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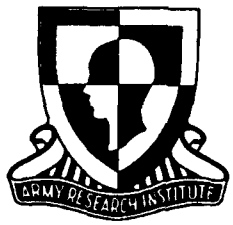

U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1620

Evaluation of a Prototype Platoon Gunnery Trainer for Armor Officer Basic Course Training

Ronald E. Kraemer
U.S. Army Research Institute

and

Dennis T. Wong
University of Louisville

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July 1992

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13. ABSTRACT *(Maximum 200 words)*

This research supports the U.S. Army Armor School's efforts to establish the effectiveness of a prototype Platoon Gunnery Trainer (PGT) for Armor Officer Basic Course (AOBC) training. To perform the research, (a) platoon-level skills that could be trained on the device were identified, (b) measures of performance (MOPs) and related methods of measurement and scoring that could be used to quantify changes in platoon-level skill proficiency were developed, and (c) a pilot test to validate and refine the MOPs and related methods was performed. A formal device evaluation for AOBC training was then conducted with 95 AOBC students. They were trained on the device in groups of 8 (except for one group of 7) as 12 separate tank platoons using 4 alternating iterations of the same offensive and defensive exercises. The results showed significant improvement (as measured by Tank Table XII type scores) in platoon tactical, gunnery, and summary performance (the criterion measures) across training trials for offensive and defensive training exercises, as well as for combined exercises. Linear trend analyses for all three measures indicated that student performance steadily improved across trials in rough proportion to the device training received.

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FOREWORD

A high priority of the U.S. Army is the efficient and cost-effective training of soldiers, crews, leaders, and units to fight and win in combat. To meet this goal, the Army is developing a Combined Arms Training Strategy (CATS) to provide direction and guidance on total force training and the mix of training resources required to achieve and sustain combat-ready forces. As part of CATS, the U.S. Army Armor School (USAARMS) is examining institutional and unit training events, their frequency, and the resources required to train to standard. To that end, the USAARMS seeks to identify the best mixture of training resources and ensure the training effectiveness of armor training aids, devices, simulators, and simulations (TADDS).

This research was performed by the Fort Knox Field Unit, U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) under the task and work unit entitled "Training Strategies for Gunnery Simulation." This task is supported by a Memorandum of Agreement dated 16 January 1989 titled "The Effects of Simulators and Other Resources on Training Readiness" with the U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Materiel Command (AMC), U.S. Army Armor Center (USAARMC) and Fort Knox, and ARI.

The research supports the efforts by USAARMS to establish the effectiveness of a prototype Platoon Gunnery Trainer (PGT) for Armor Officer Basic Course (AOBC) training. To accomplish the research, it was necessary to (a) identify the platoon-level skills that could be trained on the device, (b) develop measures of performance (MOPs) and measurement and scoring methods needed to quantify changes in platoon-level skill proficiency, and (c) conduct a pilot test to validate and refine the MOPs and related methods.

The results of the prototype PGT evaluation were briefed to the Chief, Gunnery Division, Weapons Department, USAARMS on 3 April 1992. They were also provided to the TRADOC Analysis Command at White Sands Missile Range on 21 April 1992 to support its ongoing Simulation/Simulator (SIM2) study to advance the development of future training strategies.

EDGAR M. JOHNSON
Technical Director

ACKNOWLEDGMENTS

The authors are indebted to the U.S. Army Research Institute for the Behavioral and Social Sciences Fort Knox Field Unit staff members who contributed their professional skills to this report. Billy L. Burnside provided valuable assistance in organizing the report and supervising the training capabilities assessment of the prototype platoon gunnery trainer. Dr. David W. Bessemer contributed valuable statistical guidance and direction. Mr. Merlin E. Allen provided technical expertise in the final production of training device graphics and drawings.

EVALUATION OF A PROTOTYPE PLATOON GUNNERY TRAINER FOR ARMOR OFFICER BASIC COURSE TRAINING

EXECUTIVE SUMMARY

Requirement:

This research examined the training effectiveness of a prototype Platoon Gunnery Trainer (PGT) used by the U.S. Army Armor School (USAARMS) to teach students in the Armor Officer Basic Course (AOBC) the fundamentals of tank platoon command, control, and fire distribution. The PGT, as outlined in the Armor Combined Arms Training Strategy (CATS), is to be used during the middle of 1994 to train section and platoon gunnery skills. This research was initiated at the request of the Weapons Department, USAARMS.

Procedure:

To evaluate the effectiveness of the prototype PGT for training AOBC student platoons, it was necessary to (a) determine the platoon-level skills that were trainable on the device, (b) develop measures of performance (MOPs) and related methods of measurement and scoring that could be used to quantify changes in platoon-level skill proficiency, and (c) validate and refine the MOPs and related methods developed based on the pilot test data obtained during AOBC device training. Platoon qualification (Tank Table XII) type scores were developed for assessing tactical, gunnery, and summary performance using the criteria contained in the M1 Tank Combat Tables (FM 17-12-1, C3) as the dependent variables. The tank platoon tactical scores were derived from observational ratings collected during AOBC device training exercises with a platoon summary scoresheet. The tank platoon gunnery scores were derived from the automated printout (Battle Run Summary) provided by the device on completion of a training exercise. The platoon summary performance scores were derived by combining tactical and gunnery performance scores. A biographical questionnaire was developed and used to collect student background characteristics. The effectiveness of the device for AOBC training was determined by analyzing the dependent measures and the order in which the AOBC student platoons trained on the device for both offensive and defensive training exercises, as well as for combined exercises.

Findings:

The results clearly support the training effectiveness of the prototype PGT in teaching AOBC students the fundamentals of

platoon command, control, and fire distribution. A significant improvement was found, as measured by Tank Table XII scores, in platoon tactical, gunnery, and summary performance across the trials in which the student platoons trained on the device. This improvement was found for both offensive and defensive training exercises, as well as for combined exercises. Linear trend analyses for these three criterion measures indicated that student performance steadily improved across training order in rough proportion to the training received on the device.

Utilization of Findings:

The results support the efforts by USAARMS to develop and integrate training aids, devices, simulators, and simulations (TADDS) into the Armor CATS for institutional and unit training. These findings should be of particular interest to the TRADOC Analysis Command at White Sands Missile Range (TRAC-WSMR) in its ongoing Simulation/Simulator (SIM2) study, as well as to other agencies responsible for the evaluation of training devices and simulators.

EVALUATION OF A PROTOTYPE PLATOON GUNNERY TRAINER (PGT) FOR ARMOR OFFICER BASIC COURSE (AOBC) TRAINING

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EVALUATION OF A PROTOTYPE PLATOON GUNNERY TRAINER (PGT) FOR ARMOR OFFICER BASIC COURSE (AOBC) TRAINING

Introduction

A high priority of the U.S. Army is the efficient and cost-effective training of soldiers, crews, leaders, and units to enable them to fight and win in combat. In the past, the Army has generally been able to rely on abundant training resources such as fuel, ammunition, live-fire ranges, and maneuver areas. However, significant political, social, and economic changes brought about by the disintegration of the Soviet Union have escalated budgetary and manpower constraints. Training at Army institutions and units in both the continental United States (CONUS) and U.S. Army Europe (USAREUR) is transitioning from the current device-supported, high operating tempo (OPTEMPO)/live-fire-based program to a device-based program with significantly reduced OPTEMPO/live-fire (U.S. Army Training and Doctrine Command [TRADOC], 1989). In this effort to increase training effectiveness and reduce training costs, training aids, devices, simulators, and simulations (TADSS) are being integrated into institutional and unit training.

Armor Combined Arms Training Strategy (CATS)

Armor School (USAARMS) at Fort Knox, Kentucky, is developing an Armor training strategy as part of the Combined Arms Training Strategy (CATS). This Armor CATS is described in the coordinating draft of the new Armor Branch Operational Concept (Chief of Armor, 1991) and delineated in the recent coordinating draft Training Circular TC 17-12-7 (U.S. Army Armor School [USAARMS], 1990a).

Overview. The Armor CATS provides a matrix illustration of training events and resources defined in existing doctrinal and training publications. In doing so, it presents an integration of training events, training frequencies, and training resources. The unit training strategy consists of maneuver, gunnery, and individual soldier training strategies for both the active component (AC) and the reserve component (RC).

Briefly, two significant efforts have been introduced into the overall training strategies for the FY 1994 (mid-term) and FY 1995 - 2000 (far-term) time frames in the Armor CATS. First, the TADSS that are expected to be available in each time frame are being identified and compared with the training events the TADSS will train. Second, in following the Army's crawl, walk, and run training philosophy, critical gates are being established whereby crews, platoons, companies, and battalions must execute training events in simulation to a fixed standard prior to executing the same events using full-caliber ammunition or OPTEMPO. When this is completed, it will require the demonstration of proficiency at designated critical gates prior to qualification (e.g., Combat Tables VIII and XII).

In terms of gunnery training strategies presented in the Armor CATS, TADSS have been designated for the gunnery train-up of crews, platoons, and companies to support success during live-fire qualification with full-caliber ammunition. In the mid-term time frame, the primary device identified for crew gunnery training (Tank Commander/Gunner [TC/GNR] pairs) is the Unit Conduct-of-Fire Trainer (U-COFT). A brief description of the U-COFT and its training effectiveness is presented in the following paragraphs. For a more detailed description of the U-COFT, training guidelines, and training programs, refer to Special Text ST 17-12-7-1 titled Unit Conduct-of-Fire Trainer Microstrategy (USAARMS, 1990b).

Use of U-COFT for TC/GNR Training

The purpose of the U-COFT is to increase and sustain the gunnery skills of TC/GNR teams. It does this by placing the teams in a realistically simulated crew station and presenting them with a range of computer-controlled engagement simulations (see Figure 1). An adaptive evaluation system scores performance and controls team progress through a training matrix. Each engagement exercise is scored in terms of target acquisition, reticle aim, and system management. These scores indicate the skill areas where crews are strong or need work. When a crew performs satisfactorily, the computer system automatically increases the complexity of the next scenario. The control center for the U-COFT is the instructor/operator station (IOS). At the IOS (see Figure 2), instructor/operators (I/Os) can begin an exercise, monitor crew performance, act as driver and loader, and instruct and critique crew performance.

The training effectiveness of the U-COFT has been addressed in a post-fielding training effectiveness analysis (PFTEA) of the M1 U-COFT (Hughes, Butler, Sterling, & Berglund, 1987). This study, which involved 357 crews from 6 tank battalions, found that M1 U-COFT trained crews in comparison with conventionally trained crews (a) demonstrated better tank crew coordination, (b) averaged significantly faster opening times (time to fire first round), and (c) obtained the same first round hit percentage. Results from a second live-fire qualification (Table VIII) fired by M1 crews--selected from the test battalions about three months later--found that crews that had progressed to at least reticle aim group three of the U-COFT matrix tended to improve their scores from the previous Table VIII (45 percent gained 100 points or more). By contrast, crews in lower reticle aim groups tended to lose points (41 percent lost at least 100 points).

In summary, the PFTEA results suggest that the U-COFT can provide a general indication of expected performance on live-fire exercises and compensate for a reduction in training ammunition. In a review of research findings on U-COFT transfer to live-fire performance (Morrison, Drucker, & Campshure, 1991), the authors concluded that U-COFT training transfers positively to live-fire gunnery performance. The degree to which U-COFT training can be substituted for live-fire gunnery remains to be determined.

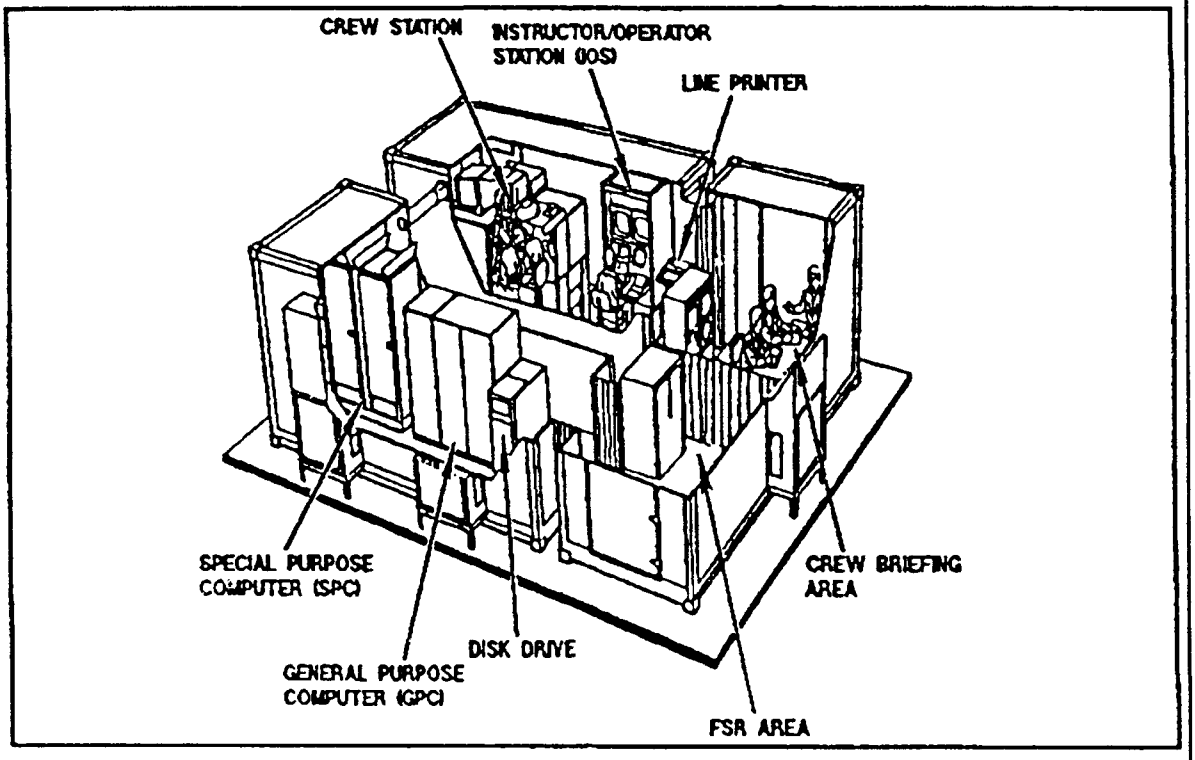

Figure 1. U-COFT major components.

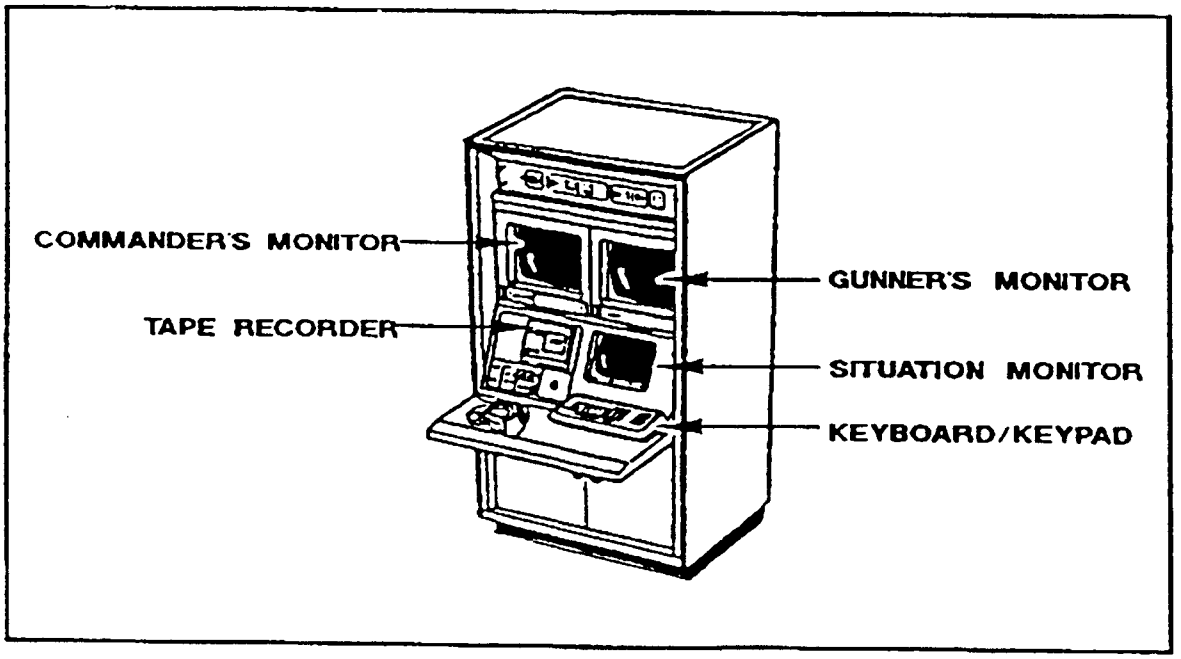

Figure 2. U-COFT Instructor Operator Station (IOS).

Need for a Platoon Gunnery Trainer (PGT)

The Armor CATS addresses platoon and crew-level performance requirements. In doing so, it becomes evident that the platoon, not the tank crew, is the basic element of armor firepower and maneuver critical to battlefield success. Observations reported from the National Training Center (NTC) support this focus by showing that success on the battlefield is directly determined by performance and training of tank platoons (Word, 1987).

While years of research have scrutinized tank crew-level performance, less effort has been directed towards establishing the skill requirements underlying tank platoon-level performance. Although platoon-level performance builds on the collective actions of individuals and tank crews, it is more than simply aggregating the performance of four tank crews. At crew-level, engagement speed and accuracy are largely a function of each crew's ability to acquire targets and complete proper target engagement procedures. At platoon-level, engagement speed and accuracy are not only a function of the tank crews' abilities but of the platoon leader's ability to command and control his tanks and distribute their fires within his assigned sector. Morrison, Meade, and Campbell (1990), for example, have recently identified three major functional areas which define platoon collective task performance; tactical movement as a unit, distribution and control of firepower, and internal and external communications.

A better understanding of platoon-level requirements and methods of assessing proficiency is essential for the development of optimal training strategies. Several research efforts have made notable strides towards untangling the complexities in this area. For example, Hoffman, Fotouhi, Meade, and Blacksten (1990) have developed a comprehensive crew and platoon gunnery test which includes both live-fire and simulation-based target engagements. Their methods of scoring combine "steel-on-target" outcome measures with process measures taken from a set of behaviorally anchored scales of crew and platoon-level gunnery performance. Kraemer and Bessemer (1987) have documented areas of improvement during simulation-based platoon gunnery training for the Canadian Army Trophy (CAT) competition. They found that dramatic improvements occurred in the areas of platoon command, control, and communications (C^3).

General Research Need

The Weapons Department, USAARMS, has acquired a prototype device called the Platoon Gunnery Trainer (PGT). This device, which also has been referred to as the M1 Unit Trainer 12 (UT-12) and the Linked-Conduct of Fire Trainer (L-COFT), consists of four U-COFTs linked together by a Platoon Data Computer (PDC). At the present time, the prototype PGT is being used to (a) train Armor Officer Basic Course (AOBC) students in the fundamentals of platoon command and control and fire distribution, (b) prepare AC and RC soldiers in Table of Organization and Equipment (TO&E) units (at commanders' discretion) for live-fire Tank Table XII

evaluation/qualification, and (c) familiarize students attending Armor Officer Advanced Course (AOAC) and Basic Noncommissioned Officer Course (BNCOC) with its training capabilities. In plans developed by the Weapons Department, future PGTs will be used to train students attending AOAC and the Advanced Noncommissioned Officer Course (ANCOC) at Fort Knox (USAARMS, 1991a).

Presently, there are no data that conclusively identify the training capabilities of the prototype PGT or demonstrate its training effectiveness. What is needed is a determination of the platoon-level skills that can be trained on the prototype device, development of measures of performance (MOPs) and related methods of measurement and scoring that can quantify changes in platoon-level skills performed on the training device, and the conduct of scientific research to determine its training effectiveness.

Background

PGT Device Development

Several versions of the prototype PGT are available for training at the USAARMS and in USAREUR. In May 1989, based on directions from the Commander, TRADOC to improve gunnery training methods for Tank Table XII, the USAARMC acquired the original version of the device. This version was developed under contract by the Simulation and Control System Department, Federal and Electronics Systems Division, General Electric (GE) Company.

In December 1989, USAREUR and Seventh Army, Combined Arms Training Center (CATC) contracted with GE to develop 2 additional PGTs. These prototype versions were to meet USAREUR's specific training needs for platoon qualification during CAT, a highly prized North Atlantic Treaty Organization (NATO) competition. The first version was to be built using the existing imagery from the M1 U-COFT, but with software designed to closely resemble the visual environment or database for the middle course (lanes 2, 3, 4, and 5) of Range 301 at Grafenwoehr, Germany. Range 301 is one of the live-fire gunnery ranges used for platoon qualification on Tank Table XII. The second version was to be built with enhanced imagery (PT2000). This imagery was to provide a more realistic terrain database and allow for more target presentations (up to 14 target arrays instead of 9) than those present in the current USAARMS's PGT.

Future PGT Device Development

The Directorate of Training Development (DOTD), USAARMS, has recently revised its training device requirement (TDR) for the M1/M1A1/M1A2 Main Battle Tank U-COFT (USAARMS, 1991b). This TDR, approved by the Deputy Chief of Staff for Research, Development and Acquisition, requires the U-COFT systems to be networked (where two or more battalions are located on an installation) to allow units to train section/platoon gunnery skills through Tank Table XII.

Among the list of essential improvements outlined in the TDR for the PGT are (a) a European and Desert database, (b) a freeze capability to allow student errors to be corrected instantly by instructors, (c) the capability to record and playback TC and GNR sight pictures during training exercises, (d) the capability for crews to acquire 4 targets simultaneously (8 in a section and 12 in a platoon training mode), (e) training exercises capable of displaying 20 targets for a crew, 30 for a section, and 60 for a platoon at specified points on the terrain database per exercise, and (f) a vastly improved communication network. Also included is a supplementary device capability to permit the generation, modification, and authoring of new scenarios for the COFTs. This unique capability is for use by the proponent and to be located at the USAARMC only.

Description of USAARMS Prototype PGT

A brief description of the major components and system capabilities of the USAARMS prototype PGT is presented below. A graphical depiction of the device is shown in Figure 3.

Major Components. The USAARMS's PGT consists of 4 M1 U-COFTs and a PDC which links all of the components together. The major components of the system are:

1. I/O stations through which the I/Os can initiate the training exercises, monitor crew-level performance, and interact with the TC/GNR teams during an exercise.

2. Special purpose computers which produce the full color and motion scenes displayed in the crew station sights during a training exercise, as well as the aural cues.

3. Tank crew stations that simulate controls, indicators, and sights required for training crew duties of the TC/GNR teams.

4. General purpose computers which provide control between station components and manage the training and evaluation system.

5. Printers which provide users with hard copies of monitor and performance display pages.

6. Disk drives which provide the programming required to run the training exercises.

7. A PDC to provide synchronized control between the four general purpose computers which can receive, sort, calculate, and transmit data back to each general purpose computer for use in the training and evaluation system.

8. A company commander (CO) station containing a situation monitor for each TC/GNR team through which the CO can begin an exercise, interact by radio with the platoon leader, and monitor crew-level performance.

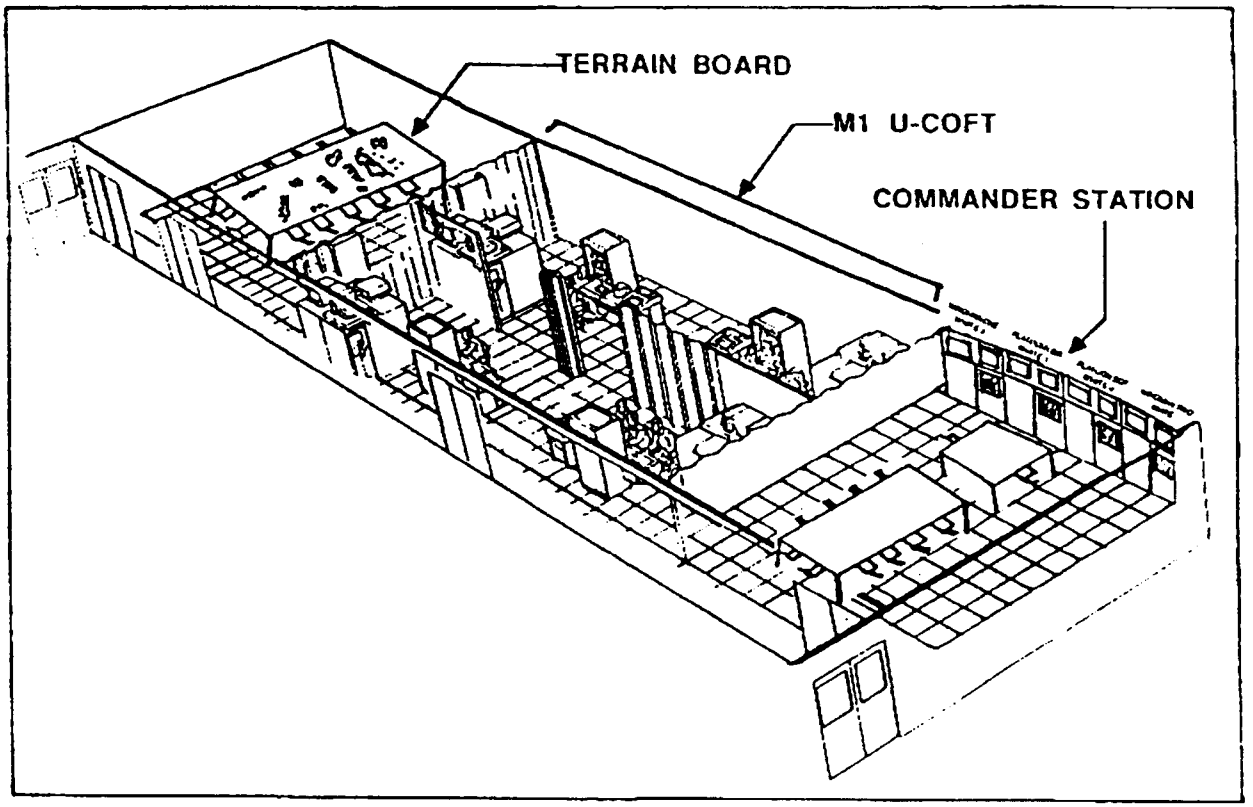

Figure 3. USAARMS prototype Platoon Gunnery Trainer (PGT).

System Capabilities. The prototype PGT provides 6 offensive and 6 defensive training scenarios or exercises. The target visibility conditions and target simulations for each exercise are the same as those currently present in the M1 U-COFTs. The terrain database is approximately 3 kilometers in width and 6 kilometers in depth. It is designed to simulate the natural terrain vegetation, lane surfaces, range markers, and the firing positions found on Range 301. The ability to move one's own tanks through the database is simulated (tanks move and stop under the control of I/Os), as are all target presentations. The device measurement capabilities are essentially the same as those present in the M1 U-COFT, with each exercise performance scored using the gunnery criteria in FM 17-12-1 (Department of the Army [DA], 1988a). A Battle Run Summary can be printed at the end of an exercise to provide a platoon performance record. Playback of an exercise is not possible, but a tape recorder on the IOS panel can be used to replay radio intercom communications. For a more comprehensive description of the device located at the USAARMS, refer to the Instructor's Utilization Handbook (GE, 1990).

PGT Training Applications

Institutional training and unit training are linked through the CATS and supported by the same TADSS capability. As outlined in the Armor CATS for the mid-term time frame, the PGT is to be used for training platoon gunnery in BNCOC, ANCOC, AOBC, AOAC,

and the Precommand Course (PCC). As discussed in the TDR for the M1/M1A1/M2 Main Battle Tank U-COFT, the systems will be networked where two or more battalions are located on the same installation to permit units to train section and platoon gunnery skills through Tank Table XII.

PGT Training Strategy in AOBC

Training is scheduled for one 4-hour and 8-hour period using 8 AOBC students to function together as a tank platoon (4 TC/GNR pairs). Most of the first 4-hour period is spent in a classroom where the students receive instruction in both platoon tactical and gunnery procedures. This instruction is usually provided by a senior noncommissioned officer (NCO) and includes the use of a sandtable and charts that replicate the terrain database. During the last 30 minutes, the students get into the 4 M1 U-COFTs and engage targets as a tank platoon. The second 8-hour period takes place about 2 weeks later. The first hour is in the classroom where the 8 AOBC students establish a training order for rotating through the different leadership positions, learn how the system operates, record the CO's operation order (OPORD), and perform platoon fire planning. The last 7 hours are spent on the device conducting 4 iterations of an offensive and defensive exercise. During this time, the students receive both tactical and gunnery assistance by the I/Os at their M1 U-COFT stations. The student at the platoon leader position receives additional tactical assistance by the CO. At the end of each exercise, or pair of exercises, the students receive a 15 minute after action review (AAR) which is conducted by the CO based on his notes and the Battle Run Summary printout.

Purpose of the Research

The purpose of this research is to evaluate the prototype PGT for AOBC training. To accomplish this, it was necessary to:

1. Determine the platoon-level skills that can be device trained based on the Army Training and Evaluation Program Mission Training Plan (ARTEP MTP) for the tank platoon (DA, 1988b).

2. Develop the platoon-level measures of performance (MOPs) and related measurement and scoring methods that can be used to quantify changes in platoon-level skill proficiency.

3. Validate and refine the platoon-level MOPs and related measurement and scoring methods by conducting a pilot test.

Approach

Identification of Prototype PGT Training Capabilities

A two step approach was followed to determine the training capabilities of the prototype PGT. The first step was to perform a user assessment by conducting individual and group interviews

with I/Os and subject matter experts (SMEs) who are responsible for training AOBC students on the device. The second step was to conduct an ARI assessment by using the rule-based methodology developed by Burnside (1990) in assessing the capabilities of the Simulation Networking (SIMNET) System.

User Assessment. Individual interview sessions were held on consecutive days with 2 civilian SMEs who operated the IOS on the M1 U-COFT during device training. Each session took place at the training site and lasted about 4 hours. After they were given a brief overview of the ARI research, the SMEs were handed a copy of the ARTEP MTP for the tank platoon and asked to identify the collective tasks, subtasks, and standards that can be trained on the device. Based on their decisions, an initial list of ARTEP MTP tasks was compiled for use during the group interviews.

The first group interview session lasted about 4 hours and was held with 9 participants; 8 senior NCOs who served as I/Os on the M1 U-COFT and 1 Armor officer who was the principal CO during device training. After they were provided a brief overview of the ARI research, they were asked a series of questions aimed to capture information on (a) the tactical and gunnery skills demonstrated by good and poor tank platoons, (b) ways in which those skills can be assessed or quantified, and (c) how these platoon skills are currently being trained in both the schoolhouse and armor units. This questioning focused on three overlapping areas in the platoon-level skills domain; skills required for prototype PGT performance, skills required for Tank Table XII performance, and the skills required in actual tank platoon combat.

Following this discussion, each participant was given a copy of the initial ARTEP MTP collective tasks compiled from the SME interviews and asked to independently (a) identify those tasks that can be trained on the device and (b) specify any other tasks that they thought could be trained but were not identified on the list. After compiling their decisions, a second session was held to discuss their disagreements about which tasks could be trained and to arrive at a group consensus. As a result of this session, a final collective task list was prepared and a copy provided to their branch chief. In general, the user assessment showed that about 9 of the 59 total ARTEP MTP tasks for the tank platoon can be trained on the prototype PGT. They indicated, however, that more collective tasks could be trained if the device software was upgraded to allow tanks to maneuver as part of tank sections in the training exercises. They also remarked that improvements in the current radio system would help reduce command and control errors by enhancing tank crew and TC-platoon leader interactions.

ARI Assessment. Three members of the ARI staff conducted a training capabilities assessment of the prototype device using the rule-based methods developed by Burnside (1990). This was accomplished by reviewing the list of ARTEP MTP tasks for the tank platoon, along with the task list from the user assessment, and rating the degree to which each task standard can be met on the device. Task standards were rated as either highly supported

(H), partially supported (P), minimally supported (M), or not supported (N). After these ratings were made, the ratings were consolidated into subtask and task ratings using the method's decision rules (see Burnside, Tables 2 and 3).

Based on the method's criterion that a task must be at least partially performable (i.e., have an "H" or "P" rating) on the device in order for it to be considered trainable, the results of the ARI capabilities assessment showed that only 8 of the 59 (13.5%) ARTEP MTP collective tasks for the platoon were trainable on the prototype PGT. Two of these 8 tasks were rated as highly supported (H) and 6 were rated as partially supported (P).

Summary. In follow-up discussions with the I/Os and SMEs who participated in the user assessment, they generally agreed with the results of the ARI assessment. They also agreed that the 8 tasks identified in both assessments, along with their associated subtasks and standards, provided a sound basis for developing platoon tactical MOPs.

In retrospect, the authors feel that the ARI assessment provides only a partial answer to what can be trained using the prototype PGT. The device was not developed to train the ARTEP MTP collective tasks for the tank platoon. It was developed to help improve training methods for platoon gunnery qualification on Tank Table XII. A separate and similar assessment should be conducted to address the tank gunnery tasks in FM 17-12-1. This combined approach would be consistent with the maneuver and gunnery strategies presented in the Armor CATS.

Development of Performance Measures (MOPs)

There are two methods of performance measurement that can be used to quantify changes in device proficiency; observational and automated. The observational method permits data to be collected manually using structured scoresheets while the automated method allows data to be collected using the recording capabilities of the training device. For this evaluation, both methods were used to measure platoon tactical and gunnery proficiency.

Tactical Performance. Tactical MOPs were developed at three levels of platoon performance; the tank crew, platoon leader, and tank platoon. An initial list of tactical MOPs was developed by examining the ARTEP MTP tasks, subtasks, and standards trainable on the prototype PGT. Additional tactical MOPs were included by examining tank crew and platoon leader behaviors identified by Drucker and Campshure (1990) for both offensive and defensive missions. The lists were further tailored by incorporating MOPs judged suitable from (a) the Exercise/AAR Checklist used by the PGT gunnery training staff (see Appendix A) and (b) the Tactical Proficiency Checklists used for Tank Combat Tables XI and XII (see FM 17-12-1, C3). To ensure coverage and accuracy at each performance level, the tactical MOPs were reviewed with the I/Os and SMEs who conduct training using the device. The doctrinal references used in this review were the Field Manual 17-15-3,

Tank Platoon SOP (USAARMC, 1985) and Training Circular 17-5-5, Handbook for M48A5, M60A1 Tank Platoon (DA, 1978). The MOPs developed at the 3 platoon performance levels are shown below.

Table 1

Measures of Performance (MOPs) for Evaluation of the Prototype PGT for AOBC Training at Three Levels of Performance Assessment

Label	Measures of Performance (MOPs)	Level C	L	P
OPFRAGO:	Issues OPORD or FRAGO to platoon		X	X
SCANS:	Scans overlapping firing sectors for targets	X		X
ORIENT:	Keeps weapons oriented in direction of enemy	X		X
INFORM:	Keeps elements informed of battlefield events	X	X	
ISSUES:	Issues clear-concise-complete orders to TCs		X	
ACKNOW:	Acknowledges platoon leader's orders	X		
CONTROL:	Reports control measures (LD, PLs)	X	X	X
MOVESET:	Orders TCs to "move and set" at each CP/BP		X	
SET:	Reports when "set" at each CP/FOX (4) or BP (3)	X	X	X
FRIEND:	Reports friendly elements on the battlefield	X	X	X
RADIO:	Uses brief-secure radio transmissions	X	X	X
FIRES:	Returns fire immediately on enemy contact	X		X
FIRECMD:	Issues complete-accurate crew fire commands	X	X	X
FIRECOM:	Issues complete-accurate platoon fire commands		X	X
CONTACT:	Sends complete-accurate-timely contact reports	X	X	X
INDFIRE:	Calls for indirect fires when assaulting FOX		X	X
SMOKE:	Orders TCs to "pop smoke" when displacing to BPs		X	
POPS:	Uses tank smoke when displacing to each BP (3)	X	X	X
GETSPOT:	Obtains complete-accurate-timely spot reports		X	
SPOT:	Sends complete-accurate-timely spot reports	X	X	X

Note. C = tank crew; L = platoon leader; P = platoon

As shown in Table 1, some tactical MOPs are appropriate at only one level of platoon assessment. For example, tank crews are not assessed on issuing an OPORD or FRAGO, keeping elements informed of battlefield events, or issuing platoon fire commands. Likewise, the platoon leader is not evaluated on scanning for targets, keeping weapons oriented, or returning immediate fire. These actions can be performed by him but are normally delegated to his tank gunner. The 6 MOPs not applicable at the platoon level of performance can be seen in Table 1.

Gunnery Performance. The device provides an automated method of measuring platoon gunnery in the form of a Battle Run Summary (see Appendix C). This Battle Run Summary identifies the gunnery performance of each tank crew and the platoon during a training exercise. For evaluation, it can be used to assess tank crew and platoon firing accuracy (targets presented divided by targets killed), overkills (targets hit by two or more crews), and platoon fire discipline (targets engaged out of sector).

As a final note, the prototype training device is used in AOBC to teach students the fundamentals of platoon-level command, control, and fire distribution. The students rotate through the different leadership positions within a platoon (TC, GNR, platoon sergeant, platoon leader) with each serving as the platoon leader or platoon sergeant just once. The learning that may occur as a result of being in these positions is incidental to the primary purpose of the training event; these positions must be manned in order to conduct platoon training on the device. For the purpose of this research, only the tank platoon summary scoresheet was used to evaluate the device for AOBC platoon-level training. If future research is needed to evaluate the device for TO&E units, then the crew and platoon leader scoresheets can be used as well.

Development of Measurement and Scoring Methods

Measurement Methods. To measure performance of the platoon tactical MOPs being trained on the device, different measurement methods were developed and tested by having the I/Os assess AOBC student performance using the 3 observational scoresheets. The first measurement method developed required the I/Os to check the MOPs on the scoresheets using a pass-fail criterion. After one day of testing 8 platoon rotations, the I/Os indicated that they could not use the method with the present scoresheets; some MOPs listed were performed more than once during a platoon offensive or defensive training exercise. For example, one of the MOPs for the platoon leader during an offensive exercise was to report when "set" at each designated checkpoint (CP). Because there were 4 CPs, this MOP could be "passed" or "failed" at different times in a training exercise.

To resolve this problem, without having to use a lengthy and duplicated list of MOPs at each level of platoon performance, a second measurement method was developed. This method used the same pass-fail criterion but required the I/Os to also indicate the percent of time each MOP was passed. For example, if the MOP was to report when "set" at each of the four CPs, the I/Os were to (a) check "passed" if the MOP was performed correctly, and (b) write down whether it was performed once (25%), twice (50%), three times (75%), or all four times (100%) during the exercise. If it was not performed, the I/Os were to check "failed". After a second day of testing 8 platoon rotations, the I/Os indicated they could use the method but were not confident in the accuracy of their scoring. This lack of scoring confidence was confirmed by analyzing the scoresheets; most time percentages generally disagreed with the number of times the measure occurred during a training exercise (e.g., time estimates of 35%, 80%, etc.).

As a result of these efforts, a third measurement method was developed and tested using AOBC students. This method required the I/Os to use a five-point rating scale to indicate whether the MOPs on the scoresheet were performed correctly during a platoon training exercise. They were to circle a (1) if it was Always performed correctly; a (2) if it was Usually performed correctly; a (3) if it was performed correctly About Half the time; a (4) if

it was Seldom performed correctly and a (5) if it was Never done correctly. To provide for more accurate data, MOPs that could only be rated as either Always, About Half, or Never performed correctly were identified by placing a dash under the appropriate column heading. In addition, a type of job aid was added at the bottom of each scoresheet to indicate the percent of time associated with each rating scale. That is, Always was 100%, Usually was 67% or More, About Half was 34 to 66%, Seldom was 33% or less, and Never was 0%. After trying out this method over a 3-day test period (24 platoon rotations), the I/Os indicated that they could use the five-point rating scale to assess the MOPs listed on the scoresheets. This consensus was confirmed by examining the scoresheet and finding very few rating errors. Consequently, this measurement method was adopted for evaluating platoon tactical performance on the prototype device. A copy of the structured scoresheets (with the respective MOPs, five-point rating scale, and job performance aid) is shown in Appendix B.

Scoring Methods. Three methods of scoring platoon-level performance were generated using the data collected during the development of the five-point rating scale method of measurement. The first scoring method was to award points based on the ratings provided for each MOP listed on the platoon summary scoresheet. In awarding points, a MOP rating of Always was worth 4 points, Usually 3 points, About Half 2 points, and Seldom 1 point. No points were awarded if a MOP was rated as Never performed. By summing the points, this method provided a platoon tactical points score (T-PTS) for both types of training exercise.

The second method of scoring was to award points based on the number of target "kills" divided by the number of targets presented (46 for offense, 41 for defense) during a training exercise, as indicated on the Battle Run Summary. By summing the points, this method provided a platoon gunnery points score (G-PTS) for both types of training exercise.

The third method of scoring was based on the procedures used to evaluate live-fire platoon performance on Tank Table XII. First, to provide a Tank Table XII type platoon tactical score (TSUM), the platoon tactical points score (T-PTS) was divided by the total points possible during an exercise (52 for offense and 48 for defense) and then multiplied by 200. Second, to provide a Tank Table XII type platoon gunnery score (GSUM), the platoon gunnery points score (G-PTS) was multiplied by 300. Third, to provide a Tank Table XII type platoon summary score (XIISUM), the Tank Table XII type platoon tactical (TSUM) and gunnery (GSUM) points score were added together.

Summary. A method of collecting observational performance data was developed to quantify changes in tank platoon tactical proficiency on the prototype PGT by AOBC students. This method involved using structured scoresheets which contained a list of tactical MOPs identified for the tank crew, platoon leader, and tank platoon along with a five-point rating scale. To score the observational data, and the automated gunnery data provided by

the device, three scoring methods were developed. These methods resulted in 3 platoon criterion measures: (a) a Tank Table XII type tactical score (TSUM), (b) a Tank Table XII type gunnery score (GSUM), and (c) a Tank Table XII type summary performance score (XIISUM). Again, for the purpose of this research, only the platoon summary scoresheet was used for evaluation.

Pilot Testing

The purpose of the pilot test was to validate and refine the platoon-level MOPs and related methods of measurement and scoring that were developed for evaluation of the prototype PGT for AOBC training. The two secondary purposes were to determine (a) the interrater reliability of the platoon summary scoresheet ratings provided by an ARI and a CO rater and (b) the improvement in tank platoon tactical, gunnery, and summary performance by the AOBC students as a result of device training.

Procedure. Following the training strategy described earlier, 2 platoons composed of 15 AOBC students were trained on the device on 2 consecutive days. The ARI investigator sat at the CO's station, observed the 8 TC/GNR monitors, and listened to the radio messages between the CO and platoon leader on the situation monitor. During each set of target presentations, 8 in offensive and 6 in defensive exercises, he tabulated whether the MOPs were performed correctly (Y/N). When an exercise ended, he averaged the responses and then circled the appropriate rating on the platoon summary scoresheet. The CO conducted the training and completed his scoresheet ratings after each exercise was completed. The I/O at the IOS provided the ARI investigator with a copy of the Battle Run Summary at the end of each exercise. The CO provided the ARI investigator with his scoresheets after all students were trained on the device. All data collection efforts performed during the pilot test were accomplished on a non-interference basis.

The pilot test data were analyzed using the Statistical Package for the Social Sciences (SPSS/PC+, 1988). The statistics were judged to be statistically significant with $\alpha = .05$. The data were analyzed to examine (a) interrater reliability of the ratings provided by two independent raters for each of the 14 MOPs, and on the average, and (b) improvement in tank platoon tactical, gunnery, and summary performance (as measured by the 3 criterion measures) by platoon training order for both types of exercise (offensive and defensive). Although the Pearson correlation coefficient was used to examine these relationships, statistical tests of significance were determined inappropriate because the platoons were not independent groups for each order of training. The t-test, however, was appropriate and used to test the average interrater reliability coefficient to determine if it was significantly different from zero.

Results. Two revisions were made to the MOPs as a result of the pilot test. First, a MOP was added to the platoon summary scoresheet to address issuing the OPORD or FRAGO. Second, for

future research with TO&E units, the wording of the MOPs on the tank crew and platoon leader scoresheets were changed to reflect the platoon summary scoresheet. As to related measurement and scoring methods, the five-point rating scale was revised to reflect the scoring methods developed for the platoon summary scoresheet. That is, the five-point scale was changed to show a (4) for Always, (3) for Usually, (2) for About Half, (1) for Seldom, and (0) for Never.

The results of the interrater reliability analyses showed a positive relationship between the ARI and CO ratings on all 14 MOPs. The average reliability coefficient, based on Fisher's Z-transformation of Pearson's correlation, was highly significant, $t(13) = 3.23$, $p = .003$. Despite having only two platoons, all but 3 MOPs (INFORM, SET, FIRES) correlated significantly between raters (see Appendix D).

The 3 criterion measures for platoon tactical (TSUM), gunnery (GSUM), and summary performance (XIISUM) also showed a positive relationship by training order. The correlations found were .21 for TSUM, .60 for GSUM, and .58 for XIISUM. No tests of significance were conducted due to the small sample size.

In summary, the platoon-level MOPs and related measurement and scoring methods developed for evaluation of the prototype PGT for AOBC training were validated and refined. Pilot test results showed that (a) platoon tactical proficiency, as identified by the 14 MOPs, can be measured and scored using the platoon summary scoresheet, (b) platoon gunnery proficiency, as defined by the percent of kills during an exercise, can be determined using the data contained in the Battle Run Summary, (c) 3 Tank Table XII type criterion measures, based on the formulas contained in FM 17-12-1, can be used to evaluate platoon tactical, gunnery, and summary performance, and (d) the ARI investigator ratings, based on the results of the interrater reliability analyses, can be used to evaluate the prototype device for AOBC training.

Prototype PGT Evaluation

Subjects. Twelve platoons composed of 95 students attending AOBC at Fort Knox during January and February, 1992 participated in the prototype PGT evaluation. The students were from 3 separate AOBC classes and trained on the device during the day session only. The number of students from each class were 40, 31, and 24 respectively. Besides the 1 Allied (foreign officer) student, 44 were in the Active Component and 50 in the Reserve Component.

The average age of the AOBC students was 23.25 years, with the range extending from 21 to 28 years. Their median time in military service was 10.00 months, with the range extending from 0 to 121 months. Their average M60A3 tank experience prior to AOBC was 1.35 months, with the range extending from 0 to 24 months. Their average M1 tank experience prior to AOBC was .50 months, with the range extending from 0 to 17 months. Their

average training device experience was 36.83 hours, with the range extending from 36 to 54 hours. Most of this training device experience was on the M1 U-COFT, which averaged 36.04 hours. None of the students had received previous training on the prototype PGT. A summary of the AOBC student biographical questionnaire data is presented in Appendix E.

Instructors. A mix of 5 military and civilian instructors conducted device training for the AOBC students. The chief instructor was a senior NCO who served as the designated CO at the commander's station for all exercises. He was responsible for conducting the one hour of preparatory classroom instruction, guiding the platoon leaders through the exercises using prompting and immediate feedback methods, and conducting the platoon AARs. The assistant instructor (AI) was located at the IOS and was the I/O for the platoon leader M1 U-COFT. He was responsible for preparing and initializing the system, serving as the CO's Fire Support Officer in training exercises, giving instructions to platoon leaders and their gunners during an exercise, and generally assisting the CO during the conduct of classroom instruction and the AARs. The three remaining instructors were responsible for serving as I/Os at the other M1 U-COFT stations. During each training session, they were the principal source of instruction for the TC/GR teams. The assistance they provided was in the form of tactical and gunnery comments to the students, assessing their major problem areas, and suggesting different methods which might help them solve these problems.

Device Training. Training on the prototype platoon gunnery device is scheduled for a group of 8 AOBC students (i.e., one platoon) for 8 hours with a 10 minute break each hour. The first hour of training is held in the classroom by the designated CO and used to (a) familiarize the students with the gunnery system and training procedures, (b) issue the OPORD for conducting a tank platoon offensive exercise, (c) allow students to prepare individual platoon fire plans, and (d) let the students establish a training order within the group for rotating through the different platoon leadership positions. The last 7 hours are spent training on the device using 4 iterations each of the same offensive and defensive exercises. The instructional strategy used during training can best be described as a team approach. During an exercise, the AOBC students are given instructions in platoon tactics and gunnery by the designated CO as well as the I/Os located at each M1 U-COFT station. At the end of an offensive and/or defensive training exercise, which average about 35 minutes, the CO gives the students an AAR of their performance. This AAR is based on the CO notes taken during the exercise and supported by the Battle Run Summary printout.

Data Collection. Two types of performance measurement data were collected throughout the evaluation of the device for AOBC training; observational and automated. Observational data were collected using the platoon summary scoresheet (see Appendix B). This scoresheet was completed by the ARI investigator during the conduct of each training exercise. A copy of the Battle Run

Summary, the automated device data, was obtained from the AI after each training exercise (see Appendix C). After all of the students completed training, a biographical questionnaire was administered by the ARI investigator (see Appendix E).

Performance Scoring. Device performance was scored using data from both the platoon summary scoresheet and the Battle Run Summary. A platoon tactical points score (T-PTS) was derived for the types of exercise by summing the rating points awarded for each MOP. A platoon gunnery points score (G-PTS) was derived for the types of exercise by dividing the number of targets killed by number of targets presented (46 for offense, 41 for defense), as shown on the Battle Run Summary printout. A Tank Table XII type platoon tactical points score (TSUM) was derived by dividing the T-PTS score by the total points possible during an exercise (52 for offense and 48 for defense) and multiplying by 200. A Tank Table XII type platoon gunnery points score (GSUM) was derived by multiplying the G-PTS score by 300. A Tank Table XII type platoon summary points score (XIISUM) was derived by summing the TSUM and GSUM scores.

Data Analyses. The data were analyzed using procedures in the Statistical Package for the Social Sciences (SPSS/PC+, 1988). In the data analyses, the test statistics were judged to be statistically significant with $\alpha = .05$. The data were analyzed by platoon training order for offensive and defensive training exercise and for both types combined to determine if performance (a) improved on each of the 14 MOPs, (b) improved on each of the performance scores, and (c) showed a positive linear trend. The test statistics used for the data analyses were the t-test and a trend analysis conducted within a multivariate analysis of variance (MANOVA). Individual Pearson correlation coefficients were not tested because of non-independent groups for each training order. Descriptive statistics were used to summarize the questionnaire data.

Results

The results are presented in Tables 2 and 3. Table 2 shows the means for the 14 MOP ratings, platoon tactical points score (T-PTS), platoon gunnery points score (G-PTS), and Tank Table XII type scores for platoon tactical (TSUM), gunnery (GSUM), and summary performance (XIISUM) by platoon training order and types of training exercise. Table 3 presents the Pearson correlation coefficients for the MOPs and 3 criterion measures (TSUM, GSUM, XIISUM) by platoon training order and types of training exercise.

Tactical Performance. Platoon tactical performance was measured by the 14 MOPs, platoon tactical points score (T-PTS), and the Tank Table XII type score (TSUM) by platoon training order and types of training exercise. As shown in Table 2, most of the 14 MOPs improved by platoon training order for both types of exercise. Mean data from the first to last platoon training order for both types of exercise indicated that all MOPs, except

Table 2

Means for Measures of Performance (MOPs) Ratings, Point Scores, and Tank Table XII Type Scores by Platoon Training Order and Types of Prototype Platoon Gunnery Trainer (PGT) Exercise

	Platoon Training Order							
	Offense				Defense			
Measures	1	3	5	7	2	4	6	8
MOPs								
OPFRAGO	4.00	3.33	4.00	4.00	3.67	3.67	4.00	4.00
SCANS	2.08	2.83	3.00	3.67	2.17	3.00	3.25	3.73
ORIENT	2.83	3.00	3.17	3.67	2.42	3.00	3.33	3.64
INFORM	2.33	2.50	3.42	3.58	2.75	3.25	3.42	3.73
CONTROL	2.00	2.17	3.08	3.25	2.00	2.67	3.00	3.36
SET	2.75	2.42	3.25	3.42	3.17	3.42	3.75	4.00
FRIEND	.83	1.50	1.50	2.33	--	--	--	--
RADIO	2.17	2.67	3.58	3.50	2.50	3.33	3.58	3.55
FIRES	2.50	3.00	3.33	3.92	2.67	3.33	3.83	3.91
FIRECOM	1.92	2.50	2.92	3.33	2.33	2.92	3.33	3.55
CONTACT	1.67	2.25	3.00	3.00	2.08	2.67	3.25	3.36
INDFIRE	2.67	3.33	3.00	3.67	--	--	--	--
SMOKE	--	--	--	--	2.67	3.83	4.00	3.91
SPOT	1.92	2.67	3.17	3.67	2.67	2.83	3.67	3.73
Points								
T-PTS	29.67	34.17	40.42	45.00	31.08	37.92	42.42	44.45
G-PTS	48.37	59.42	57.97	61.96	51.02	61.38	59.35	60.09
TT XII								
TSUM	114.10	131.41	155.45	173.08	129.51	157.99	176.74	185.23
GSUM	145.11	178.26	173.91	185.87	153.05	184.15	178.05	180.27
XIISUM	259.21	309.67	329.36	358.95	282.56	342.13	354.78	365.49

Note. N = 12 except for last (8) training order (N = 11).

OPFRAGO for offense, improved markedly. Also, the means for the T-PTS and TSUM scores increased by training order for both types of training exercise.

As shown in Table 3, all but 2 of the 14 MOPs (OPFRAGO and INDFIRE) had sizable correlations with platoon training order for both types of exercise and when the exercises were combined. The average correlations--based on Fisher's Z-transformation of Pearson's correlation--were found to be highly significantly different from zero for offense, $t(13) = 7.07$, $p = .000$, defense, $t(13) = 9.01$, $p = .000$, and combined exercises, $t(13) = 8.06$, $p = .000$. The TSUM score also correlated highly with tank platoon training order for both individual and combined exercises.

Table 3

Pearson Correlation Coefficients for Measures of Performance (MOPs) Ratings and Tank Table XII Type Scores by Platoon Training Order and Types of Prototype Platoon Gunnery Trainer Exercise

Measures	Correlation with Platoon Training Order Offense	Defense	Combined
MOPs			
OPFRAGO	.09	.18	.13
SCANS	.77	.70	.73
ORIENT	.54	.63	.56
INFORM	.59	.57	.59
CONTROL	.55	.40	.46
SET	.38	.40	.43
FRIENDLY	.37	--	.37
RADIO	.63	.51	.58
FIRES	.74	.73	.74
FIRECOM	.50	.58	.54
CONTACT	.57	.53	.57
INDFIRE	.18	--	.18
SMOKE	--	.41	.41
SPOT	.69	.58	.65
AVERAGE	.54***	.54***	.52***
TT XII			
TSUM	.69	.77	.74
GSUM	.46	.32	.39
XIISUM	.68	.63	.67

Note. The average correlation coefficient, based on Fisher's Z-transformation of Pearson's correlation, was tested with a t-test.

***p<.001, two-tailed.

Gunnery Performance. Platoon gunnery performance on the device was measured by the gunnery points score (G-PTS), which indicated the percent of target "kills" by all four tank crews in the platoon, and the Tank Table XII type score (GSUM) by platoon training order and types of training exercise. As shown in Table 2, the GPTS and GSUM scores generally increased across training order by types of training exercise. Moreover, it can be seen that both of these measures increased from the first to the last platoon training order for both types of exercise. As shown in Table 3, the GSUM score moderately correlated with platoon training order for both types of training exercise and when the exercises were combined.

Summary Performance. Platoon summary performance on the device was measured by the Tank Table XII summary score (XIISUM) by platoon training order for both types of training exercise. As shown in Table 2, the XIISUM score improved across training order for both types of exercise. As shown in Table 3, the XIISUM score also correlated highly with platoon training order for both types of training exercise and when combined.

Trend Analyses on Performance Scoring. Figure 4 depicts the Tank Table XII type scores for TSUM, GSUM, and XIISUM by platoon training order. To examine the changes in performance for the 3 criterion measures, trend components were tested in repeated-measures analyses of variance (ANOVAs) using the multivariate analysis of variance (MANOVA) procedure available in SPSS/PC+. Platoon training order served as the repeated-measures factor. A detailed description of the statistical procedures used for these analyses are presented in Appendix G.

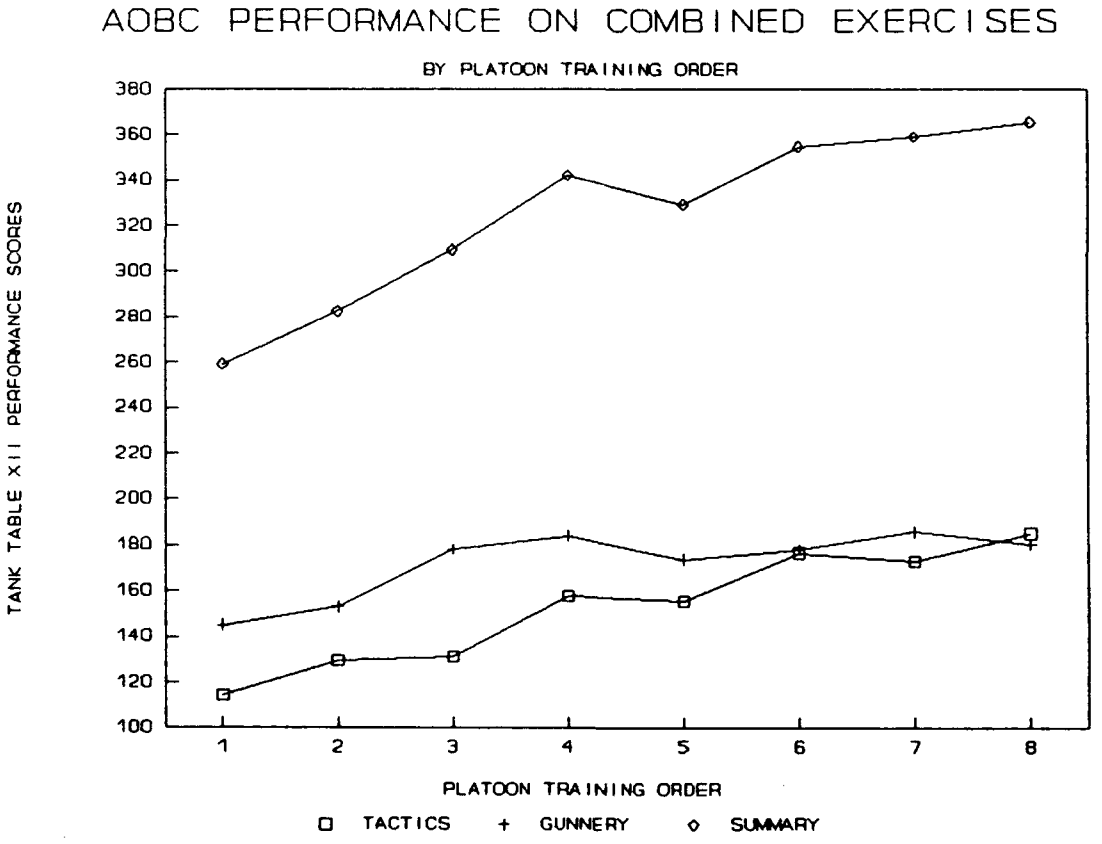

Figure 4. AOBC performance on combined exercises.

A significant platoon training order effect was found on TSUM [Pillai's trace = .915, multivariate $F(7, 5) = 7.72$, $p = .019$)], GSUM [Pillai's trace = .909, multivariate $F(7, 5) = 7.13$, $p = .023$] and XIISUM [Pillai's trace = .925, multivariate $F(7, 5) = 8.80$, $p = .015$]. As shown in Appendix F, the linear trend for all three criterion measures was the only significant trend component ($p<.007$). This indicated that TSUM, GSUM, and XIISUM

performance steadily improved across platoon training order in approximate proportion to the additional training received.

Furthermore, the linear trend varied between platoons for TSUM [$F(9.38, 55.45) = 2.73$, $p<.006$], GSUM [$F(9.25, 54.67) = 3.09$, $p<.002$], and XIISUM [$F(7.58, 44.79) = 4.39$, $p<.001$]. The *df* for these tests are adjusted values (see Appendix G). These results indicated that the gains in performance differed from platoon to platoon due to variations in training methods and prior experience.

Discussion/Conclusions

Training Effectiveness

The rationale underlying training effectiveness evaluations is to determine whether a training program teaches task-relevant knowledge and skills adequately and efficiently. The ultimate test of training effectiveness is the transfer of training from the classroom to an operational or field setting. If this level of testing is not possible, one form of quantitative assessment is to measure trainee performance from the beginning of training to the end. The gain in scores throughout training then becomes an expression of the effectiveness of training with the device.

In this research, AOBC students were taught the fundamentals of tank platoon command, control, and fire distribution using a prototype device called the Platoon Gunnery Trainer or PGT. The training strategy used in AOBC requires 8 students to rotate through the different leadership positions as members of a tank platoon. Device training consists of 4 alternating iterations of the same offensive and defensive training exercises, with each student being in the tank platoon leader/sergeant position for just one training exercise (battle run).

The tactical performance of each AOBC platoon was measured using an observational platoon summary scoresheet which contained 14 MOPs and a five-point rating scale. The gunnery performance of each platoon was measured using the percent of target kills obtained by the four tank crews during a training exercise, as shown on the Battle Run Summary printout. These two measurements were then used to derive Tank Table XII type scores, based on the scoring formulas in FM 17-12-1, to evaluate platoon tactical, gunnery, and summary performance.

The research results clearly show the effectiveness of the prototype PGT in training AOBC students in the fundamentals of platoon command, control, and fire distribution. This conclusion is supported by the significant improvement (as measured by Tank Table XII type scores) found in platoon tactical, gunnery, and summary performance by platoon training order for both offensive and defensive training exercises, and when the types of exercise were combined.

Although significant improvements were found in the platoon-level skill proficiency of the AOBC students as a direct result of training on the device, the limitations of the research make it difficult to speculate on the impact of the training results. First of all, noncomparative measurement is the simplest form of quantitative assessment that can be used to assess training device effectiveness. As the training of AOBC students was not amenable to experimental control, performance measured on the prototype platoon gunnery trainer was not compared with alternate methods of training, or with training in any other devices, or with performance in operational or field settings. Secondly, the data collected for assessing platoon tactical performance are based on ratings provided by a single ARI investigator using a tank platoon summary scoresheet. Although significant interrater reliability was demonstrated during the pilot test, there is the possibility that rater bias resulted in higher ratings being given for the platoons in the last training orders. It has been argued, however, that when an individual rater is given specific performance related information (in this case the 14 MOPs listed on the platoon summary performance scoresheet), the amount of variance in the ratings due to bias or rating error is reduced (Czajka & DeNisi, 1988). Lastly, both the tactical and gunnery scores depend on the performance of the four crews (TC/GNR pairs) in the platoon. Had one or more of the crews shown a distinct lack of proficiency in either tactical or gunnery performance during the conduct of a training exercise, it could be argued that a simple rearrangement in the platoon rotation order or a revised sequencing of types of training exercise may have produced different results. In this regard, however, it should be recalled that the platoon training order was established by the AOBC students and not by the training instructor or the ARI investigator. What was observed to occur at the start of each training session was that the more confident AOBC students would choose to be the first platoon leaders trained while the less confident students would wait until the end of the platoon rotation order to be trained.

Training Methods

There is evidence available in the research literature to suggest that how a training device is used often accounts for more improvement than the characteristics of the device. That is, sophisticated device hardware and software refinements may result in only token increases in training improvement, whereas a simple innovation in use of the device may substantially increase its effectiveness. Some observations made by the research staff as to such applications are presented below.

The 8 hours scheduled on the device appear sufficient for the purpose of training AOBC students in platoon-level tactical and gunnery skills. However, two 4-hour training periods (on the same or two different days), rather than one continuous 8-hour period, would have been more beneficial to achieving the training objective. Signs of mental fatigue were observed near the end of a training session, as were signs of eye discomfort partly caused

by changes in light intensity used to display the visual scenes in the M1 U-COFTs. These impediments to training effectiveness can be avoided by a more diligent use of training time.

The sequencing of training devices in a curriculum should be based on a scheme that matches the device to the learner's state of readiness. This would save expensive simulator time and help optimize both instructor and student efforts. In observing AOBC student performance on the prototype platoon gunnery trainer, it was apparent that most students had received adequate classroom training in tank platoon tactics to begin learning the command, control and fire distribution skills required during a training exercise. It was also apparent, however, that the majority of the students lacked the gunnery skills necessary to acquire and engage targets with the M1 tank. As shown in the biographical summary (see Appendix E), the majority of students were trained on the M60A3 tank and averaged less than three weeks as an TC/GNR on the M1 tank prior to AOBC. This lack of tank gunnery training readiness is not intended to be an indictment of the present training program, but an affirmation that AOBC students require extensive gunnery training before they can achieve a Tank Table XII qualification score on the device. To increase the benefits of device training, additional consideration should be given to increasing the amount of M1 tank gunnery training AOBC students receive before training on the device, scheduling device training later in AOBC, or using Excellence in Armor (EIA) soldiers enrolled in Armor One Station Unit Training (OSUT) as TC/GNR pairs for the AOBC student platoon leaders.

It is a widely accepted training principal that the overall training effectiveness of a device depends on how well training is standardized and the quality of the trainers who provide the training. During the conduct of this research, several different trainers were used at the CO and I/O positions to train the AOBC students. Not all of the trainers demonstrated the same training abilities or followed the syllabus developed for training. For example, some COs guided the AOBC student platoon leaders through a training exercise by using verbal prompts or cues and providing immediate corrective feedback when an error occurred while others avoided using such techniques altogether and waited until the AAR to provide remediation. Additionally, some COs required students to call for indirect fire at each phase of an offensive exercise while others followed the training syllabus and required indirect fires be requested only in the assault. At the IOS, some I/Os would present targets while the platoon leader was still issuing his OPORD or FRAGO and move the tanks to the next CP/BP without waiting for the platoon leader's command. At the 3 remaining I/O stations, some I/Os would actively participate in the training by assisting the TC/GNRs in both tactical and gunnery procedures while others would just operate their station. Although these examples are not inclusive of the differences that were observed, they do suggest the need for continually monitoring training to ensure qualified trainers and training standardization. Such efforts would help to minimize training deficiencies that can adversely affect the quality of training.

Additional Considerations

The purpose of providing AOBC students training on the prototype PGT is to teach the fundamentals of platoon command, control, and fire distribution. As it appears, however, too much emphasis is being placed on the gunnery aspects of performance rather than on the tactical portion of training. During the AAR, for example, the students are being critiqued on their tactical performance but the primary emphasis is focused on the gunnery results provided in the Battle Run Summary printout. From their conversations, it was apparent that whether they successfully completed a platoon training exercise depended on whether they attained a platoon gunnery qualification score. On a follow-up examination of the device printouts, the data indicate that students trained during the second half of the training order were firing more main gun rounds and engaging more targets out of their assigned sectors than those trained earlier. What this clearly suggests is a need to refocus their attention to the tactical aspects of device training by using some form of observational scoresheet or automated printout that adequately addresses platoon tactical performance.

The observational scoresheet developed and used during this research appears to be an appropriate form that can provide the AOBC students with a platoon tactical performance score. As was demonstrated during the pilot test, the CO was capable of rating a platoon's tactical performance by using the platoon summary scoresheet following a training exercise. By merely summing the rating points for each of the 14 MOPs and multiplying the total by 200, the CO could easily provide the AOBC students with a Tank Table XII type tactical score to complement their platoon gunnery performance score. This approach should help refocus students' attention to the tactical skills being trained on the device. If desired, the two performance scores can be combined (as was done in this research) to provide trainers and students with a better indication of how well they performed on Tank Table XII types of training exercise.

In the future development of a platoon gunnery trainer, device hardware and computer software developers should be encouraged to develop an automated tank platoon tactical scoring system similar to that already developed for scoring tank platoon gunnery. A solid foundation on which to develop such a tactical scoring system would be the 14 MOPs identified on the platoon summary scoresheet. For example, the requirement to keep the platoon's tank weapons system oriented in the direction of the enemy could be determined by measuring the location of the gun tube relative to target location. The same sort of measurement could be accomplished for the requirement of each tank crew to scan for targets in their assigned sectors. A time measurement could be added to determine whether the platoon returned fire immediately on enemy contact. With the advancements being made in computer technology today, voice recognition software systems should be available to measure the requirements associated with platoon tactical reporting requirements.

Future Research

This research evaluated the effectiveness of the prototype PGT as it is currently used by the USAARMS for AOBC training. That is, it determined whether the prototype device trained AOBC students in the fundamentals of platoon command and control and fire distribution. What remains to be determined in future research is (a) whether the prototype platoon gunnery trainer can be use to effectively train sections and platoons in both active and reserve component TO&E units, and (b) if the results of that training transfers or leads to increased performance on Tank Table XII. The answers provided by this research would provide the USAARMS with invaluable information in the development of the Armor CATS.

Major Conclusions

The prototype platoon gunnery trainer used by the USAARMS was successful in improving the tactical and gunnery skill proficiency of AOBC students. Specifically:

1. Platoon tactical, gunnery, and summary performance, as measured by Tank Table XII type scores, improved significantly by platoon training order for both types of training exercise, and when the exercises were combined.

2. Platoon tactical, gunnery, and summary performance, as measured by Tank Table XII type scores, significantly improved across platoon training order in approximate proportion to the additional device training received.

3. The platoon summary scoresheet developed by ARI can be used to collect observational data for assessing tank platoon tactical performance on the prototype PGT.

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APPENDIX A

EXERCISE/AAR CHECKLIST FOR PROTOTYPE PLATOON GUNNERY TRAINER (PGT)

EXERCISE/AAR CHECKLIST (DEFENSE)

UT 12 Exercise

NAME: _____ CLASS: _____ CREW: _____

EVALUATOR: _____

1. Fire Planning.

   ____ conducts detailed map reconnaissance.

   ____ plans TRPs.

   ____ establishes trigger point/line.

   ____ assigns overlapping sectors of fire.

   ____ plans for indirect fires.

2. Operations Order.

   ____ issues complete/concise FRAGO to platoon over radio.

3. Movement.

   ____ displaces on order.

   ____ uses indirect fires.

   ____ uses smoke.

   ____ gun tubes remain oriented at enemy during displacement.

   ____ reports phase lines.

   ____ reports when SET on BPs.

4. React to Contact.

   ____ engages enemy when vehicles are at trigger point/line.

   ____ uses indirect fires to suppress enemy.

   ____ sends contact report to the Co Cdr.

   ____ develops situation - issues fire commands as necessary.

   ____ sends accurate spot report to the Co Cdr.

EXERCISE/AAR CHECKLIST (OFFENSE)

UT 12 Exercise

NAME: _____ CLASS: _____ CREW: _____

EVALUATOR: _____

1. Fire Planning.

____ conducts detailed map reconnaissance.

____ plans TRPs.

____ assigns overlapping sectors of fire.

____ plans for indirect fires.

2. Operations Order.

____ enemy situation.

____ friendly situation.

____ mission.

____ execution (maneuver).

____ commander's intent.

____ ammunition/resupply.

3. Movement.

____ reports crossing LD.

____ reports phase lines.

____ orients fires within sector of responsibility.

____ reports when SET on CPs.

4. React to Contact.

____ returns fire immediately - TC alerts Plt Ldr.

____ Plt Ldr initiates battle drill (evaluate command).

____ sends contact report to the Co Cdr.

____ develops situation-issues fire commands/controls fires.

____ sends accurate spot report to the Co Cdr.

APPENDIX B

OBSERVATIONAL SCORESHEETS FOR EVALUATING PLATOON-LEVEL PERFORMANCE ON THE PROTOTYPE PLATOON GUNNERY TRAINER (PGT)

PT#5894

Unit _____ Crew Position _____ Date _____

PGT Exercise No _____ Instructor/Operator _____

Tank Crew Performance

Task Execution	Rating Scale: Always	Usually	About Half	Seldom	Never
Scans for targets in designated firing sector.	4	3	2	1	0
Orients tank weapons in direction of enemy.	4	3	2	1	0
Acknowledges platoon leader's orders.	4	3	2	1	0
Reports "set" at each CP/FOX (4) or BP (3).	4	3	2	1	0
Reports friendly forces detected in area.	4	3	2	1	0
Returns fire immediately on enemy contact.	4	3	2	1	0
Issues complete-accurate crew fire commands.	4	3	2	1	0
Sends complete-accurate-timely contact reports.	4	3	2	1	0
Uses brief-secure radio transmissions.	4	3	2	1	0
Pops tank smoke as directed and when ordered.	4	3	2	1	0
Sends complete-accurate-timely spot reports.	4	3	2	1	0

REMARKS:

_____

_____

_____

_____

_____

Rating Scale				
Always (4)	Usually (3)	About Half (2)	Seldom (1)	Never (0)
100%	67% or More	34 to 66%	33% or Less	00%

PT#5894

Unit _____ Crew Position _____ Date _____

PGT Exercise No _____ Instructor/Operator _____

Platoon Leader Performance
Offense

Task Execution	Rating Scale: Always	Usually	About Half	Seldom	Never
Issues OPORD (abbreviated) to tank platoon	4	-	-	-	0
Gives TCs clear-concise-complete instructions.	4	3	2	1	0
Orders TCs to "move and set" to each CP (3).	4	3	-	1	0
Reports when platoon crosses the LD.	4	-	-	-	0
Reports when platoon crosses each PL (3).	4	3	-	1	0
Scans for targets in designated firing sector.	4	3	2	1	0
Orients tank weapons in direction of enemy.	4	3	2	1	0
Reports friendly forces detected in area.	4	-	2	-	0
Returns fire immediately on enemy contact.	4	3	2	1	0
Issues complete-accurate platoon fire commands.	4	3	2	1	0
Sends complete-accurate-timely contact reports.	4	3	2	1	0
Uses brief-secure radio transmissions.	4	3	2	1	0
Informs TCs of battlefield events from CO.	4	3	2	1	0
Calls for indirect fire when assaulting FOX.	4	-	-	-	0
Reports when "set" at each CP (3) and FOX.	4	3	2	1	0
Sends complete-accurate-timely spot reports.	4	3	2	1	0

REMARKS:

Rating Scale				
Always (4)	Usually (3)	About Half (2)	Seldom (1)	Never (0)
100%	67% or More	34 to 66%	33% or Less	00%

PT#5894

Unit _____ Crew Position _____ Date _____

PGT Exercise No _____ Instructor/Operator _____

Platoon Leader Performance
Defense

Task Execution	Rating Scale: Always	Usually	About Half	Seldom	Never
Issues FRAGO (abbreviated) to tank platoon.	4	-	-	-	0
Gives TCs clear-concise-complete instructions.	4	3	2	1	0
Orders "move and set" to each BP (3).	4	3	-	1	0
Orders "pop smoke" when moving to each BP (3).	4	3	-	1	0
Reports when platoon crosses each PL (3).	4	3	-	1	0
Scans for targets in designated firing sector.	4	3	2	1	0
Orients tank weapons in direction of enemy.	4	3	2	1	0
Reports friendly forces detected in area.	4	-	2	-	0
Returns fire immediately on enemy contact.	4	3	2	1	0
Issues complete-accurate platoon fire commands.	4	3	2	1	0
Sends complete-accurate-timely contact reports.	4	3	2	1	0
Uses brief-secure radio transmissions.	4	3	2	1	0
Informs TCs of battlefield events from CO.	4	3	2	1	0
Reports when "set" at each BP (3).	4	3	-	1	0
Sends complete-accurate-timely spot reports.	4	3	2	1	0

REMARKS:

Rating Scale				
Always (4)	Usually (3)	About Half (2)	Seldom (1)	Never (0)
100%	67% or More	34 to 66%	33% or Less	00%

PT#5894

Unit _____ Crew Position _____ Date _____

PGT Exercise No _____ Instructor/Operator _____

Tank Platoon Performance Summary

Task Execution	Rating Scale: Always	Usually	About Half	Seldom	Never
Issued OPORD or FRAGO to platoon.	4	-	-	-	0
Scanned overlapping firing sectors for targets.	4	3	2	1	0
Kept weapons oriented in direction of enemy.	4	3	2	1	0
Kept elements informed of battlefield events.	4	3	2	1	0
Reported control measures (LD, PLs [3]).	4	3	2	1	0
Reported "set" at each CP/FOX (4) or BP (3).	4	3	2	1	0
Reported friendly elements on the battlefield.	4	-	2	-	0
Used brief-secure radio transmissions.	4	3	2	1	0
Returned fire immediately on enemy contact.	4	3	2	1	0
Issued complete-accurate platoon fire commands.	4	3	2	1	0
Sent complete-accurate-timely contact reports.	4	3	2	1	0
Used indirect fires when assaulting objective.	4	-	-	-	0
Used tank smoke when displacing to each BP (3).	4	3	-	1	0
Sent complete-accurate-timely spot reports.	4	3	2	1	0

REMARKS:

_____

_____

_____

Rating Scale				
Always (4)	Usually (3)	About Half (2)	Seldom (1)	Never (0)
100%	67% or More	34 to 66%	33% or Less	00%

APPENDIX C

UT 12 Battle Run Summary

Date: 2/20/92 Instructor: OWENS J Program: UT 12/T-COFT
Vehicle: XXX Commander: Platoon Name:
Exercise No: 404113 Gunner:

Task No	Target Number	Target Type	Firing Tank	Kill Time	Point Total	Platoon WM1	Hit/Miss PL	Hit/Miss PS	Status WM2
1	V1	BMP	.	0.00					
	V2	BMP	WM1	0.00		MISS			
	V3	BMP	.	0.00					
	V4	BRDM2	.	0.00					
	V5	BRDM2	WM2	34.74*					KILL
	V6	HIND-D	PL,PS	30.10*			MISS	KILL	
	V7	HIND-D	PS	49.69*				KILL	
2	V8	T72-WH	PL	7.10			KILL		
	V9	T72-WH	PL	23.06			KILL		
	V10	T72-WH	PS	35.15*				KILL	
	V11	T72-WH	PS	9.70				KILL	
	V12	T72-WH	.	0.00					
	V13	T72-WH	.	0.00					
	V14	T72-WH	.	0.00					
	V15	T72-WH	.	0.00					
	V16	T72-WH	.	0.00					
3	V17	BMP	PS	31.58*				KILL	
	V18	BMP	WM1	21.56*		KILL			
	V19	BMP	.	0.00					
4	V20	T72-WH	.	0.00					
	V21	T72-WH	.	0.00					
	V22	T72-WH	WM1	26.44		KILL			
	V23	BRDM2	PS	19.30				KILL	
	V24	BRDM2	PL	33.30*			KILL		
	V25	BMP	WM1	0.00		MISS			
	V26	BMP	.	0.00					
	V27	BMP	.	0.00					
5	V28	BMP	WM2	26.30					KILL
	V29	BMP	PS	26.31				KILL	
	V30	BMP	WM2	17.61					KILL
	V31	BMP	PL	7.55			KILL		
	V32	BMP	WM1	5.06		KILL			
	V33	HIND-D	WM1	36.18*		KILL			
	V34	HIND-D	.	0.00					
6	V35	T72-WH	WM1	0.00		MISS			
	V36	T72-WH	WM1	22.94		KILL			
	V37	T72-WH	.	0.00					
	V38	T72-WH	PL,PS	22.32			KILL	MISS	
	V39	T72-WH	PL	37.84*			KILL		
	V40	T72-WH	PS	0.00				MISS	
	V41	T72-WH	.	0.00					

----------Target Summary---------- Platoon Score: 102.4
Presented: 41 Rounds: 34 Kills: 14 Percent: 34 Rating: Unqualified
Status: Exercise Complete - Freeze
Keypad Options: Perf, Repeat, Shot Pat, Print, Terminate

APPENDIX D

Interrater Reliability Table

Table D-1

Interrater Reliability Ratings for AOBC Prototype PGT Performance by ARI Investigator and Company Commander

MOPs	Interrater Reliability	Label
OPFRAGO	1.00**	Issued OPORD or FRAGO to platoon
SCANS	.83**	Scanned overlapping firing sectors for targets
ORIENT	.57*	Kept weapons oriented in direction of enemy
INFORM	.29	Kept elements informed of battlefield events
CONTROL	.77**	Reported control measures (LD, PLs, CPs, BPs)
SET	.26	Reported "set" at each CP/FOX (4) or BP (3)
FRIENDLY	.80**	Reported friendly elements on the battlefield
RADIO	.59*	Used brief-secure radio transmissions
FIRES	.30	Returned fire immediately on enemy contact
FIRECOM	.83**	Issued complete-accurate platoon fire commands
CONTACT	.78**	Sent completely-accurate-timely contact reports
INDFIRE	1.00**	Used indirect fires when assaulting objective
SMOKE	1.00**	Used tank smoke when displacing to each BP (3)
SPOT	.69**	Sent complete-accurate-timely spot reports
AVERAGE	.86**	

* $p<.05$, two-tailed; ** $p<.01$, two-tailed.

Note: The average reliability coefficient, based on Fisher's Z-transformation of Pearson's correlation, was tested with a t-test.

APPENDIX E

Summary of Biographical Data

1. Mean Age: 23.25 years. Range: 21 to 28 years.

2. Current Rank: 01 92 02 3

3. Active Component: AC 44 Reserve Component: RES 11
   RC 50 NG 27
   (Allied Officer) 1 IRR 12

4. Median Total Time in Military Service: 2 years 11 months

5. Mean Tank Experience Prior to AOB:
   (a) M60A3 Gunner .12 months (b) M1(A1) Gunner .10 months
   (c) M60A3 TC .19 months (d) M1(A1) TC .20 months
   (e) M60A3 Plt Ldr .71 months (f) M1(A1) Plt Ldr 1.17 months

   Mean Total Tank Experience: M60A3: 1.35 months M1: .50 months

6. Mean Training Device Experience Including AOB:
   (a) U-COFT 36.04 hours (b) SIMNET .21 hours
   (c) VIGS .32 hours (d) Other .32 hours

   Mean Total Training Device Experience: 36.83 hours

APPENDIX F

Analysis of Variance Tables For Trend Components

Table F

Summary of Trend Components on Tank Table XII Platoon Tactical, Gunnery, and Summary Performance by Training Order

Source of Variance	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	p[1]
Tactical Performance (TSUM)						
Linear	52425.04	8554.27	52425.04	777.66	67.41	.000
Quadratic	529.57	2960.39	529.57	269.13	1.97	.188
Cubic	21.97	2086.92	21.97	189.72	.12	.740
Quartic	83.94	3096.74	83.94	281.52	.30	.596
Quintic	305.92	2432.11	305.92	221.10	1.38	.264
Sextic	1.86	3885.76	1.86	353.25	.01	.943
Septic	2282.40	4046.79	2282.40	367.89	6.20	.030
Gunnery Performance (GSUM)						
Linear	12531.69	11941.14	12531.69	1085.56	11.54	.006
Quadratic	3556.85	4340.19	3556.85	394.56	9.01	.012
Cubic	812.59	3783.61	812.59	343.96	2.36	.153
Quartic	39.14	6051.45	39.14	550.13	.07	.795
Quintic	2295.29	4540.78	2295.29	412.80	5.56	.038
Sextic	113.91	2603.39	113.91	236.67	.48	.502
Septic	91.73	1525.84	91.73	138.71	.66	.433
Summary Performance (XIISUM)						
Linear	116231.31	29951.18	116231.31	2722.83	42.69	.000
Quadratic	6830.12	7829.95	6830.12	711.81	9.60	.010
Cubic	565.40	6601.02	565.40	600.09	.94	.353
Quartic	238.08	9993.66	238.08	908.51	.26	.619
Quintic	923.74	8723.56	923.74	793.05	1.16	.304
Sextic	86.02	3620.38	86.02	329.13	.26	.619
Septic	3291.44	3505.95	3291.44	318.72	10.33	.008

[1] $p < .007$ to maintain family-wise error rate for individual trends at the .05 level of significance.