

Research Report 1449

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AD-A190 584

Training Command, Control, and Communications Skills on Simcat

Scott E. Graham

ARI Field Unit at Fort Knox, Kentucky
Training Research Laboratory



U. S. Army

Research Institute for the Behavioral and Social Sciences

August 1987

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE		4. PERFORMING ORGANIZATION REPORT NUMBER(S) ARI Research Report 1449	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ARI Research Report 1449		5. MONITORING ORGANIZATION REPORT NUMBER(S) --	
6a. NAME OF PERFORMING ORGANIZATION ARI Field Unit at Fort Knox, Kentucky	6b. OFFICE SYMBOL (If applicable) PERI-IK	7a. NAME OF MONITORING ORGANIZATION --	
6c. ADDRESS (City, State, and ZIP Code) Fort Knox, KY 40121-5620		7b. ADDRESS (City, State, and ZIP Code) --	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Army Research Institute for the Behavioral and Social Sciences	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER --	
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 63743A	PROJECT NO. 2Q263743 A794
		TASK NO. 3.3.1	WORK UNIT ACCESSION NO. H 1
11. TITLE (Include Security Classification) Training Command, Control, and Communications Skills on SIMCAT			
12. PERSONAL AUTHOR(S) Scott E. Graham			
13a. TYPE OF REPORT Final Report	13b. TIME COVERED FROM 01/87 TO 06/87	14. DATE OF REPORT (Year, Month, Day) August 1987	15. PAGE COUNT 61
16. SUPPLEMENTARY NOTATION --			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	Training devices; Command and control, Training simulators; Armor, Training; Army training, Tanks; Performance (Human)	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The Simulation in Combined Arms Training (SIMCAT) device has been developed by the Army Research Institute (ARI) as a research tool to investigate the feasibility of low fidelity microcomputer-based simulators for training Armor Command, Control, and Communications (C ₃) skills. This research evaluates a SIMCAT training package designed to train C ₃ skills to Tank Commanders (TC), including tasks identified as frequent problems for Armor units at the National Training Center. The results indicate that SIMCAT Single Tank Tactical Exercises (STTX) are an effective means for training novice and highly experienced TCs. The paper also discusses simulation requirement issues, additional SIMCAT training applications, and potential problems for implementing technology-based training.			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Scott E. Graham		22b. TELEPHONE (Include Area Code) (502) 624-2613	22c. OFFICE SYMBOL PERI-IK

Research Report 1449

**Training Command, Control,
and Communications Skills
on Simcat**

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Office, Deputy Chief of Staff for Personnel
Department of the Army

August 1987

Amy Project Number
2Q263743A794

Education and Training

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FOREWORD

The U. S. Army Research Institute (ARI) has developed the Simulation in Combined Arms Training (SIMCAT) device in an effort to investigate potential applications of low-cost microcomputer-based simulations. This report describes how SIMCAT has been effectively used to hone the command, control, and communication skills currently being taught to M1 tank commanders in the 19K Basic Non-Commissioned Officer's Course (BNCOC). SIMCAT appears to be a good fit for the walk phase of the crawl-walk-run training model used at the Armor School and elsewhere.

This effort is part of the Fort Knox Field Unit's research program to apply new training technology to Armor skills training needs. The research is covered under a Memorandum of Agreement signed by Headquarters, Training and Doctrine Command (TRADOC), U.S. Army Armor Center (USAARMC), and USARI dated 28 March 1987, with the results having been briefed to Brigadier General Funk, Assistant Commandant, U.S. Army Armor School (USAARMS) in April 1987. Plans are underway for a trial implementation of a company/team-level SIMCAT training package in the Armor Officer Advanced Course at Fort Knox.



EDGAR M. JOHNSON
Technical Director

TRAINING COMMAND, CONTROL, AND COMMUNICATION SKILLS ON SIMCAT

EXECUTIVE SUMMARY

Requirement:

To evaluate the effectiveness of the Simulation in Combined Arms Training (SIMCAT) device Single Tank Tactical Exercises (STTX) for training tank commander (TC) command, control, and communication (C³) skills.

Procedure:

The STTXs required TCs to perform a number of critical C³ tasks, including communication on radio nets, decoding messages, and sending and receiving reports. Successful performance required tasks to be completed within real time. The primary performance measures were Number of Actions, which scored whether the soldier gave some response when required, and Accuracy of Actions, which evaluated the doctrinal accuracy of the soldiers' responses. A pilot experiment was first run to refine the STTX training package and experimental procedures.

The primary experiment trained and evaluated 24 TCs. The main variable of interest evaluated whether C³ performance improved over three STTX runs. Other independent variables were TC experience, GT level, amount of SIMCAT procedural training, and whether the TCs were trained one or two at a time.

Findings:

The results indicate SIMCAT STTXs are an effective means for training TC C³ skills. Number of actions performed and the accuracy of those actions increased across the STTX runs for all soldier trained--experienced and inexperienced--higher General Technical (GT) and low GT. The results also demonstrate that C³ refresher training is needed even for highly experienced NCOs, as initial STTX performance for NETT soldiers showed considerable room for improvement. The STTX did, however, train the experienced NCOs to near-perfect performance levels after two 45-minute STTX runs. Regression analyses revealed that GT score was a stronger predictor of STTX performance than experience and that the performance effects attributable to individual differences decreased with additional STTX training.

The report also discusses simulation requirement issues, particularly with respect to the cue and response requirements of the tasks being trained. Cue and response requirements specify the characteristics of the stimuli that must be presented by the simulator to elicit the set of behaviors to be trained. The level of SIMCAT fidelity was found to be sufficient for training most of

the C³ skills included in the STTX. While the SIMCAT target engagement cues differed greatly from the real world, the appearance of the low-fidelity opposing force (OPFOR) graphics was virtually always sufficient to elicit the C³ responses. Future decisions about fidelity requirements of C³ and tactical simulations should be derived from front-end analyses that specify the tasks to be trained.

Utilization of Findings:

The results of the research have been given to the Armor School as guidelines for the cue and response requirements of future C³ and tactical simulations. The research demonstrates that SIMCAT-like devices are appropriate for training a number of single tank tasks trained in the 19K Basic Non-Commissioned Officers Course (BNCOC). Plans are underway to assess the effectiveness of low-fidelity simulations for training platoon level and company/team C³ tasks, including a trial implementation in the Armor Officer Advanced Course.

TRAINING COMMAND, CONTROL, AND COMMUNICATION SKILLS ON SIMCAT

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TRAINING COMMAND, CONTROL, AND COMMUNICATION SKILLS ON SIMCAT

INTRODUCTION

The complexity of the modern battlefield requires soldiers at all echelons to be better trained on a greater variety of tasks than ever before. Armor Non-Commissioned Officers (NCO) are being trained to fight in accordance with AirLand Battle doctrine which advocates decentralized command and control. As a result, Tank Commanders (TC) and platoon sergeants must not only be skillful fighters of their own tanks, but possess the command, control, and communication (C³) skills necessary to ensure tactical success. The importance of small unit actions is repeatedly demonstrated at the National Training Center (NTC). BG Leland (1985), former commander of NTC, states that skillful execution of fundamental individual and small unit tasks is a prerequisite of mission success. He further states that there is nothing more important to battlefield success than effective command and control. It is, therefore, essential that the Army strives to improve the quality and quantity of small unit C³ training.

While the need for improved C³ training is increasing, unit and institutional training budgets are becoming increasingly strained. Rising costs of ammunition, fuel, and increasing restrictions on maneuver training areas are limiting traditional C³ training opportunities. The Defense Science Board has urged that emerging instructional technologies be used to meet this challenge and has said that greater emphasis needs to be placed on the development of low-cost simulators that can be produced in far greater numbers than the full-mission simulators currently being fielded (U.S. Department of Defense, Defense Science Board, 1982). In response, the U.S. Army Research Institute (ARI) has developed the Simulation in Combined Arms Training (SIMCAT) device. SIMCAT is a research tool designed to investigate the feasibility of microcomputer-based simulators for training Armor C³ skills.

Simulation Requirements Issues

While simulators have been used in military and commercial training for some time, many of the research issues concerning optimal design and use of simulation have remained largely unaddressed. Development and evaluation of simulator-based training has often focused on maximizing "real world" features, despite evidence that fidelity is not necessarily related to training effectiveness (Prophet & Boyd, 1970; Flexman, Roscoe, Williams & Williges, 1972). By contrast, there is a dearth of research which prescribes, or even models, an optimal use of simulation as a function of learner characteristics or skill levels. Similarly, little information has been available which prescribes what simulator features or level of fidelity is required to train what types of skills. Part of the problem, as Haggard (1986) notes, is that there has been no good way of delineating the aspects of simulation. Another part of the problem is that simulation development too often includes front-end training analyses which are viewed as obligatory, the findings of which are forgotten when compromises must be made with real world fidelity, technology limitations, and/or cost.

The ARI Orlando Field Unit has an ongoing research program designed to address some of these problems. A model is under development which will prescribe the optimum design and use of training systems (Sticha, Blacksten,

Buede & Cross, 1986). The Optimization of Simulation-Based Training Systems (OSBATS) model contains five modules which are constructed to address the following questions for particular simulation applications: (1) Should a full-mission simulator, part-mission simulator, or actual equipment trainer be selected? (2) Which available training medium meets the training requirement at a minimum cost? (3) What instructional features should be included in the design of the training device? (4) What level of fidelity or technological sophistication is most warranted? and (5) How can the available training resources be optimally allocated?

These modules are clearly not independent. The model handles the interrelation by solving the modules iteratively. The lack of independence is due in part to the same information being required to solve more than one question. For example, information about training task requirements, entry-level trainee performance, and cost of training with actual equipment is input to several modules.

Of particular interest in the evaluation of SIMCAT is a type of information used in the OSBATS model labeled cue and response requirements of tasks being trained. Cue and response requirements basically specify the characteristics of the stimuli which must be presented by the simulator to elicit the set of behaviors to be trained. If the correct behaviors can be trained on the device, training transfer will occur to the extent that cues in the real world trigger the same learned behaviors. Decisions about training media selection and simulator fidelity are therefore determined in part by the cue and response requirements of the tasks to be trained.

Simulator fidelity is perhaps best characterized by two separate dimensions (Sticha, Blacksten, Knerr, Morrison, & Cross, 1986). The first dimension--realism--refers to the physical and operational similarity between the simulator and actual equipment, including the realism of sensory stimuli produced by the training device. The second dimension--comprehensiveness--refers to the range of tasks that can be trained on the simulator. While the dimensions are conceptually independent, Sticha et.al. (1986) state that it seems more meaningful to describe comprehensiveness in terms of the range of simulated tasks for which realism is adequate. The problem then becomes operationally defining adequate.

The potential advantages of simulator-based training are numerous. Foremost, simulation reduces the reliance on actual equipment trainers which are costly, dangerous, and sometimes, as in the case of expensive weapon systems, scarce. The rising cost of fuel and ammunition also is prohibiting extensive training with actual equipment. One of the potentially greatest benefits of the device-based training is that operational conditions can be simulated which can not otherwise be safely realized. For example, simulators can train crews to operate with equipment malfunctions, under degraded visibility conditions, and with induced physical and mental stress. In addition, simulators can present a variety of target scenarios on numerous types of terrains.

Armor training in recent years has attempted to incorporate a "crawl-walk-run" training approach (Brown, 1983). The approach prescribes that basic skills and job knowledge should first be learned in the classroom

(crawl), then practiced in non-resource intensive exercises (walk), and finally refined and consolidated in field training exercises (run). Training simulations most obviously match the walk phase, as a transition between the predominant platform instruction received in the classroom and the field. A strong argument can be made that well-constructed simulated training is more effective for skills training than much of the classroom or field training currently being delivered. This advantage results from simulation training including well-established instructional features and attributes of good training. For example, in good training:

- o Tasks are well-defined and can be isolated for training.
- o Standardized training opportunities are presented to all soldiers.
- o Training is repeated until soldiers perform to standard.
- o Performance measurement is reliable.
- o Feedback is immediate and accurate.
- o Multiple trials are presented so that skills can be overlearned.

ARI has attempted to incorporate these characteristics into SIMCAT and its accompanying training package, the Single Tank Tactical Exercises (STTX).

Description of SIMCAT

The SIMCAT system contains six networked IBM PC microcomputers each with a color monitor and videodisc player. Four of the stations are configured to represent M1 tank commander stations with the other two being the Controller's station and a station for controlling opposing force (OPFOR) vehicles. The color monitors continuously display overhead or "birds-eye" views of photographed terrain maps stored on videodiscs. The terrain map is similar to standard Army maps with the exception that there are no grid lines or coordinates. Figure 1 shows the SIMCAT hardware configuration.

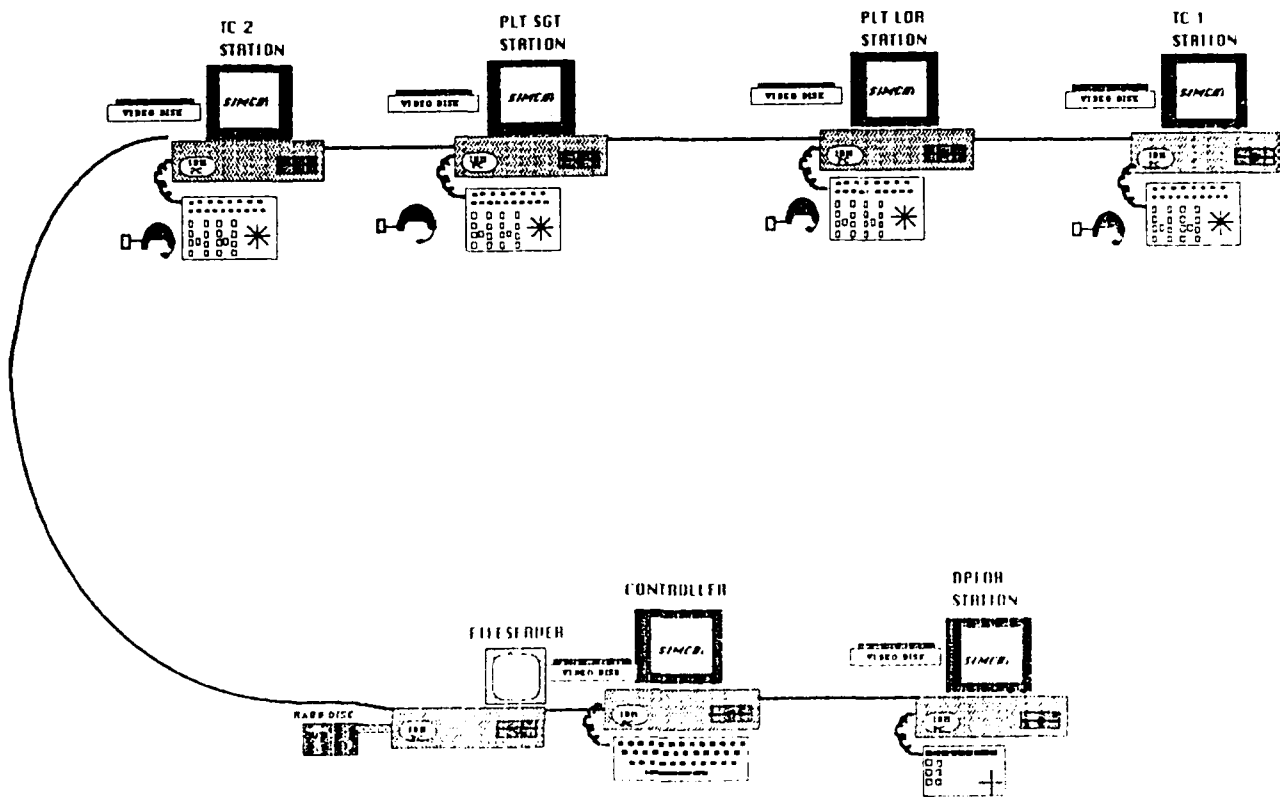


Figure 1. SIMCAT Hardware Configuration

Graphic icons or symbols are used to represent friendly and OPFOR vehicles and are overlaid on the videodisc maps. Each SIMCAT TC controls the movement of his tank (icon) and its weapon systems by means of a touchpad. With the touchpad shown in figure 2 (from O'Brien, 1987), the TC can rotate the tank turret and give driving and fire commands which are executed by the computer. He can also give arm and hand signals to the other SIMCAT TCs and request a display which shows tank status, e.g., amount of fuel remaining. Appendix A includes the SIMCAT instructions used in the research which provide a more detailed description of SIMCAT functions.

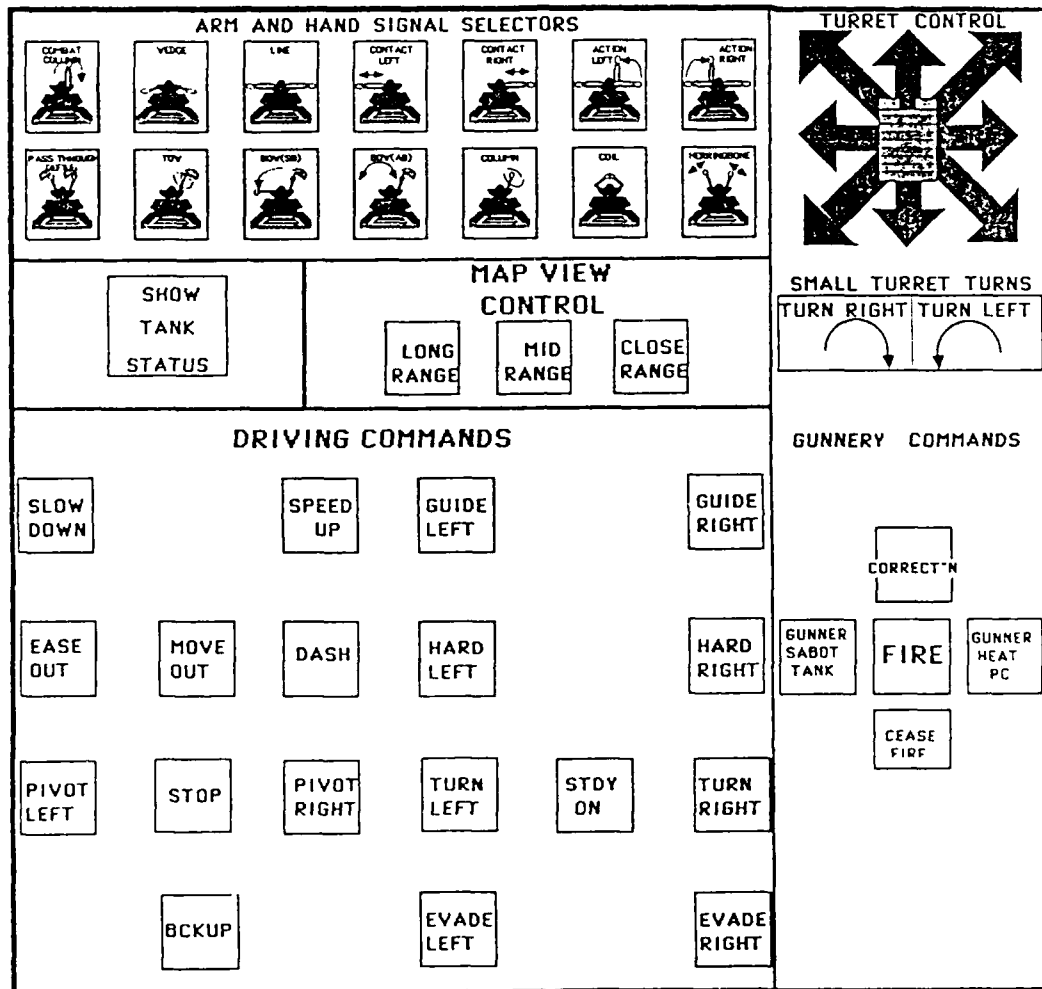


Figure 2. SIMCAT Touchpad

The terrain map encoded on the videodisc represents an area approximately 20 km x 6 km west of Fort Knox, KY. By touching the appropriate map view control on the touchpad, the TC can select from among three visual displays -- a close-up view which maximizes terrain detail, a far view which maximizes the area of display, and an intermediate view. Figures 3 and 4 (from O'Brien, 1987) show the general area of the terrain and the three available display ranges as they would appear on the color monitors.

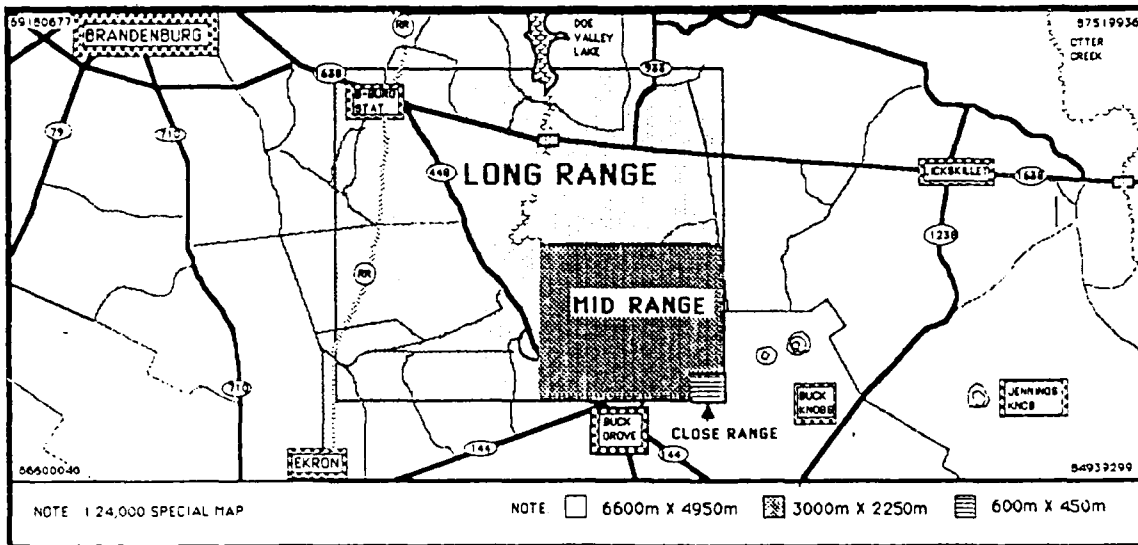


Figure 3. SIMCAT Terrain Base

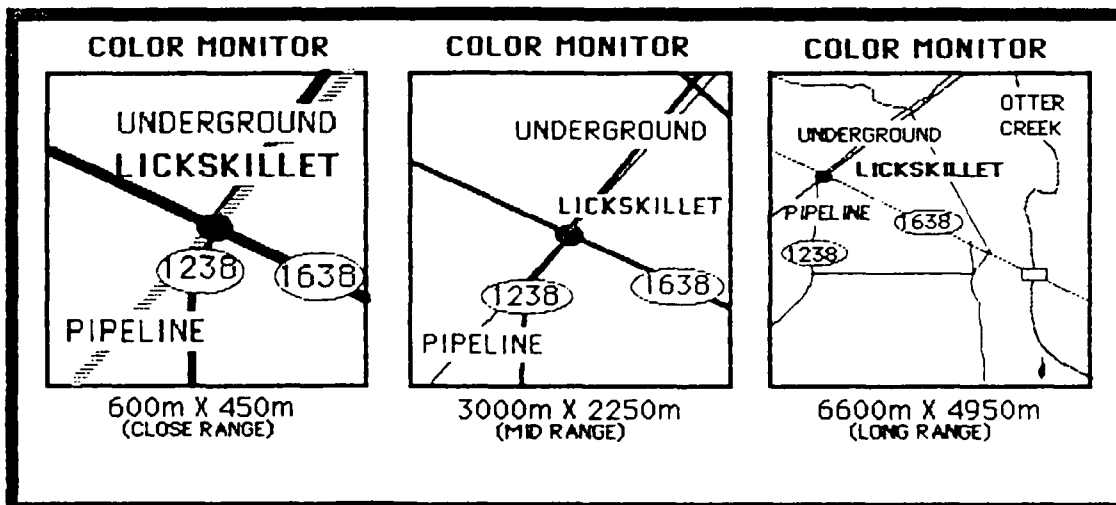


Figure 4. SIMCAT Range Scales

The SIMCAT system includes a terrain data base with elevation and trafficability data encoded in 30 x 30 meter grids. The elevation data is used to calculate line-of-sight. As a result, each SIMCAT TC can see his vehicle and only those friendly and OPFOR vehicles which are unobstructed by taller terrain features. You can not see through hills. The trafficability data determines the maximum speed the tank can move in the various types of terrain, for example, 70 kilometers per hour (kph) on highways and 35 kph cross. These speeds are relative to the scale of 1:24,000 geodetic terrain country. It takes the same amount of time to travel 3 km at 50 kph on the SIMCAT map as it would to travel 3 km at 50 kph in a tank. Movement is represented on SIMCAT by having the tank icon move across the stationary terrain map. As the tank icon nears the edge of the screen, the map shifts and the icon is repositioned at the center of the screen.

Target engagements are also controlled with the touchpad. The friendly M1 tank has a main gun which can fire both SABOT and HEAT rounds and a coax machinegun. OPFOR vehicles include T72 tanks, which can fire SABOT, and BMPs which fire main gun HEAT ammunition or SAGGER missiles. The OPFOR controller can have up to 10 OPFOR vehicles and has the capability of preprogramming movement routes. SIMCAT also can deliver indirect artillery fire from the OPFOR station or the controller's station. Target engagement outcomes are determined by a conflict resolution data base which contains hit/kill probabilities for various types of engagements at different ranges. When a vehicle is hit, an explosion icon is overlaid on the target. If the vehicle is killed, the vehicle icon is replaced with a burned-up junkpile icon and a message is displayed on the monitor indicating that station has been killed.

The SIMCAT communication network is an independent system containing four combat vehicle crewman's (CVC) helmets and controller and OPFOR headsets. Each station has a standard tank communication control box which allows the station to switch between two communication nets, e.g., company and platoon nets. The controller can monitor either net and can introduce simulated electronic countermeasures (ECM) by jamming with a white noise generator.

SIMCAT is not a gunnery trainer nor a driver trainer, despite the movement and target engagement capabilities. These features are included as a means to train C³ skills. Similarly, while SIMCAT has the capability of modeling friendly and threat hit/kill probabilities and movement rates, those values are important only to the extent C³ training is realized. One of SIMCAT's biggest training advantages is, however, that the device requires decisions, command actions, and communications to be made in real time.

Development of Single Tank Tactical Exercises

While SIMCAT has primarily been designed to investigate platoon-level C³ training, there is also a need for Armor NCO training to develop individual TC C³ skills. The ARI Fort Knox Field Unit, as part of the Fort Knox Training Technology Field Activity (TTFA), has worked for several years with the 19K Basic Non-Commissioned Officers Course (BNCOC) which trains M1 tank TCs. BNCOC C³ training includes platform instruction and culminates with a five day situational training exercise (STX) conducted in the field. SIMCAT is potentially appropriate for training the walk phase transition between the classroom and STX. In addition, observations of BNCOC STXs have revealed the

need for more standardized C³ training experiences, better individual feedback, and a clearer focus on individual TC skill development (Drucker & Morrison, 1987). SIMCAT has the capability to deliver such training.

ARI has developed a series of single tank tactical exercises (STTX) for using SIMCAT to train individual TC C³ skills (O'Brien, 1986; Kristiansen, 1987). The SIMCAT STTXs require TCs to perform a number of critical tasks including communication on radio nets, decoding messages, and sending and receiving reports. The TCs upon engaging enemy targets must, for example, prepare and send contact and spot reports using doctrinally correct formats. Improved training of these tasks is greatly needed as preliminary analyses of a study being conducted by the Weapons Systems Dept., USAARMC, on performance weaknesses of armor units at the National Training Center indicate a majority of units failed to give accurate spot and contact reports. Other critical skills trained in the STTXs include calling for and adjusting indirect fires. Graham & Black (1985), in an effort to define TC excellence, found that task, calling for indirect fire, was rated for TCs as most critical, using a combined rating of importance to mission success and frequency of failure.

Each STTX has the TC move his tank along a designated route indicated by a map overlay. Along the route, certain events occur which require the TC to perform various tasks. Certain STTX events require sequential performance of several tasks. For example, engaging an OPFOR vehicle, be it a T72 or BMP, requires the TC to submit a contact report, give a fire command, and then after the engagement, submit a spot report. Successful performance requires these tasks to be performed within real time standards. SIMCAT STTX training is structured so that training minimally consists of an STTX run, an after-action review in which performance of all tasks are critiqued, and a second STTX run. Additional STTX runs should ideally be made until all tasks can be performed to standard. This requirement is, in part, a reaction to standard training procedures which assume that a critique of substandard performance results in acceptable performance.

Purpose of Research

The purpose of the research was to:

1. Evaluate the effectiveness of the SIMCAT STTXs for training TC C³ skills.
2. Evaluate the effects of TC experience and mental aptitude on C³ skill acquisition.
3. Separate the procedural skills necessary to operate the device from the cognitive skills being trained with the device.
4. Refine the SIMCAT STTX training package.

These objectives were accomplished in two experiments. The first or pilot experiment was used to refine the STTXs and performance measures and to assess the feasibility of the independent variables. The pilot variables included performance across trials, level of TC experience, and amount of SIMCAT driving training. The second or primary experiment fully investigated

the variables of interest in a more controlled and systematic manner. As a note, while the SIMCAT STTXs used a TC and driver/gunner, the focus of the training, and hence the training evaluation, was on the TC's performance.

PILOT EXPERIMENT

Method

Participants. Nine NCOs from the 1st Armor Training Brigade (IATB) served as SIMCAT TCs. In addition, nine enlisted men from the IATB served as SIMCAT driver/gunners.

SIMCAT training required a controller and someone to operate the OPFOR station. Three persons, a sergeant and major from the ARI Field Unit and a retired lieutenant colonel, alternated in these two positions. Two civilian evaluators scored the SIMCAT performance and conducted the after-action reviews.

Procedure. Each experimental session began by randomly pairing an NCO with an enlisted man to form two SIMCAT TC and driver/gunner pairs. Each pair was separately given instructions about SIMCAT's operation. The instructions are presented at Appendix A and contain sections explaining map displays, friendly and OPFOR vehicles, movement controls, gunnery procedures, line of sight calculations, and communications. The instructions took approximately 30 minutes including time for the driver/gunner to try each function. The pair was given 15 minutes to practice moving the tank and coordinating target engagements. Half of the driver/gunners were given an additional two hour individual training period in the morning, in addition to the 45 minute training with the TC. The training and STTX procedures required the driver/gunner to make all inputs on the function touchpad. The only parts of the SIMCAT system that the TC touched were the communication control box and the CVC helmet. All C³ tasks, including communications and map tasks, were performed exclusively by the TC.

The controller then presented instructions pertaining to the STTXs. These instructions, part of the STTX controller's guide, are at Appendix B. The controller guide was developed under contract by LTC(ret) Richard E. O'Brien, Human Resources Research Organization (HumRRO). The soldiers were told that the two tanks were operating independently in the STTXs and that they would not see each other on the screen. The controller described a scenario which said the tanks were part of a company which had departed a rear assembly and were moving to a forward assembly area. As each tank had moved out, a track was broken. The company executive officer had told them to fix the track as quickly as possible and to rejoin the company. The enemy had been rapidly withdrawing, but OPFOR vehicles were still in the area. During the move they would have radio communications with their platoon leader (the SIMCAT controller).

The controller then described the SIMCAT system and identified the additional items the soldiers would need in the STTXs. These were:

- o 1:50,000 scale tactical map

- o Tank platoon SOP, FC 17-15-3
- o Armor school extract of CEOI, KTV 600A
- o Authentication extract
- o Coordinate scale
- o Protractor
- o Grease pencil
- o Route overlay with start point, route, and release point.

The controller gave the radio frequency to be used in the exercises and the call signs of the platoon net and fire support net. The first STTX was then begun with a call from the platoon leader to open the radio net. After the exercise was completed, the evaluator conducted an after-action review (AAR) covering each of the tasks, reinforcing correct performance and correcting incorrect performance. Following the AAR, there was a 15 minute break, followed by a second run down a different STTX route.

Each AAR was structured to follow the order of events in the previous STTX. The TC was first told what actions were required at each STTX event and then was given more details about how the actions should be performed. For engaging an OPFOR vehicle, for example, the TC was told that he should do three things: give a contact report, a fire command, and a spot report. The TC was then told that a doctrinally correct contact report contained three elements: the word "contact," the type of target, e.g., "tank," and the direction, e.g., "northwest." The AAR took approximately 10 minutes.

STTX Description

Four STTXs were developed consisting of four separate routes. All STTXs contained the same events, only the order of the events varied. While STTX action was mostly continuous, events occurred at discrete points along the routes at which the TC had to perform certain tasks. As mentioned earlier, the majority of the events, e.g., engaging a T72, required the TC to perform several tasks in real time. The events are presented below.

- a. Start Point
 - Respond to net call
 - Respond to authentication challenge using authentication table
 - Issue authentication challenge
- b. Plot Minefield
 - Decode friendly minefield coordinates
 - Plot minefield coordinates on tactical map

- c. Call for and adjust indirect fire
 - Request fire mission
 - Calculate observer target (OT) line
 - Use bracketing to adjust range
 - Hit target when firing for effect
- d. Engage T72
 - Submit contact report
 - Give fire command
 - Submit spot report using SALUTE format
- e. React to enemy indirect fire
 - React, e.g., give command to button up
 - Submit SPOT report
- f. Bypass minefield
 - Select bypass route
 - Direct driver around minefield
- g. React to electronics countermeasures
 - Encode message
 - Submit interference (MIJI) report
- h. Engage BMP
 - Submit contact report
 - Give fire command
 - Submit spot report
- i. Release point
 - Arrive correct location
 - Leave radio net
 - Submit situation report

Performance Measures. One purpose of the pilot experiment was to refine data collection procedures and instruments. Appendix C contains a score sheet from one of the STTXs following modifications. The revisions will be discussed later. The primary performance measures recorded were for accuracy; measures of speed were also gathered. In the instructions the soldiers were told that accuracy was most important, but that they should try to go as fast as possible. In the pilot experiment, time data were not, however, analyzed.

The scoresheets were designed so that two types of accuracy measures could readily be scored. These were:

a. Actions--scored on the sheets with the Go-No Gos--indicated whether the soldier had given some response when required. For example, when engaging a T72, did the TC give some form of a contact report, fire command, and spot report.

b. Accuracy of actions--scored on the sheets by checking within the parentheses--indicated whether the action was correct or not, e.g., were the minefield coordinates correctly decoded? The accuracy measure also scored

the doctrinal accuracy of the reports given by separately scoring each required line in the report. The order of the required lines was not, however, scored. The TCs were given credit, for example, for each of the five lines in the request for indirect fire regardless of the order.

The pilot experiment required 17 actions to be performed, with 38 possible points for accuracy of actions.

Because one independent variable in the pilot experiment was amount of driver training, a measure was constructed to assess driver accuracy. The TCs were told that they should ensure their driver/gunner kept the tank on the path indicated by the route overlay. One driver error was recorded everytime the tank was off the path by as much as 1/2 tank width. Two driver errors were recorded when the tank got off the path by a full-tank width, at which time the evaluator told the TC to get his driver back on the road.

Design. The primary independent variable of interest was the repeated measure of performance across STTX runs. Soldiers were given one STTX run, an AAR, and a second STTX run. If SIMCAT training is valuable, performance needs to improve with SIMCAT training.

A second variable examined the effects of TC experience on SIMCAT performance. "Experienced" TCs were operationally defined as soldiers with ranks of sergeant first class and staff sergeants who had graduated from the Advanced Non-Commissioned Officers Course (ANCOC). "Inexperienced" TCs conversely were defined as soldiers with ranks of sergeant and staff sergeants who had not graduated from ANCOC. If SIMCAT realistically represents TC task requirements, experienced TCs should perform better. It was also hypothesized that soldiers with lower initial skill levels, i.e., the low TC experience group, would show the greatest improvement across the STTX runs.

A third independent variable was amount of driver training. Driver/gunners in the "low" driver training condition, along with his TC, received a 45 minute orientation/training period just before the two STTX runs. Driver/gunners in the "high" driver training condition were given a two hour individual training period in the morning, in addition to the 45 minute training with the TC. Because TCs in the high driver training condition should have to pay less attention to their driver/gunners than TCs in the low driving training condition, it was hypothesized that additional training of driver/gunner procedural skills would lead to small TC performance gains.

Results

The results of the pilot experiment suggest SIMCAT may be an effective means for training individual Armor C³ skills. Table 1 shows performance improves in the second STTX run both for the number of actions performed and the accuracy of the actions. In addition, the number of driver errors drops.

Analysis of the driver errors shows the driver/gunners had little difficulty keeping the graphic tanks on the prescribed paths. Driver/gunners (n = 4) receiving the additional 2 hours of training performed only slightly better than those driver/gunners who did not (n = 5), with combined means for the two runs of 5.3 and 5.8 driver errors, respectively. Remember that a

Table 1

Number of actions, accuracy of actions, and number of driver errors for two STTX runs in pilot experiment

	Run 1	Run 2	Number Possible
Actions	11.6	15.2	17
Accuracy	14.6	26.0	38
Driver Errors (N=9)	3.4	2.1	0

Table 2 breaks down STTX performance by TC experience. The results show experienced TCs performed better than inexperienced TCs on both STTX runs. Performance on the second STTX run for the experienced TCs was still, however, considerably below the maximum. These data suggest more than two STTX runs are needed for both inexperienced and experienced groups.

Table 2

Performance of inexperienced and experienced TCs in pilot experiment

	Inexperienced (n = 5)		Experienced (n = 4)	
	Run 1	Run 2	Run 1	Run 2
Actions	10.6	15.0	12.8	15.5
Accuracy	11.4	23.4	18.5	29.2
Driver Errors	3.8	2.4	2.9	1.7

full tank-width off the road counted as two errors. Of greater importance is the impact of driver errors on TC performance. No statistically significant correlations were found between TC performance and driver errors. A correlation of .37 was found between number of actions performed on the first STTX run and driver errors. This value is non-significant and in the opposite direction of a relationship that would indicate good driver performance (fewer errors) was related to good TC performance (higher number of actions).

Contrary to what was hypothesized, the results on driver errors indicate additional driver training had no positive impact on TC performance. This finding was likely because SIMCAT driving on the STTXs was good in both groups. As a result, the primary experiment will incorporate only the low driver training condition.

STTX Refinements

Several modifications were made to the STTX procedures and routes. The primary goal was to reduce the time required to make each run, while maximizing the amount of training. To accomplish this, the STTX runs needed to be better structured so that there was minimal waiting or dead time. The scoring procedures also were simplified and made more specific to help ensure acceptable rater reliability.

The biggest problem was that the controller, who served as platoon leader, had to communicate with both tanks. The initial STTX procedure had the TCs talk on independent radio nets so that they could not hear each other. This procedure was possible because the SIMCAT communication system is such that when the controller is talking on one net, a light comes on when a transmission is coming in on the other net. The controller would then switch and talk on the other net. Certain STTX tasks, particularly calling for and adjusting indirect fire, required so many communications that a bottleneck tended to develop. For example, one TC would be adjusting fire and the second TC would have to wait to give a contact report, the timing of which was critical.

Several changes were made to alleviate the communication bottleneck. First, the two radio nets were redefined as a platoon net and a fire support team (FIST) net, the latter of which was used exclusively for calling and adjusting indirect fire. As in a tank platoon, both TCs then communicated to their platoon leader on the same net. The OPFOR controller was given the additional responsibility of serving as the FIST. He communicated on the FIST net, plotted indirect fire adjustments based on the TC reports, and entered the adjustments into the SIMCAT system. Inasmuch as the call for and adjusting indirect fire scenarios took approximately 10 minutes to execute, the redistribution of responsibility greatly reduced the platoon leader/controller's workload and communication bottleneck.

The order and exact placement of events within the STTX were also improved which allowed the STTX runs to go more smoothly. The STTX routes were restructured so that a call for fire mission would be given to one TC at the beginning of the run. As just described, that task required the TC to switch to the FIST net. At that time, the controller would give the other TC encoded minefield coordinates, a relatively lengthy process. When the first TC completed the fire mission, he would switch back to the platoon leader/controller and would then receive the minefield coordinates for decoding.

The electronic jamming, and hence the training of interference reports, was also eliminated for several reasons. The encrypting portion of the task took too long, approximately 15 minutes. In addition, placing both TCs on the same platoon net required both TCs to be jammed and to call in interference reports at the same time. Lastly, while interference reports are ostensibly a task required of TCs, the task would almost never be performed by a TC on a platoon net. The elimination of this task and the other changes resulted in STTX runs which took about 35 minutes to complete.

Other modifications included the addition of three checkpoints to each STTX run, at which the TC had to stop and report his location. The checkpoints aided the controller in coordinating the two STTX runs. In addition,

a second color monitor was added to the controller's station so that the platoon leader/controller and OPFOR/FIST could see the location of both tanks at all times. SIMCAT normally requires the controller to switch between views of the various tanks. The simultaneous views aided the timely coordination of events between the two tanks. The color monitor and the FIST's communication system were moved from one of the two SIMCAT workstations not being used. The ability to reconfigure SIMCAT at a minimum cost to meet the specific needs of different training applications is a plus.

PRIMARY EXPERIMENT

Based on the results of the pilot experiment, the primary experiment added a third STTX run. Given that the radio nets were redefined, a variable was introduced to explore the impact of having both TCs talk on the same net. Half of the TC/gunner-driver pairs were run two at a time, as in the pilot experiment, while the other half were run one pair at a time. This manipulation attempted to determine whether TCs run two at time were cued by the radio communications of the other TC.

Method

Participants. Twenty-four NCOs served as SIMCAT TCs. Half were from the 2ATB, while half were from an Armor Center M1 New Equipment Training (NET) team. In addition, 24 junior NCOs and enlisted men from 2ATB served as SIMCAT driver/gunners. There was also a controller/platoon leader, an OPFOR/FIST, and two evaluators.

Procedure. The procedures were the same as in the pilot experiment, with the following exceptions. Three STTX runs were made instead of two. The TC/driver-gunner pairs were randomly assigned to run either one at a time or two at a time. The revised scoresheets at Appendix C were used for all subjects. The general technical (GT) score from the Armed Forces Vocational Aptitude Battery (ASVAB) was also obtained for each participant as a approximation of intellectual ability.

Performance Measures. The primary performance measures were the same as those used in the pilot--number of actions performed and accuracy of actions. Table 3 shows the 20 possible actions performed and the 38 possible accuracy points. Note, for example, that for each spot report, five accuracy points were available and are indicated by a "5".

In addition to the composite performance measures, the results were analyzed by task. The analyses, for example, separately evaluated the effects of the SIMCAT STTX training on the task calling for and adjusting indirect fire.

Design. The primary independent variable remained the repeated measure of performance across the three STTX runs. The second independent variable was again TC experience. "Experienced" TCs were defined as being from the M1 Net Team and were characterized by ranks of sergeant first class and staff sergeants with recent tank experience. The M1 NETT NCOs selected were ones who train and evaluate tactics. "Inexperienced" TCs were defined as soldiers

Table 3

Single Tank Tactical Exercise Scoring Criteria

<u>Actions Performed</u>	<u>Accuracy of Actions</u>
o Open radio net	- Respond to net call - Respond to authentication challenge (use KTC 1400 authentication system) - Issue authentication challenge
o Record/repeat encoded minefield coordinates	- Repeat coordinates correctly
o Decode coordinates	- Decode correctly (using KTC 600 tactical operations code)
o Plot friendly minefield on map	
o Submit contact report (BMP)	- <u>3</u> required lines
o Issue fire command (BMP)	- Correct fire command
o Submit spot report (BMP)	- <u>5</u> required lines (including grid coordinates of BMP)
o React to enemy indirect fire (direct hatches closed)	
o Submit spot report following indirect fire	- <u>5</u> required lines
o Direct driver around minefield	
o Submit contact report (T72)	- <u>3</u> required lines
o Issue fire command (T72)	- Correct fire command
o Submit spot report (T72)	- <u>5</u> required lines
o Report arrival at <u>3</u> checkpoints	
o Request indirect fire using grid mission	- <u>5</u> required lines

Table 3 (continued)

Single Tank Tactical Exercise Scoring Criteria

<u>Actions Performed</u>	<u>Accuracy of Actions</u>
o Report observer target (OT) line to FIST when adjusting fire	- Correct OT line - Hit target when firing for effect - Stepped spotting rounds toward OT line - Used brackets to adjust range
o Report arrival at release point	
o Close radio net	- Issue authentication challenge (part of automated CEOI)

from the training support units of the 2ATB and included corporals, sergeants and staff sergeants with no recent tactical experiences in TO&E Armor units. The SIMCAT TC/driver-gunner crews were also run either one or two at a time. The primary experiment therefore was a mixed 3 x 2 x 2 factorial design with a within-subject variable of STTX runs (first, second, third) and between subject variables of TC experience (experienced, inexperienced) and number of crews (one at a time, two at a time). Statistical analyses were done using multivariate ANOVA procedures from SPSS-X.

A secondary statistical design introduced a variable which split the TCs on the basis of their GT score. "High" GT soldiers were defined as soldiers with scores at or above the GT population mean, $GT \geq 100$, while "low" GT soldiers were defined as having scores below 100. This variable was substituted for number of crews, resulting in another 3 x 2 x 2 mixed factorial design with factors of STTX runs, TC experience, and GT group. This design addressed the classic nature-nurture question as to which is more important, experience or trait-like GT abilities, in this case relative to the acquisition of Armor C³ skills.

Results

Improvement over STTX runs. The results of the primary experiment replicate the pilot experiment results in finding SIMCAT to be an effective means for training TC C³ skills. Figure 5 shows the increase in number of actions performed across the three STTX runs for the inexperienced and experienced TCs.

A multivariate Analysis of Variance (ANOVA) substantiated that performance improved over STTX runs, $F(2,19) = 30.73$, $p < .001$, and that experienced TCs performed more actions than inexperienced TCs, $F(1,20) = 11.31$, $p < .01$.

A similar pattern was found for number of accurate actions performed and is shown in Figure 6.

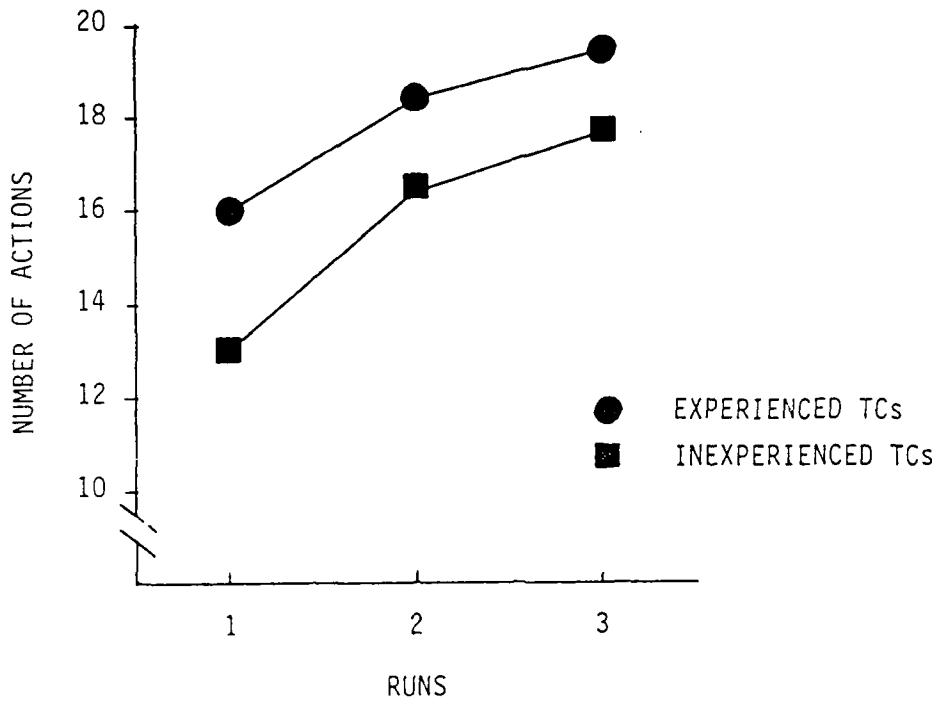


Figure 5. Number of actions performed across STTX runs

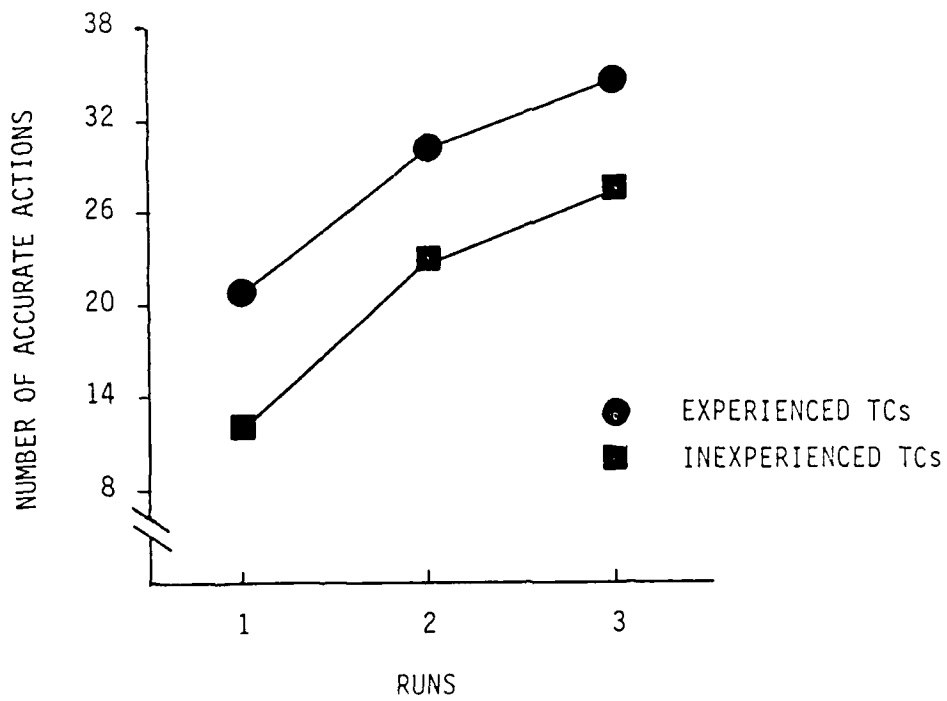


Figure 6. Number of accurate actions performed across STTX runs

Similar to number of actions performed, an ANOVA showed the accuracy of actions performed improved over trials, $F(2,19) = 123.80$, $p < .001$, and experienced TCs performed more accurate actions than inexperienced TCs, $F(1,20) = 22.25$, $p < .001$.

Separate ANOVAs were also computed for performance on the individual tasks. In certain cases, similar tasks were combined, e.g., contact reports and spot reports. The following task measures showed significant improvement ($p < .05$) over the STTX trials.

1. Number of reports.
2. Accuracy of reports (contact & spot).
3. CEOI authentications.
4. Number of authentication challenges.
5. Number of fire commands.
6. Accuracy of fire commands.
7. Minefield coordinate decoding.
8. Minefield plots on terrain map.
9. Reaction to enemy indirect fires.
10. Call for fire requests.
11. Firing for effect.
12. Proper indirect fire adjustments, e.g., bracketing for range.
13. Calculation of observer-target (OT) line.
14. Time to complete STTX run.

The following measures did not improve over the STTX runs.

1. Checkpoint reports.
2. Bypassing of minefields.

Number of crews

Tank commanders run one crew at a time performed more actions ($m = 18.0$) than those who were run two crews at a time ($m = 15.8$), $F(1,20) = 84.52$, $p < .001$. The same main effect was found for accuracy of actions with soldiers run in the one at a time condition ($m = 27.4$) being more accurate than those run two at a time ($m = 21.6$), $F(1,20) = 12.86$, $p < .01$. Separate ANOVAs on individual task measures revealed only 4 measures were related to number of crews. TCs run one at a time performed better than TCs run in pairs on:

1. Minefield plots on terrain map.
2. Firing for effect.
3. Calculation of OT line.
4. Time to complete STTX run.

Performance differences as a function of number of crews on the tasks firing for effect and calculation of observer-target line are difficult to understand, as those tasks were performed while the TC was on the FIST net. The time to complete the STTX runs difference is a result of the STTX procedures which required the controller to switch between crews. Sometimes a TC had to wait, for example, a number of seconds to give a report to the platoon leader/controller because the controller was talking to the other TC. While statistically significant, $F(1,20) = 3.91, p < .05$, the practical difference may be negligible. The one crew at a time required a mean time of 35.6 minutes and the two crews at a time required a mean time of 39.7 minutes to complete the STTX runs. These times do not include the AARs.

GT and experience. Figure 7 shows experienced TCs performed more actions than inexperienced TCs, $F(1,20) = 11.31, p < .01$ and that TCs in the high GT group ($GT > 100$) performed more actions than those in the low GT group ($GT < 100$), $F(1,20) = 12.35, p < .01$. No interactions were found.

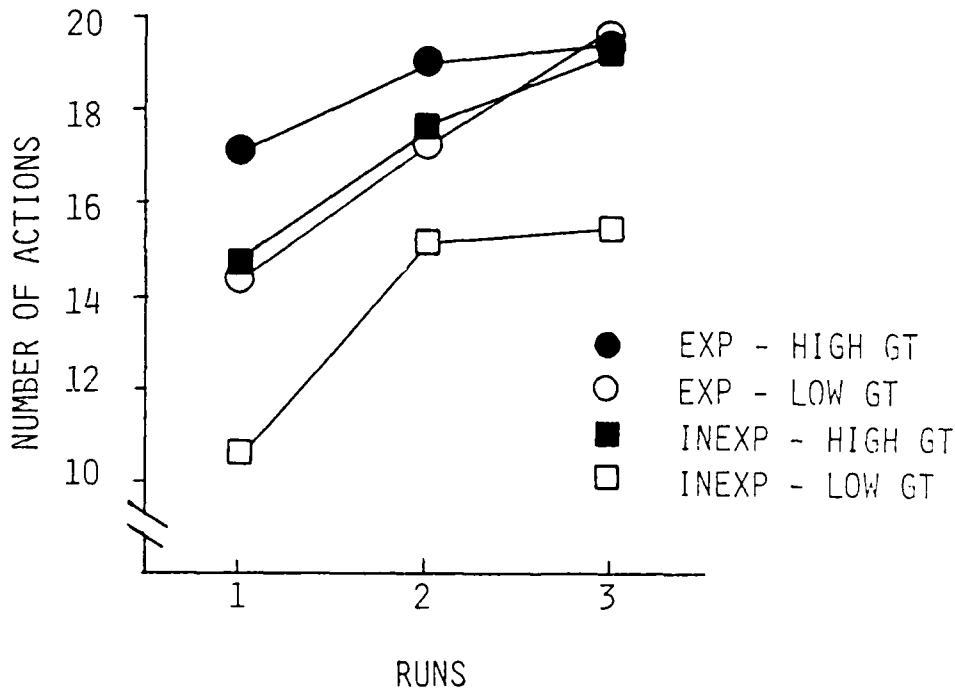


Figure 7. Number of actions as a function of experience and GT

Similarly, Figure 8 shows that experienced TCs made more accurate actions than inexperienced TCs, $F(1,20) = 22.23, p < .001$ and that high GT TCs were more accurate than low GT TCs $F(1,20) = 12.31, p < .01$. Again no interactions between variables were found which are indicated in Table 8 by the essentially parallel lines.

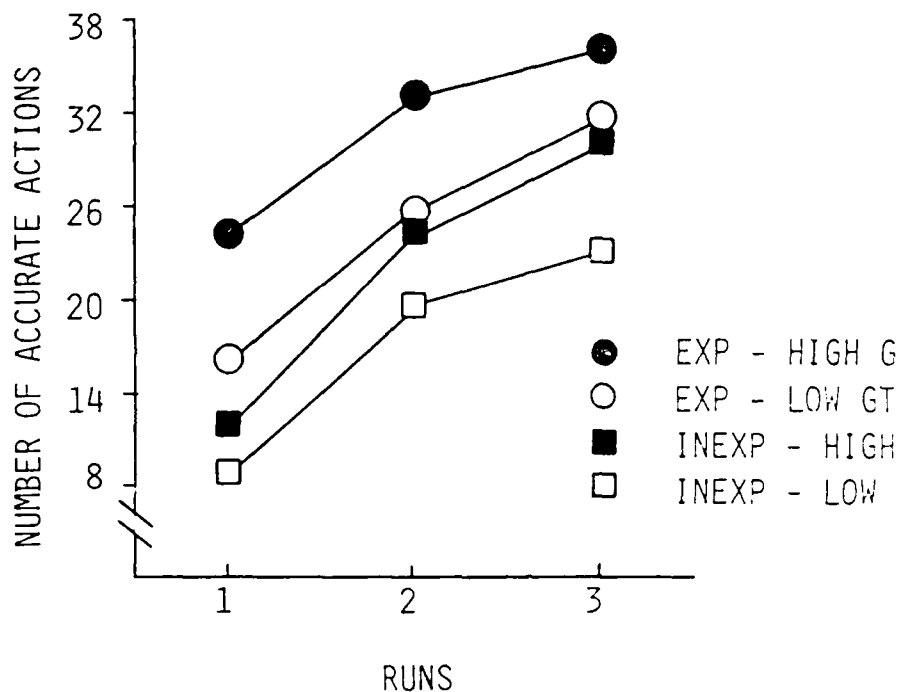


Figure 8. Number of accurate actions as a function of experience and GT

Table 4 lists the tank measures and indicates those tasks in which performance differed as a function of GT and/or experience. In all cases when differences occurred, the experienced and/or higher GT TCs performed better. Also indicated are the tasks in which performance improved across the STTX runs.

The decreasing R^2 s over the STTX runs indicate that with additional training less and less of the performance differences are attributable to GT and TIS. In this experiment, STTX training reduced the effects of individual differences. The regression analyses also revealed that GT was a much stronger predictor of STTX performance than TIS. For the most part, TIS did not relate to performance after the effects of GT were taken into account.

DISCUSSION

Research Findings

Training with SIMCAT led to improved C^3 performance for all of the soldiers trained--experienced and inexperienced--high GT and low GT--run one at a time or two at a time. SIMCAT training resulted in both more actions being

Table 4

Task measures which differ as a function of GT, experience, or STTX training

Task Measures	GT Differences	Experience Differences	STTX Improvement
1. Number of Reports			X
2. Accuracy of Reports	X	X	X
3. CEOI authentications			X
4. Authentication challenges			X
5. Number of fire commands	X	X	X
6. Accuracy of fire commands	X	X	X
7. Minefield coordinate decoding	X	X	X
8. Minefield plots on terrain map	X	X	X
9. Reaction to enemy indirect fire			X
10. Call for fire requests	X	X	X
11. Firing for effect	X	X	X
12. Proper indirect fire adjustments	X	X	X
13. Calculation of OT line	X	X	X
14. Time to complete STTX runs	X	X	X
15. Checkpoint reports		X	
16. Bypassing of minefields	X	X	

Performance on the majority of the tasks differ as a function of both GT and experience. With only one exception, checkpoint reports, GT and experience had effects on the same tasks.

In an effort to separate out the effects of GT and experience, multiple regression analyses were conducted. Tables 5 and 6 show the results of the analyses using GT score and time in service (TIS) as predictors of number of actions and number of accurate actions, respectively. The correlation between GT and TIS in this sample was .28.

Table 5

Regression analysis predicting number of actions

	STTX Run			
	<u>1</u>	<u>2</u>	<u>3</u>	
BETA _{GT}	.65**	.54*	.28	
BETA _{TIS}	.04	-.05	-.02	
R ²	.44	.27	.08	
Mean	14.5	17.5	18.6	** p < .01 * p < .05

Table 6

Regression analysis predicting number of accurate actions

	STTX Run			
	<u>1</u>	<u>2</u>	<u>3</u>	
BETA _{GT}	.44*	.60*	.46*	
BETA _{TIS}	.39*	.11	.10	
R ²	.44	.42	.24	
Mean	16.1	26.4	31.0	* p < .05

performed and the actions being more accurate. While the training effectiveness is in part, attributable to SIMCAT's design and features, the key aspect of the STTX training may have simply been the application of basic learning principles. First, a specific set of TC C³ tasks were selected for training. The first STTX run gave the TCs an opportunity to perform these tasks. Following the attempt the TCs were given structured feedback on how to perform the tasks correctly. The second STTX run gave the TCs another opportunity to complete the tasks, followed by more feedback, and then a third STTX to again practice the tasks. Too often and for various reasons, Army training gives a soldier (or unit) one shot at a task or mission. Upon completion, the soldier is told what was wrong. It is often then assumed that the soldier has correctly incorporated the feedback and will be able to perform the task when later required.

What training research has shown, and to a large extent what common sense says, is that if you need to be prepared to perform a task at some later opportunity, you have to practice the task over and over. Furthermore, you must not just practice the task until you can perform it correctly once, but so you can perform it correctly over and over again. This is sometimes called overlearning. SIMCAT STTX training, and to a large extent simulator training in general, provides the opportunity to practice tasks repeatedly with feedback, at a relatively low cost. Another big advantage of SIMCAT training is that the C³ tasks are practiced in real time. Soldiers, for example, must communicate on the radio, engage targets and respond to indirect fire all within seconds.

The STTX training was found to be equally effective for experienced and inexperienced TCs. While the experienced TCs performed better than inexperienced TCs at the beginning and end of training, the relatively low first STTX run performance of the experienced TCs indicates C³ skills do decay. Refresher training is therefore needed, even for highly experienced NCOs. Soldiers from the M1 NET team were selected as experienced TCs because they had recently taught C³ content material. These results reinforce that which is often said as to the difference between knowing something and being able to do something. Apparently, the NET team knew what the C³ tasks required, but

were not initially able to perform the tasks in real time. The three-hour STTX training did, however, get the experienced TCs back up to near perfect performance. Inasmuch as the third STTX run measured performance gains from the first two STTXs, C³ skills were likely even greater after three hours than indicated by the third run scores. ARI has plans to use SIMCAT and other simulators to identify those C³ skills which decay most rapidly.

The experienced TCs seemed to appreciate the SIMCAT STTX training even more than the inexperienced TCs and better understood that the STTXs were designed to provide C³ refresher training. One sergeant first class from the NET Team said that he "definitely had become rusty on these (C³) skills." Another said he "learned a lot." Another asked whether the NET Team could come back and run on SIMCAT as a platoon. While the comments from the inexperienced TCs were overwhelmingly positive, there were more instances when the inexperienced TCs focused on irregularities in the system. For example, a couple of inexperienced TCs commented on differences between the 1:50,000 scale lap map and the SIMCAT videodisc terrain map, or said, "this isn't the way we do it in our company" even though they presumably understood the SIMCAT procedures were doctrinally correct. It is not surprising that the experienced TCs spoke more highly of the STTX training, because on the whole, it was refresher training for them with their performance being very good. By contrast, some inexperienced TCs were overwhelmed during the first STTX run, successfully completing none of the tasks. Concerning the irregularities between the maps, the situation will always exist in the field, particularly when one focuses on man-made features such as houses or roads, as the inexperienced TCs tended to do. The skill of being able to use information on different maps will become even more critical if digitized terrain displays are added to tanks as part of the proposed Battlefield Management System (BMS).

The results also found that TCs with higher GT scores performed better than those with lower scores. There has been considerable interest within the Armor community of late as to whether smart tankers are better (Scribner, Smith & Phillips, 1986). To a large extent research has looked for relationships between ASVAB and tank gunnery performance. The research has typically found only a small relationship between verbal tests and tasks requiring psychomotor skills (e.g., Smith & Graham, 1987). The tasks trained and evaluated in the STTX were, however, cognitive/verbal tasks, e.g., decision-making, verbal decoding, and report making. GT scores would be expected to correlate much higher with these cognitive/verbal tasks than with psychomotor tasks required in tank gunnery. The results also showed that while experience and higher GT scores were related to better performance, experience was a poor predictor when the effects of GT were taken separately into account.

Army training attempts to minimize individual differences, as the goal is to have all soldiers perform to standard. The regression analyses found this to be the case with SIMCAT training, as the R² approached zero by the third STTX run. This result may be due, in part, to a ceiling effect. Had the tasks been more difficult, the influence of GT and possibly experience may have still been seen at the end. The results also reflect the paradox in the criterion-referenced testing approach used by the Army, that is, tasks being evaluated Go/No Go. On one hand, knowing a soldier has obtained a "Go", theoretically ensures that soldier can perform a particular task to standard on a given day, as opposed to just knowing how to do the task. On the other

hand, the Go/No Go approach does not always challenge each soldier to be the best that he can. The standard may not be high enough for that individual or require a skill level that will generalize to later combat situations.

Tank commanders who were trained one at a time performed better than those trained two at a time. This result is opposite of the intent of the experimental manipulation. It was speculated that soldiers run two at a time might listen to the other TC on the net and be cued to the correct action, thereby getting less training. Apparently this monitoring had little positive effect. Training more TCs on SIMCAT at the same time is desirable if there is no degradation in training, as less resources are required per soldier.

Identification of Device-specific Skills

One of the goals in designing and evaluating the STTXs was to separate the skills being trained on the device from the device-specific skills required to operate the device. The thrust was two-fold. First, the STTX procedures required a driver/gunner to operate SIMCAT. While not all that difficult, manipulating the SIMCAT tank along the STTX route required considerable attention. Had the TC been required to operate SIMCAT, too much effort would have likely been placed on driving and gunnery procedures. Inasmuch as SIMCAT is not a driver trainer nor a gunnery trainer, the attention paid to those tasks would have largely been wasted. Furthermore, improvements in STTX performance could not have been attributed to improved C³ skills, but to greater familiarity with the device.

The second approach for separating out device-specific skills was to make a conscious effort to identify tasks employing such skills. There is a potential pitfall in simulation design and evaluation in assuming that all procedures required in the simulator operation equally represent the real world and/or are trained equally well. The danger becomes even greater when the simulator procedure is given the same name as the procedure used on the actual equipment. Discussions that use the label tend to blur the distinction between what is required on the simulator and what is required in the real world. A case in point for SIMCAT and the Unit-Conduct of Fire Trainer (UCOFT) involves "Target Acquisition." While both simulators require soldiers to detect and identify, i.e., acquire, targets, the acquisition of computer-generated images on a cathode ray tube screen is very different from the acquisition of plywood pop-up targets on a gunnery range or OPFOR tanks on the battlefield. This distinction is, however, rarely made, despite recent evidence that UCOFT target acquisition training may be unrelated to performance in the field (Rapkoch & Robinson, 1986).

One STTX task that showed a device-specific component was adjusting indirect fire. The procedure required the TC to first give the FIST the direction of the OT line. Adjustments were then made relative to the OT line, e.g., left 100 meters, add 300 meters. In the field, the observer is by definition on the OT line, whereas on SIMCAT the TC must envision the OT line on the screen between his tank icon and the target. Instead of making adjustments relative to the OT line, a number of soldiers adjusted to the screen, e.g., "add" meant move up the screen, "left" meant move left of the screen. When the soldiers were told during the AAR what they were doing

wrong most smiled, nodded, and did not make the mistake again. Interestingly, GT score was more highly correlated with fire for effect accuracy and proper indirect fire adjustment procedures than with any other tasks. A basic definition of intelligence is the ability to adapt quickly to new situations. High GT soldiers may have adjusted more quickly to the SIMCAT call for fire dynamics than did the lower GT soldiers.

SIMCAT Fidelity

Does SIMCAT contain the proper level of fidelity or technological sophistication for training Armor C³ skills? As discussed in the introduction, a key question is whether the device provides the proper cues for eliciting the required response. At one level, the answer seems unequivocally yes, as C³ performance increased for all soldiers trained. At another level, it is still not known whether the SIMCAT STTX training transfers to the field. Improvement on the device is a necessary but not sufficient condition for training transfer. When, for example, an OPFOR tank pops up over a hill at the National Training Center (NTC), will the TC give a contact report, fire command, and spot report as he did when a SIMCAT target appeared. Again, this is not known. One can, however, reasonably assume the converse. If the TC did not make these reports on SIMCAT and received no additional C³ training, he would probably not perform these C³ tasks adequately as part of an NTC exercise.

Specifying the degree of SIMCAT fidelity as a part-task trainer is not easy. The tank driving and gunnery functions are weakly represented on SIMCAT. SIMCAT is explicitly not a driving nor gunnery trainer, but a device to train Armor C³ skills. For training C³ skills, SIMCAT uses actual military maps, CEOI extracts, CVC helmets, and radio control boxes. The point being made here is that as a part-task C³ trainer, SIMCAT contains a number of high-fidelity attributes. At another level, SIMCAT is a low-cost, low-fidelity microcomputer-based simulation.

The similarity of real world cues and cues presented in the simulation varies from task to task. The relative amount of training transfer across tasks can roughly be expected to parallel the amount of similarity. At the high end are tasks involving communication on the radio nets and use of the CEOI, e.g., authentication and decoding. A major part of the STTX focused on training contact and spot reports. While the target engagement cues differed greatly from the real world, the appearance of a red OPFOR tank was virtually always sufficient to elicit at least a fire command. The fidelity level appears to be adequate for training these reporting tasks. That SIMCAT fidelity weakly represents gunnery procedures is irrelevant, as SIMCAT expressly is not a gunnery trainer.

SIMCAT fidelity is probably sufficient only for training parts of other tasks. Regarding call for and adjusting indirect fire, the STTX trained the communication formats and the concepts of proper adjustment, e.g., bracketing for range. Clearly, SIMCAT does not train range estimation skills, a critical component of indirect fire adjustments. Also, the SIMCAT map display makes the grid mission call for fire technique overly easy. As for the task of reacting to indirect fire, the STTX trained the TCs to command the crew to close the hatches and to give a spot report. It is suspected that the real

world cues of receiving nearby artillery fire are even more salient than seeing an indirect fire icon on the SIMCAT screen. The STTX probably better trained the need for a spot report than the need to button up.

One advantage of networked microcomputer-based simulations is that they can be reconfigured to meet specific needs. For the present research, one of the two unused SIMCAT stations was used to provide an extra controller monitor and communication system for the OPFOR/FIST. The ability to reconfigure is particularly important for ARI and the schools whose functions include training research and development. In addition, training needs change more rapidly than device acquisition, and new device applications are identified after devices have been procured, e.g., job-sample testing.

SIMCAT Difficulties

SIMCAT is not without problems. The biggest problems seem to involve movement and speed control, particularly when SIMCAT is used for platoon exercises. These problems were minimized in the current STTX by having a dedicated driver/gunner and by the selection of simple routes. Also, when more vehicles are added to the scenarios (up to four friendly and ten OPFOR) the system slows down considerably. The STTXs evaluated only used two friendly and four OPFOR vehicles. ARI is currently developing a second-generation device, the Platoon-Level Battlefield Simulation (PLBS), which will remedy these problems with advanced hardware and networking, and the addition of joysticks for movement control.

Another problem for SIMCAT and the STTXs is that training is resource intensive, particularly for personnel. The current STTX required three persons (controller, OPFOR/FIST, and evaluator) for training one TC at a time, and four persons (another evaluator) when training two TCs at a time. The PLBS system will help reduce the personnel requirements by adding some automated data collection capabilities. As it stands, for non-research purposes, one evaluator/debriefer could be used to train two TCs simultaneously.

Implementation Issues

The research demonstrates SIMCAT-like devices can be an effective means for training Armor C³ skills. The research also demonstrates that effective simulation-based training must include training support packages developed to meet specific training needs. The STTX evaluated here was developed to train individual TC C³ tasks as might be taught in 19K BNCOC. Included as part of the prototype training package were instructions, controller's guide, route overlays and evaluation sheets. Future training simulations should develop similar materials for either institutional or unit training. As is always the case, acceptance hinges on users from the school or unit providing input into the development or at least modifications to the package.

SIMCAT/PLBS-like devices seem appropriate for a number of Armor training applications in addition to BNCOC. Perhaps the best use may be for training new platoon leaders as part of the Armor Officer Basic Course (AOB). The 2LTs could receive both individual C³ training with the STTXs and platoon-level C³ training, e.g., distribution of platoon fire. Four novice platoon leaders could be trained simultaneously, one serving as platoon leader while the others receive cross-training as platoon sergeant and wingmen. ARI has

plans to evaluate SIMCAT/PLBS training effectiveness in AOB, reserve component units and intact TO&E platoons. In addition, plans are underway to develop a PLBS integrated tactical exercise at the Armor School in which TCs from BNCOC, platoon sergeants from the Advanced Non-Commissioned Officers Course (ANCOC), and platoon leaders from AOB would be trained together.

For each of these applications, a separate structured training package must be developed. As with all training, the training exercises should match specific objectives. Many combat simulators, including SIMCAT, have the capability of playing force-on-force free-play scenarios. Free-play is enticing and somewhat combat-like, but there is little evidence to support free-play training effectiveness. To the contrary, free-play force-on-force promotes gamesmanship, i.e., beating the other guy, and often results in the soldier trying to take advantage of the idiosyncrasies of the device. This process develops device-specific skills, rather than those specified by the training objectives.

Successful implementation of SIMCAT-like devices in the school or unit also requires that persons be trained to operate and maintain the system. Depending on the amount of system use, this requirement may be for one or more persons whose primary responsibilities are simulator operations. Full time personnel requirements are not trivial and are becoming increasingly necessary with the addition of technology-based training. The operators' responsibilities would likely include the loading of files containing initial conditions of training scenarios, performing preventative hardware maintenance, backing up software and student records, and training others to use the simulation training package.

In the wake of technology, training researchers are challenged to stand tough on time-tested training development principles. Quality training requires careful front-end analyses, the purpose of which is to identify skill requirements and skill deficiencies. From these analyses, training devices should be developed and evaluated. Too often it seems this process is being reversed. Only after the high-priced high-tech simulators are built, are training researchers asked what can be trained with the device. Technology demonstrations and marketing seem to be driving training device development more than ever before. Contractors gladly adorn simulators with whistles and bells and the latest technological innovations to enhance the high-tech look of the device. Little regard is paid to the potential training value of any particular feature. Given that this backwards process will inevitably continue to occur, the training researcher's role should be that of an honest broker, telling the user which skills are trained by a device and which are not.

Training simulations, including SIMCAT, hold great potential for improving Army training. The research presented here showed SIMCAT was an effective means for training Armor C³ skills. Soldiers received repeated practice on a number of C³ tasks with quality feedback at a relatively low cost. No simulator is, however, a panacea of Armor training needs. What is needed is a training plan which optimally mixes the skills training of various training devices. Low-cost, low fidelity, part-task trainers like SIMCAT/PLBS should be included in the plan.

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APPENDIX A

Instructions for SIMCAT Operations

Display Maps

1. The SIMCAT terrain appears on the monitor in the form of a map. The map shows an area of Kentucky just north of Fort Knox.
2. There are three different views of the map that you can select--a close-view, a mid-view, and a far-view. All of the exercises today will be on the mid-view. This shows a piece of terrain 3,000 meters wide and 2,250 meters high. Press the MID RANGE key to bring up the mid-view map display.

Vehicles

1. There are both friendly and OPFOR vehicles shown on SIMCAT. The friendly vehicles are blue and the OPFOR vehicles are red.
2. The only friendly vehicles that can appear on SIMCAT are M1 tanks. The blue vehicles that you see on this screen is an M1 tank. You will be the tank commander (driver) of an M1 tank. You will know your tank from any other M1 tanks by a green circle that will appear in the middle of the tank.
3. There are two types of OPFOR vehicles--T72 tanks and BMPs. The T72 tanks look just like M1s except that they are red. The red tank on this screen is a T-72. The BMPs are diamond shaped and are also red. The diamond shaped vehicle on this screen is a BMP.
4. Each vehicle can fire one or more of its weapon systems. For today's exercise, only the main gun on the M1 tank can be fired. However, you will be able to fire either SABOT or HEAT.
5. While the T72, like the M1, will only be able to fire the main gun, the BMP will be able to fire either its main gun or a SAGGER missile.

Movement Control

1. All movement is controlled by pushing buttons on a control panel. That is, you start the tank, determine its speed and direction, and stop it by pushing certain buttons on the keypad. When you press a button to start the tank or to change direction of movement, the tank will not respond immediately. SIMCAT requires one or two seconds to process the command and execute it. Sometimes, it may even take longer.
2. Notice there are 18 driver commands. To start the tank, simply push the button labeled MOVE OUT. Do this right now and watch the screen to see what happens. The tank will begin to move in a second or two and will accelerate (speed up) to the speed limit.

3. The speed at which the tank will move will depend on the terrain. The tank can travel at 70 KPH on highways, 35 KPH cross country, 15 KPH through woods, and 3 KPH through water. The speed that the tank is traveling is shown on the lower right hand corner of the screen.
4. To slow the tank down, press the SLOW DOWN button. When you do this, in one or two seconds the tank will start to slow down to 5 KPH. Now press the SLOW DOWN button and watch this happen.
5. To speed up, press the SPEED UP button. In a second or two the tank will start to accelerate to the maximum speed for the terrain on which it is traveling.
6. To make a right turn, press the HARD RIGHT button. In a second or two, the tank will turn 90° to the right. To make a left turn, press the HARD LEFT button. The tank will turn 90° to the left. Remember the tank won't start to turn for one or two seconds.
7. Lets talk a minute about the small delay after you press a button. If you are impatient and press the button twice before the tank turns, SIMCAT will remember that you pressed the button twice and will execute the command two times. Quickly press the HARD LEFT button twice and see what happens. The tank will turn 90° and then another 90° .
8. If you want to make a smaller turn, you can press the GUIDE LEFT key or the GUIDE RIGHT key. This will cause the tank to turn 15° instead of 90° . Press the GUIDE LEFT key and watch the monitor. Notice that the tank turns just slightly to the left. Now press the GUIDE RIGHT key and notice that the tank turns slightly to the right. These keys are most helpful for navigating on the move.
9. If you want to turn the tank at a different angle, you can press the TURN LEFT or TURN RIGHT keys. This will cause the tank to keep on turning 15° until you tell it to stop turning. Press the TURN LEFT key and see what happens. To stop the tank from turning any more, press the STEADY ON key. Press the key and watch what happens. Now press the TURN RIGHT key. Press the STEADY ON key to stop the tank from turning.
10. Notice when you press the STEADY ON key, the tank does not stop turning immediately. It will continue to turn for 2 or 3 seconds before it stops. To turn the tank in the direction in which you want it to go, you have to anticipate that the tank will turn slightly even after you press the STEADY ON key. With a little practice you will be able to anticipate when to press the STEADY ON button. Right now practice turning the tank and getting it to go in the direction you want it to go.
11. To stop the tank, press the STOP button. Notice that in one or two seconds, the tank will slow down and then stop completely. Press the STOP button and watch what happens.

12. To turn the tank when you are stopped, press either the PIVOT LEFT or PIVOT RIGHT key. Press the PIVOT LEFT key and watch what happens. Now press the PIVOT RIGHT key. Notice that the tank turns 90° when you pivot left or right.

13. To move the tank in reverse, press the BACKUP button. In one or two seconds, the tank will start to move in reverse and will usually accelerate to 25 KPH. Press the BACKUP button now.

14. Now stop the tank by pressing the STOP button. To move out slowly in a forward direction, press the EASE OUT button. The tank will move out and accelerate to 5 KPH. Press the EASE OUT key and watch what happens.

15. Press the STOP key. To move out quickly in a forward direction, press the DASH button. The tank will move out and accelerate to the maximum speed. Press the DASH key and watch what happens.

16. Now lets assume that a BMP has fired a SAGGER missile and it is coming right toward you. The tank commander should tell you to EVADE LEFT or EVADE RIGHT. If you get such a command, simply press the EVADE LEFT or EVADE RIGHT key. Press these keys and watch what happens. Notice that the tank makes a series of 15° turns. When the tank stops zig-zagging, it will continue to move, but in a slightly different direction.

17. Remember we said that when you press the MOVE OUT button, the tank will accelerate to the maximum speed for that type of terrain. Suppose you are moving cross country at the maximum speed of 35 KPH. Now you enter a wooded area where the speed limit is 15 KPH. The tank will automatically slow down to 15 KPH. If you press the SPEED UP button, the tank will not go any faster. This is because it is already moving at the maximum speed for the terrain. Move the tank into a wooded area and watch the speed in the lower right hand corner of the screen.

18. Now suppose you leave the woods and are moving cross country again where the maximum speed is 35 KPH. The tank will not speed up unless you press the SPEED UP button. This is because the tank will not speed up automatically when it moves over terrain with a higher maximum speed. It will slow down when it moves over terrain with a lower maximum speed, but it will not speed up when it moves over terrain with a higher maximum speed. Move the tank out of the woods and notice that it will not speed up until you press the SPEED UP key.

19. If you are not sure what kind of terrain the tank is moving on, you can ask SIMCAT by pressing the SHOW TANK STATUS key. The terrain will be on the top line of a message that will appear on the screen. For example, the message may say cross country, woods, secondary road, and so on.

20. All vehicles on SIMCAT can move through water. However, the vehicles can move in water no faster than 3 KPH. If the tank slows down automatically to 3 KPH, you probably entered a small body of water. You can check this by hitting the SHOW TANK STATUS button. If the message says "barrier," this means that your tank is moving through water.

21. While SIMCAT records at all times where your tank is located on the map, it is only accurate to the nearest 30 meters. Sometimes SIMCAT simulates that you are going through water when you are near but not actually in the water.

22. To be a good driver on SIMCAT, you must do the following:

- a. Watch the speed of your tank.
- b. Be aware of the type of terrain over which your tank is moving.
- c. Remember that the tank will not speed up automatically. To restore the tank to its maximum speed, you must press the SPEED UP key. Because of the large number of ponds on the SIMCAT display, it is very easy for your tank to slow down automatically to 3 KPH. You must pay attention so that you can quickly cause the tank to speed up again once it leaves the water.

Gunnery

1. Only the main gun can be fired on the M1 tank. You can fire either SABOT or HEAT. To fire the main gun, there must be an OPFOR target on your screen. If the target is a T72 tank, you must fire by pushing TANK. If the target is a BMP (which is a red diamond), you must by pushing PC.

2. To hit a target, the gun tube must be pointed in the general direction of the target. To aim the gun at a target, you must first slew the turret in the general direction of the target. Do this by pressing one of the turret control arrows. This will cause the gun tube to turn in the direction that you indicated. Press the arrow pointing to the left. Notice that the gun tube will point to the left. This will be true no matter what the direction the tank may be facing.

3. Once the gun tube is pointed toward the target, you should hit the target as long as the gun tube is within 20° of the target. To get within 20°, you may have to make small adjustments. Press the TURN RIGHT key to make small adjustments to the right; press the TURN LEFT key to make small adjustments to the left.

4. To fire at a target, the tank commander must first decide whether the target is an enemy tank or BMP. If the target is a tank, the tank commander should give a proper fire command. If the target is a BMP, the tank commander should also give the proper fire command. The battlecarry is SABOT. When the driver/gunner hears the fire command, he should turn the gun tube toward the target by first pressing one of the arrow keys and then by fire

tuning his aim by pressing either the TURN RIGHT or TURN LEFT keys. When the gun tube is pointed toward the target, the driver/gunner should then press the TANK button or the PC button.

5. In a few seconds, the tank commander will hear either IDENTIFIED or CANNOT IDENTIFY. If he hears IDENTIFY, he should then say FIRE. The driver/gunner should then press the FIRE button. The gun will then fire until the target is destroyed.

6. If the tank commander hears CANNOT IDENTIFY, this means either that the wrong fire command was chosen or the gun tube is not within 20° of the target. The tank commander must then repeat the entire fire command.

7. SIMCAT gunnery is much more effective when firing from a stationary tank. When you see an OPFOR threat, you should therefore stop before engaging it.

Line of Sight

1. You will see friendly or OPFOR vehicles whenever you have line of sight. Vehicles will appear on the screen as soon as line of sight is achieved and will disappear whenever line of sight is lost. However, you can see all of the map display regardless of line of sight. In addition, you can see indirect fire bursts regardless of line of sight.

2. If you are trying to shoot a moving target and lose line of sight, you will not be able to hit it.

3. Whenever you have line of sight with another vehicle, it has line of sight with you.

Communications

1. The Controller will act as your platoon leader. You will be able to communicate with him on the platoon net by pushing the switch on your helmet to the forward position.

2. The radio will not be used for communications between the tank commander and his driver/gunner.

Special Instructions

1. The TC should not show the map to the driver. The TC should direct the driver by giving navigation commands.

2. The battlecarry is SABOT.

3. The driver must try to keep the tank on the road. The TC should make sure that he does this.

4. Accuracy is most important, but speed is also important.

APPENDIX B

Single Tank Tactical Exercise Controller's Guide

GENERAL NARRATIVE

"Good morning (or afternoon) and welcome to the Single Tank Tactical Exercise. I am _____, and during the exercise I will be the controller. This is _____, the assistant controller, and this is _____ and _____, the station evaluators.

During the exercise you will maneuver your tank from a start point along a prescribed route, to release point. From the start point to the release point you will be subjected to environmental cues, standard operating procedure requirements cues, and controller directed cues. These cues will require you to respond by executing appropriate operational tasks.

The scenario for the exercise is: You are part of a tank company which has just departed a rear assembly area and is moving to a forward assembly area. As you move out of the rear assembly area your tank broke a track. The company executive officer told you to fix the track as soon as possible and rejoin the company at the forward assembly area. The enemy has been rapidly withdrawing, however, stay behind units may be in the area. During all prior operations the enemy has not used chemical munitions. During the move you will have radio communications with your platoon leader.

Today we will operate two student stations and conduct simultaneously a single tank tactical exercise at each station. Crews will operate independently of each other.

Each student station will consist of a tank commander and a gunner/driver.

- Tank commanders will issue driving and firing commands, provide information to the controller, receive information and orders from the controller, and monitor tank speed.
- Gunners/drivers will execute tank commander driving and firing commands, lay the main gun for direction, make main gun final lays, and provide tank commanders, upon request, tank status and terrain condition information.

Now let's briefly review the major components which are at each student station and the purpose of each component.

- Color Monitor. The TV screen provides a 3000m x 2250m terrain view. The screen also displays tank status, terrain conditions, and tank speed.

During the exercise radio frequencies will be on 55.25. The call signs for stations in the exercise are as follows:

NET 1 (Platoon Net)	
NET	RED
NCS (CTL-PL)	RED 6
TC1	RED 1
TC2	RED 2

NET 2 (Fire Support Net)	
NET	SALVO
NCS (FIST)	SALVO 5
PL	RED 6
TC1	RED 1
TC2	RED 2

There is an evaluator at each station. _____ is the evaluator for Station 1 and _____ is the evaluator for Station 2. The evaluator's job is to evaluate tank commander proficiency of operational tasks. Tank commanders will be required to perform operational tasks in response to various exercise cues. Evaluators will not assist students in the performance of operational tasks, however, they may assist students experiencing problems with system functions.

Are there any questions to this point? Good. Now take the route overlay and transcribe it onto the tactical map. When you are finished you should have on the tactical map a start point, a route to follow, and a release point.

At this time we'll take a short break."

Controller brings "up" on the system a single tank tactical exercise.

- Gunner/Driver Touch Panel. The touch panel provides the means by which the gunner/driver moves and stops the tank, lays the main gun for direction, makes main gun final lays, inputs fire command information into the system, fires the main gun, and displays tank status and terrain condition information.
- Communications System. The system, a CVC helmet and an intercommunications control box provides the means by which the tank commander communicates with the controller. The tank commander communicates with the gunner/driver by "clear" voice, no electronic communications.

- 1:50,000 Scale Tactical Map. The map is used by the tank commander to determine his actual location in the operational area in reference to the tank's location on the color monitor.

In addition to the four major station components the following items are also available at each student station.

- o Tank Platoon SOP, FC 17-15-3
- o Armor School Extract of the CEOI, KTV 600A

The above documents include formats of reports required during the exercise and the tactical operations code required to encode and decode messages. SET 1 of the Tactical Operations Code will be used during the exercise.

- o Authentication table extract

This document will be used during the exercise for authentication and encoding information for a MIJI report.

- o Coordinate scale
- o Protractor
- o Grease pencil
- o Lead pencil
- o Route overlay (The route overlay includes the start point (SP), the route, the release point (RP), checks points along the route, and reference target areas)

ROUTE A (S TO N) NARRATIVE

"Give me your attention. Orient your map with the terrain display on your color monitor. Note the location of the start point on the map and on the color monitor. Note the location of your tank on the map and on the color monitor. If your tank is not on the start point, direct your driver to move the tank to the start point. If your gun tube is not pointing north, direct your gunner to traverse the turret until the gun tube is pointing north.

Pause for a signal from the station evaluators that the tanks are at the designated start points and that the gun tubes are pointing north.

Tank commanders, from this point all communications between the controller and you will be by radio. Put on your CVC helmet. Good luck."

ACTION: START POINT

TASKS: Enter a Radio net
Respond to an Authentication Challenge

"RED--THIS IS RED SIX--OVER"
"RED SIX--THIS IS RED _____--OVER"
"RED _____--THIS IS RED SIX--AUTHENTICATE _____--OVER"
"RED SIX--THIS IS RED _____--I AUTHENTICATE _____--AUTHENTICATE

--OVER"
"RED _____--THIS IS RED SIX--I AUTHENTICATE _____--OUT"

ACTION: REQUEST/ADJUST INDIRECT FIRE

Send the following message to the tank commander:

"RED _____ --THIS IS RED SIX--BREAK--READBACK--ENEMY INFANTRY
PLATOON DUG IN AT THE ROAD JUNCTION AT TARGET AREA A--BREAK--
DESTROY ENEMY PATROL WITH INDIRECT FIRE--BREAK--I AUTHENTICATE

--OVER"

"THIS IS RED _____ --I READBACK--(Controller checks accuracy
of readback)--OVER"

"THIS IS RED SIX--READBACK CORRECT--OUT"

At this time the tank commander switches frequencies from
the platoon net to the company fire support net. The
controller's FDC takes over the execution of the tank
commander's fire mission.

Monitor Action

"SALVO FIVE--THIS IS RED _____ --FIRE MISSION--OVER"

"THIS IS SALVO FIVE--FIRE MISSION--OUT"

"GRID _____ --OVER"

"GRID _____ --OUT"

"INFANTRY PLATOON--DUG IN--ADJUST FIRE--OVER"

"INFANTRY PLATOON--DUG IN--ADJUST FIRE--AUTHENTICATE _____ --
OVER"

"I AUTHENTICATE _____ --OVER"

"AUTHENTICATE CORRECT--OUT"

FDC sets up simulator to impact indirect fire 300 meters south
and 300 meters west of the target. Coordinates 7310 9870.

FDC determines observer (TC)-target line as 1511 mils or
85 degrees.

TASK: ADJUST FIRE

"Direction _____ --OVER"
"Direction _____ --OUT"

FDC inputs into the simulator subsequent adjustment rounds exactly as the tank commander requests the adjustments be made.

"RIGHT _____ or (LEFT _____) --DROP _____ or (ADD _____) --OVER"
"RIGHT _____ or (LEFT _____) --DROP _____ or (ADD _____) --OUT"
"SHOT--OVER"
"SHOT--OUT"
"LEFT _____ or (RIGHT _____) --ADD _____ or (DROP _____) --OVER"
"LEFT _____ or (RIGHT _____) --ADD _____ or (DROP _____) --OVER"
"SHOT--OVER"
"SHOT--OUT"
"RIGHT _____ or (LEFT _____) --DROP _____ or (ADD _____) --OVER"
"RIGHT _____ or (LEFT _____) --DROP _____ or (ADD _____) --OUT"
"SHOT--OVER"
"SHOT--OUT"
"LEFT _____ or (RIGHT _____) --ADD _____ or (DROP _____) --
FIRE FOR EFFECT--OVER"
"LEFT _____ or (RIGHT _____) --ADD _____ or (DROP _____) --
FIRE FOR EFFECT--OUT"
"ROUNDS COMPLETE--OVER"
"ROUNDS COMPLETE--OUT"
"END OF MISSION--TARGET DESTROYED--OVER"
"END OF MISSION--TARGET DESTROYED--OUT"

TASK: Submit a SPOT Report

"THIS IS RED _____ --SPOTREP-- _____ --AT _____ --TIME _____ --

--OVER"
"THIS IS RED SIX--ROGER--OUT"

ACTION: START POINT (CONTINUED)

TASK: Plot a Minefield Location on a Tactical Map

"RED _____--THIS IS RED SIX--OVER"

"THIS IS RED _____--OVER"

"THIS IS RED SIX--PLOT ON YOUR MAP THE FOLLOWING MINEFIELD
LOCATION--BREAK--READBACK--I SET JE--OWT--VUI--BREAK--I SET--ET--
FXK--PKW--BREAK--OVER"

"THIS IS RED _____--I READBACK--(Controller checks accuracy
of readback)--OVER"

"THIS IS RED SIX--READBACK CORRECT--OUT"

Pause for signal from the station evaluators that the tank commanders have plotted the minefield location on their tactical map.

Direct the tank commander to move out, to stop and report at each check point, and to move beyond check points only with permission from the controller.

ACTION: BYPASS A KNOWN MINEFIELD

TASK: Select a Route to Bypass a Minefield

Monitor Action

TASK: Direct the Driver Around a Minefield

Monitor Action

ACTION: ENGAGE A BMP

TASK: Submit a Contact Report

"THIS IS RED _____--CONTACT--NORTHWEST--BMP--OUT"

Monitor Action

TASK: Issue a Fire Command

"GUNNER--HEAT--PC--(pause)--FIRE"

Monitor Action

TASK: Submit a SPOT Report

"THIS IS RED _____--SPOTREP--ONE BMP--STATIONARY--AT _____--
TIME _____--DESTROYED BMP--_____--OVER"
"THIS IS RED SIX--ROGER--OUT"

ACTION: ENGAGE A T72 TANK

TASK: Submit a Contact Report

"THIS IS RED _____--CONTACT--EAST--TANK--OUT"

Monitor Action

TASK: Issue a Fire COMMAND

"GUNNER-SABOT-TANK-(pause)-FIRE"

Monitor Action

TASK: Submit a SPOT Report

"THIS IS RED _____ --SPOTREP--ONE T72 TANK--STATIONARY--AT
______ --TIME _____ --DESTROYED TANK-- _____ --OVER"
"THIS IS RED SIX--ROGER--OUT"

ACTION: REACT TO ELECTRONIC COUNTERMEASURES

TASK: Encode/Decode Messages

The tank commander is approaching Check Point 2 and is continuing his mission.

The controller injects interference into the radio net and continues to do so until receiving a signal from the station evaluator that the tank commander is ready to submit an interference report.

TASK: Submit an INTERFERENCE Report

"RED SIX--THIS IS RED _____ --OVER"
"RED _____ --THIS IS RED SIX--OVER"
"THIS IS RED _____ -- REPORT--BREAK--LINE 1--
LINE 2-- _____ LINE 3--RED _____ LINE 4-- _____ LINE 5--
______ --3BREAK--OVER"

Type of report and line entries 1, 2, 4, and 5 are sent in code. Controller decodes these items.

"THIS IS RED SIX--ROGER--OUT"

ACTION: REACT TO ENEMY INDIRECT FIRE

TASK: Evade Enemy Indirect Fire

As the tank commander approaches Check Point 2 located at 7455 5011 the controller brings enemy indirect fire to impact 200 meters east of the check point, i.e., 7475 0110. CAUTION: Do not attempt to place indirect fire adjacent to a moving vehicle because the timing is too difficult and the vehicle may be hit and destroyed.

Monitor Action

TASK: Submit a SPOT Report

"THIS IS RED TWO--SPOTREP--ENEMY INDIRECT FIRE--
ROUNDS--AT____--TIME____--____--OVER"
"THIS IS RED SIX--OUT"

ACTION: RELEASE POINT

TASK: Arrive at Designated Release Point

Monitor Action

TASK: Leave a Radio Net

"RED _____--THIS IS RED SIX--CLOSE DOWN--OVER"

"RED SIX--THIS IS RED _____--AUTHENTICATE _____--OVER"

"RED _____--THIS IS RED SIX--I AUTHENTICATE _____--OVER"

"RED SIX--THIS IS RED _____--ROGER--OUT"

Verify completion with the station evaluator. If the other tank commander has compiled his exercise, close down this exercise and prepare to bring up on the system the next exercise.

APPENDIX C

Experiment Score Sheets

LANE A

TC: _____ D/G: _____
 Last First Last First

Scorer: _____ Run: 1 2 3 4

TC: _____ Crews: _____ Date: _____
 Experienced 1 Inexperienced 2 Day Month

1. OPEN NET

- A. Clock time when net was opened: _____
- B. Responded to net call () GO NO-GO
- C. Responded to authentication challenge ()
- D. Issued authentication challenge ()

2. REQUEST AND ADJUST INDIRECT FIRE

(Scorer: Start watch on OUT)

- A. Elapsed time from OUT to indirect fire request: _____
- B. Requested indirect fire GO NO-GO
 FIRE MISSION or ADJUST FIRE ()
 GRID _____ (734/990) ()
 TARGET DESCRIPTION ()
 ADJUST FIRE ()
 AUTHENTICATION ()
- C. Gave OT line GO NO-GO
 DIRECTION _____ (1320 mils)
 (+ or - 150 mils) ()

D. First adjustment
Right: _____ Left: _____
Add: _____ Drop: _____

Second adjustment
Right: _____ Left: _____
Add: _____ Drop: _____

Third adjustment
Right: _____ Left: _____
Add: _____ Drop: _____

Fourth adjustment
Right: _____ Left: _____
Add: _____ Drop: _____

- E. Hit target when firing for effect ()
- F. Used linear deviation to adjust deflection onto OT line ()
- G. Used bracket system to adjust range ()
- H. Performance errors
-
-

3. PLOT MINEFIELD

A. Repeated minefield coordinates GO NO-GO
I SET..JEOWTVUI
I SET..ETFXKPKW ()

(Scorer: Start watch when TC says "OVER")

- B. Elapsed time from OVER to completion of decoding: _____
- C. Decoded minefield coordinates GO NO-GO
728/994 729/994 ()
- D. Plotted minefield on tactical map GO NO-GO
(+ or - 100 meters NS and EW)

E. Performance errors

4. BYPASS MINEFIELD

A. Directed driver around minefield

B. Performance errors

5. CHECK POINT 1

A. Clock time upon reaching CP1

B. Reported arrival at CP1

GO NO-GO

6. ENGAGE BMP

(Scorer: Start watch when BMP appears)

A. Submitted contact report (before or while
engaging BMP)

CONTACT ()
NORTH (or grid) ()
BMP ()

GO NO-GO

B. Elapsed time from BMP to "GUNNER"

GO NO-GO

C. Issued fire command
GUNNER-SABOT-PC
FIRE-FIRE HEAT ()

GO NO-GO

D. Submitted spot report

SPOTREP ()
DESTROYED PC ()
GRID _____ (729/003) ()
TIME _____ ()
CONTINUING MISSION ()

GO NO-GO

E. Elapsed time from CEASE FIRE
to spot report:

F. Performance errors

7. ENGAGE T72

(Scorer: Start watch when T72 appears)

- A. Submitted contact report (before or while
engaging T72) GO NO-GO
CONTACT ()
NORTHEAST (or grid) ()
TANK ()
- B. Elapsed time from T72 to "GUNNER" _____
- C. Issued fire command GO NO-GO
GUNNER-SABOT-TANK
FIRE ()
- D. Submitted spot report GO NO-GO
SPOTREP ()
DESTROYED TANK ()
GRID _____ (749/008) ()
TIME _____ ()
CONTINUING MISSION ()
- E. Elapsed time from CEASE FIRE
to spot report: _____
- F. Performance errors
-
-

8. CHECK POINT 2

- A. Clock time upon reaching CP2: _____
- B. Reported arrival at CP2 GO NO-GO

9. REACT TO ENEMY INDIRECT FIRE

(Scorer: Start watch when indirect fire appears)

- A. Reacted to indirect fire GO NO-GO
- B. Submitted spot report GO NO-GO
 - SPOTREP ()
 - RECEIVING INDIRECT FIRE ()
 - GRID _____ (745/014) ()
 - TIME _____ ()
 - CONTINUING MISSION ()

C. Elapsed time to spot report: _____

D. Performance errors

10. CHECK POINT 3

- A. Clock time upon reaching CP3: _____
- B. Reported arrival at CP3: GO NO-GO

11. RELEASE POINT

- A. Clock time at release point arrival: _____
- B. Reported arrival at release point GO NO-GO
- C. Responded to net call to close down
 Issued authentication challenge () GO NO-GO
- D. Performance errors

12. DRIVING AND NAVIGATION ERRORS

