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Use of Weaponeer Marksmanship Trainer in Predicting M16A1 Rifle Qualification Performance

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This research was conducted to determine if Weaponeer, an M16A1 rifle marksmanship trainer, can be used to predict soldier annual rifle qualification, or record fire, performance and to examine Weaponeer's training effectiveness. In Experiment 1, 69 initial entry soldiers were divided into three equal groups, varying according to Weaponeer target scenario difficulty. Each soldier was tested twice on a scenario prior to firing record fire. All firing on Weaponeer was done from the foxhole supported position; firing during record fire was

20. Abstract

done from both the foxhole supported and prone unsupported positions. Weaponeer performance under the most difficult scenario appeared the best predictor of record fire performance. Predictions improved when later shots and firing position were considered on the device. Experiment 2 sought to confirm and extend the results of Experiment 1. Subjects were 244 permanent party troops divided into five groups. Experimental groups varied according to amount and type (firing position) of training on Weaponeer prior to firing the test scenario and record fire. The control group did not fire on Weaponeer, only firing record fire. Results indicated that Weaponeer can be used to predict M16A1 rifle record fire performance as long as training is not provided immediately in advance of testing on Weaponeer. Experimental groups performed no better at record fire than the control group. [illegible]

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FOREWORD

Performance assessment of Army ground forces is a continuing problem. Recent Army and public reviews of this problem have indicated that current levels are difficult to determine and difficult to maintain. The deployment of increasing numbers and types of training devices to units may provide a partial solution to these problems to the extent that the devices are designed to include a performance assessment capability and are training effective. This research was designed to examine the possibility of developing such an assessment capability in Weaponeer, an M16A1 rifle marksmanship trainer, and to test the effectiveness of this device in promoting annual rifle qualification (record fire) performance.

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USE OF WEAPONEER MARKSMANSHIP TRAINER IN PREDICTING M16A1 RIFLE QUALIFICATION PERFORMANCE

EXECUTIVE SUMMARY

Requirement:

This research was carried out to investigate the performance assessment capability of Weaponeer, an M16A1 rifle marksmanship trainer, and to test the effectiveness of this device in promoting soldiers' annual rifle qualification (record fire) performance.

Procedure:

The purpose of Experiment 1 was to determine which among three test scenarios on Weaponeer would enable the most accurate predictions about a soldier's record fire performance. Sixty-nine initial entry soldiers were divided into three groups, varying according to the difficulty of the Weaponeer test scenario. Each soldier was tested twice on a scenario, firing 64 shots 24- to 48-hours before record fire. All firing on Weaponeer was done from the foxhole supported position; firing during record fire was done from both the foxhole supported and prone unsupported positions.

In Experiment 2, an attempt was made to confirm and extend the results of Experiment 1. Two hundred and forty four permanent party soldiers were divided into five groups. Soldiers tested on Weaponeer zeroed then received varying amounts of training on the device (Group 2, 0 shots; Group 3, 32 shots; Groups 4 and 5, 64 shots) prior to firing two sets of 32 shots on the most difficult Experiment 1 scenario (hereafter referred to as the 8-24 scenario). Training on Weaponeer was either from the foxhole supported position (Groups 3 and 4) or both foxhole supported and prone unsupported positions (Group 5). Testing on Weaponeer and at record fire involved the use of both positions. Control soldiers (Group 1) did not fire on Weaponeer, only firing record fire.

Findings:

Experiment 1.

1. The most difficult scenario on Weaponeer (8-24) proved the best predictor of record fire performance. Soldiers tested on the other two scenarios tended to show uniformly high scores on Weaponeer but the usual wide variation in record fire scores. Overall, performance on the 8-24 scenario accounted for about 31% of the variance associated with record fire scores.

2. Correlations for all scenarios, generally, were higher between performance during the second set of 32 shots on Weaponeer and record fire performance than between the first set of 32 shots and record fire.

3. When firing position on Weaponeer and at record fire was taken into account, Weaponeer's abilty to serve as a predictor improved. For soldiers firing the 8-24 scenario, performance from the foxhole supported position on Weaponeer correlated better with performance from the foxhole at record fire than performance from the prone.

Experiment 2.

1. Only Group 2 soldiers' Weaponeer performance correlated highly with record fire performance. These soldiers were treated most like soldiers tested using the 8-24 scenario in Experiment 1.

2. Unlike Experiment 1, providing soldiers an additional set of 32 shots on Weaponeer did not improve its ability to serve as a predictor of record fire performance. If anything, it degraded this ability. This observation appears related to the fact that soldiers zeroed prior to firing in Experiment 2, reducing intraindividual variability prior to firing the first set of 32 shots. For soldiers in Groups 3, 4, and 5 it also probably is due to the fact that additional Weaponeer training was provided prior to firing the test scenario.

3. Weaponeer predictions may be improved by having soldiers use the device from both the foxhole supported and prone unsupported positions, but the effect of firing position clearly can be diminished by other factors (e.g., scenario difficulty).

4. Weaponeer training had a clear beneficial effect on Weaponeer performance, but it had no apparent effect on record fire performance. Groups receiving training on Weaponeer performed no better at record fire than the no (Weaponeer) training control group.

5. In general, soldiers tested according to procedures described for Group 2 and who fire 33 or above on Weaponeer would be expected to qualify at record fire; soldiers who fire below 33 would not be expected to qualify at record fire.

Utilization of Findings:

Specific procedures were provided for using Weaponeer to predict soldiers' performance at record fire. These procedures appear particularly applicable to soldiers in units who have ready access to Weaponeer but not to ranges capable of satisfying marksmanship training and record fire requirements (e.g., USAREUR, Reserve, National Guard). Recommendations also were provided for using Weaponeer during marksmanship training.

USE OF WEAPONEER MARKSMANSHIP TRAINER IN PREDICTING
M16A1 RIFLE QUALIFICATION PERFORMANCE

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USE OF WEAPONEER MARKSMANSHIP TRAINER IN PREDICTING
M16A1 RIFLE QUALIFICATION PERFORMANCE

INTRODUCTION

Most scenarios for a full-scale confrontation between the U.S. and any of its major potential adversaries suggest that the majority of Army units will have to be prepared to fight immediately with little or no opportunity for post-mobilization training. Comparisons of the military strengths of the U.S. and the Warsaw pact countries also indicate that the U.S. forces are likely to be heavily outnumbered, often by a ratio of five to one or more. To have any chance for success, the Army will have to maintain a consistently high level of combat readiness. Maintaining this high level of combat readiness will necessitate frequent evaluations of individual and unit proficiency and the development of effective means to diagnose and remediate performance deficiencies.

The need for more frequent performance evaluations is not easily met. The Army's emphases on performance-oriented training and criterion-referenced testing already have increased the demand for training and evaluation uses of operational equipment and accompanying support resources requirements (e.g., fuel, ammunition, spare parts) during a time of inflation and budgetary constraints. More frequent performance-oriented individual and collective readiness evaluations would thus tend to strain an already tight situation.

A proposed solution to the problem of conducting more frequent evaluations in the face of tight resource constraints is to conduct (some of) these evaluations on training devices (e.g., simulators, mock ups, etc.) instead of actual equipment (e.g., Hopkins, 1975). Precedent already exists for employing simulators in this way. The commercial airlines and Federal Aviation Administration use flight simulators extensively in proficiency assessment. Also, the military is making greater use of training devices to evaluate individual and collective skills in other areas such as maintenance, antisubmarine warfare, and air defense artillery (Hawley & Dawdy, 1981a).

Improving the proficiency assessment capabilities of the Army is the idea behind the training Device Performance Assessment Capability (DPAC, formerly DORAC) concept (e.g., Finley, Strasel, Schendel, & Hawley, 1981; Strasel, Hawley, & Finley, 1982). The concept suggests that training devices could and should be designed with the embedded capability for assessing performance as an indicator of operational readiness. It would provide procedures: (a) to select device(s) and device characteristics for performance assessment, (b) to predict field performance from training device performance on any particular device, and (c) to incorporate DPAC data into training management, proficiency certification, readiness reporting and training device specifications (Hawley & Dawdy, 1981a, 1981b).

The research reported here was carried out to investigate the performance assessment capability of Weaponeer, a stand-alone rifle marksmanship simulator. More specifically, two experiments were conducted to determine if performance on Weaponeer can be used to predict soldiers' M16A1 live-fire qualification, or "record fire," performance. Record fire is an annual requirement, and its conduct imposes time and cost burdens on commanders who must transport troops and billet them at remote record fire facilities. This is a particular problem for commanders in such places as Europe and Korea because of the scarcity of certified outdoor range facilities capable of satisfying marksmanship training and record fire requirements.

This research is similar in concept to research conducted by Marcus and Hughes (1979) using an indoor Combat Training Theater simulation for the M16A1 rifle as an alternative to actual record fire. The Combat Training Theater involves having soldiers fire subcaliber ammunition at silhouette targets projected against a paper screen. Marcus and Hughes (1979) found performance on the Combat Training Theater to be more internally consistent, better controlled, and less resource intensive than performance in the actual, outdoor setting. However, performance on the Combat Training Theater bore no clear relationship to record fire performance. Marcus and Hughes (1979) attributed this result to the unreliability of the outdoor range scores they obtained.

EXPERIMENT 1[1]

One purpose of Experiment 1 was to determine which among three test scenarios on Weaponeer would enable the most accurate predictions about soldiers' record fire performance. A second purpose was to provide data on the effect of increasing amounts of Weaponeer experience on the ability of this device to serve as a predictor of record fire performance. Given results of Marcus and Hughes' (1979) earlier research, attempts were made to increase the reliability of results obtained at record fire. Range personnel were fully informed about the ongoing testing, all test soldiers were randomly assigned to two adjoining record fire lanes, and ARI scientists worked in conjunction with independent support personnel scoring hits and misses on those lanes.

Method

Subjects. Sixty-nine initial entry soldiers undergoing Basic Rifle Marksmanship training at Fort Benning, Georgia, were divided into three equal groups. Assignment to groups was random with the constraint that high- and low-skill shooters be divided evenly across groups. Judgments about soldiers' shooting skills were based on progress charts maintained by company cadre.

Apparatus. Weaponeer is an M16A1 rifle marksmanship simulator designed to facilitate diagnosis of soldiers' shooting problems (e.g., Schendel & Williams, 1982). The device appears in Figure 1. A non-restorable M16A1 rifle is equipped with a target sensor that receives infrared light from a light emitting diode contained on the target. When the rifle is aimed and fired, this sensing system provides precise information about target acquisition and shot location which is processed by a computer in the console. Weaponeer has a memory for recording up to 32 predicted shot impacts and a printer for providing a printout of all shots on selected targets. Recoil is simulated by the operation of a recoil rod which attaches to the barrel of the rifle. The sound of the rifle is transmitted through earphones.

Weaponeer has three targets: a scaled 100-meter (m), "E-type" (kneeling man) silhouette target, a scaled 250-m, "E-type" silhouette target, and a scaled 25-m "zeroing" target. (Zeroing involves adjusting a rifle's sights until point of bullet impact coincides with point of aim.) Targets are presented one

[1]Experiment 1 appears in the Proceedings of the Eighth Symposium, Psychology in the Department of Defense, U.S. Air Force Academy, April 1982.

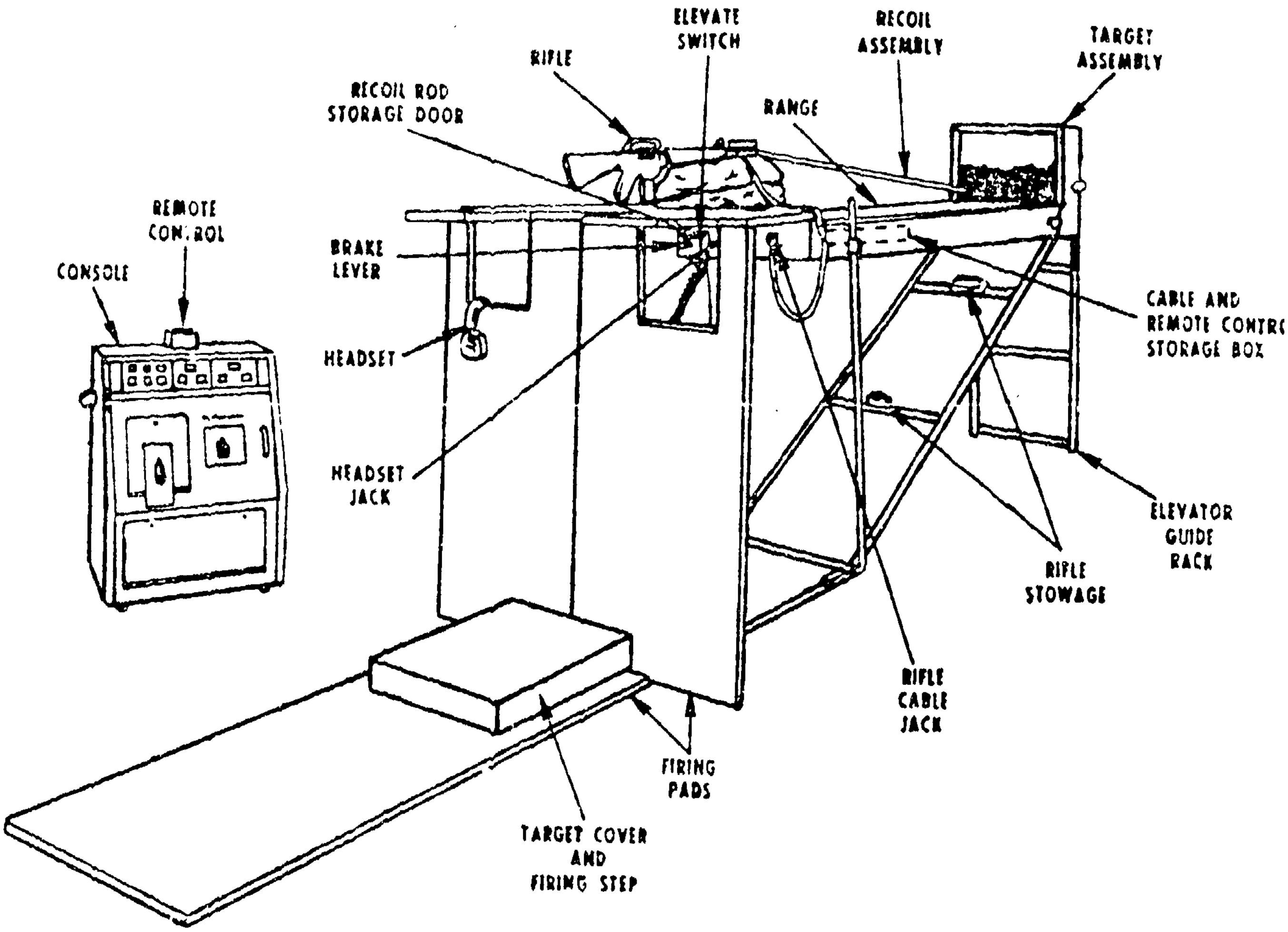

Figure 1. Weaponeer

at a time but may be activated singly or in automated sequence by pressing the appropriate button(s) on Weaponeer's control panel or remote control box. The silhouette targets may be programmed to fail when hit by pressing the "kill" button. Exposure time may be varied from 2 to 30 seconds (s) for the 250-m target or set for continuous presentation. Firing pads used with Weaponeer provide the capability for the firer to engage targets from any position.

A video display shows the shooter's aiming point which appears as a dot, or ball of light. The screen also displays the selected target and the location of hits (and misses). Two unique features of the video display are the "replay" and "each shot" controls. When activated, the replay feature shows the movement of the rifle 3 s prior to firing, while the each shot feature displays the location of each shot fired in the order it was fired. The video display also includes such information as the number of hits on the target, the number of misses, late shots (fired after the target has dropped), and the total number of shots fired.

Procedure. Each soldier was allowed to fire, with feedback, one three-round shot group at Weaponeer's 100-m target and one three-round shot group at Weaponeer's 250-m target. Each soldier then was tested twice on a scenario, receiving 64 shots in all. Soldiers receiving the "8-24" scenario fired eight shots at the 100-m and 24 shots at the 250-m targets. Soldiers receiving the "24-8" scenario fired the reverse pattern. Soldiers receiving the "Random" scenario fired 32 shots at a 50-50 random mix of the two targets. The 100-m target always was presented for 2 s, and the 250-m target always was presented for 4 s. The intertarget interval, typically, was between 1 to 4 s but occasionally was as long as 8 s. Both targets fell when hit. Soldiers receiving the 8-24 scenario and the 24-8 scenario were tested using the same, randomized schedules of target presentations which were controlled remotely by the experimenter. For soldiers receiving the Random scenario, target presentations were under the internal control of the Weaponeer. All firing was done from the foxhole supported position. Soldiers rested briefly between the first and second set of 32 shots on a scenario but were not allowed to view the video screen nor told their scores until they had completed testing.

Record fire occurred 24- to 48-hours after testing. Soldiers were assigned randomly to one of two firing lanes. ARI scientists worked in conjunction with independent support personnel scoring firers on those lanes. The course-of-fire consisted of 14 "F-type" (prone man) silhouettes seen at 50 ($n = 5$) and 100 ($n = 9$) m and 26 "E-type" silhouettes seen at 150 ($n = 10$), 200 ($n = 8$), 250 ($n = 5$), and 300 ($n = 3$) m. The first half of this course was shot from the foxhole supported position; the second half from the prone unsupported position. Targets fell when hit. Record fire scores associated with particular shooting classifications were as follows: 0 to 22--Unqualified; 23 to 29--Marksman; 30 to 35--Sharpshooter; 36 to 40--Expert.

Results and Discussion

Scenario. Table 1 presents the correlation coefficients (rs) between groups' scores on Weaponeer (first set of 32 shots, second set of 32 shots, overall) and performance at record fire. (In these and all other Experiment 1 analyses $r \geq .41$, $p < .05$; $r \geq .53$, $p < .01$). Overall rs for the three test scenarios did not differ significantly. Nevertheless, the 8-24 scenario was selected as most likely to provide the most accurate predictions about record fire performance for two reasons. First, one soldier's data contributed disproportionately to the strength of the _r_ between overall performance on the Random scenario and at record fire. When this soldier's data were removed and the _r_ recomputed, it dropped from .66 to .41. Second, soldiers tested on the Random and 24-8 scenarios tended to show uniformly high scores on Weaponeer but the usual wide variation in record fire scores. For illustration, 52% of the soldiers tested using the 8-24 scenario hit over half the targets presented on Weaponeer. This compared to 78% of those tested using the Random scenario and 87% of those tested using the 24-8 scenario.

Set of 32 shots. As shown in Table 1, the _rs_ for all scenarios, generally, were higher between performance during the second set of 32 shots and record fire performance than between the first set of 32 shots and record fire. This observation is not supported statistically, but it is supported by the consistent nature of the data and probably reflects a reduction in the variability of subjects' individual performances on Weaponeer. Reductions in intraindividual variability almost always result from extended practice on a task, and generally are revealed by improvements in intertrial (or, in this case, intertest) _rs_ (e.g., Jones, 1969). The fact that soldiers were not zeroed prior to testing undoubtedly contributed to initial variablity. This variability is likely to have been reduced substantially by the second set of 32 shots, assuming that soldiers were using the hit and miss feedback they received and adjusting their points of aim accordingly.

Firing position. Record fire involves firing 20 shots from a foxhole supported position followed by 20 shots from the prone unsupported position. However, all testing on Weaponeer was done from the foxhole supported position. Therefore, a series of correlational analyses were performed to determine if the Weaponeer data more accurately reflected record fire performance from the foxhole than from the prone. As shown in Table 2, the 8-24 scenario yielded more accurate predictions about record fire performance when firing position was taken into account (first 32 shots, $t(20) = 2.42$, $p < .05$; second 32 shots, $t(20) = 2.47$, $p < .05$; overall, $t(20) = 2.85$, $p < .05$). Similar results were obtained using the Random scenario, although these within-group differences were not significant. It may be that the simplicity of the Random and 24-8 scenarios acted to disrupt the effect of firing position.

Subsequent analyses of other data collected by Thompson, Smith, Morey, and Osborne (1980) suggest that the effect of firing position is not peculiar to our use of Weaponeer. These analyses revealed that practice record fire is a significantly better predictor of record fire performance when firing position is taken into account. (Practice record fire also includes 20 shots from a foxhole supported position followed by 20 shots from the prone unsupported position.)

EXPERIMENT 2

Data obtained in Experiment 1 suggest that Weaponeer performance is a good predictor of record fire performance, and this prediction may be enhanced when later shots and firing postion are considered on the device. In Experiment 2, we sought to extend and confirm these results. In addition, we sought to assess the effects of increasing amounts of Weaponeer training on record fire performance.

Table 1

Correlations Between Groups' Scores on Weaponeer and Performance at Record Fire

			Record Fire Overall
		First 32 Shots	.44
	8-24	Second 32 Shots	.60
		Overall	.56
		First 32 Shots	.62
Weaponeer	Random	Second 32 Shots	.66
		Overall	.66
		First 32 Shots	.36
	24-8	Second 32 Shots	.41
		Overall	.41

Note. $r \geq .41$, $p < .05$; $r \geq .53$, $p < .01$

Table 2

Correlations Between Groups' Scores on Weaponeer and Performance at Record Fire When Firing Position is Taken into Account

			Record Fire	
			Foxhole (First half)	Prone (Second Half)
	8-24	First 32 Shots	.62	.15
		Second 32 Shots	.74	.32
		Overall	.74	.26
Weaponeer	Random	First 32 Shots	.59	.54
		Second 32 Shots	.60	.46
		Overall	.53	.52
	24-8	First 32 Shots	.23	.43
		Second 32 Shots	.42	.32
		Overall	.37	.38

Note. $r \geq .41$, $p < .05$; $r \geq .53$, $p < .01$

Specific questions examined in this experiment were as follows:

1. Do the Experiment 1 results hold for soldiers other than initial entry soldiers? Soldiers in units frequently do not have ready access to range facilities capable of satisfying record fire requirements and may benefit from firing (some) record fire on Weaponeer.

2. Can the strength of the relationship between Weaponeer performance and record fire performance be increased by having soldiers zero and then receive additional training on Weaponeer prior to firing a test scenario? Results of Experiment 1 suggest that procedures geared toward limiting intraindividual variability on Weaponeer may improve its ability to serve as a predictor of record fire performance.

3. Can predictions based on Weaponeer performance be improved by having soldiers fire on the device from both the foxhole supported position and prone unsupported position? Again, data obtained in Experiment 1 suggest that firing position may have to be taken into account if Weaponeer performance is going to be used to predict record fire performance.

4. What is the effect of Weaponeer training on record fire performance? In Experiment 2, we included a no (Weaponeer) training control group to measure the effect of increasing amounts of Weaponeer training on record fire performance. This was done to help fill a gap in the training literature on Weaponeer. Much of the research designed to test Weaponeer's effectiveness as a training device has been plagued by procedural problems. None of this research offers very compelling evidence supporting Weaponeer's training value. And, some of this research suggests that Weaponeer may be ineffective in remediating shooting problems, at least when it is used for short durations and in the absence of other more conventional forms of marksmanship training. One purpose of Experiment 2 was to assess the value of extended amounts of firing on Weaponeer, under conditions similar to record fire, on subsequent record fire performance.

Method

Subjects. The subjects were 244 male (n = 236) and female (n = 8) soldiers drawn from the 1st and 2d Infantry Training Brigades at Fort Benning, Georgia, who fired record fire between 26 and 27 March and 4 and 5 June 1982. Soldiers were assigned randomly to groups with the constraint that roughly equal numbers of females appear in each group. Fifty-two soldiers were tested in the control group; 48 soldiers were tested in each of the other four groups. None of the soldiers who participated in Experiment 2 had participated in Experiment 1.

Apparatus. The apparatus was the same as in Experiment 1.

Design and procedure. During Experiment 2, prior to firing, each experimental soldier zeroed the rifle on Weaponeer. Zeroing was accomplished by having each soldier aim, without firing, at the center of mass of Weaponeer's scaled, 250-m target. The soldier said "now" when he (she) felt he (she) had acquired the correct sight picture. If the light dot on the video screen coincided with the target's center of mass, no sight adjustments were made. Otherwise, sights were adjusted as required. Each soldier then confirmed his (her) zero using this same procedure.

Soldiers were tested according to the following design. Soldiers in the control group (Group 1) did not fire on Weaponeer, but did fire record fire. Soldiers in Group 2 zeroed on Weaponeer but received no training on the device prior to firing the 8-24 test scenario. As in Experiment 1, soldiers in Group 2 were tested twice on the 8-24 scenario, receiving 64 shots in all. Unlike Experiment 1, half the soldiers in Group 2 fired 32 shots from the foxhole supported position followed by 32 shots from the prone unsupported position. The other half of this group fired from the same positions but in the reverse order. These soldiers then fired record fire. Soldiers in Group 3 zeroed and then fired 32 shots on the "Random" scenario. This scenario was the same as that used during Experiment 1, although this time it was used strictly for training purposes. All soldiers in Group 3 fired the Random scenario from the foxhole supported position. These soldiers then fired the 8-24 test scenario and record fire according to the same procedures as soldiers in Group 2. Soldiers in Group 4 were treated exactly like soldiers in Group 3 with the exception that these soldiers fired the Random scenario twice, receiving a total of 64 shots as training. Soldiers in Group 5 were treated like soldiers in Group 4 with one exception. In firing the Random scenario, half the soldiers in Group 5 fired 32 shots from the foxhole supported position followed by 32 shots from the prone unsupported position. The other half fired from the same positions but in the reverse order.

Most other procedures were the same as in Experiment 1. Weaponeer's scaled, 100-m target always was presented for 2 s, and the scaled 250-m target always was presented for 4 s. The intertarget interval, typically, was between 1 to 4 s, but occasionally ran as long as 8 s. Both targets fell when hit. The 8-24 scenario was controlled remotely by the experimenter. Order of target presentations for this scenario was the same as in Experiment 1. The Random scenario was under the internal control of Weaponeer. Soldiers rested briefly following each set of 32 shots. Soldiers in Groups 3 through 5 were allowed to view the video screen to examine specific shot locations during training. Soldiers were not allowed to view the video screen during testing, but were told their scores and allowed to examine their shot locations following testing.

Record fire occurred 24- to 48-hours after Weaponeer testing. Unlike Experiment 1, soldiers were assigned randomly to one of eight firing lanes. All scoring was accomplished by independent support personnel. These personnel were fully informed about scoring procedures and the purpose of this research prior to the onset of record fire. In addition, an ARI scientist and numerous range personnel were available to assist in scorekeeping and to answer any questions arising during the course of testing. The course-of-fire was the same as in Experiment 1.

Results and Discussion

Population. To determine if the results of Experiment 1 apply to soldiers other than initial entry soldiers, correlational analyses were performed on Group 2 soldiers' data. Group 2 soldiers' data were selected because these soldiers were treated most like soldiers tested using the 8-24 scenario in Experiment 1.

As in Experiment 1, Group 2 soldier's performance on Weaponeer correlated with their performance at record fire, $r = .54$. (In this and all other

Experiment 2 analyses, $r \geq .29$, $p < .05$; $r \geq .37$, $p < .01$.). This result lends converging support to results obtained in Experiment 1 and suggests that Weaponeer may be used to predict record fire performance of soldiers in units as well as soldiers undergoing institutional training.

Set of 32 shots. Table 3 presents the rs for groups as a function of set of 32 shots on Weaponeer and firing position at record fire. Unlike Experiment 1, no evidence was obtained that providing soldiers an additional set of 32 shots on Weaponeer improves its ability to serve as a predictor of record fire performance. If anything, additional firing degraded this ability. This observation probably is due, in part, to the fact that soldiers zeroed prior to firing in this experiment, reducing intraindividual variability on Weaponeer prior to firing the first set of 32 shots. For soldiers in Groups 3, 4, and 5, it also probably is due to the fact that additional Weaponeer training was provided prior to firing the test scenario.

Firing position. While data obtained in Experiment 1 suggest that predictions based on Weaponeer performance can be improved by having soldiers fire on the device from both foxhole supported and prone unsupported positions, data obtained in Experiment 2 were inconsistent with this view. It is not clear why this effect failed to materialize in Group 2, but its failure to materialize in Groups 3, 4, and 5 may be because it was overshadowed by the effect of additional training. In Experiment 1, soldiers receiving the two simpler scenarios (Random and 24-8 scenarios) showed little, if any, effect of firing position. If training served to make the 8-24 scenario simpler, this could account for the absence of a firing position effect in Groups 3, 4, and 5.

Weaponeer training. Preliminary firing on Weaponeer had a clear beneficial effect on Weaponeer performance, $F(3, 188) = 2.87$, $p < .05$. Means and standard deviations for Groups 2 through 5 on the 8-24 test scenario were as follows: Group 2 ($M = 35.62$, $SD = 12.64$); Group 3 ($M = 38.29$, $SD = 12.61$); Group 4 ($M = 39.98$, $SD = 10.44$); Group 5 ($M = 42.42$, $SD = 10.86$). Post hoc comparisons revealed that performance in Group 5 was significantly better than performance in Group 2 (LSD, $p < .05$) and marginally better than performance in Group 3 (LSD, $.05 < p < .10$). Furthermore, performance in Group 4 was marginally better than performance in Group 2 (LSD, $.05 < p < .10$).

In contrast, Weaponeer training had no apparent impact on record fire performance, $F(4, 235) = 1.14$, $p > .05$. Means and standard deviations for the five groups were as follows: Control ($M = 26.79$, $SD = 7.53$); Group 2 ($M = 24.63$, $SD = 8.72$); Group 3 ($M = 26.25$, $SD = 6.22$); Group 4 ($M = 27.71$; $SD = 6.60$); Group 5 ($M = 26.50$, $SD = 7.08$). Thus, Weaponeer training resulted in fairly uniform increases in performance on Weaponeer but had no effect on performance at record fire. As a result, the strength of the rs between Weaponeer performance and record fire performance in groups receiving Weaponeer training (Groups 3, 4, and 5) was degraded.

Utilization. Our initial concern in conducting this research was in determining whether or not Weaponeer performance and record fire performance are related. That a relationship exists and can be described using a linear model was evidenced in both Experiment 1 and Experiment 2. The solid, heavy line presented in Figure 2 is the regression line describing the observed relationship between Group 2 soldiers' performance on Weaponeer and their performance at record fire. The dotted, dashed, and lighter solid lines

Table 3

Correlations for Groups Presented as a Function of Set of 32 Shots on Weaponeer and Firing Position at Record Fire

			Record Fire		
			Foxhole (First Half)	Prone (Second Half)	Overall
Weaponeer	Group 2	First 32 Shots	.45	.51	.52
		Second 32 Shots	.37	.33	.38
		Overall	.49	.50	.54
	Group 3	First 32 Shots	.02	.16	.11
		Second 32 Shots	.25	.28	.30
		Overall	.17	.27	.25
	Group 4	First 32 Shots	.25	.30	.30
		Second 32 Shots	.26	.21	.25
		Overall	.33	.33	.36
	Group 5	First 32 Shots	.27	.22	.27
		Second 32 Shots	.01	.05	.03
		Overall	.20	.18	.21

Note. $r \geq .29$, $p < .05$; $r \geq .37$, $p < .01$

Table 4

Correlations for Groups Presented as a Function of Firing Positions on Weaponeer and at Record Fire

			Record Fire	
		Foxhole	Prone	Overall
Weaponeer	Group 2 Foxhole	.55	.50	.56
	Group 2 Prone	.32	.38	.38
	Group 2 Overall	.49	.50	.54
	Group 3 Foxhole	.17	.20	.26
	Group 3 Prone	.12	.20	.19
	Group 3 Overall	.17	.27	.25
	Group 4 Foxhole	.20	.33	.29
	Group 4 Prone	.36	.24	.33
	Group 4 Overall	.33	.33	.36
	Group 5 Foxhole	.23	.21	.24
	Group 5 Prone	.13	.11	.13
	Group 5 Overall	.20	.18	.21

Note. $\underline{r} \geq .29$, $\underline{p} < .05$; $\underline{r} \geq .37$, $\underline{p} < .01$

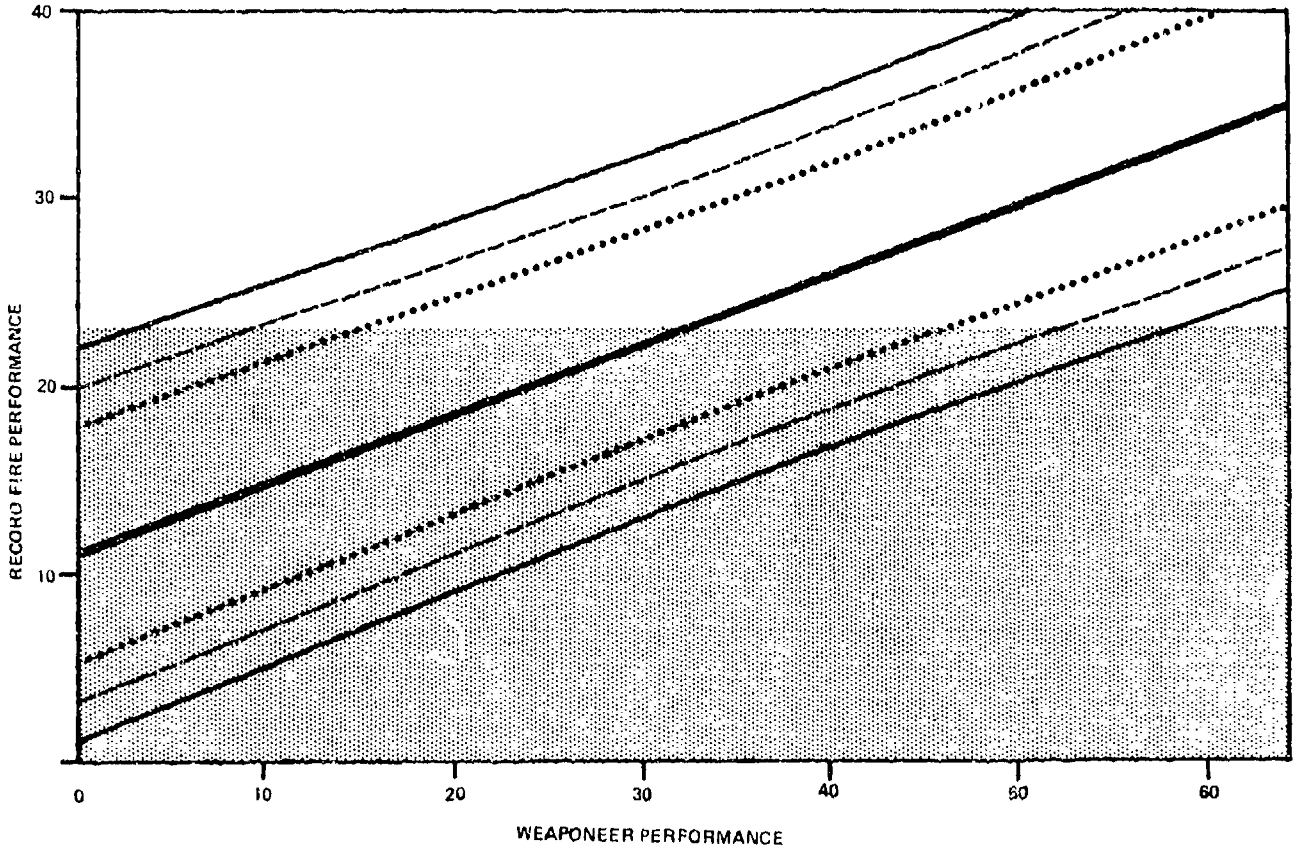

Figure 2. Relationship Between Weaponeer Performance and Record Fire Performance. Confidence Intervals Surrounding Regression Line (Heavy Solid Line) are as follows: 60% (Dotted Lines), 70% (Dashed Lines), and 80% (Light Solid Lines). Area in White Represents Qualifying Scores at Record Fire.

represent the 60%, 70%, and 80% confidence intervals about this regression line respectively. The shaded area represents a record fire score of 23 (criterion for qualification) or below. Thus, for example, if a soldier fired a score of 40 on Weaponeer, we can predict at probability (p) = .60 that this soldier will shoot between 21 and 32 at record fire. We also can predict at p = .80 that this soldier will shoot between 15 and 36 at record fire. Since most of the scores that the soldier is likely to shoot equal 23 or above, it is reasonable to expect this soldier will qualify at record fire. Of course, this prediction may be better or worse for any particular soldier, depending on where his (her) score falls along the x axis.

Pursuing this analysis one step further, expectancy tables for predicting success were generated following procedures described by Thorndike (1978). This analysis indicated that a cutoff score of 33 on Weaponeer would maximize hit rate (i.e., correctly predicted successes and failures)--73%--while minimizing false negatives (i.e., successes predicted as failures)--19%--and, more importantly, false positives (i.e., failures predicted as successes)--8%. Stated another way, soldiers tested according to procedures described for Group 2 and who fire 33 or above reasonably can be expected to qualify at record fire; those who fire below 33 can be expected to fail record fire.

GENERAL DISCUSSION

This research was designed to examine the performance assessment capabilities of Weaponeer and to test the effectiveness of this device in promoting record fire performance. One purpose of Experiment 1 was to determine which among three test scenarios on Weaponeer would enable the most accurate predictions about soldiers' record fire performance. A second purpose was to determine the effect of increasing amounts of Weaponeer experience on the accuracy of these predictions. Sixty-nine initial entry soldiers were divided into three equal groups, varying according to the difficulty of the Weaponeer test scenario. Each soldier was tested twice on a scenario, firing 64 shots prior to firing record fire. All firing on Weaponeer was done from the foxhole supported position; firing during record fire was done from both the foxhole supported and prone unsupported positions. The most difficult scenario (8-24 scenario) appeared to enable the most accurate predictions about soldiers' record fire performance. This prediction was enhanced when later shots and firing position were considered on the device.

In Experiment 2, we sought to confirm and extend the results of Experiment 1. Two hundred and forty four permanent party soldiers were divided into five groups. Soldiers tested on Weaponeer zeroed then received varying amounts of training on the device (Group 2, 0 shots; Group 3, 32 shots; Groups 4 and 5, 64 shots) prior to firing two sets of 32 shots on the 8-24 scenario. Training on Weaponeer was from either the foxhole supported position (Groups 3 and 4) or both foxhole supported and prone unsupported positions (Group 5). Testing on Weaponeer and at record fire involved the use of both positions. Control soldiers did not fire on Weaponeer, only firing record fire. Results indicated that Weaponeer can be used to predict M16A1 record fire performance as long as training is not provided immediately in advance of firing the 8-24 scenario. Training on Weaponeer improved performance on Weaponeer but failed to affect record fire performance.

Three sets of observations from these experiments merit further discussion. The first set of observations relates to Weaponeer's ability to serve as a predictor of M16A1 record fire performance, the second concerns the effects of certain procedural variables on this ability, and the third relates to the use of Weaponeer in marksmanship training.

Weaponeer can be used to predict record fire performance. This conclusion was supported in two separate experiments employing different soldier populations. Using Experiment 2 procedures and setting the criterion for Weaponeer qualification at 33, soldiers likely to fail at actual record fire can be identified. This indicates that the performance assessment capability of Weaponeer is at least potentially usable as a DFAC for rifle marksmanship. However, it is important to remember that these predictions can be undermined by factors that artificially raise or lower scores obtained on Weaponeer or at record fire. Factors known to affect performance at record fire include lane-to-lane differences, equipment failure, grader bias, and variations in vegetation and weather (e.g., Marcus & Hughes, 1979). Problems encountered using Weaponeer are less related to its reliability than its availability. Weaponeer is a limited resource which may make it difficult for unit commanders to schedule the use of the device over extended periods for testing purposes.

A number of procedural variables appeared to influence Weaponeer's ability to serve as a predictor of record fire performance. Key variables are summarized below:

(a) Scenario difficulty. Scenario difficulty, apparently, is affected by both the difficulty of targets involved in a scenario (Experiment 1) and amount of training allowed against those targets (Experiment 2). In these experiments, events that served to reduce scenario difficulty also tended to reduce Weaponeer's ability to serve as a predictor of record fire performance.

(b) Set of 32 shots (versus zeroing). Set of 32 shots only appeared to affect Weaponeer's ability to serve as a predictor of record fire performance when soldiers did not zero on the device. Given this result, the temptation is to conclude that soldiers may zero on Weaponeer and only fire 32 shots, say 16 from the foxhole supported position and 16 from the prone unsupported position. This appears possible given an r of .52 between Group 2 soldiers' first set of 32 shots on Weaponeer and record fire performance (See Table 3). However, neither of these experiments included a condition designed specifically to test this possibility.

(c) Firing position. Firing position on Weaponeer may influence the ability of the device to serve as a predictor of record fire performance, but the effect of firing position clearly can be diminished by other factors (e.g., scenario difficulty).

Apparently, if marksmanship training on Weaponeer is going to have an appreciable, positive impact on record fire performance, training must be extended well beyond 64 shots. In fact, it could be argued that it must be extended well beyond 128 shots. Experiment 2 soldiers (Groups 2 - 5) fired two sets of 32 shots, with hit/miss feedback, during testing after being provided as many as 64 rounds, with precise feedback, during training (Group 5). They still performed no better at record fire than the no (Weaponeer) training control group (Group 1). This is not to say that Weaponeer is ineffective as a training device, only to say that, if it is going to raise soldiers' record fire performance, Weaponeer training will have to be fairly extensive. Most installations do not have the quantities of Weaponeers necessary to provide this extensive training to every soldier that needs it.

Schendel and Williams (1982) have outlined an alternative approach for using Weaponeer during marksmanship training. Briefly, this approach involves using Weaponeer strictly as a diagnositic device, that is, as an aid to identifying soldiers' shooting problems. Once a soldier's shooting problems have been diagnosed, he (she) engages in conventional forms of marksmanship training designed to remediate his (her) particular performance deficiencies. The advantage of this approach is that large numbers of soldiers can be trained without placing an excessive burdon on Weaponeer resources. Time is not spent using Weaponeer to correct shooting problems that can be corrected elsewhere. And, instructors can concentrate their efforts in areas where soldiers need help the most.

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APPENDIX A. SCHEDULES FOR 8-24 AND 24-8 WEAPONEER TARGET SCENARIOS

8-24 Scenario

1	250	17	250
2	250	18	250
3	250	19	250
4	100	20	250
5	250	21	100
6	250	22	250
7	250	23	100
8	100	24	250
9	250	25	250
10	250	26	250
11	250	27	100
12	250	28	250
13	250	29	250
14	250	30	250
15	100	31	100
16	100	32	250

Note. Tabled values reflect simulated ranges to targets in meters.

24-8 Scenario

1	100	17	100
2	100	18	250
3	250	19	100
4	100	20	100
5	250	21	100
6	100	22	100
7	100	23	100
8	100	24	100
9	100	25	100
10	250	26	250
11	100	27	250
12	100	28	100
13	100	29	100
14	100	30	100
15	100	31	250
16	250	32	100

Note. Tabled values reflect simulated ranges to targets in meters.

APPENDIX B

RESULTS OF ANALYSES OF FIRING POSITION DATA COLLECTED BUT NOT REPORTED BY THOMPSON, SMITH, MOREY, AND OSBORNE (1980); DATA ARE FOR MALE SOLDIERS COMPLETING ALL TRAINING

		RECORD FIRE (FOXHOLE)	RECORD FIRE (PRONE)
TRACK I (n=82)	PRACTICE RECORD FIRE (FOXHOLE)	.86	.34
	PRACTICE RECORD FIRE (PRONE)	.28	.22
TRACK II (n=173)	PRACTICE RECORD FIRE (FOXHOLE)	.46	.32
	PRACTICE RECORD FIRE (PRONE)	.26	.33
TRACK III (n=146)	PRACTICE RECORD FIRE (FOXHOLE)	.48	.37
	PRACTICE RECORD FIRE (PRONE)	.34	.45
TRACK IV (n=119)	PRACTICE RECORD FIRE (FOXHOLE)	.74	-.65
	PRACTICE RECORD FIRE (PRONE)	-.66	.91