and final live-fire exercises to measure the amount of AH-64A flight time. Finally, the on-site researcher obtained the number of hours that the participating aviators used the CWEPT and TSTT from a computer data base maintained by personnel at the simulator facility.

Measures of Effectiveness

Several measures of effectiveness (MOEs) were obtained during the live-fire and CMS gunnery performance tests. When more than one run was completed by a crew during the initial live-fire exercise, the performance on the last run completed was used. With the exception of engagement time, the MOEs differed from one weapon system to another and from the live-fire exercises to the CMS tests. Each of the measures and their source are described in the following sections.

Engagement time. Engagement time was defined as the time between when the crew acknowledged the target handover and when they called weapons clear. The VRS was used during the live-fire exercises and the CMS tests to record TADS displays during each engagement. All engagement time measures were obtained using hand-held stop watches and the VRS videotapes after the exercises. The live-fire range and CMS protocol were designed to utilize the 1-hour videotapes efficiently and to provide objective start and finish events to aid in measuring engagement time.

30 mm target effect. For the live-fire exercises, 30 mm target effect was defined as the number of rounds that passed through the BSS Doppler fan and landed in the target effect area (hits) divided by the total number of rounds fired from the aircraft (shots). The number of hits was provided by the BSS operator and the shots were obtained from the rounds

counter on the VRS videotape of the engagements. Thus, the hits/shots ratio is the percentage of rounds in the target effect area or box.

Rocket target effect. For the live-fire exercises, rocket target effect was defined for each 4-rocket engagement as the mean distance from the target (miss distance). The down-range miss distance and the cross-range miss distance for each rocket impact was provided by the DSS operator. For each rocket impact sensed by the DSS, the cross- and down-range miss distances were used to compute the absolute miss distance using the Pythagorean theorem. Because the DSS demonstrated good sensitivity for rocket impacts out to 350 m, all rocket impacts that were not detected by the DSS were assigned 500 m miss distances by the researcher.

Hellfire target effect. During the live-fire exercises, the VRS videotapes were viewed immediately after each run by the squadron SIP and evaluated using the brigade standard for missile target kills. The information taken from the tapes was used to evaluate proper mode selection, switch settings, target acquisition, missile launch, and guidance. The squadron SIPs recorded whether the target was killed on brigade evaluation sheets.

CMS target effect. The ownship performance data sheets generated by the CMS after each engagement were the source of the target effect measures for 30 mm, rocket, and missile performance in the simulator. For each weapon trigger pull, the CMS calculated the mean miss distance for the rounds fired. If any rounds from a trigger pull hit the target, the mean miss distance was always zero. The mean distances for each trigger pull were used to compute the mean miss distance for each engagement by creating a rounds-weighted sum of miss distance and then dividing by the total number of rounds fired. In addition to miss distance, target impacts (kills) were recorded for each engagement.

Results

The first major objective of this research was to determine the effectiveness of the CMS for the sustainment of crew gunnery skills. CMS effectiveness was determined by analyzing the live-fire gunnery exercises, the CMS gunnery test, and the other training activities.

Live-Fire Gunnery Performance Test

The effectiveness of the CMS was directly tested by comparing the performance of the training groups during the pretest and the posttest live-fire exercises. Because the simulator could have differential effectiveness across weapon systems, the training effectiveness of the CMS was analyzed separately for each weapon. Further, the training effectiveness of the CMS was analyzed separately for measures of target effect and engagement time to determine if the simulator had a differential effect on the two aspects of gunnery performance.

Two-factor repeated measures analysis of variance (ANOVA) tests were conducted on each dependent measure. Training (simulator vs. control) was analyzed as a between-group variable. Trial (initial vs. final exercise) was analyzed as a within-group, or repeated measures, variable. In this ANOVA design, transfer of training is indicated by a significant interaction between training and trial. Positive transfer is indicated when the simulator group performs better than the control group during the final exercise. Ideally, the gunnery performance of both groups would be equivalent at the initial live-fire exercise (matched groups) and differ at the final live-fire exercise. A trial main effect would indicate significant changes in the performance across trials unrelated to training group. A training main effect indicates a lack of equivalence between the groups across trials.

The results from the six live-fire analyses (three weapon systems by two measures) are presented in the following paragraphs. All of these analyses were initially conducted separately for day and night. In no case, however, did the trends found for day or night differ from the combined trends. To simplify the presentation of the results, only the analyses of the data combined across day and night are reported.

Finally, for each of the analyses presented below, the gunnery performance measures are graphed. Each graph displays the mean and one standard error of the mean (plus and minus) for each training group during the initial and final live-fire exercises. The standard error of the mean quantifies the variability in the data and, when graphed, provides a visual indication of the differences in the individual scores and the significance of the differences between the means. Means with standard error bars that overlap are generally not significantly different from one another; means with nonoverlapping error bars usually differ significantly.

Engagement time. The times for the 30 mm gun and Hellfire missile engagements were similar and averaged 69 and 66 seconds, respectively (see Figures 7 and 8). In contrast, the rocket engagement times were substantially longer, averaging 159 seconds per engagement (see Figure 9). This difference was the result of the requirement that each of the four rockets in each engagement must be fired individually. The standard errors of the mean are shown as vertical bars in all the figures.

There were no significant interaction effects for any of the engagement times, but there were differences in the trends shown for the three weapon systems. The engagement times for the 30 mm gun (see Figure 7) indicate that the simulator group improvement was slower than the control group improvement over the course of the experiment (i.e., negative transfer). However, both the missile and rocket data demonstrate a trend toward positive CMS transfer (see Figures 8 and 9).

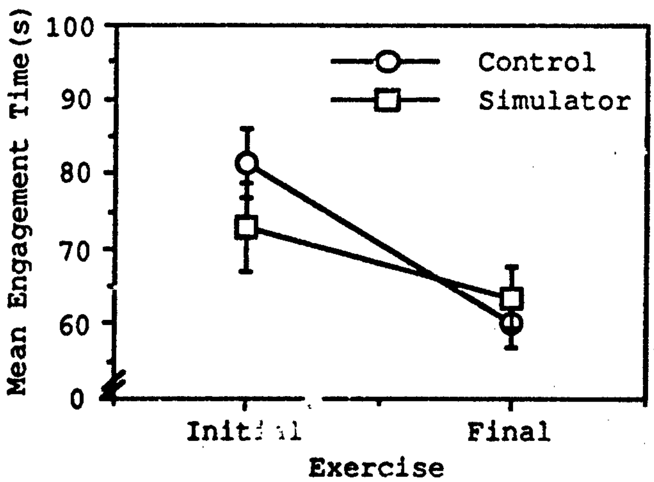

Figure 7. The mean 30 mm engagement time ± 1 standard error during the initial and final live-fire exercises as a function of training group.

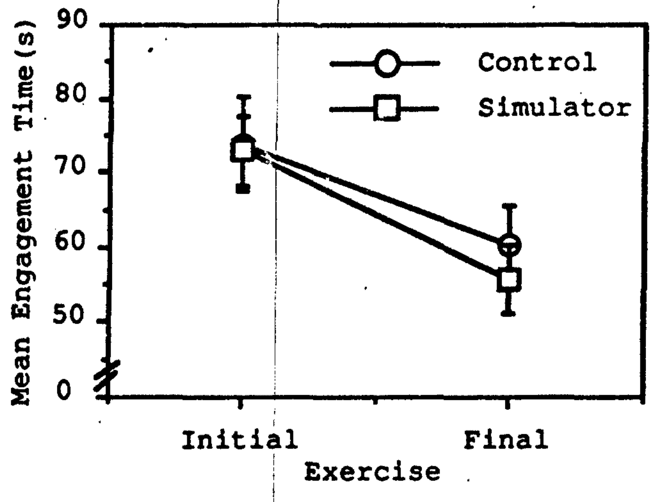

Figure 8. The mean Hellfire engagement time ± 1 standard error during the initial and final live-fire exercises as a function of training group.

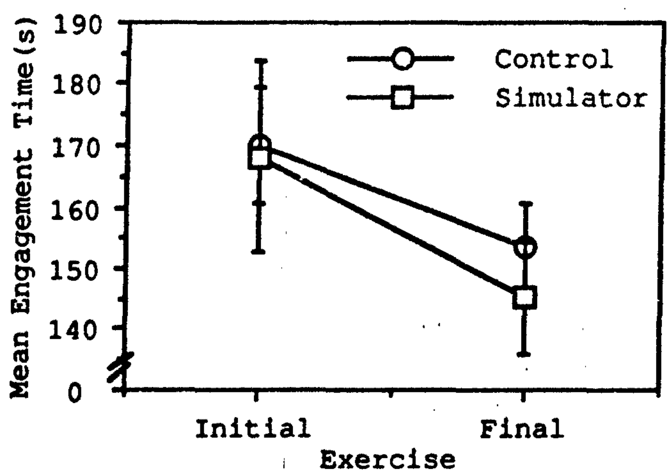

Figure 9. The mean rocket engagement time ± 1 standard error during the initial and final live-fire exercises as a function of training group.

There were significant improvements in both groups between the initial and final live-fire exercises (i.e., trial main effect) for the 30 mm gun (F (1, 15) = 13.53, p <.05) and the Hellfire missile (F (1, 15) = 11.80, p <.05). This 15-second improvement may be due to the practice received during the initial live-fire exercise or some other non-CMS training that occurred between the initial and final live-fire exercises. A similar improvement of 20 seconds in the rocket data was not significant, however, probably because of the large amount of variance within the groups (see the standard error bars in Figure 9).

Overall, the engagement time data show no significant effect on CMS training. The engagement data, however, do demonstrate a consistent (≈17%) improvement over the course of the experiment.

<u>Target effect</u>. Averaged across firing points, the 30 mm gun performance for all groups was approximately 50% (see Figure 10). Though there were strong range-to-target effects in the 30 mm target effect data (see Hamilton, 1991), there were no significant CMS training effects. The performance of the simulator and control groups was almost identical during the initial exercise, but the control group performed slightly better than the experimental group during the final live-fire exercise.

The mean miss distance for rockets varied from approximately 350 m to 250 m during the experiment (see Figure 11). The mean miss distance for the control group was significantly better than the simulator group during both exercises (F (1, 15) =15.26, p <.05). However, the ANOVA did not indicate a CMS training effect (i.e., trial by training interaction). There was also a significant improvement in mean miss distance of approximately 50 m from the initial to the final live-fire exercises (F (1, 15) = 6.66, p <.05). This effect can probably be attributed to improvements in rocket pod alignment techniques implemented between the initial and final exercises (see Hamilton, 1991).

Finally, the Hellfire performance was quite high: The crews always scored at least 9 of the 16 possible missile kills. Missile kill performance was nearly identical at the initial exercise, but the control group performance was slightly better than the simulator group performance during the final live-fire exercise (see Figure 12). However, there were no significant differences in the Hellfire missile performance.

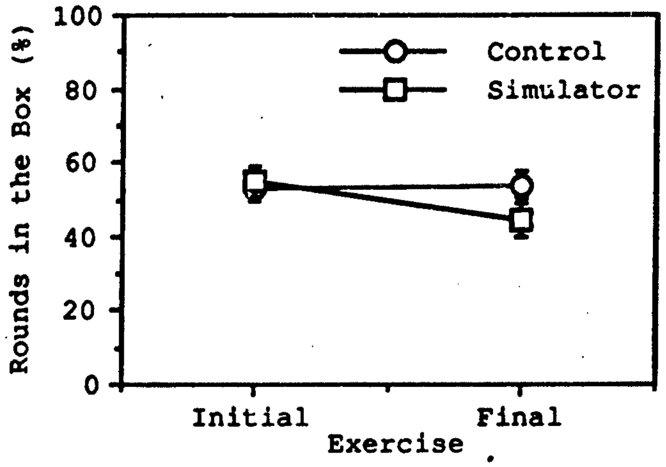

Figure 10. The percentage of hits ± 1 standard error for the 30 mm gun during the initial and final live-fire exercises as a function of training group.

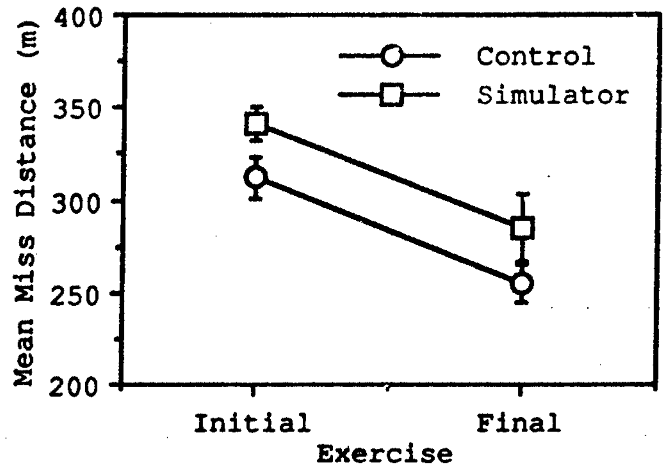

Figure 11. The mean miss distance ± 1 standard error for the rockets during the initial and final live-fire exercises as a function of training group.

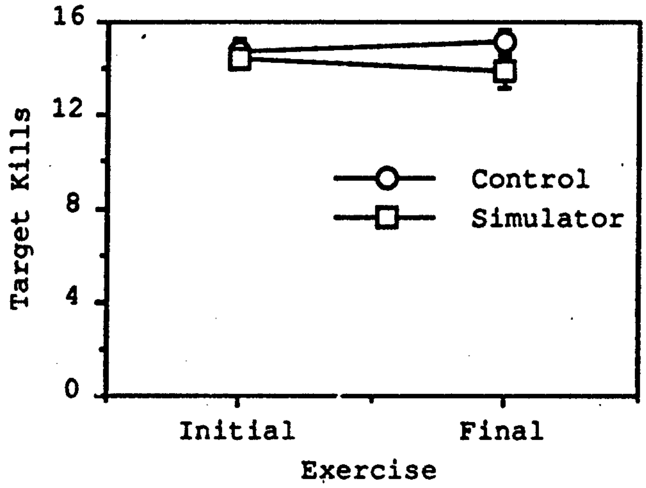

Figure 12. The percentage of judged target kills ± 1 standard error for the Hellfire missiles during the initial and final live-fire exercises as a function of training group.

Overall, the live-fire gunnery range results show little evidence of CMS training effectiveness in the simulator group or of skill decay in the control group. There were several examples of initial-to-final performance improvements, but the trends were not related to CMS training.

<u>CMS Gunnery Performance Test</u>

The analysis of the effect of simulator training on gunnery performance in the CMS was conducted using the same ANOVA design used for the live-fire data. Examination of the differential performance in the CMS is a test of training effectiveness as opposed to simulator effectiveness. The control group was expected to show some skill decay; the simulator group was expected to show some skill enhancement.

As in the live-fire analyses, engagement time and target effect measures (mean miss distance and number of target kills) were analyzed separately for each weapon system. The target effect measures generated by the CMS are classified and cannot be reported in detail. However, the overall trends found during these analyses are sufficient to evaluate the effect of the simulator training on simulator performance.

Overall, there were no significant effects at the $p < .05$ level for nine ANOVAs (3 weapons by 3 measures), but the gunnery performance trends in the simulator were more consistent than those found in the live-fire exercises. Gunnery performance of the simulator group improved for each of the measures across all weapons systems and, with one exception, improved by a greater amount than the control group. Moreover, some indication of skill decay was found in the control group for both rocket target effect measures.

Other Training Activities

Data were collected and analyzed for differential use by the two training groups for four types of training: JAAT, aircraft, CWEPT, and TSTT. The aviators were instructed to complete a Postflight Debriefing form after every training activity, but they were very inconsistent in complying with this requirement. As a result, the information about non-CMS training activities is drawn only from more reliable sources.

First, the unit involved in the research participated in a JAAT training exercise at Fort Hood, Texas, 2 months before the final live-fire exercises. Four of the control group crews participated in the training, but no additional information is available about the type or amount of training they received. Second, the mean flight hours per crewmember during the experimental period were larger in the control group ($M_{NoCMS} = 127$, $SE = 10.7$) than the simulator group ($M_{CMS} = 101$, $SE = 8.0$), but the differences were not statistically significant. The greater number of aircraft flight hours in the control group may be partially attributed to the JAAT exercise.

Third, CWEPT records indicated the participating crews did not use the device very often and there was no statistically significant difference between the average number of hours each group used the device ($M_{NoCMS} = 1.31$, $SE = .368$; $M_{CMS} = 1.25$, $SE = .829$). Finally, a TSTT training device was available to participating crews during the initial stages of the research, but it was removed approximately 3 months before the final live-fire exercises. Discussions with personnel managing the device again indicated little or no use of the device by the participating crews.

Discussion

The first major objective of this research was to determine the effectiveness of the CMS for the sustainment of crew gunnery skills. The effectiveness of the CMS was directly tested by measuring the differential performance of the training groups between the initial and final live-fire exercises. The results of these tests can be summarized in three statements.

First, after five gunnery training sessions in the CMS, the simulator crews did not have significantly better engagement time or target effect performance when compared to the control group. Second, the results of the initial and final CMS gunnery performance tests showed consistent but nonsignificant performance improvements in the simulator group. Third, there were no significant differences in the other training practices of the simulator and control group aviators. Though these findings appear to indicate that the CMS is ineffective in sustaining gunnery skills, a number of factors should be considered before drawing final conclusions from the research results.

Skill Decay

The best demonstration of training effectiveness for skill sustainment is for the control group to show skill decay while the simulator group maintains their skill level. The results of this research show no sign of skill decay by the control group. Indeed, the performance of the control group improved in many instances over the course of the research. As anticipated in the design considerations, a measurable loss of skill in the control group would be required to demonstrate skill sustainment, and thus, CMS training effectiveness.

The primary reason that skill decay was not observed in the control group is probably the short time span of the research. The minimum length of time for aviator skill decay has been shown to be at least 6 months (Ruffner & Bickley, 1983; Ruffner, Wick, & Bickley, 1984). However, appreciable skill loss probably occurs sometime between 6 months and a year for aviators not engaged in any form of gunnery training. Skill decay in the control group may also have been minimized by factors such as participation of the control group in the JAAT training exercises, aircraft dry-fire exercises, the initial CMS test, or simple mental rehearsal.

Skill Enhancement

An alternative method of demonstrating training effectiveness for skill sustainment is for the simulator group to show skill enhancement while the control group maintains their skill level. The research results demonstrate that CMS training over a 6-month period was not sufficient to make the simulator group's skill measurably better than the control group's. This finding probably indicates that the participating aviators were highly proficient when the research began. Ironically, the high level of gunnery proficiency may be the result of a successful unit training program that included the fielding, staffing, and effective use of CMS facilities in the unit.

Another explanation of the lack of skill enhancement may be that the measures of effectiveness were not sufficiently sensitive to detect increases in the aviator's gunnery proficiency. Sensitive measures are difficult to identify because of the amount of variability introduced by random variables such as different aircraft, aircraft maintenance, and weather. Nonetheless, the results from other analyses conducted to evaluate the AH-64A gunnery standards indicate that the performance measures were sensitive to several factors other than aviator training, including changes in range to target and differences in aircraft weapons maintenance procedures (see Hamilton, 1991). As a result, the lack of skill enhancement is more likely attributable to high initial skill levels than to insensitivity in the measures of effectiveness.

Conclusions

The results of this research support three conclusions related to the first objective of this research, to determine the effectiveness of the CMS for sustaining crew gunnery skills. First, this experiment found no significant positive or negative transfer of training from the CMS to the live-fire gunnery range. Thus, the training effectiveness of the CMS to sustain crew gunnery skills remains equivocal.

Second, the gunnery proficiency of operational AH-64A aviators is at or near an asymptotic level of performance. For this reason, the CMS did not substantially improve aviator performance during the 6-month period of this experiment. However, there is no evidence that monthly CMS training produces any negative transfer to the aircraft.

Third, the restriction from CMS training was insufficient to bring about skill decay in the control group over the 6-month period of this research. Although previous research indicated that skill decay could occur within 6 months, there was no evidence of skill loss in the control group during the final live-fire exercises. Thus, current levels of aircraft and other forms of gunnery training are sufficient to maintain crew gunnery skills in proficient aviators for up to 6 months without the aid of CMS training.

The second objective of this research was to provide data to establish an optimum combination of aircraft and flight simulator training for the sustainment of crew gunnery skills. Because the research did not establish the benefits of short term CMS training or the critical period for gunnery skill decay, the obtained data are insufficient to determine the optimal use of the CMS for gunnery training of operational aviators.

Recommendations

Until additional empirical data can be obtained, the CMS should remain an integral part of operational gunnery training. The results indicate that if aircraft hours and other gunnery training (e.g., JAATs) are funded at the levels observed in this research, the critical period for gunnery skill decay in proficient aviators is 6 months or longer. Thus, CMS gunnery training may be required only biannually. Nevertheless, a more conservative quarterly CMS gunnery training may be advisable, especially when the participating aviators may have benefited from the initial live-fire and CMS gunnery tests. However, if the support for aircraft hours and other gunnery training exercises is reduced, gunnery skills may decay in less than 6 months unless CMS training is increased. In fact, there is no statistically significant evidence of negative transfer when CMS gunnery training is conducted on a monthly basis.

Research Limitations

As with any research, the application of the results of this experiment is limited by the conditions under which they were obtained. Although there are others, the four major limitations brought about by the selection of sustainment training, gunnery training, crew training, and the measures of effectiveness are discussed in the following paragraphs.

First, the research was designed to measure the training effectiveness of the CMS for sustaining skills. As such, it produced information pertinent to unit sustainment training but not to the acquisition of skills. Thus, the five CMS training sessions that did not produce positive transfer to the aircraft for proficient aviators might significantly improve the performance of unskilled aviators. Second, the research focused on gunnery skills; different results may be obtained for other skills such as instrument flight and emergency procedures.

Third, the research addressed only the crew level of gunnery training. The Army has structured the gunnery training of its aviators in a logical progression from the acquisition of individual skills, through crew skills and coordination, to team skills and coordination. The effectiveness of the CMS may be different for the other levels of gunnery training.

Fourth, the MOEs used in this research further limit the generalizability of the results. Although speed and accuracy are classic measures of gunnery skill, many other skills are critical to the success of helicopter gunnery missions. One example is the identification, selection, and use of terrain to mask the helicopter from enemy threat. Because the criterion for selecting firing points on the gunnery range and for selecting battle positions during a gunnery mission differ significantly, appropriate terrain masking techniques were not emphasized during this research project. However, terrain masking is a tactical gunnery skill that the CMS may be effective in training.

Future Research

The costs of AH-64A gunnery training resources (e.g., flight and range time, ammunition) have increased the Army's dependence on flight simulators for training that was previously accomplished in the aircraft. Most Army aviators are required to accomplish a portion of their annual flight requirements in a flight simulator. Furthermore, the trend toward substituting simulator training for aircraft training is likely to continue as resources become more expensive and simulator technology becomes more advanced.

The Army has not based the deployment or utilization of flight simulators on empirical training effectiveness data that relate to the acquisition or sustainment of gunnery skills. In fact, individual unit commanders are responsible for determining the mix of aircraft, simulators, and other training devices that make up their training program. Even when two or more units share the same simulator site, there are differences in the ways that units use the flight simulators. Decisions about the trade-off between aircraft and simulator time should be based on empirical demonstrations of the simulator's effectiveness for training specific tasks. Commanders could use this information to develop training programs that achieve their training goals and maximize the utilization and effectiveness of the training resources available.

This research represents an initial step toward empirically determining the effectiveness of the CMS for satisfying the gunnery training requirements of operational aviation units. The results of this research add significantly to the knowledge base about the time course of AH-64A gunnery skill decay and sustainment in operational units, but many questions remain to be answered.

Thus, further investigations of gunnery skill decay in proficient aviators should be conducted over a longer period of time, such as 12 to 18 months. The research should be designed to establish the relative effectiveness of each of the alternative training devices currently available to operational units for sustaining gunnery skills. If sufficient control can be maintained during the proposed research, the information necessary to design an efficient training strategy could be determined.

Because good gunnery and tactical skills affect crew survivability, research that requires the significant loss of those skills may be unethical. In the design of future research, control groups should be identified whose lives would not be endangered by a discontinuation of gunnery training (e.g., aviators retiring from active duty, aviators assigned to nonflying duties).

Finally, future research should be given adequate fiscal, personnel, and operational support. The utility of the current research was severely limited by crew attrition and scheduling problems that must be resolved before satisfactory data can be obtained to address questions about sustaining AH-64 gunnery skills.

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APPENDIX A

AH-64 CMS GUNNERY RESEARCH PROGRAM
DEMOGRAPHIC SURVEY

6th CAVALRY BRIGADE--AIR COMBAT (CBAC)

PART A INSTRUCTIONS: Part A consists of questions that provide information about your personal background and experience. Answer each item that applies to you by checking in the appropriate bracket [√] or by printing the required information in the space provided. When answering items about flight hours, you may refer to records, if available, or you may estimate the flight hours as closely as possible. Your responses will be used for research purposes only.

1. Name: ____
   Last First Middle

2. Social Security Number: ___ ___ ___ - ___ ___ - ___ ___ ___ ___

3. Today's Date: ______________________________
   (Month) (Day) (Year)

4. What is your age ?
   ________ Years

5. What is your current rank?

[ ] WO1	[ ] 2LT
[ ] CW2	[ ] 1LT
[ ] CW3	[ ] CPT
[ ] CW4	[ ] MAJ
	[ ] LTC
	[ ] COL

6. To which unit are you assigned?
   Unit: ________________Squadron ________________Troop

7. How long have you been assigned to your present troop?
   ________ years and ________ months

8. Do you anticipate reassignment prior to October 1990?

[ ] Yes

[ ] No

If yes, give expected date and location of reassignment ____________________

____

9. Currently, what is your primary duty position in the unit?

____

10. What additional duties do you perform in your unit?

____

____

____

11. How long have you been on active duty military service?

________ years and ________ months of active service

12. How long has it been since you graduated from initial Army flight training?

________ years and ________ months

13. How long has it been since you graduated from the AH-64 AQC?

________ years and ________ months

14. Were you an IERW turnaround student in the AH-64 AQC?

[ ] Yes

[ ] No

If no, what was your primary aircraft before entering the AH-64 AQC?

____

15. Indicate the total number of flight hours you have logged in each of the following aircraft. Also, check [√] the highest duty category you have held in each aircraft.

a. **Military Rotary Wing**

			PI	PC	UT	IP	SI	IE
AH-64:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
AH-1:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
OH-58:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
UH-1:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

(Specify other aircraft)________________________________

b. **Military Fixed Wing**

UH-21:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
C-12:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
OV-1:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other:	________	hours	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

(Specify other aircraft)________________________________

16. How many flight hours have you logged in each seat of the AH-64?
Front Seat:__________ hours
Back Seat:__________ hours

17. How many flight hours have you logged in each seat of the AH-64 CMS?
Front Seat:__________ hours
Back Seat:__________ hours

18. How many flight hours have you logged in each seat of the AH-64 CWEPT?
Front Seat:__________ hours
Back Seat:__________ hours

19. How many night flight hours have you logged in each seat of the AH-64?
Front Seat:__________ hours
Back Seat:__________ hours

20. If you were an AH-1 pilot previously, how long has it been since you completed the AH-1 Crew Gunnery Tables?

_______ years and _______ months

21. After arriving at your present unit, what was your original crew station designation?

[ ] AH-64 front seat

[ ] AH-64 back seat

[ ] Other (explain) ______________________________

22. How many training hours were required for you to attain RL2 and RL1 status in your originally designated seat? (Check here [ ] if you did not attain RL2 or RL1 in your originally designated seat.)

__________ flight hours to RL2 from RL3

__________ CMS hours to RL2 from RL3

__________ flight hours to RL1 from RL2

__________ CMS hours to RL1 from RL2

23. What is your current crew station designation?

[ ] AH-64 front seat

[ ] AH-64 back seat

[ ] Both seats (explain) ______________________________

24. What is your current Readiness Level?

RL Front	RL Back
[ ] RL1 in the front seat	[ ] RL1 in the back seat
[ ] RL2 in the front seat	[ ] RL2 in the back seat
[ ] RL3 in the front seat	[ ] RL3 in the back seat

25. Excluding IP evaluations, how many crewmembers have you flown with since entering the 6th CBAC?

__________ crewmembers

26. Have you been assigned to a fixed crewmate?

[ ] Yes

[ ] No

27. If you are a member of a fixed crew, how many hours has your crew trained together?

___________ flight hours

___________ CMS hours

28. How many of your flights, if any, have been delayed or rescheduled due to the unavailability of an appropriately trained (i.e., current in the required seat) crewmate?

___________ flights have been delayed or rescheduled

29. How many times have you participated in gunnery exercises at the Dalton/Henson range complex?

___________ times flying the AH-64A

___________ times flying other aircraft

6th CAVALRY BRIGADE--AIR COMBAT (CBAC)

PART B INSTRUCTIONS: Part B consists of questions that provide information about your experience with the AH-64 optical systems. The questions ask for both objective and subjective information. Answer each item that applies to you by checking in the appropriate bracket [√] or by printing your answer in the space provided. This information will be treated as highly confidential; individual responses will not be seen by anyone except the research staff.

30. In the back seat, how often do you optimize your PNVS FLIR?
    - [ ] Only during preflight checks
    - [ ] Rarely during flight
    - [ ] Occasionally during flight
    - [ ] Frequently during flight

31. In the front seat, how often do you optimize your TADS FLIR?
    - [ ] Only during preflight checks
    - [ ] Rarely during flight
    - [ ] Occasionally during flight
    - [ ] Frequently during flight

32. In the back seat, to what extent does the flight symbology interfere with your ability to see terrain features during NOE flight?
    - [ ] Not at all
    - [ ] Slightly
    - [ ] Moderately
    - [ ] A great deal

33. In the front seat, to what extent does the TADS weapons symbology interfere with your ability to see targets?
    - [ ] Not at all
    - [ ] Slightly
    - [ ] Moderately
    - [ ] A great deal

34. How difficult is it to read the numbers on the helmet-mounted display?
    [ ] Not at all difficult
    [ ] Slightly difficult
    [ ] Moderately difficult
    [ ] Very difficult
    [ ] Extremely difficult

35. How much practice is required to handover targets proficiently between crewmembers using the flight and weapons symbologies?
    [ ] Only initial practice
    [ ] Occasional practice
    [ ] Frequent practice
    [ ] Constant practice

36. In your opinion, how likely are there to be misinterpretations of the different symbologies on the PNVS and TADS as a result of changing crew stations?
    [ ] Not at all likely
    [ ] Slightly likely
    [ ] Moderately likely
    [ ] Very likely
    [ ] Extremely likely

37. List the three flight symbols that interfere most with the IR imagery.

    ____

    ____

    ____

38. List the three weapons symbols that interfere most with the IR imagery.

    ____

    ____

    ____

39. In the front seat, what percentage of your time during traveling flight do you spend monitoring the PNVS?

    __________ percent monitoring the PNVS

40. In the back seat, what percentage of your time during traveling flight do you spend monitoring the TADS?

___________ percent monitoring the TADS

41. In the back seat, what percentage of your time during target engagements do you spend monitoring the TADS?

___________ percent monitoring the TADS

42. At the end of the AQC, how proficient were you in using the PNVS to fly the AH-64?

[ ] Minimally proficient
[ ] Marginally proficient
[ ] Moderately proficient
[ ] Highly proficient
[ ] Extremely proficient

43. At the end of the AQC, how proficient were you in operating the TADS?

[ ] Minimally proficient
[ ] Marginally proficient
[ ] Moderately proficient
[ ] Highly proficient
[ ] Extremely proficient

44. Currently, how proficient are you in flying with the PNVS?

[ ] Minimally proficient
[ ] Marginally proficient
[ ] Moderately proficient
[ ] Highly proficient
[ ] Extremely proficient

45. Currently, how proficient are you in operating the TADS?

[ ] Minimally proficient
[ ] Marginally proficient
[ ] Moderately proficient
[ ] Highly proficient
[ ] Extremely proficient

6th CAVALRY BRIGADE--AIR COMBAT (CBAC)

PART C INSTRUCTIONS: Part C consists of questions that provide information about your personal opinions and preferences. Answer each item that applies to you by checking in the appropriate bracket [√] or by printing your answer in the space provided. This information will be treated as highly confidential; individual responses will not be seen by anyone except the research staff.

46. Which crew station was most difficult for you to learn during the AQC?
    - [ ] Front seat
    - [ ] Back seat
    - [ ] Both seats were equally difficult

47. At the end of the AQC, in which seat did you prefer to be designated if you had to be assigned to only one seat?
    - [ ] Front seat
    - [ ] Back seat
    - [ ] Both seats preferred equally

48. Currently, in which seat would you prefer to be designated if you had to be assigned to only one seat?
    - [ ] Front seat
    - [ ] Back seat
    - [ ] Either seat would be preferred equally

49. Rank order the factors that you believe were considered in making your seat designation. (Put a "1" beside the most important, a "2" beside the next most important, etc. until all factors have been ranked. Put a "0" beside any factors that were not considered. Other than "0," do not use the same number twice.)

    ________ Needs of the unit (front/back seat manning requirements)
    ________ Unit policy (e.g., assign all new personnel to front seat)
    ________ Personal capabilities in the AH-64 as formally evaluated by the unit
    ________ Personal capabilities in the CMS as formally evaluated by the unit
    ________ Personal capabilities as evaluated during the AQC
    ________ Personal preferences
    ________ Recommendations of unit aviators who knew my capabilities

50. How proficiently could you perform if you were required to occupy your nondesignated crew station in an emergency? (If you are current in both seats, indicate which seat you occupy least often: ____________________; then rate your proficiency in that seat.)

[ ] Not proficient--mission could not be accomplished
[ ] Minimally proficient
[ ] Marginally proficient
[ ] Moderately proficient
[ ] Highly proficient
[ ] Extremely proficient

51. In your opinion, how many hours of refresher training would be required for you to attain RL2 and RL1 status in your non-designated seat?

__________ flight hours to RL2 from RL3
__________ CMS hours to RL2 from RL3
__________ flight hours to RL1 from RL2
__________ CMS hours to RL1 from RL2

52. How adequate is your semiannual familiarization training in the opposite seat?

[ ] Highly inadequate
[ ] Moderately inadequate
[ ] Marginally inadequate
[ ] Marginally adequate
[ ] Moderately adequate
[ ] Highly adequate
[ ] More than adequate

53. To operate effectively as an AH-64 crew, how important is it that you train regularly with the same crewmember?

[ ] Not at all important--the crew only need to be proficient in their own seat
[ ] Slightly important--it is helpful to know how the other crewmember will perform
[ ] Moderately important--regular crew training facilitates crew coordination
[ ] Highly important--regular crew training may affect mission success
[ ] Extremely important--regular crew training is critical to mission success

54. How often do you verbally crosscheck your crewmate to ensure he has completed a prescribed task before you proceed with your tasks?

[ ] Almost never
[ ] Infrequently
[ ] Occasionally
[ ] Frequently
[ ] Almost always

55. Use the following scale to rate the amount of crew communication that is required to perform the mission segments that are listed below, if the crewmembers have never flown together before.

1	2	3	4	5	6	7	8	9
No Crew Communication		Little Crew Communication		Moderate Crew Communication		High Crew Communication		Constant Crew Communication

a. ________ Preflight planning and checks
b. ________ Takeoff and departure
c. ________ Enroute in contour flight (day)
d. ________ Enroute in NOE flight (day)
e. ________ Enroute in contour flight (night using PNVS)
f. ________ Enroute in NOE flight (night using PNVS)
g. ________ Target acquisition (day)
h. ________ Target acquisition (night)
i. ________ Target engagement (day using HELLFIRE)
j. ________ Target engagement (night using HELLFIRE)
k. ________ Target engagement (day using rockets)
l. ________ Target engagement (night using rockets)
m. ________ Target engagement (day using 30 mm)
n. ________ Target engagement (night using 30 mm)

56. Use the following scale to rate the amount of crew communication that is required to perform the mission segments that are listed below, if the crewmembers have trained together as a fixed crew for six months.

1	2	3	4	5	6	7	8	9
No Crew Communication		Little Crew Communication		Moderate Crew Communication		High Crew Communication		Constant Crew Communication

a. ________ Preflight planning and checks

b. ________ Takeoff and departure

c. ________ Enroute in contour flight (day)

d. ________ Enroute in NOE flight (day)

e. ________ Enroute in contour flight (night using PNVS)

f. ________ Enroute in NOE flight (night using PNVS)

g. ________ Target acquisition (day)

h. ________ Target acquisition (night)

i. ________ Target engagement (day using HELLFIRE)

j. ________ Target engagement (night using HELLFIRE)

k. ________ Target engagement (day using rockets)

l. ________ Target engagement (night using rockets)

m. ________ Target engagement (day using 30 mm)

n. ________ Target engagement (night using 30 mm)

57. Use the following scale to rate the effectiveness of the CMS and CWEPT in training field unit aviators in each seat.

1	2	3	4	5	6	7	8	9
Not Effective		Slightly Effective		Moderately Effective		Highly Effective		Extremely Effective

a. ________ CMS training in the front seat

b. ________ CWEPT training in the front seat

c. ________ CMS training in the back seat

d. ________ CWEPT training in the back seat

58. How many semiannual flight hours do you believe you would need to maintain proficiency in the front seat?

________ flight hours

________ CMS hours

59. How many semiannual flight hours do you believe you would need to maintain proficiency in the back seat?

________ flight hours

________ CMS hours

60. How many semiannual flight hours do you believe you would need to maintain proficiency in both seats (dual seat currency)?

________ flight hours

________ CMS hours

APPENDIX B
POSTFLIGHT DEBRIEFING

AH-64 CMS POST FIELDING TRAINING EFFECTIVENESS ANALYSIS

The following questions refer to the flight that you have just completed and should be answered as soon after the flight as possible. Read each item carefully and answer by checking [√] the appropriate box or by writing in the space provided. Respond to all questions. Regardless of the crew station you occupied, you are to complete one of these forms each time you fly in an AH-64A aircraft, the Combat Mission Simulator (CMS), or the Cockpit Weapons and Emergency Procedural Trainer (CWEPT).

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1. What was the **date** of this flight? ____________________

2. What is your full **name and rank**?

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3. What is the **other crewmember's** full name and rank?

____

4. To which **unit** are you assigned? Circle the appropriate designation.

Squadron:	1/6	3/6	4/6	
Troop:	HHT	A	B	C

5. Which **crew station** did you occupy during this flight? 1[ ] Pilot 2[ ] CPG

6. Were you the **PC** for this flight? 1[ ] Yes 2[ ] No

7. What was the primary **mission** of this flight? [check one]
   - 1[ ] Satisfy requirements of individual aircrew training program
   - 2[ ] Satisfy requirements of crew training program
   - 3[ ] Battle drill
   - 4[ ] Border mission
   - 5[ ] Checkride (specify type)____________________
   - 6[ ] Other (specify)____________________

8. Did **more than one aircraft** fly on this mission? 1[ ] Yes 2[ ] No

   If yes,

   a. How many OH-58s? ________

   b. How many AH-64s? ________

9. During this flight, how much **flight time** did you log? _____ hours

10. During this flight, how much **flight time** did you log under the following **flight conditions**?

    a. Day ________ hours　　d. Terrain ________ hours
    b. Hood ________ hours　　e. System ________ hours
    c. Night ________ hours　　f. Weather ________ hours

11. During this flight, how much **flight time** did you log under the following **flight modes**:

    a. Contact ________ hours　　f. Low-Level ________ hours
    b. Tactics ________ hours　　g. Contour ________ hours
    c. Gunnery ________ hours　　h. Formation ________ hours
    d. NOE ________ hours　　i. Admin. ________ hours
    e. Other (specify)______________________ ________ hours

12. Did you receive **target handovers** from another aircraft? 1[ ] Yes 2[ ] No

    If yes, how many? ___________ target handovers

13. Was this flight in the AH-64, CMS, or CWEPT?

    1[ ] AH-64
    2[ ] CMS
    3[ ] CWEPT

14. Enter below the number of rounds fired during the flight.

WEAPON SYSTEM	ROUNDS		
	Live	Dry-Fire	Simulated
30mm			
Rockets			
HELLFIRE			

15. In the following table, document the number of times that you practiced specific gunnery tasks on this flight. In the row for each gunnery task that you practiced, enter the **number of times** you employed each (a) sight system, (b) method of range determination, (c) aircraft mode, and (d) target mode. **Include the tasks practiced by both crewmembers on this flight**, not just yourself. If neither crewmember practiced a specific task, enter zero across the row so that each block contains a response. This table must be completed **every time you fly** in the AH-64 or CMS.

WEAPON SYSTEM	SIGHT SYSTEM					RANGE METHOD			AIRCRAFT MODE		TARGET MODE	
	IHADSS P	IHADSS G	TADS P	TADS G	COOP	LRF	Manual	Hand Over	Hover	Run-ning	Station-ary	Moving
30MM												
Rockets												
HELLFIRE												

APPENDIX C

INSTRUCTOR/OPERATOR SITUATION AND TARGET HANDOVER SHEETS

INSTRUCTOR/OPERATOR SITUATION

REFERENCE: SPECIAL MAP, TODENDORF 1:50,000, REPRODUCTION 1:100,000

CONDITIONS: DAY/PNVS

DURATION: 1.5 HR

SEQUENCE OF EVENTS:

(a) Brief crew as to the conduct of the exercise. Emphasize that weapon selection will be directed by the Scout (Instructor), which is not the norm.

(b) ARI/Instructor will gather the information on page ___ for data collection by crew.

(c) Hostility interrupt will be on.

(d) Crew will conduct day mission, then conduct the same mission under PNVS.

(e) Target engagements will be moving targets from a hover, stationary targets from a hover, and moving targets with the aircraft running fire.

CONDUCT OF THE OPERATION:

(a) Initialize trainer to IC, set 126, insert TEE 318. (Stop all movement of targets.) Crew conducts boresighting (IHADSS and TADS), inserts doppler, present position, and firing points 1 and 2.

(b) Doppler: PPOS (Holding Area) VK86507202; Firing Position 1 - VK84537290; Firing Position 2 - VK84217268.

(c) Crew calls Scout ready.

(d) Move from the holding area to Firing Position 1, BP 22. Give three target handovers.

(e) Move to Firing Position 2, call set.

(f) Move from BP 22 on heading 210° to grid 8369.

(g) Turn right, fly heading 030° to grid 8576. Continue heading to grid 8576.

(h) Turn left to heading 210°, return to BP 22.

(i) Return to holding area.

SCENARIO: TARGET HANDOVERS

(A) FIRING POSITION 1

TGT 1	Type	=	2 T-80 Tanks, Moving South
	Azimuth	=	020°
	Range	=	7000 - 5000 m
	Method	=	Hellfire (LOAL HI, LOBL), CPG, TADS
TGT 2	Type	=	BMP Stationary
	Azimuth	=	015°
	Range	=	4200 m
	Method	=	2.75, COOP, 4 engagements, 1 pair each
TGT 3	Type	=	ZSU Stationary
	Azimuth	=	010°
	Range	=	3900 m
	Method	=	30 mm, CPG, TADS, 20 rounds

(B) FIRING POSITION 2

TGT 1	Type	=	T-80 Tanks, Stationary
	Azimuth	=	280°
	Range	=	2800 m
	Method	=	Hellfire (LOBL), CPG, TADS
TGT 2	Type	=	BMP, Stationary
	Azimuth	=	275°
	Range	=	2200 m
	Method	=	30 mm, PLT, IHADSS, 20 rounds (CPG identify and give handover to pilot)
TGT 3	Type	=	BMP, Stationary
	Azimuth	=	220°
	Range	=	5800 m
	Method	=	2.75, COOP, 4 engagements, 1 pair each

(C) TRAVERSING LOWLAND ROUTE

TGT 4	Type	=	BMP, Moving North
	Azimuth	=	315°
	Range	=	2500 - 1500
	Method	=	30 mm, CPG, TADS, 20 rounds

TGT 5	Type	=	BTR-60, Moving North
	Azimuth	=	240°
	Range	=	3000 - 2000 m
	Method	=	30 mm, CPG, TADS, 20 rounds

(D) FIRING POSITION 1

TGT 6	Type	=	T-80 Tank, Stationary
	Azimuth	=	220°
	Range	=	5000 m
	Method	=	Hellfire (LOAL), CPG, TADS