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Effects of Target Acquisition and Prioritization Information on Gunner Simulator Performance

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U. S. Army

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The objective of this research was to determine if automated target location and prioritization information would facilitate tank gunner performance.

Armor Crewmen individually completed two sessions (phases) of 50 sabot rounds using a part-task, arcade type M60A1 gunnery simulator, "Battlesight." A 2x2 design was used with the target location window display either present or absent in Phase I and present or absent in Phase II. Gunners were scored on the time required to fire 50 rounds, the number of hits on enemy (Continued)

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20. (Continued)

tanks, the number of times they were killed by enemy tanks, and the number of points scored during the session.

Soldiers with access to the target prioritization and location information took less time to fire 50 rounds and were killed less frequently than soldiers without access to this information. Soldiers who first used the window and then were shifted to no window showed large decrements in performance; soldiers shifted from no window to window showed significant improvement in performance. Soldiers reported that access to the target information was a valuable aid in detecting targets.

The results indicate that target location and prioritization information would be of great value as part of a vehicle integrated intelligence package, and that the device is potentially useful in gunnery training and skill retention.

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FOREWORD

The Army Research Institute for the Behavioral and Social Sciences (ARI) performs research to determine the effects of future battlefield conditions on tank gunnery performance. As part of this effort, the Fort Knox Field Unit is conducting research to evaluate how providing selected information to commander and crew might improve the combat effectiveness of armor crews.

This report presents the results of an investigation of the effects of providing target location and priority information to tank gunners. Target location and priority data are probable candidates for a Vehicle Integrated Intelligence ($V(INT)^2$) system.

The long-term goal of this research is to enhance soldier readiness by facilitating soldier capabilities in future friendly weapons systems and by devising countermeasures to future battlefield threats.

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EFFECTS OF TARGET ACQUISITION AND PRIORITIZATION INFORMATION ON GUNNER SIMULATOR PERFORMANCE

EXECUTIVE SUMMARY

Requirement:

New technologies offer many opportunities for improving armor system capabilities to enhance crew performance. Unfortunately, expensive technologies are frequently adopted into weapon systems in the absence of any hard data supporting their effectiveness. The purpose of this research is to evaluate the effectiveness of a radar-type display that provides target location and prioritization information.

Procedure:

Forty armor crewmen individually completed two sessions (phases) of 50 rounds each on the Battlesight gunnery simulator. Presence or absence of a wide angle target location window displaying target location and prioritization information in Phase I was combined factorially with presence or absence of the window display in Phase II. Dependent variables were (1) time to complete each session, (2) number of enemy tanks hit, (3) number of times killed by enemy tanks, and (4) total points scored in the session.

Findings:

Results indicated that the automated target location and prioritization information significantly reduced time to complete the session and number of times the player was killed; hits and points scored were not affected. Soldiers shifted from window in Phase I to no window in Phase II showed decrements in performance, whereas soldiers shifted from no window to window showed significant improvement in performance. Soldiers reported that the window display was a valuable aid in detecting targets.

Utilization of Findings:

The results suggest that target location and prioritization information would greatly assist in detecting and destroying enemy armor targets. Comments from armor crewmen and National Guard and Reserve officers suggest that Battlesight would be very useful in gunnery training and in skill retention in armories.

EFFECTS OF TARGET ACQUISITION AND PRIORITIZATION INFORMATION ON GUNNER SIMULATOR PERFORMANCE

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EFFECTS OF TARGET ACQUISITION AND PRIORITIZATION INFORMATION ON GUNNER SIMULATOR PERFORMANCE

INTRODUCTION

Vehicle integrated intelligence ($V(INT)^2$) is a total vehicle system that provides selected information to various levels of command and crew positions to improve armor combat capability. $V(INT)^2$ is a command and control aid which receives, assimilates, and processes information, and then presents it in a logical sequence to the operator. The $V(INT)^2$ system might include an elaborate sensor array (both on board and external), an on-board computer, artificial intelligence, and a display system. The information provided by such a system could be used by commanders in the allocation and distribution of fire and the maneuver of forces. By knowing the location of friendly and enemy weapons systems, the commander at each echelon from the tank through the battalion would be better able to use the most appropriate weapon to engage the threat. Fewer missed targets or gaps in the scheme of maneuvers will then exist.

Information presented by $V(INT)^2$ might include: (1) continuous information such as a terrain map, friendly and enemy vehicle locations, obstacles, and contaminated areas; (2) real time information such as orders, artillery and air support, battlefield identification friend or foe, and friendly and enemy vehicles damaged/destroyed; (3) on-call information such as new map sheets, availability of artillery and air support, the operational plan, weapons availability, sectors of fire, and target location, range, hand-off and priority; (4) logistics data; (5) maintenance data; and (6) administrative data.[2] Much research is needed on the effect of this information on crew and unit performance, which information to present, and how to train soldiers to utilize this information. Few studies have addressed these questions and to date only one study has investigated the effect of automated target location information.

The US Army Human Engineering Laboratory and the German Ministry of Defense conducted a study evaluating the effects of presenting to tank platoon leaders real time location information on enemy and/or friendly tanks.[3] The study was conducted using the APKA system which is a mobile, computer driven, interaction simulator operating in real-time. The system utilizes tank commander and driver displays, and up to 40 tanks of two different types may be allocated to opposing forces. The test consisted of 72 free-play, opposing-force battles. Three conditions were evaluated: baseline, in which

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[1]Blasche, T., & Lickteig, C. Utilization of a vehicle integrated intelligence ($V(INT)^2$) system in armor units (Working Paper 83-3). Fort Knox, KY: US Army Research Institute, October 1983.

[2]Ibid.

[3]Walker, J.R., & Reimer, J. Information requirements for command and control (IRC^2): Phase 1A (Technical Note 6-84). Aberdeen Proving Ground, MD: US Army Human Engineering Laboratory, March 1984.

tion in which automated information was presented. Soldiers in this group (NW-W) engaged targets faster and were killed less often than soldiers in the W-NW group. In addition, the group who were privy to the automated information in Phase I and were shifted to the non-automated condition in Phase II were killed more often in Phase II than any other group. For example, the W-NW group was killed 20.6 times on the average in Phase II compared with an average of 12.4 times for the NW-NW group. Finally, the group who was given the automated information in both phases (W-W group) of the experiment were killed almost twice as often in Phase II as the group who was without automated information in Phase I and were shifted to the automated information condition in Phase II. This pattern of results suggests that the best strategy may be to train the soldiers first in the degraded mode followed by training with the automated system. More research is required to confirm or reject this hypothesis.

the information necessary to make this distinction. Future V(INT)^2 systems may provide automated vehicle recognition and identification features, thus solving the problems described above.

The soldiers participating in this experiment clearly liked the Battlesight simulator. They particularly liked the window display feature and the realism of engaging moving targets. However, their approval of the Battlesight says little about the training value of the device. Although the device clearly has potential as a gunnery trainer, it has several shortcomings which may reduce its training value. As mentioned above it presents only threat tanks; no friendly tanks or other enemy vehicles are presented. Thus target recognition and identification are not trained. No fire commands are built into the device and the gunners therefore search and fire at will.[6] This mode of operation is contrary to current tank gunnery doctrine and may constitute negative training. Battlesight also includes no switches and controls other than the gunner's control handles; hence, the gunner is not required to select his ammunition or the weapon he will use. Finally, as presently designed, Battlesight allows the gunner to be sloppy in tracking and laying on the target. Battlesight permits the gunner to slew rapidly to the target, firing as the reticle moves across the target to achieve a target kill.

Despite these shortcomings, the Battlesight concept is a good one and with several modifications Battlesight could be an excellent part-task gunnery trainer. Outstanding features include its computer-generated imagery and its programmability. Because of its low cost, Battlesight would be of considerable value if placed in National Guard and Reserve armories, where it could be used to maintain gunnery skills.

Some of the soldiers who were given access to the Battlesight display window failed to use it to their maximum advantage and a couple of soldiers appeared not to use the window at all. Rather than concentrate on the window display and slew rapidly, some soldiers traversed tentatively, shifting their attention between the window display and the reticle area where the tanks appear. This strategy resulted in slower acquisition times and their own tanks being destroyed more frequently. These findings support the conclusion of Walker and Reimer[5] that soldiers need training in the use of V(INT)^2 information to make maximum utilization of its effectiveness. More research is required to examine not only how best to train soldiers to use this information, but also to determine what information to present and in what form it is to be presented.

The results of this research have implications for training soldiers to use automated systems. Of the four groups tested, the best performance was exhibited by the group who were first trained without the automated target location and prioritization information, and then were shifted to the condi-

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[5]Ibid.

[6]Although the Battlesight trainer used in this research did not include fire commands, Battlesight has recently been modified to include voice fire commands and an automatic slewing function to simulate tank commander actions.

rapidly, stopping to make the final lay with the reticle when the colored dots representing the tanks appeared in the window. The colored dots helped the subjects engage the most dangerous targets first by making them easily distinguishable from less dangerous targets. With the window blocked, subjects were forced to traverse slowly enough to see targets moving across terrain and amongst houses. Without the colored dots to indicate the location and relative danger of threats, subjects typically engaged the first target they saw, even though a more dangerous threat might be in a sector of the gaming area adjacent to the reticle. Subjects reported scanning more slowly when operating without the window display and slower times to complete the phase confirmed these reports. These slower times and failure to engage the most dangerous targets first resulted in no-window subjects being killed more often by enemy fire.

The results of this research are consistent with those of Walker and Reimer[4] in showing that the wide-field-of-view location of enemy targets may be of value in defeating armor forces. However, the present research included target prioritization as well as target location information and no data were gathered to determine the relative contribution of target location versus prioritization. Additional research is needed to evaluate the effects of providing target location information alone versus providing both target location and prioritization information.

In the present research, it is important to note not only the kind of information presented but also the manner and context in which it was presented. The radar-type display presented target location and prioritization information in an essentially noise-free environment. That is, the display presented targets as colored dots against a solid background. The background contained no visual noise that might be mistaken for targets. If a colored dot appeared, then a target was present; false alarms were highly unlikely and the colored dots were clearly visible against the green background, increasing the probability of detecting targets. Information channels for detecting enemy vehicles in current U.S. tanks (e.g., daylight optics and thermal sights) do not provide a noise-free signal. Tanks and other armor targets as seen through tank optics often are camouflaged so that they blend with their background, making target detection a difficult task at near ranges. As range increases, targets tend to all darken so camouflage is not as critical in defeating detection as are clutter (noisy signal) and limitation of optics available. Target detection using thermal sights is somewhat easier, but hot spots in the environment provide noise that increases false alarms, making target detection more difficult. The large performance increments resulting from the information provided by the window display must be attributed in part to the noise-free signal provided by the display. One might expect smaller performance increments from using the display as the background noise in the display increases. The Battlesight radar-type display gave target location and prioritization information but did not aid the gunner in distinguishing enemy from friendly vehicles. Since only threat vehicles were presented by the Battlesight, the gunners did not need to recognize vehicles as friend or foe, but on the battlefield gunners must obtain

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[4]Ibid.

Table 7

Subjects' Responses and Suggestions
From the Post-experiment Questionnaire

Item	Frequency
Question 1. The best feature of this trainer:	
Window display	6
Firing at moving targets	5
Traversing	3
Firing at targets	3
Using the sight reticles	2
Using the magnetic palm brake	2
It was realistic	2
Question 2. The worst feature of the device was:	
Not knowing the location of tanks that fired	6
Instability of the controls	5
It wasn't realistic	3
Not having a tank commander	2
Too much scanning without the window	2
Tanks looked like trees	2
Poor resolution of screen	2
Not accurate at long ranges	2
Question 3. Special strategies used with the window display:	
Shot red blips first, then yellow	7
Centered blips on the "V"	6
Question 4. Special strategies used without the window:	
Traversed back and forth in the immediate area where other targets were located	8
Traversed slower	5
Searched using a G pattern	4
Used stop and go scanning	2
Question 10. Comments:	
Use the Battlesight in gunnery training	6
Needs ammunition selection	5
Needs fire commands	5
Construct an M60A3 Battlesight	3
Window display was helpful	2

Table 6

Means and Standard Deviations for Total Kills

	Phase I		Phase II	
	Mean	S.D.	Mean	S.D.
W-W	5.6	4.14	6.6	3.27
W-NW	10.7	5.01	20.6	7.56
NW-W	17.1	8.53	3.5	3.57
NW-NW	14.4	6.13	12.4	8.44

A step-wise multiple regression analysis was conducted to determine if any subject demographic variables were significantly related to time, kills, hits, or points. None of the variables were significant at the .05 level.

Post Experiment Questionnaire

The subjects generally reacted favorably to the window display. Only two of 20 subjects preferred operating without the window display. Subjects were divided almost equally on a preference of the device window or the M60A1 unity window. Twenty-two of 30 subjects thought the color coding of the targets on the display was "very helpful", five thought it was "helpful", and three thought it was "slightly helpful." Twenty-four of 30 said the display made hard-to-see targets easier to acquire, four said the display made it more difficult, and two said "neither." Twenty-one of 30 subjects said the display made easily seen targets easier to acquire, two said the display made it more difficult, and seven said "neither."

Subject responses to open-ended questions are presented in Table 7. Subjects thought the window was the best feature of the device, and not knowing the location of tanks firing on them was the worst feature of the device. When using the window subjects used the color coding of the targets and the "V" to center the targets. When not using the window, subjects said they traversed in the area of burning tanks and traversed at a slower rate.

Recommendations made by the subjects were that the Battlesight be used in gunnery training, and that an M60A3 Battlesight be constructed. The subjects said that the device needed ammunition selection and fire commands. National Guard and Reserve officers who participated in pilot trials highly recommended that the devices be placed in armories.

DISCUSSION

The Battlesight target location and prioritization information provided by the window display clearly improved the gunner's ability to quickly locate and destroy enemy targets. Access to the window allowed subjects to traverse

Table 4

Means and Standard Deviations for Total Time

	Phase I		Phase II	
	Mean	S.D.	Mean	S.D.
W-W	19.15	5.15	18.22	4.63
W-NW	22.20	7.73	40.59	12.07
NW-W	31.22	13.31	17.05	2.48
NW-NW	29.76	7.76	29.37	13.55

The groups also differed significantly in the number of times that they were killed by the threat ($F(3,36) = 10.86$, $p < .0001$). Phase was not a significant factor ($F < 1$), but the phase x group interaction was significant ($F(3,36) = 10.56$, $p < .0001$). This interaction also indicated that there were changes in performance from Phase I to Phase II for the shifted groups. The NW-W group (mean times killed = 3.5) was killed less in Phase II than the NW-NW group (12.4), whereas the W-NW group was killed more than the other three groups in Phase II (20.6) ($p < .05$). These data are summarized in Tables 5 and 6.

Table 5

Summary Table of 2 (Phase) x 4 (Groups) Analysis of Variance for Total Kills

Source	SS	df	MS	F	Prob
Total	5206.48	79	65.90	-	-
Group	1027.14	3	342	10.86	.0001
Error	1134.85	36	31.52	-	-
Phase	27.61	1	27.61	0.62	.4364
Phase x Group	1412.24	3	470.75	10.56	.0001
Error	1604.65	36	44.57		

RESULTS

The initial analyses were performed using a 4 (Groups) x 2 (Phase) x 10 (Trials) repeated measures analysis of variance with a trial consisting of a block of 10 rounds. This analysis was performed on four dependent variables: (1) time (to fire 10 rounds); (2) kills (number of occasions on which the player's tank was killed; (3) target hits (number of threat tanks killed); and (4) points (accumulated by player during each 10 shot block). The primary purpose of these analyses were to determine if improvement in performance occurred over trials. There were no significant effects for trials either as a main effect or an interaction. Therefore, only analyses for total scores for each phase are reported.

Total scores were analyzed using a 4 (Groups) x 2 (Phase) repeated measure analysis of variance of (1) total time, (2) kills, (3) target hits, and (4) total points for each phase.

There were significant differences among the groups for time to fire 50 rounds as evidenced by a significant groups main effect ($F(3,36) = 8.33$, $p < .0002$). This main effect is attributable to the fact that the W-W group took significantly less time than did the NW-NW or the W-NW group. The phase main effect was not significant ($F < 1$). The phase x group interaction was significant ($F(3,36) = 9.83$, $p < .0001$). This interaction indicates that there were changes in performance from Phase I to Phase II for the two shifted groups. The NW-W group had the lowest time in phase II (17.05 min), significantly lower than the NW-NW group (29.37 min) ($p < .05$); the W-NW group had the highest time in Phase II (40.59 min) ($p < .05$). These data are summarized in Tables 3 and 4.

Table 3

Summary Table of 2 (Phase) x 4 (Groups) Analysis of Variance for Total Time

Source	SS	df	MS	F	Prob
Total	1081.39	79	13.69	-	-
Group	1974.98	3	658.33	8.33	.0002
Error	2845.00	36	79.03	-	-
Phase	10.55	1	10.56	0.12	.7257
Phase x Group	2689.16	3	896.39	9.83	.0001
Error	3281.69	36	91.16		

Procedure

Subjects were randomly assigned to one of the four groups in Table 2. Subjects arrived in pairs, completed the demographic questionnaire and received instructions for phase I (see Appendices C and D for instructions). The subjects alternated time on the Battlesight with one member of the pair being tested while the other member rested. The first subject, after being briefly familiarized with the Battlesight, completed phase I, followed by the second subject. Phase II proceeded in a similar fashion following a 30-40 minute rest break. Each phase consisted of one session on the Battlesight, with a session lasting until the subject had expended fifty rounds of ammunition. After completing both phases of the experiment, the subject answered the post-experiment questionnaire and was released to return to his unit.

The gaming scenario was as follows. The subject traversed the target area using the gunner control handles and fired on threat tanks at will. Reload time was pre-set at four seconds, at which time the word "UP" appeared on the gaming area portion of the display signaling the fact that a round had been loaded. Threat tanks were either stationary, flanking or closing and could fire at the subject at any time. Threat tanks could engage the player's tank and score "kills" on the subject, with a restart occurring if the subject was killed 10 times. One to four threat tanks were active (i.e., they could engage the player's tank) at any one time. The probability of a threat tank engaging the player's tank varied as a function of range, elapsed time since the beginning of the session and number of rounds fired by the player. The probability of a threat tank killing the player's tank was a function of target range and whether the threat tank was stationary or moving. The probability of the player killing the threat tank also varied as a function of target range. Hit probabilities for the player's tank and for the threat tanks engaging him are programmable. The hit probability values used in this research (see Appendix E) were selected to minimize the number of times the player got "killed" by enemy fire. Being killed too often tended to disrupt the game play and reduce the player's motivation to perform well. The subject received 1,000 points for a first-round hit on a threat tank, 500 points for a second-round hit, 250 for a third-round hit and 50 points for all other hits regardless of range. Time-to-engage targets did not directly affect the player's score, but could affect how many times the player was killed.

During each phase of the experiment, subjects engaged targets with or without the benefit of the wide-field-of-view target location display window. During phases in which subjects received the NO-WINDOW condition, the target location display was obscured with a piece of cardboard. The cardboard was removed for sessions in which subjects had access to the display window.

A data collector sat on a stool behind the Battlesight and recorded the time to complete each session using a stopwatch. The data collector also recorded the number of hits on enemy tanks, the number of times the subject was killed, and the total score.

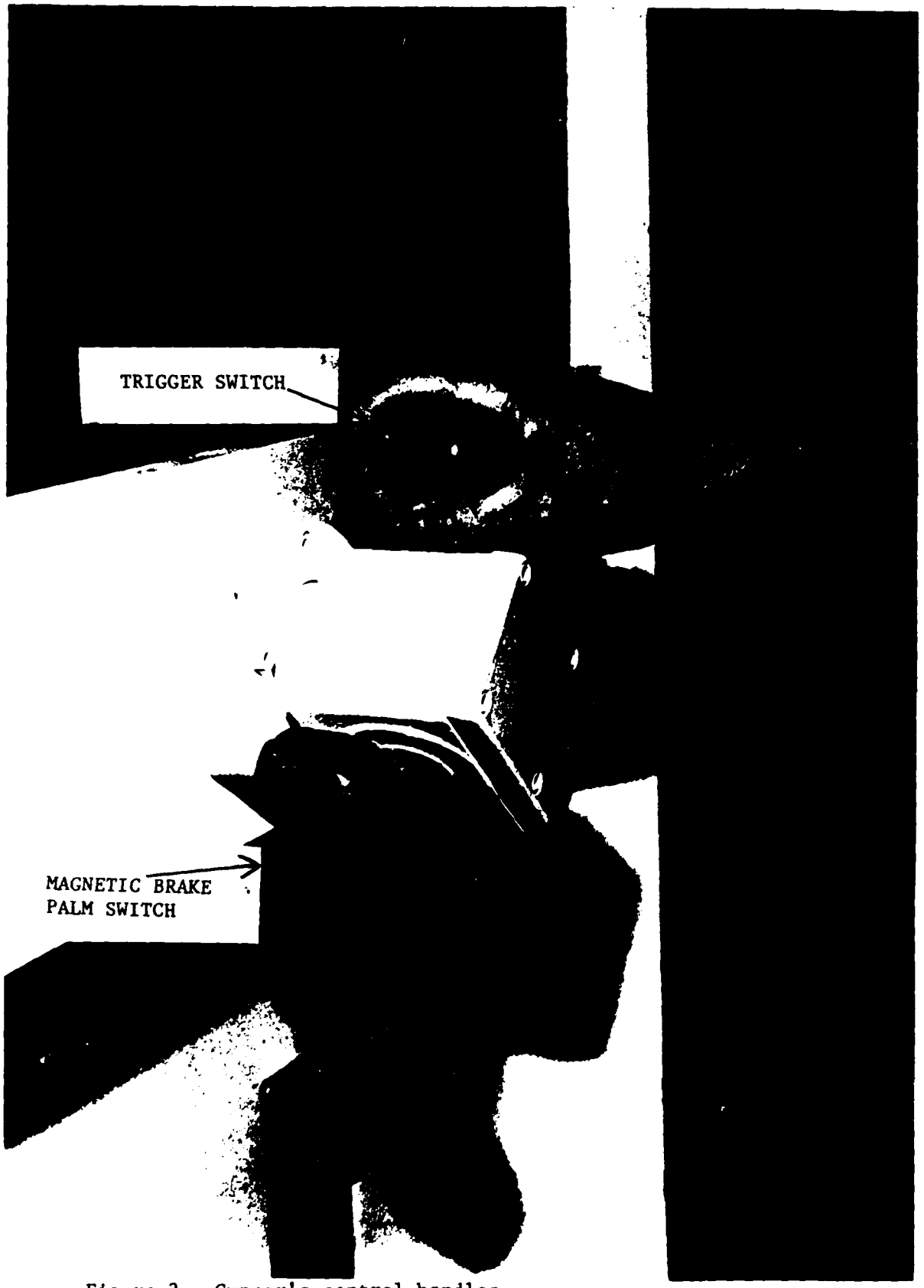

Figure 3. Gunner's control handles.

prioritization information provided by the colored dots only indicate the relative ranges of the threat vehicles. The dots do not differentiate between a threat which has its gun tube pointed toward the players tank and a threat that is simply crossing the player's field-of-view. The wide-field-view provided by this display simulated the field-of-view provided on the M60A1 tank by the 1 x power gunner's unity window. In the middle of the display is a "V" mark. When a dot is inside the "V", the target is in the field-of-view of the gunner's primary sight. The lower portion of the gaming area displayed the subject's score, elapsed time, rounds remaining, and gun azimuth and elevation.

Gunner's control handles similar to those found in the M60A1 tank were used to track targets and fire main gun rounds (Figure 3). The handles, or cadillacs as they are often called, consist of a magnetic brake palm switch for traversing the 102 degree gaming area and a trigger switch for firing the gun. No other M60A1 switches or controls are provided; the gunner interacts with the game solely through the gunner's control handles.

Each subject completed a demographic questionnaire (Appendix A) and a post-experiment questionnaire (Appendix B). The demographic questionnaire requested information on age, rank, armor experience, gunnery experience, video-game experience, education, and rank. The post-experiment questionnaire elicited information concerning opinions of the simulator, the display, and target location strategies used.

Experimental Design

The experimental design was a 2x2 factorial with the presence or absence of the window display (providing target location and prioritization information) in phases I and II. The conditions presented to each of the four groups in each phase of the experiment are shown in Table 2.

Table 2

Experimental Conditions by Subject Group

Group	Phase I	Phase II
W-W (control)	Window	Window
NW-NW (control)	No Window	No Window
W-NW (experimental)	Window	No Window
NW-W (experimental)	No Window	Window

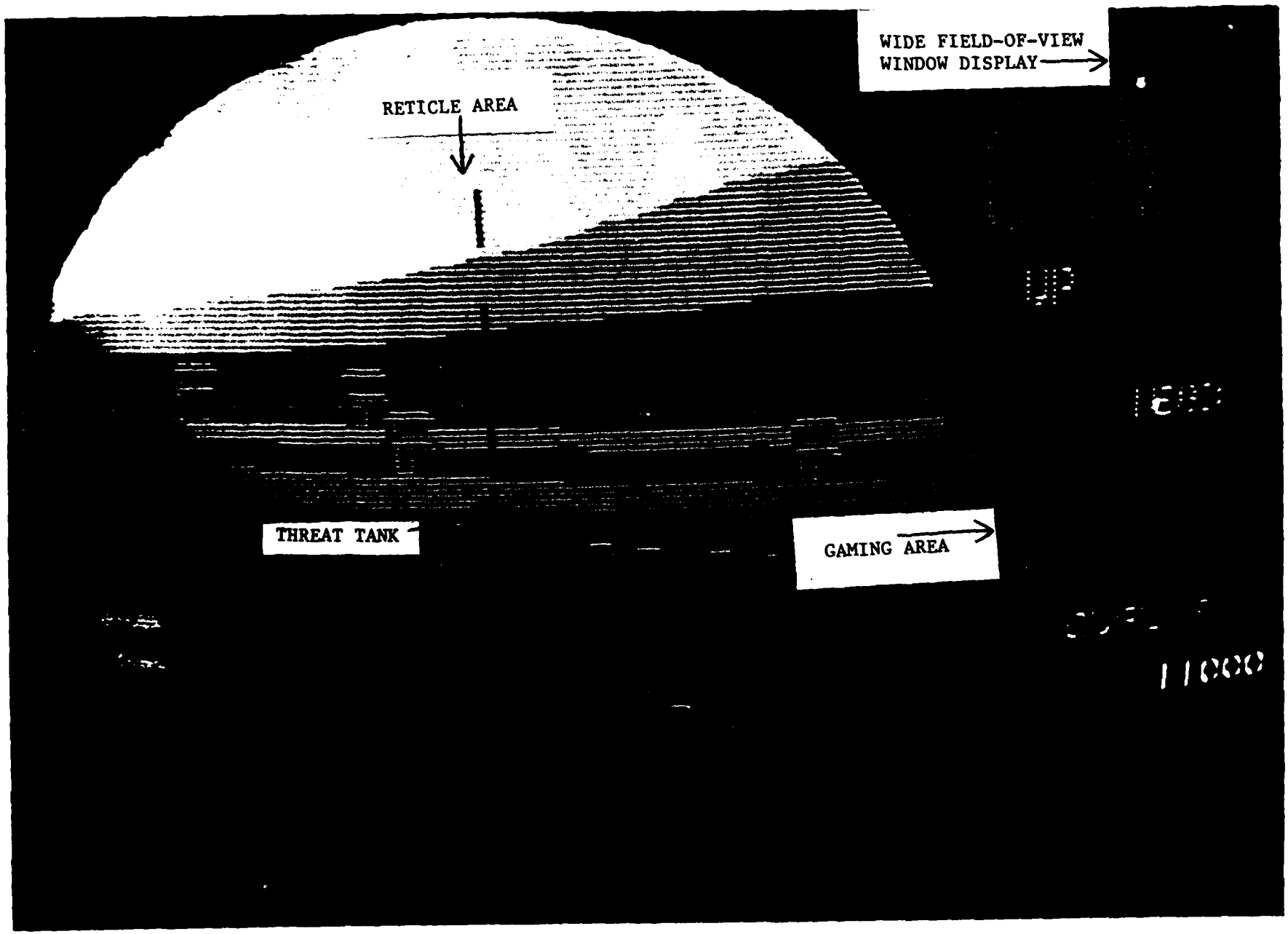

Figure 2. Battlesight CRT display.

Figure 1. Rear view of Battlesight simulator.

Table 1

Demographic Data

Subj #	Rank	Age (Yrs)	Time in Service (Mo)	Time in Armor (Mo)	Time as Gunner (Mo)	Time as A1 Gnr (Mo)	Educ	Wears Glasses	Fired Table VIII	Qual[1]	Dist[2]	Video Exp[3]
1	E-5	21	52	52	28	6	HS	No	2	2	0	0
2	E-2	19	10	10	0	0	HS	No	0	0	0	2
3	E-5	22	46	46	6	6	HS	Yes	0	0	0	6
4	E-1	21	24	24	0	0	GED	No	1	1	0	0
5	E-5	25	73	73	30	28	HS	No	0	0	0	0
6	E-2	18	8	8	0	0	GED	Yes	0	0	0	12
7	E-3	29	80	40	24	24	Coll	No	3	3	2	0
8	E-2	21	6	6	1	1	HS	No	0	0	0	10
9	E-3	19	17	15	3	1	HS	No	0	0	0	10
10	E-2	20	10	10	1	1	HS	No	0	0	0	20
11	E-7	35	224	120	0	0	GED	Yes	0	0	0	0
12	E-5	22	43	42	12	0	HS	No	0	0	0	0
13	E-5	29	44	44	0	0	HS	No	0	0	0	10
14	E-2	21	8	8	0	0	HS	No	0	0	0	30
15	E-6	31	158	144	6	6	HS	No	1	1	1	0
16	E-4	26	50	50	10	0	Coll	No	0	0	0	0
17	E-4	24	72	60	36	12	HS	No	1	1	1	1
18	E-6	28	110	15	0	0	HS	No	0	0	0	0
19	E-1	20	6	6	0	0	HS	No	0	0	0	0
20	E-2	23	10	10	0	0	Coll	No	0	0	0	0
21	E-1	20	5	5	0	0	HS	Yes	0	0	0	2
22	E-5	23	51	63	24	24	HS	No	0	0	0	0
23	E-7	35	145	145	18	0	Coll	No	0	0	0	0
24	E-5	23	48	48	24	6	GED	No	1	1	0	0
25	E-3	21	22	22	0	0	HS	No	0	0	0	2
26	E-5	25	46	48	24	0	Coll	No	0	0	0	0
27	E-5	22	43	39	12	0	HS	No	0	0	0	5
28	E-1	18	7	3	3	0	No HS	No	0	0	0	20
29	E-5	27	46	46	24	1	HS	No	0	0	0	0
30	E-6	32	153	150	0	0	HS	Yes	0	0	0	0
31	E-5	22	48	40	0	0	GED	Yes	0	0	0	0
32	E-5	25	72	72	27	27	HS	Yes	3	2	1	0
33	E-5	25	78	78	36	24	HS	No	3	2	1	0
34	E-1	21	6	6	2	0	HS	Yes	0	0	0	8
35	E-6	29	72	70	50	24	HS	Yes	2	1	1	1
36	E-2	28	9	9	6	9	Coll	No	1	0	0	2
37	E-5	26	35	33	12	4	HS	No	1	1	0	5
38	E-2	19	6	6	0	0	HS	No	0	0	0	0
39	E-5	26	27	27	9	0	GED	No	0	0	0	2
40	E-1	19	7	7	0	0	Coll	Yes	2	0	0	35

[1]Qualified on Table VIII.
[2]Qualified distinguished on Table VIII.
[3]Number of times played video arcade game in the last 30 days.

the platoon operated with only the normal operational orders information; friendly, in which the real-time locations of all friendly tanks were shown to the platoon leader on a separate video screen; and friendly-enemy, in which real-time locations of all enemy and friendly tanks were displayed to the platoon leader using different symbols. Results indicated that platoons with electronic position information won more battles, but that differences between the friendly and friendly-enemy conditions were not substantial. In addition, platoon leaders failed to use the information effectively. The authors report that this failure was likely due to the lack of specific training in ways to take maximum advantage of this information. The lack of substantial differences between friendly and friendly-enemy conditions may have been the result of not prioritizing the enemy target location information.

The purpose of the present experiment was to assess the effects of providing real-time information on enemy location and prioritization information to M60A1 gunners using the Battlesight, an arcade-style gunnery simulator. A secondary goal of the study was to demonstrate how an arcade style gunnery game might be used as a training device.

METHOD

Subjects

The subjects were 40 tank crewmen from I Company, 2nd Squadron, 6th Cavalry at the Armor Center, Fort Knox, Kentucky. Mean time in the service for the group was 49.4 months, with 42.5 mean months in armor. Only 12 had fired Table VIII as a gunner. Twenty-one were E-5 and above, and 19 were E-4 and below. Nineteen had played a video game in the last 30 days. Complete demographic data for the subjects are presented in Table 1. The subjects were randomly assigned to one of four groups (n = 10/group).

Apparatus

The apparatus was a prototype of a single player, arcade-style trainer called Battlesight (Figure 1). Battlesight is a low-cost, part-task trainer employing computer generated-graphics and sound effects. The trainer's display consists of a nineteen-inch color cathode ray tube (CRT). The CRT is partially masked to provide two distinct display areas, a reticle area and a gaming area (Figure 2). The reticle area is an 11-inch diameter circle which depicts the battlefield as viewed through the M32E gunner's periscope. Animations of Soviet T-62 tanks at ranges of 1100 to 5000 meters are shown moving among houses, rubble and trees. The threat tanks move at different speeds, change direction and may assume defilade or partial defilade positions. Threat tanks also fire at the game player and may "kill" him if he is not skilled enough to kill them first. The gaming area displays two types of information. In the upper portion of the gaming area is a radar-type display with colored dots that show the gross location of threat tanks in a wide (10 x 15 degrees) field-of-view. The color of the dots indicate which targets are greater threats to the player's tank, with red representing a most dangerous threat (range less than 1500m), yellow a dangerous threat (range 1500-2000m), and blue a least dangerous threat (range 2000-5000m). The target

APPENDIX A
BIOGRAPHICAL QUESTIONNAIRE

Date _____

Biographical Questionnaire

Gunner's Name _____ Subject #_____

Unit or Class _____

Bumper No _____

1. Do you wear glasses? Yes No

   If yes, do you wear them when firing? Yes No NA

2. Have you ever used a gunnery trainer like this? Yes No

   If yes, how many times? _____; which one? _____

   If yes, when did you last use it? _____ months ago

3. How long have you served in armor? _____ months

4. How long have you been a gunner? _____ months

5. How long have you served as an M60A1 gunner? _____ months

6. How long has it been since your last M60A1 gunnery practice?

   _____ months

7. As an M60A1 gunner how many times have you fired table VIII? _____

   How many times did you qualify? _____

   How many times did you qualify distinguished? _____

8. Total time in service? _____ years _____ months

9. Rank E-__ O-__

10. Highest grade completed? _____

    a. High school graduate

    b. GED

    c. Some college

    d. College graduate

    e. Not a high school graduate

11. Age _____ years

12. How many times in the last month have you played a video arcade game?
____ times. If yes, which ones: _____

_____

APPENDIX B
POST-EXPERIMENT QUESTIONNAIRE

Date _____

Post-Experiment Questionnaire

Gunner's Name _____ Subject #_____

Unit or Class _____

1. As a device for training M60A1 gunnery engagements, what was the single best feature of this trainer?

   What was the worst feature of the trainer?

2. Did you notice anything unusual about your sight picture?

   Yes No

   If yes, what did you notice?

   Did it affect your ability to detect targets? Yes No

   Did it affect your ability to hit targets? Yes No

   What did you do to maintain your speed and accuracy under these conditions?

3. What special strategies, if any, did you use to acquire and hit targets when using the target (colored blips) display?

4. What special strategies, if any, did you use to acquire and hit targets without the target display?

5. Did you prefer operating with or without the target location display?

   a. With

   b. Without

   c. Not applicable

6. I would prefer a unity window such as is found on the tank to the target location display on this device.

Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
5	4	3	2	1

7. How helpful is the color coding of the target blips on the display that indicates which targets are more dangerous?

   a. Very helpful

   b. Helpful

   c. Slightly helpful

   d. Not helpful

8. Did the target location display make hard-to-see targets easier or more difficult to acquire?

   a. Easier

   b. More difficult

   c. Neither

9. Did the target location display make easily seen targets easier or more difficult to acquire?

   a. Easier

   b. More difficult

   c. Neither

10. What additional comments, if any, do you have on the trainer or the training you received?

APPENDIX C
WINDOW INSTRUCTIONS

Today you will be using battlesight to practice your target acquisition and engagement skills. Battlesight is an arcade-style trainer that presents simulated armor targets in a variety of settings. Assume that the trainer is your tank and that you are the gunner. Your tank is part of an armor battalion that has attacked and successfully penetrated the enemy's forward echelons. In the attack you lost your tank commander, so that you are operating with a three-man crew. Without the TC you must constantly scan the horizon for the enemy. You are now well behind the enemy's forward-deployed combat forces, where your mission is to attack the enemy's troop reinforcements as they are sent forward.

You have 50 rounds of SABOT onboard for engaging armor targets. Each time you fire a round, your loader will load another round of SABOT, but you must wait for the loader's "up" before you can engage the next target. When several targets appear at the same time, always engage the most dangerous targets first. The most dangerous targets are those that are closest to you. For moving targets you must apply the standard 2 1/2 mil manual lead to obtain target kills.

Your tank is equipped with a special display located just to the right of your sight. The display provides information that is useful in tank gunnery. Helpful information includes Target Range, Ammo Available, and UP (which indicates the round is chambered and the gun is ready to fire). Other displayed information that may interest you includes your score and the time elapsed since you began the battle.

The display also helps you to locate targets on the battlefield. As you slew the turret across the terrain, colored dots or blips will appear on the upper portion of the display. By moving the gunner control handles in the appropriate direction, you can position the targets in your sight picture by centering the blips in the V on the display. A red blip indicates that the target is a most dangerous target. A yellow blip designates a dangerous target and a blue blip designates a less dangerous target. When more than one target appears, the more dangerous targets should be engaged first. Some targets visible on the target location display may not be immediately visible in your sight picture due to the targets being hidden behind a tree, a house, a hill . . . or it may be in a defilade position.

Threat tanks may appear anywhere within a 102 degree circular section of the battlefield. However the enemy will typically select a 10 degree sector for massing their attack. Targets are most likely to appear in this sector and the two target sectors bordering this sector. If you traverse beyond the 102 degree circular section, trees and houses will disappear and you will find no targets to engage.

Battlesight has a few features that you will never encounter on the battlefield. For example you cannot fire through trees or buildings to hit target vehicles. Also when you complete each phase of the experiment, the scene will freeze and a tune will play. Following the tune, the battle will resume. When you have fired all 50 rounds, or you have been killed 10 times, the battle will end.

APPENDIX D
NO WINDOW INSTRUCTIONS

Today you will be using battlesight to practice your target acquisition and engagement skills. Battlesight is an arcade-style trainer that presents simulated armor targets in a variety of settings. Assume that the trainer is your tank and that you are the gunner. Your tank is part of an armor battalion that has attacked and successfully penetrated the enemy's forward echelons. In the attack you lost your tank commander, so that you are operating with a three-man crew. Without the TC you must constantly scan the horizon for the enemy. You are now well behind the enemy's forward-deployed combat forces, where your mission is to attack the enemy's troop reinforcements as they are sent forward.

You have 50 rounds of SABOT onboard for engaging armor targets. Each time you fire a round, your loader will load another round of SABOT, but you must wait for the loader's "up" before you can engage the next target. When several targets appear at the same time, always engage the most dangerous targets first. The most dangerous targets are those that are closest to you. For moving targets you must apply the standard 2 1/2 mil manual lead to obtain target kills.

Your tank is equipped with a special display located just to the right of your sight. The display provides information that is useful in tank gunnery. Helpful information includes Target Range, Ammo Available, and UP (which indicates the round is chambered and the gun is ready to fire). Other displayed information that may interest you includes your score and the time elapsed since you began the battle.

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Battlesight has a few features that you will never encounter on the battlefield. For example you cannot fire through trees or buildings to hit target vehicles. Also when you complete each phase of the experiment, the scene will freeze and a tune will play. Following the tune, the battle will resume. When you have fired all 50 rounds, or you have been killed 10 times, the battle will end.

APPENDIX E
PROBABILITY OF HITS AND KILLS

Hit Probability for a Threat Tank Firing on the Subject

Range	Stationary Threat Prob.	Moving Threat Prob.
<1500m	.40	.20
1500-2000m	.30	.15
2000-2500m	.20	.10
>2500m	.10	.05

Hit Probability for a Subject Firing on a Threat

Range	Stationary Threat Prob.	Moving Threat Prob.
<1500m	.87	.75
1500-2000m	.66	.55
2000-2500m	.51	.435
>2500m	.30	.22

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