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Bradley Fighting Vehicle Conduct of Fire Trainer: The Instructor Operator

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This research note reports on preliminary research conducted into the impact of the Conduct of Fire Trainer (COFT) Instructor Operators for the Bradley Fighting Vehicle on apparent COFT gunnery performance. Some Instructor Operators were shown to have consistent behavior patterns which may have masked true gunnery performance. Further research is needed.

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FOREWORD

The Army Research Institute (ARI) has been involved in a long term project focusing on improving the combat effectiveness of the Bradley Fighting Vehicle. Among the critical issues which have been addressed are those related to Bradley gunnery, and most particularly, to gunnery training devices. This report describes some aspects of one of the major Bradley devices, the Conduct of Fire Trainer (COFT), and problems related to the COFT instructor/operator.

The ARI Fort Benning Field Unit, a division of the Training Research Laboratory, performed the research reported here. Under ARI's mission to conduct research on training and training technology using infantry combat systems, Task 3.4.2, Advanced Methods and Systems for Fighting Vehicle Training, is organized under the "Train the Force" program area. Sponsorship for this research comes under a May 1983 Memorandum of Understanding between ARI, the TRADOC Training Technology Agency, and the U. S. Army Infantry School.

Initial briefings of the results of this research to the Infantry School and to personnel within the Bradley Detachment, First Battalion, 29th Infantry Regiment, have provided positive feedback, and encouragement for further research in the area.

BRADLEY FIGHTING VEHICLE CONDUCT OF FIRE TRAINER: THE INSTRUCTOR/OPERATOR

EXECUTIVE SUMMARY

Requirement:

Research into Bradley Fighting Vehicle training led to the investigation of its major gunnery training device, the Conduct of Fire Trainer (COFT). While the COFT is excellent for sharpening gunnery skills, some problems were apparent with respect to the COFT instructor/operator (IO) who provides the actual training. The research focused on these instructor related areas.

Procedure:

COFT gunnery training was monitored in an institutional environment, and observations were made on instructor/operator behavior. Additionally, the computer printouts of gunnery data were analyzed to discern instructor patterns of behavior which impacted on gunnery performance as measured by the COFT.

Findings:

The identified problems related to the Bradley Conduct of Fire Trainer instructor/operator suggest that the instructor should receive not only initial COFT and Bradley training, but should have his performance periodically monitored to insure continued good training and maximum effectiveness of the device. Some IO performance is predictable, and independent of the crew's gunnery skills, and thereby becomes an additional factor in gunnery.

Utilization of Findings:

Bradley battalions can use the results of this preliminary research as a basis for improving COFT instructor/operator performance to insure maintenance of quality gunnery training and as an initial approach to start looking at IO performance.

BRADLEY FIGHTING VEHICLE CONDUCT OF FIRE TRAINER: THE INSTRUCTOR/ OPERATOR

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BRADLEY FIGHTING VEHICLE CONDUCT OF FIRE TRAINER: THE INSTRUCTOR/OPERATOR

INTRODUCTION

The Conduct of Fire Trainer (COFT) was designed to assist in tank (M60 and M1) and Bradley Fighting Vehicle (BFV) gunnery training. Developed by the Simulation and Control Systems Department of the General Electric Company, the device was fielded in the early 1980s, initially to institutional training locations (the Armor School at Fort Knox, KY and the Infantry School at Fort Benning, GA), but as more became available, to units in Europe, Korea, and throughout the United States in both active and reserve components. Although the tank and Bradley systems are similar, this research was based on the Bradley trainer.

The COFT is a complex simulator. It is a single vehicle gunnery trainer, created to improve and sustain crew gunnery skills. General and special purpose computers run the system, provide training scenarios, and store data. The training shelter has a crew compartment which very closely replicates the interior of the BFV turret. The Instructor/Operator (IO) station, adjacent to the crew station, is manned by a specially trained instructor who watches a computer console and monitors and guides training in the COFT. The station has two screens on which the IO can see the same views as are seen by the commander and gunner. It also has a situation monitor where he can select and attend to the training scenarios. The key to the effectiveness of the COFT is the IO.

Gunnery Training

COFT gunnery training is accomplished through the combination of the computer generated graphics and scenarios and scoring, and the skills of the IO. The BFV COFT has a library of exercises, including 84 for the commander, and 300 for the gunner. Although the commander and gunner have separate sets of exercises, based on who is actually firing, their performance is not independent. In one of the few reports of research on the COFT, Graham (1986) found that the performance of more experienced M1 tank commanders impacted positively on gunner hit rate.

COFT exercises are sequenced in increasing level of difficulty. A student progresses through a specially designed matrix until he has mastered the skills, and is "certified," indicating that he has shown, in combination with a partner, the ability to execute successfully the combat gunnery skills required of an individual at his position.

Gunnery moves from simple to more complex. The gunner is presented single and multiple targets, both stationary and moving, at short and long ranges. The gunner progresses from the TOW missile through 25mm and coax machinegun firing, in a variety of environmental conditions. Day and night engagements, with both unlimited and limited visibility conditions are presented, as well as malfunctions requiring either corrective action (open hatch) or the use of back up equipment (manual mode, the auxiliary sight).

The commander/gunner exercise matrix (shown in Figure 1) is taken from General Electric Co., COFT training materials (1984, 1986). The vertical axis indicates the level of difficulty as measured by range to the target and number of targets; the diagonal axis, the visibility conditions; and the horizontal axis the level of difficulty of the exercise as measured by type or motion of targets, and other environmental circumstances.

As the gunner proceeds with an exercise, the computer scores him on a number of dimensions: time to acquire the target (as measured from the time it is fully exposed to when he announces that he has identified it); time to fire; time to hit; and time to kill the target. The computer also records the location of missile impact on tank targets, and the number and kinds of rounds of 25mm ammunition fired at BMPs and helicopters. For the coax machinegun, the system records the number of rounds fired, the percentage and pattern of coverage on area targets (troops), or the number of hits on a point target (trucks).

The gunner is graded on coverage and times. He is downgraded for failure to hit or kill in a reasonable time, for shooting the wrong ammunition, for failure to fire, for firing at friendly targets, and in the case of multiple targets, for failure to fire at the more dangerous target first. The student is also graded in systems management (the ability to work together as a crew and make no errors in magnification or ammunition switch setting), target acquisition (time to identify) and reticle aim (time to fire, hit and kill, with no errors in identification or ammunition).

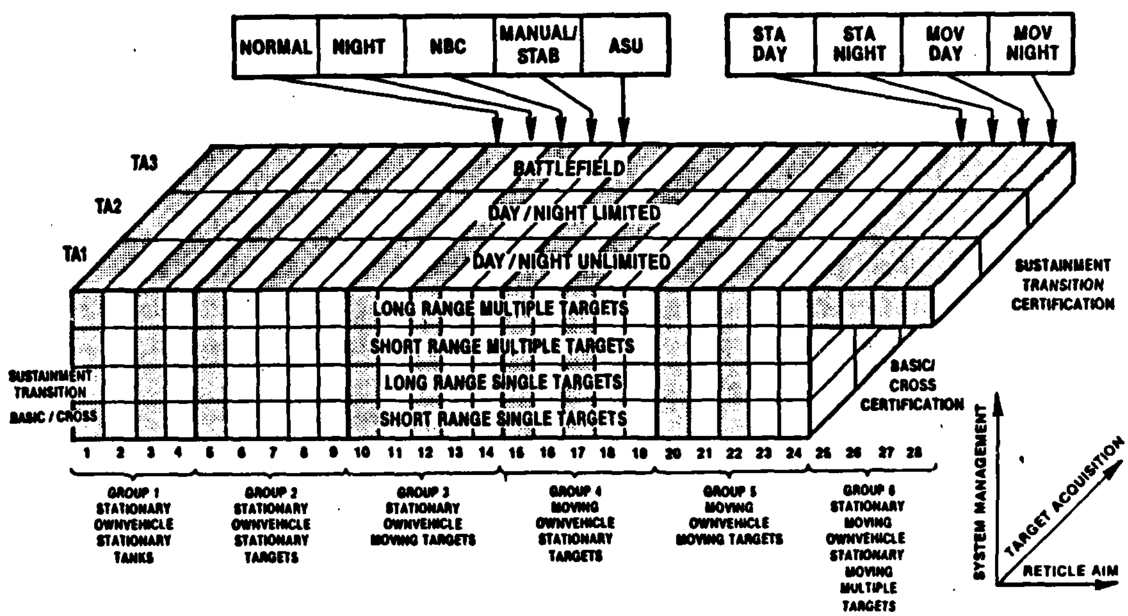

Figure 1. BFV COFT commander/gunner training matrix.

Previous COFT Research

Only limited systematic research has been done on the COFT in institutions and units although some units are now beginning to keep performance data. Using the COFT as a performance measure, Witmer (1987) found that degraded mode tank gunnery is poorly trained. Black and Graham (1986) urged development of expanded and more adequate COFT performance measures. Kraemer and Bessemer (1987), in an analysis of another tank training simulator, found that the COFT provided positive benefits for gunnery performance. Numerous attempts have been made to suggest possible COFT training strategies, from Butler's early work (1980, 1982) on the COFT for Bradley Infantry and Cavalry Fighting Vehicles, to Bachman's battalion commander survey results (1985). A training device support package was fielded for use with the Bradley COFT (FC 23-5, 1985) and the most recent COFT strategies appear in the Bradley M2/M3 Fighting Vehicle Gunnery Training Devices Guide (FC 23-5, 1987, draft) and Armor Training Device Macro Strategy (TC 17-12-7, 1987, draft).

The Instructor/Operator (IO) Problem

The fielding of the BFV Unit Conduct of Fire Trainer brought a number of problems, both anticipated and unanticipated. One of the most frequently mentioned, and one on which the least amount of research has been conducted, is that of the role and impact of the IO, the individual whose job it is to provide the link between the device and the trainee.

Although the COFT is a well-designed and complex training device, it is dependent on instructor quality. The computer driven scoring and scenarios provide excellent practice of skills for the gunner and commander working together, but the amount of training received is based on the feedback and performance critique provided by the IO. His role is much greater than merely providing entry into the computer's library of exercises.

The IO must provide information to the crew members about the training they will receive each session (pre-brief), must conduct the training (to include instruction during the session), and then must be able to provide a critique of their performance at the end of the day's session (de-brief). By inspection of the crew's records (printed out on an exercise by exercise basis in hard copy), the IO can assess gunnery strengths and weaknesses, and provide information on areas to be practiced between COFT gunnery sessions. The printouts are meaningless to the crew without expert interpretation. If no feedback is provided, completed exercises become little more than video games, rather than powerful gunnery training sessions.

The important role of the IO was little understood in the early days of COFT fielding. COFT training is instructor intensive: a one to one ratio of instructors to COFTs is needed. However, an IO can not train all day, hour after hour, and maintain his effectiveness, a problem which is universally acknowledged, but was not realized in the design stage of the COFT program. The IO begins to experience what has become known as burnout.

Burnout, as used at the COFT site, has no particular definition, but when questioned, everyone seems to know what it means. The American Heritage

Dictionary defines burnout as becoming "exhausted, especially as a result of long term stress" (1982, 2nd edition, p. 219). Stress for the COFT IO is partially physical fatigue (eyes and ears, muscle tension, long periods of sedentary behavior) from operating his equipment. Stress also comes from the overstimulation from rapidly moving images on the computer screen. Eventually, motivation and attention span drop, and despite efforts to prevent it, the IO is no longer an effective trainer.

In a study of burnout among teachers, Jackson, Schwab and Schuler (1986) cited three elements of burnout. First, it refers to the individual's emotional exhaustion. This exhaustion is partially dependent on degree of involvement; the more involved he is in his job, the more likely he is to attain burnout. A second factor in burnout is depersonalization. Treating people like objects reduces job satisfaction, because although it reduces involvement, sometimes involvement is appropriate. Finally, the third component is a feeling of low personal accomplishment. There seems to be little utility in performance of the job to standard; correct performance has little recognizable effect. Aspects of all three of these components are apparent in IO behavior in the COFT.

The concept and design of the COFT and the implementation plans focused, quite appropriately, on the Bradley gunnery involved, and on the maximum use of the COFT in the training environment. Little attention was paid to the problems involved in staffing the IO stations, other than ensuring that the personnel, already Bradley trained, were then fully trained in IO duties. The neglect of the role of the IO was not intentional. Until the COFTs were in use on a regular basis, this oversight was not apparent. However, at present, nearly every formal or informal discussion of the COFT program and its recognized benefits for gunnery training now includes some reference to IO problems.

Objective

The Army Research Institute (ARI) interest in the Fort Benning Bradley COFT program had started before the initial fielding of the device, including observation of training at the contractor facility, followed by the first usage in the institution. In early 1986 it was suggested that an outsider who knew the COFT and Bradley, but had no direct connection with either one, might be able to identify some of the emerging IO problems and their impact on training. An ARI researcher began to monitor classroom COFT instruction and observe training. The formal data collection was supplemented by extensive formal and informal conversations with the IOs. Other COFT and Bradley Instructor Detachment (BID) cadre and students, and additional Infantry School personnel were also interviewed. These interviews provided further insight into some of the problems already identified, and alerted the observer to others. The observations and interviews were supplemented by hard copy printouts of the gunnery data generated during the training. The present paper reports on findings from the gunnery data.

METHOD

Subjects

Ten IOs were observed in performance of their COFT duties over a ten day period. Six IOs were observed over a period of time during which they completed from 25 to 100 exercises. The other four IOs were observed primarily as they relieved other IOs and therefore had fewer complete exercises. Of the original ten, one left the COFT branch in the middle of the data collection effort; his data were discarded. Of the other nine observed, all were experienced in both COFT and Bradley skills. They ranged in rank from sergeant to sergeant first class; all were from Military Occupational Specialty 11M, Fighting Vehicle Infantryman.

No attempt was made to critique the performance of particular individuals. There were instances of exemplary, professional behavior under very trying conditions; there were instances where performance was marginal. Throughout, however, even in the very best IOs, the burnout problems were apparent. For some the problem areas were overriding, and actively interfered with duty performance; for others the problems were more of a nagging dissatisfaction.

Procedure

Over a ten day period in 1986, COFT training at Fort Benning was monitored. The focus on institutional training was intentional. Since students and instructors are accustomed to classroom visitors, their performance is rarely affected by civilian observers. More importantly, although units have regular COFT scheduling, and progression through the matrix with stabilized crews, there appeared to be problems uniquely associated with implementation of the COFT into Bradley institutional programs of instruction. The two BFV courses monitored most often were the Commanders Course and the Master Gunner Course. Offered by the BID, these are specialized courses designed to train officers and noncommissioned officers in Bradley skills. The Commanders Course consisted of lieutenants, captains, and a few majors; additionally there were NCOs from E-5 through E-7. The Master Gunner Course was limited to NCOs; their rank was comparable to those in the Commanders Course. At the time of this research, the student populations in both the Commanders Course and the Master Gunners Course were very inexperienced in BFV skills; for most of the students, the course was their first Bradley training.

At the beginning of each training day, the observer entered a COFT with the instructor and the students. The instructors knew, and the students were told, that the IOs were the subject of the research and that student performance was not being watched. The observer sat behind and to the side of the instructor. The IO's view of the situation monitor and the commander and gunner screens were visible, and the voices of both the crew and the IO could be heard easily. The same COFT was monitored all morning; in the afternoon a different COFT, with a different IO, was visited. The next day two additional COFTs were monitored. In the following days, the four COFTs were revisited; in the next week the same procedure was used, with a different student group. The observer adhered to the set schedule, despite IO changes, in order that any IO rotations or substitutions might occur naturally without outside influence. (Students are assigned randomly to COFTs at the start of the training and remain in the same one regardless of instructor; IOs work in the same COFT every day, except when they substitute for one another.)

Gunnery Data

Throughout the observation period, the paper printouts of student gunnery performance were saved for later analysis. A large number of exercises from both the commander and gunner matrix were represented; extensive data from nine IOs and many student crews were collected. Some of the exercises had few repetitions; three of the IOs had far fewer exercises than the others. To reduce the data to manageable proportions, the following decisions were made. Data from the three IOs with only a few exercises were discarded, and the total number of exercises analyzed was reduced to fourteen, where at least 25 iterations of each exercise occurred. Results based on these 14 exercises and the six IOs (labeled A through F) are presented in the following sections.

Selected Exercises and Performance Measures

Of the fourteen exercises selected for analysis, four were from the commander's matrix, ten from the gunner's. Computer scored items which go across all exercises, and are relatively independent of exercise content include target acquisition/identification time (ID), number of 25mm rounds fired, time to fire, number of hits, and numbers of target acquisition and system management errors (TAE and SME respectively). An additional measure, hit rate, can be derived from dividing the number of 25mm hits per exercise by the number of 25mm rounds fired. It should be noted that these measures are not independent and for several reasons, the absolute numbers presented in the following tables should not be taken out of context.

For example, in any one exercise, ID time alone is not a very accurate measure as unlike the computer assessed measures, ID is dependent on the IO's pressing the ID key when the gunner says "identified." Since all other times (fire, hit, and kill) are dependent on ID time, the absolute value (time) should be treated with caution. Additionally, the mean times for any of these measures (as derived from the performance analysis printouts) are not true measures of elapsed time, since they are based on averages from different numbers and types of targets, over a series of scenarios within a specific exercise. However, as an average or representative value, they can be inspected across exercises and IOs. Additionally, the student population from which this data was collected was very inexperienced. Since they were students in institutional courses, with little prior BFV experience, overall gunnery scores were low, as would be expected.

A brief description of the exercises used for data analysis is found in Appendix A. The number of iterations of the exercises for each IO is given in Table 1.

Table 1

Number of Iterations of Selected Exercises for each IO

		INSTRUCTOR/OPERATORS					
EX #	ITERATIONS	A	B	C	D	E	F
41211	57	13	13	8	8	9	6
41311	31	4	2	9	7	6	3
42221	28	6	1	4	8	8	1
42511	30	1	4	10	8	7	0
51211	63	14	12	7	8	14	8
51251	35	5	3	8	8	7	4
51311	55	13	8	8	8	12	6
51411	28	2	0	9	7	4	6
52211	31	6	4	4	8	8	1
52321	43	6	7	7	9	13	1
53311	38	2	5	11	7	5	8
53321	25	1	2	7	7	4	4
54223	25	4	8	7	0	1	5
54233	25	4	8	2	0	1	10
TOTAL	514	81	77	101	93	99	63

RESULTS AND DISCUSSION

The major problem areas identified, and potential solutions to some of the problems, provided the content of reports previously furnished to the BID (Salter, 1986; 1987). Primary areas of concern were human factors and the use of the COFT in the institution. The present report focuses on analysis of the computer generated gunnery performance data, and the impact of the IOs on this data. Recurring IO behavior patterns can be shown to impact on students' apparent gunnery performance, potentially masking true gunnery performance.

In the institutional environment, because of the inexperience of the students, the diversity of IOs, and numbers and types of exercises represented, the quality of individual crew performances, as evidenced by the student records, would be expected to be distributed evenly across all the IOs. Each IO ought to have had both good and bad gunners, both capable and less capable crews, and therefore the student records should show variable (both good and bad) performances on each measure. However, as can be shown by close inspection of the records, this does not appear to be the case. The data show that some IOs have student records that are consistently good or consistently poor, that their crews are characterized by predictably good or bad performances on some measures. Since crew performance records should be dependent on the crew's gunnery skills, it appears that some IOs are themselves impacting in a predictable manner on the gunnery performance measures. This hypothesis is made in lieu of the unlikely event that despite random assignment of crews to COFTs, particular IOs always got good crews, while others always had poor performers.

To test the validity of this hypothesis, the data were treated in the following manner. For each exercise, for each of the seven performance measures (ID time, time to fire, number of hits, number of rounds, hit rate, and target acquisition and system management errors) an overall mean was calculated. Additionally, each individual IO's students' mean score (over all of his students over all iterations of the exercise) for each of the performance measures was calculated. Then the six IOs' means were compared to the overall mean.

For example, exercise 41211 was given 57 times; the mean target identification (ID) time value over all IOs over all iterations of this exercise was 6.41 seconds. IO A had 13 iterations of exercise 41211; his overall student mean ID time was 6.23 seconds. IO B's student mean was 5.62 seconds (over 13 iterations). Similarly, IO C (8 iterations) had a mean of 9.90 seconds on ID time on exercise 41211. IOs D, E, and F had means of 4.66, 8.25, and 3.38 seconds respectively. This procedure, looking at the IO's means in relation to the overall means, eliminates any differences in ID value based on a specific crew's performance. In relation to the mean, recurring patterns are presumably due to the IO and any behaviors he may be bringing to all exercises for all crews. On a short term basis, if the IO is not unduly influencing their performance, crew performance ought to cluster around the mean.

All of the data were treated in this manner for each of the seven measures. It would be reasonable to assume that, other things being equal, over the course of all students, over all exercises, there should be no particular patterns of responses on any of the measures. ID times should be short for some students, long for others. Any systematic deviations from this chance distribution can be attributed to something beyond the student, i.e., the IO.

Using the example of ID time, if the IO is not a variable in performance, IO means ought to vary with respect to their position in relation to the overall mean over the course of all the exercises. However, inspection of Tables 2 - 8 indicates that the distribution of IO means above and below the overall means is different from what might be expected. In each of the tables, an overall performance mean is given for each exercise, followed by each IO's mean value for the measure on that exercise. No statistical tests were performed because of the non-independence of the data; however, IO means which exceed Z scores at the 80% confidence levels were noted. An asterisk indicates that the IO did not administer the exercise.

Table 2 shows the identification time means for each of the 14 exercises. Although IOs A and B are fairly well represented above and below the overall mean, IO B's scores tend to be extreme. IO D and F had mean scores that were always (100% of the time) below the overall mean, indicating that their crews always had short (fast) ID times. IOs C and E tended to have relatively long (slow) times.

Table 2

Mean Identification Times (in seconds) and IO Relationship to the Overall Mean

EX #	Overall mean	sd	Instructor/Operator Means A	B	C	D	E	F
41211	6.41	2.73	6.23	5.62	9.90[a]	4.66	8.25	3.38
41311	5.15	2.23	4.90	8.55[a]	6.59	2.21[a]	5.47	5.07
42221	7.55	2.80	9.30	11.40[a]	8.28	5.78	7.56	4.20[a]
42511	3.62	2.72	9.80[a]	6.35	5.16	0.76	2.26	*
51211	6.85	2.51	6.29	6.53	7.71	5.80	8.75	5.40
51311	4.87	1.92	5.00	8.17[a]	4.95	3.16	5.23	4.85
51251	5.38	1.92	5.59	5.09	6.69	3.86	6.88	2.58[a]
51411	3.48	1.63	2.95	*	5.17	1.73	3.80	2.95
52211	9.05	3.40	7.43	12.45	12.75	6.71	9.41	6.20
52321	6.01	3.09	5.30	9.44	5.51	2.87	7.02	4.70
53311	4.17	1.69	3.25	4.36	5.18	3.21	4.00	3.82
53321	5.94	2.43	4.40	10.05[a]	5.84	4.26	8.05	5.32
54223	7.78	3.17	7.20	8.20	9.73	*	5.50	5.32
54233	7.06	2.82	7.98	6.79	7.75	*	8.20	6.66
# above/below overall[b]			5/9	9/4	12/2	0/12	11/3	0/13
% above/below			36/64	69/31	86/14	0/100	79/21	0/100

Note. [a] = beyond 80% confidence limits. [b] χ^2 (5, N = 80) = 39.35, p = <.001

Table 3 shows the time to fire, in seconds. Time to fire is dependent on ID time, but is impacted on by the crew's ability to get the shot fired after the target has been identified. For time to fire, IOs A and C had means evenly spread above and below the mean, while for IO B, the time to fire values were very high (long). IO D showed consistently low (fast) times to fire, and IO F usually so. IO E had most scores above the mean, indicating a generally slow time to fire.

Table 3

Mean Times to Fire (in seconds) and IO Relationship to the Overall Mean

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41211	13.96	2.71	12.50	14.41	16.33	12.56	15.79	10.72
41311	12.62	2.44	10.93	17.50[a]	13.70	10.28	13.17	12.93
42221	15.55	1.92	15.85	20.30[a]	16.03	14.85	15.64	11.90[a]
42511	8.06	3.21	12.60[a]	12.70[a]	9.66	5.13	5.82	*
51211	14.98	2.60	13.88	16.08	15.03	14.39	15.35	13.28
51251	13.21	2.18	13.18	14.16	13.19	12.80	14.55	9.95[a]
51311	13.75	2.83	12.98	19.97[a]	13.73	11.71	14.47	12.95
51411	7.80	2.25	6.30	*	10.11	6.41	8.35	6.07
52211	17.91	3.05	16.52	22.53[a]	19.93	16.51	17.46	14.40
52321	14.86	3.19	14.53	18.63	14.66	12.71	14.81	12.20
53311	21.41	3.07	19.85	26.58[a]	20.62	20.11	21.58	20.70
53321	25.03	2.77	26.80	25.40	24.90	24.96	25.48	28.07
54223	25.29	3.99	25.30	26.76	25.00	*	25.00	23.40
54233	25.72	3.27	25.85	27.21	27.10	*	26.70	23.58
# above/below overall[b]			5/9	13/0	8/6	0/12	10/4	2/11
% above/below			36/64	100/0	57/43	0/100	71/29	15/85

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 80) = 35.04, p = <.001

Table 4 shows that with respect to the number of 25mm rounds fired, the IOs had great variability, as would be expected with the possible exception of IOs C, D, and E. They were consistently below (C) or above (D and E) the overall mean number of rounds.

Table 4

Mean Number of 25mm Rounds Fired and IO Relationship to the Overall Mean

EX #	Overall mean	sd	Instructor/Operator Means A	B	C	D	E	F
41211	67.56	19.84	72.30	66.00	52.50	76.88	67.89	67.83
41311	105.29	32.71	120.00	125.00	88.11	107.00	130.00	70.67
42221	70.00	18.24	65.83	83.00	58.75	80.13	67.25	68.00
42511	106.40	31.98	93.00	97.50	90.60	126.38	113.14	*
51211	59.13	20.47	64.21	58.17	46.63	63.75	61.07	56.13
51251	111.73	25.17	99.54	120.38	98.75	124.25	120.33	110.00
51311	102.46	26.57	104.25	105.33	96.75	100.38	124.71	80.25
51411	75.07	15.72	75.50	*	63.56	85.14	76.50	79.50
52211	66.10	21.64	69.50	54.00	47.75	85.38	55.37	58.00
52321	147.16	44.52	161.67	114.43	126.88	163.33	159.38	139.00
53311	84.73	20.44	78.50	85.40	69.82	77.00	91.80	108.75
53321	92.20	29.47	95.00	71.50	71.00	109.29	94.50	111.00
54223	72.92	15.84	76.75	63.38	73.86	*	75.00	75.40
54233	74.36	18.39	70.00	73.63	80.50	*	66.00	76.30
# above/below overall[b]			9/5	5/8	2/12	10/2	11/3	6/7
% above/below			64/36	38/62	14/86	83/17	79/21	46/54

Note. [b] χ^2 (5, N = 80) = 15.83, *p* = <.01

Table 5 shows the mean number of hits (25mm only) for each exercise. For each exercise there is an optimum or maximum number of hits which can be recorded, as the hit counters stop when the target is killed, regardless of continued firing. Depending on the scenario and the number of 25mm targets, an exercise will have 30 to 35 hits overall; hence the IOs with low means have crews with relatively poor performance. The IOs with high numbers of hits are approaching the maximum possible. IOs A, D, E, and F show high means; B and C are low.

Table 5

Mean Number of 25mm Hits and IO Relationship to the Overall Mean

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41211	33.56	4.48	35.15	31.08	32.00	35.50	32.44	36.67
41311	37.42	4.02	39.25	28.50[a]	37.11	38.86	37.67	38.00
42221	32.46	4.48	32.00	30.00	30.25	33.50	32.87	35.00
42511	21.17	3.22	21.00	17.50	20.70	21.50	23.57	*
51211	33.40	4.69	35.71	31.42	30.00	34.88	33.36	34.38
51251	39.11	5.17	39.62	33.75	39.13	41.75	40.00	39.83
51311	36.86	6.63	40.80	21.33[a]	37.50	39.50	36.00	39.00
51411	43.36	2.59	45.00	*	41.78	45.00	44.25	42.67
52211	26.23	6.56	32.00	18.25	19.50	29.25	26.88	21.00
52321	26.35	8.87	30.33	13.29[a]	28.57	30.00	27.92	25.00
53311	38.29	4.53	42.00	36.20	36.00	39.71	41.60	38.50
53321	31.28	7.77	28.00	20.50[a]	27.29	36.57	33.75	32.75
54223	30.26	8.54	32.50	28.00	25.71	*	36.00	37.80
54233	31.24	6.99	30.25	29.38	31.00	*	20.00[a]	34.30
# above/below overall[b]			10/4	0/13	3/11	12/0	10/4	10/3
% above/below			71/29	0/100	21/29	100/0	71/29	77/23

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 80) = 37.69, *p* = <.001

Table 6 shows the overall and individual IO means for hit rate. Hit rate (not scored by the computer) is a derived measure, calculated by dividing the total number of 25mm hits by the number of 25mm rounds fired, a possible measure of efficiency. IO B has crews consistently below the overall mean in hit rate; IO D shows a majority with low rate. IO C, however, shows great efficiency, in several cases very far above the overall mean rate. The other IOs have less definitive patterns.

Table 6

Mean 25mm Hit Rate and IO Relationship to the Overall Mean

EX #	Overall mean	sd	Instructor/Operator Means A	B	C	D	E	F
41211	0.51	.059	0.49	0.47	0.61	0.46	0.48	0.54
41311	0.37	.106	0.33	0.23	0.42	0.36	0.31	0.54[a]
42221	0.46	.060	0.49	0.36[a]	0.51	0.42	0.49	0.51
42511	0.21	.030	0.23	0.18	0.23	0.17	0.23	*
51211	0.58	.040	0.56	0.54	0.64[a]	0.55	0.55	0.61
51251	0.35	.046	0.40	0.28	0.40	0.34	0.33	0.36
51311	0.36	.100	0.39	0.20[a]	0.39	0.39	0.29	0.49[a]
51411	0.59	.047	0.60	*	0.66	0.53	0.58	0.58
52211	0.40	.064	0.46	0.34	0.41	0.34	0.49[a]	0.36
52321	0.18	.035	0.19	0.12[a]	0.23[a]	0.18	0.19	0.18
53311	0.47	.074	0.54	0.42	0.52	0.52	0.45	0.35[a]
53321	0.33	.038	0.29	0.29	0.38[a]	0.33	0.36	0.30
54223	0.44	.058	0.42	0.44	0.35[a]	*	0.48	0.50
54233	0.39	.058	0.43	0.40	0.39	*	0.30[a]	0.45
# above/below overall[b]			9/5	1/11	12/1	2/10	6/8	8/4
% above/below			64/36	8/92	92/8	17/83	43/57	66/33

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 80) = 31.83, p = <.001

Tables 7 and 8 show the overall mean numbers of errors in target acquisition and systems management. Although there is considerable variance, none of the IOs is strongly above or below the mean except IO B whose crews had relatively high error rates. Target acquisition errors are scored for errors in identification, firing at friendly targets, not firing, etc. These mistakes are not unusual for new crews, and therefore many crews, regardless of IO influence, would make them. Similarly, Systems Management errors are those of switch settings, with incorrect ammunition or weapon choice, firing in low magnification, and errors of defilade. These are also typical of new crews.

Table 7

Mean Number of TAE and IO Relationship to the Overall Mean

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41211	1.09	1.12	0.77	1.23	1.25	0.75	1.44	1.17
41311	0.32	0.75	0.25	1.00	0.11	0.57	0.33	0.00
42221	1.21	1.26	1.83	1.00	0.50	1.67	1.87	0.00
42511	0.47	.63	1.00	0.25	0.20	1.00	0.29	*
51211	1.58	1.12	1.21	2.00	1.75	1.25	1.86	1.25
51251	0.93	.94	1.08	0.88	1.38	1.00	0.92	0.00
51311	0.29	.67	0.00	1.00	0.25	0.00	0.29	0.75
51411	0.50	.64	0.00	*	1.00	0.43	0.00	0.33
52211	2.96	2.21	1.67	4.75	4.75	2.00	2.88	5.00
52321	1.28	2.03	0.50	4.14[a]	0.00	0.11	1.38	4.00[a]
53311	1.89	1.48	1.00	1.80	2.36	1.43	1.20	2.60
53321	2.84	2.29	4.00	4.00	3.00	1.29	2.75	2.75
54223	3.56	3.18	2.50	4.00	5.29	*	1.00	1.80
54233	3.64	2.08	2.75	4.75	2.00	*	6.00	3.20
# above/below overall[b]			4/10	9/4	8/6	4/8	6/7	5/8
% above/below			29/71	69/31	57/43	33/67	46/54	38/62

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 79) = 6.56, p = >.05

Table 8

Mean Number of SME and IO Relationship to the Overall Mean

EX #	Overall mean	sd	A	B	C	D	E	F
			Instructor/Operator Means					
41211	3.19	1.73	3.54	3.31	3.00	3.00	3.11	2.33
41311	2.90	1.90	1.50	4.00	2.44	3.25	3.67	2.33
42221	3.96	2.03	4.33	4.00	4.75	4.00	3.62	1.00[a]
42511	0.47	.51	0.00	0.00	0.90	0.00	0.71	*
51211	2.73	1.46	3.21	3.08	2.50	2.75	2.14	2.63
51251	5.29	1.85	4.85	6.38	5.63	4.38	5.83	4.50
51311	3.51	2.05	3.00	5.33	3.13	3.50	4.29	2.25
51411	0.32	0.55	0.00	*	0.33	0.42	0.25	0.33
52211	3.94	1.69	4.00	4.00	3.00	4.13	3.88	6.00
52321	6.40	1.90	6.50	6.43	7.50	5.44	6.38	5.00
53311	2.03	1.38	1.00	1.80	3.09	1.42	1.60	1.75
53321	3.32	1.41	4.00	3.00	4.57	2.00	4.00	2.75
54223	2.56	1.61	2.50	2.63	3.29	*	1.00	1.80
54233	2.04	1.17	2.25	2.13	2.50	*	2.00	1.80
# above/below overall[b]			7/7	10/3	9/5	4/8	5/9	2/11
% above/below			50/50	77/23	64/36	33/67	36/64	15/85

Note. [a] = beyond 80% confidence limits. [b] χ^2 (5, N = 80) = 13.61, p = <.02, >.01

IO Behavior Patterns

From inspection of Tables 2 through 8, it is readily apparent that for some measures, certain IOs fall either above or below the mean in consistent, and possibly predictable, patterns. The IO's patterns alone, or in combination with other items, may cause problems in assessing true crew gunnery performance. Problems normally attributable to the gunner or commander in a crew may in fact be a part of the IO's regular performance pattern and independent of the particular crew's performance.

Analysis of an IO's crews' records from this perspective may offer clues to IO behavior and strengths and weaknesses, showing areas needing improvement. It also provides overall support for the suggestion that IO behavior, independent of crew behavior, can impact on gunnery performance as measured by the COFT. Therefore the IO, as a factor in gunnery, must be standardized as much as possibl Only through training and continuous retraining of the IO is quality of s 'ent instruction maintained.

For this particular set of data, in summarizing the overall picture obtained about each IO from the pattern of performance measures for the different exercises, definite patterns and potential problems were clear. For these exercises, IO A rarely appeared in the extreme; he had a good number of hits and good hit rate, and generally low ID times and error scores. There was variability in his crews' performance, however, as would be expected. IO B, however, presents a much different picture. His data showed consistently slow times to ID and fire, and his error rates were relatively high. His crews had low (below average) numbers of hits, and low hit rate. It is probable that this IO's overall impact, so consistently negative, may have been masking true crew gunnery performance.

IO C was slow (above average) on ID times, relatively low on number of 25 rounds and low on hits but otherwise his overall crew performance was average. IO D was consistently low on ID time, and low in time to fire, indicating that his crews were responding quickly. They were also high (above average) in numbers of hits. IO E was somewhat high on ID time and time to fire, with a high number of 25mm rounds and number of hits. Like the previous two, IO E was not too extreme. The crews of IO F, like IO D, showed low ID time and time to fire, and a high number of hits. Errors were generally low.

A closer look at the results shows problems which are apparent in the patterns of behavior which characterize the IOs. In the institution, with newly formed and newly trained crews, in their initial stages of gunnery and COFT performance, gunnery performance should not be expected to be too good. Each IO should have some crews that do well, but others which do not. Although a good IO will eventually be able to teach his crews to have low ID and times to fire, with high numbers of hits and high hit rate and low numbers of errors, such performance on a consistent basis by new crews may indicate that the IO is offering too much assistance. If ID time is always very low, the IO may be laying the crew on the target, giving too much help on location; since time to fire is directly related to ID time a low (good) score on time to fire may be due to the IO. On the opposite dimension, if the times are always very long, the IO may not be giving proper guidance and may not be assisting the crew in skill development.

Too few (always below average) hits indicates that the IO may not be providing enough information to assist the crew in learning gunnery concepts and skills. If all IOs are doing well, each IO should have some crews with high numbers of hits, some with low; no one IO should by chance alone have received all the crews whose performance is characterized by low numbers of hits.

Looking again at the IOs' means, IO A appears to have done a good job as IO. His crews' performances on ID, fire time, hits, rate and errors were good, but not extreme. He had some crews do poorly, but most well. The performance by IO D was similar, but his values were more extreme; he had far less evidence of poor performances. IO F had values in the same directions as A and D, but far more consistently; his crews, from the same sample of novices as the others, may have been "too good to be true."

In the other direction, IO B's crews were always poor, whether on ID time, time to fire, number of hits or error rate. Values were often in the extreme. This IO may have been inattentive to crew needs, or not sufficiently well trained in gunnery to have been able to correct their errors, and bring their performance more in line with other crews. If this was in fact the case, the apparent poor gunnery (like the good gunnery of IO F's crews) may be more attributable to the IO than to the gunners. IO C was less extreme than B, but tending toward negative impact; IO E was generally neutral, similar to A, but with less good performances.

BFV gunnery performance as measured by the records of crews with IOs D and F is simply too good to be true in the institutional environment; performance by crews with IO B and C is also too poor to be by chance alone. These consistencies of performance, over all crews should provide a warning that, independent of gunnery skills, IO performance is an additional variable in gunnery performance as measured by the COFT. In a system where the variables are so carefully accounted for, if variability of performance can be attributed to the IO, unless it is acknowledged, it is an uncontrolled factor, with unknown impact.

Additional Exercises

Based on the preceding discussion and the data from Tables 2 through 8, it ought to be possible (as confirmation of the potential for use of this measure) to predict with some general level of confidence the individual IO's crews' patterns of scores (in relation to the mean) on another set of exercises. If the direction of the IO's crews in relation to the mean was other than by chance alone, the patterns or tendencies exhibited in the original data ought again to occur in another set of exercises. To test this hypothesis, the remainder of the data collected during the observation period was analyzed, using exercises with at least 4 of the 6 IOs represented, and at least 15 total iterations of each exercise. (Some other exercises had only a few iterations, and three or fewer IOs represented; it was felt that these should be totally discarded.)

Table 9 shows the additional exercises, and the number of iterations for each IO. (Brief descriptions of the exercises are at Appendix B.) These exercises had been removed from the original set because of the low number of repetitions; however, they represent the same time frame and the same student population as the original set of fourteen. The same type of data conversion was made for these additional exercises as for the original set. For each IO the mean value of each performance measure over all iterations of a particular exercise was noted, and compared to the overall mean (over all IOs) for that exercise. Again, an asterisk (*) indicates that the IO did not have any crews fire the exercise.

Table 9

Number of Iterations of Additional Exercises for each IO

EX #	ITERATIONS	INSTRUCTOR/OPERATORS A	B	C	D	E	F
41411	24	2	0	6	7	4	5
42223	20	0	4	4	1	3	8
42311	19	5	3	1	2	7	1
51221	23	4	2	4	7	6	0
51421	20	0	0	8	4	4	4
52212	18	1	6	4	0	3	4
53233	23	4	7	3	0	1	8
TOTAL	147	16	22	30	21	28	30

Table 10 shows the mean ID times, and how each IO's mean fell in relation to the overall mean. Comparing Table 10 results with those in Table 2 shows that IOs B, C, D and F adhered to their initially very strong patterns, and that the other two, not extreme in the first set of data, again were not extreme.

Table 10

Mean ID Times (in seconds) and IO Relationship to the Overall Mean: Additional Exercises

EX #	Overall mean	sd	Instructor/Operator Means A	B	C	D	E	F
41411	3.59	1.73	3.65	*	6.65^{a}	1.51	3.68	2.50
42223	8.72	2.65	*	8.83	12.88^{a}	8.50	7.83	5.56
42311	8.77	5.50	4.56	10.03	17.90^{a}	2.95	5.90	11.30
51221	8.85	2.06	8.15	9.20	10.43	5.67^{a}	10.78	*
51421	5.00	2.00	*	*	5.61	2.93	5.20	3.65
52212	9.12	3.13	7.30	10.47	12.08	*	11.20	4.53^{a}
53233	4.60	2.88	7.03	4.93	7.07	*	4.10	3.84
# above/below overall^{b}			2/3	5/0	7/0	0/0	4/3	1/5
% above/below			40/60	100/0	100/0	0/100	57/43	17/83

Note. ^{a} = beyond 80% confidence limits. ^{b} χ^2 (5, N = 35) = 19.99, p = <.01.

Table 11 shows the mean time to fire scores for the additional data, and can be compared with Table 3. IOs B, D, and F maintained their strong patterns of behavior; IO A was again not strongly above or below the mean. Again IO B's performance showed values well above the mean.

Table 11

Mean Times to Fire (in seconds) and IO Relationship to the Overall Mean: Additional Exercises

EX #	Overall mean	sd	Instructor/Operator Means A	B	C	D	E	F
41411	7.11	2.32	6.50	*	10.27[a]	4.72	8.70	5.38
42223	15.65	2.75	*	19.10	17.38	15.90	13.53	12.35
42311	13.80	3.16	11.66	17.43	17.90[a]	10.80	13.71	11.30
51221	16.28	1.84	14.65	18.50	16.28	14.30	17.67	*
51421	8.00	1.57	*	*	9.46	6.73	9.25	6.55
52212	16.95	3.88	13.30	21.57	19.20	*	18.10	12.58
53233	22.00	1.80	22.88	24.70[a]	21.30	*	20.20	20.94
# above/below overall[b]			1/4	5/0	5/1	1/4	4/3	0/6
% above/below			20/80	100/0	83/17	20/80	57/43	0/100

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 34) = 19.38, p = <.01

Table 12 can be compared with Table 4, where the mean numbers of 25mm rounds fired are shown. Only IO C maintained a particular pattern; the others either remained at a middle ground or reversed the original pattern (A and F).

Table 12

Mean Number of 25mm Rounds Fired and IO Relationship to the Overall Mean: Additional Exercises

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41411	81.88	15.20	80.50	*	76.83	89.71	60.75[a]	101.60[a]
42223	71.63	5.67	*	72.50	73.25	64.00[a]	69.00	79.38[a]
42311	140.28	16.78	129.80	147.67	166.00[a]	128.50	148.71	121.00
51221	63.03	9.29	66.50	59.00	48.75[a]	71.71	69.17	*
51421	73.05	3.51	*	*	68.88	77.25	72.75	73.50
52212	58.97	5.93	57.00	61.83	52.50	*	60.00	68.50[a]
53233	67.37	9.59	55.75	73.57	61.67	*	80.00[a]	65.88
# above/below overall[b]			1/4	4/1	2/5	3/2	4/3	4/2
% above/below			20/80	80/20	29/71	60/40	57/43	67/33

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 35) = 5.78, p = > .05.

In Table 13 the mean number of hits is shown, and can be compared to Table 5. A low mean indicates poor hit performance. This table clearly shows that all six IOs maintained their original strong patterns, A, D, E and F with high numbers of hits and IOs B and C low.

Table 13

Mean Number of 25mm Hits and IO Relationship to the Overall Mean: Additional Exercises

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41411	44.99	0.74	46.00[a]	*	44.67	45.29	45.00	44.00[a]
42223	30.27	5.10	*	26.50	23.75	36.00	34.00	31.13
42311	32.17	5.70	34.00	23.33[a]	30.00	39.00	29.71	37.00
51221	31.58	3.42	32.25	32.00	30.25	36.43[a]	27.00[a]	*
51421	42.47	2.04	*	*	42.38	45.00	42.50	40.00
52212	24.72	4.97	27.00	23.33	17.00[a]	*	26.00	30.25
53233	34.24	1.68	34.25	31.86[a]	33.50	*	36.00	35.63
# above/below overall[b]			5/0	1/4	0/7	5/0	5/2	4/2
% above/below			100/0	20/80	0/100	100/0	71/29	67/33

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 35) = 22.64, p = <.001

Table 14 shows mean hit rates in the supplementary exercises, and can be compared to Table 6. IO B maintained his very much below average position.

Table 14

Mean 25mm Hit Rate and IO Relationship to the Overall Mean: Additional Exercises

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41411	0.56	0.11	0.57	*	0.58	0.50	0.74[a]	0.43
42223	0.43	0.10	*	0.37	0.32	0.56[a]	0.49	0.39
42311	0.24	0.06	0.26	0.16[a]	0.18	0.30	0.20	0.31
51221	0.51	0.08	0.48	0.54	0.62[a]	0.51	0.39[a]	*
51421	0.58	0.03	*	*	0.62[a]	0.58	0.58	0.54[a]
52212	0.41	0.06	0.47	0.38	0.32[a]	*	0.43	0.44
53233	0.51	0.07	0.61[a]	0.43	0.54	*	0.45	0.54
# above/below overall[b]			4/1	1/4	4/3	2/1	3/3	3/3
% above/below			80/20	20/80	57/43	67/33	50/50	50/50

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 32) = 3.99, p = > .05.

In Table 15, like Table 7, Target Acquisition Error means are shown. TAE includes identification and classification errors, firing at non-targets, friendly targets, or not firing. The IOs show consistency in numbers of TA errors, and IO B's crews have many.

Table 15

Mean Number of TAE and IO Relationship to the Overall Mean: Additional Exercises

	Overall		Instructor/Operator Means					
EX #	mean	sd	A	B	C	D	E	F
41411	0.34	0.41	0.00	*	1.00[a]	0.43	0.25	0.00
42223	1.96	1.54	*	3.25	3.75	0.00	1.67	1.13
42311	0.88	1.30	0.00	2.00	3.00[a]	0.00	0.29	0.00
51221	1.91	1.39	0.75	3.50	1.25	0.71	3.33	*
51421	0.22	0.29	*	*	0.25	0.62[a]	0.50	0.00
52212	3.63	1.50	3.00	4.17	2.25	*	6.00[a]	2.75
53233	2.94	1.76	2.25	2.86	6.00[a]	*	2.00	1.63
# above/below overall[b]			0/5	4/1	5/2	2/3	3/4	0/6
% above/below			0/100	80/20	71/29	40/60	43/57	0/100

Note. [a] = beyond 80% confidence limits. [b] χ^2 (5, N = 35) = 13.56, p = <.02, >.01.

Table 16, like Table 8, shows Systems Management Errors, including those of switch settings. These include instances of firing in low magnification, selecting the wrong ammunition or weapon system for a particular target, or defilade errors. Only IO B crews showed very low performances.

Table 16

Mean Number of SME and IO Relationship to the Overall Mean: Additional Exercises

EX #	Overall mean	sd	A	B	C	D	E	F
			Instructor/Operator Means					
41411	0.58	0.58	1.50[a]	*	0.75	0.42	0.25	0.00
42223	2.80	0.86	*	2.67	3.25	4.00[a]	2.33	1.75
42311	4.62	0.75	3.50[a]	4.67	5.00	4.00	5.57	5.00
51221	3.32	0.46	4.00[a]	3.50	3.25	3.00	2.83	*
51421	0.31	0.13	*	*	0.25	0.25	0.25	0.50[a]
52212	3.24	0.76	2.00[a]	3.67	4.00	*	3.30	3.25
53233	2.72	0.89	3.00	2.86	4.00[a]	*	2.00	1.75
# above/below overall[b]			3/2	4/1	5/2	1/4	2/5	3/3
% above/below			60/40	80/20	71/29	20/80	29/71	50/50

Note. [a] = beyond 80% confidence limits. [b] X^2 (5, N = 35) = 6.31, p = > .05.

These overall findings can be seen more easily in Table 17 which shows the percentages above and below the mean for all seven performance measures for the IOs on both the first and second set of exercises. It can be seen that for this set of IOs, time to identify, time to fire, and number of 25mm hits were good predictors from the first set of exercises to the second.

Four of the six IOs maintained their strong direction in ID time from the first set of exercises to the second. Three of the six IOs maintained their very strong positions for time to fire. In no case did an IO relationship to the overall mean vary in direction. For number of hits, all IOs convincingly maintained their positions in relation to the mean. IOs A, D, E, and F were consistently above the mean in numbers of hits, while B and C were consistently below. ID time, time to fire, and number of hits are all important measures in assessment of gunnery performance.

Two other measures (number of rounds and hit rate) did not show these same correlations for the two sets of exercises. However, some IOs were quite predictable. Both error rates showed high correlations between IO position on the first set of data and the second set.

Table 17

Summary of IO Relationship to the Mean on Performance Measures for Two Sets of Exercises (in percentage of the time ABOVE/BELOW the mean) and Correlation (R_0) between Sets

MEASURE/SET	A	B	C	D	E	F
			INSTRUCTOR/OPERATOR			
IDENTIFICATION TIME (R_0 = .886)*						
SET 1	36/64	69/31	86/14	0/100	79/21	0/100
SET 2	40/60	100/0	100/0	0/100	57/43	17/83
TIME TO FIRE (R_0 = .843)*						
SET 1	36/64	100/0	57/43	0/100	71/29	15/85
SET 2	20/80	100/0	83/27	20/80	57/43	0/100
25MM ROUNDS (R_0 = -.086)						
SET 1	64/36	38/62	14/86	83/17	79/21	46/54
SET 2	20/80	80/20	29/71	60/40	57/43	67/33
25MM HITS (R_0 = .700)						
SET 1	71/29	0/100	21/79	100/0	71/29	77/23
SET 2	100/0	20/80	0/100	100/0	79/21	67/33
HIT RATE (R_0 = .330)						
SET 1	64/36	08/92	92/18	17/83	43/57	67/33
SET 2	80/20	20/80	57/43	67/33	50/50	50/50
TARGET ACQUISITION ERRORS (R_0 = .900)*						
SET 1	09/71	69/31	57/43	33/67	46/54	38/62
SET 2	0/100	80/20	71/29	40/60	43/57	0/100
SYSTEMS MANAGEMENT ERRORS (R_0 = .830)*						
SET 1	50/50	77/23	64/36	33/67	36/64	15/85
SET 2	60/40	80/20	71/29	20/80	29/71	50/50

Note. * $p = < .05$

One further observation is inescapable. Although some of the IOs show more variability, IO B's crew performances are extremely predictable. Based on the data collected, it would appear that all of IO B's crews were poor gunners, since all appeared on the undesirable side of the means on each exercise. ID and fire times were high (slow), hits and hit rate were low, and errors high. Either IO B had extremely poor luck in the random assignment of crews to his COFT or in some manner he was doing a much less than adequate job in training. To a lesser degree, IOs D and F, by their extremely predictable crew performances (albeit in the positive direction) are suspect in their surprisingly good identification and fire times, high hits and low errors, considering that the crews were from an inexperienced student population.

Summary

Although the data presented in the preceding tables are difficult to follow, they may indeed show a trend, or show that it is important to observe an IO, to see if patterns develop in his behavior independent of the students he is training. Further research is needed, but it appears that only certain crew performance measures may need to be monitored to assess IO performance.

Identification times, and times to fire should be watched; some IOs have consistently high or low crew means. Since times over all crews over all exercises should approach an average level, consistency despite crew changes may indicate a problem. An IO whose crews are always below the mean on ID time may be laying them on the target, or giving them too much help in locating it. Conversely, an IO with consistently long times may not be giving enough information or may be failing to stress the need to scan properly. A low ID time followed by a high time to fire should not occur logically; when this happens repeatedly, the IO may need to be reminded to help the crew with procedures, fire commands, etc.

For this group of IOs on this set of exercises, the number of hits also appears to follow a pattern, with some IOs consistently high in crew hits, and others consistently low. The hit counter stops when the target is killed, producing a potentially optimum number of hits per scenario (for 25mm ammunition at a BMP or a helicopter, five hits per target is both the ideal minimum and the ideal maximum). An IO whose crews are always low in numbers of hits may be impacting negatively on their performance by not attending to the gunnery skills he should be training, and providing sufficient guidance on methods of achieving first round hits or efficient burst on target techniques. Time to kill data, and number of kills, not used in this data collection, may yield useful information.

Hit rate as a measure of efficiency of firing, the actual number of rounds of 25mm ammunition fired, and error rates are very strongly tied to the other measures, but were for this set of data less revealing about IO performance. However, an IO whose crews over all exercises make many errors should probably be monitored. Similarly, an IO whose crews fire many rounds needs to be reminded that crew performance is downgraded for excessive ammunition use. It would certainly be possible to develop a data base for the most frequently used exercises, with normative values and standard deviations for some of the more critical performance measures. Gunnery print outs could then be monitored periodically. Probably only extremes of behavior patterns should be of concern for any of the measures; fluctuations around the mid-point are desirable, and likely, particularly in the institutional environment. Since crew performance is variable, crew performance records ought to reflect that variability.

CONCLUSIONS

It is obvious that the impact of the COFT on gunnery training is dependent on the performance of the IO who serves as the link between the device and the crew. Since an IO's behavior is often predictable, independent of crew performance or the specific exercise, it should not be overlooked, nor should the reasons for the IO behavior. Additionally, since performance on the COFT is increasingly being used as a prerequisite for live fire gunnery, the impact of the IO becomes critical.

Based on the observations of COFT training and the gunnery data, it is apparent that there may be a need for a standardized COFT instructor training program which does more than simply train IO skills. Each IO must have a comprehensive BFV gunnery background, with sufficient retesting and periodic recertification to insure that gunnery instructional performance does not deteriorate. The IO skills used to provide student feedback must not be allowed to decay through lack of practice or because of inadequate background. This becomes particularly important in view of IO turnover.

There are for the COFT IO few rewards for good job performance, and few penalties for inadequate or poor performance, and IOs are not necessarily using all of their skills. For example, a portion of the IO's job is to pre-brief and de-brief his students, to detail demonstrated strengths and weaknesses. However, since the IO in the institution may not see the crew again, or the crew has no opportunity to practice due to the constraints of the POI, the IO may lose his motivation to do these portions of his job. Without practice these skills decay. Additionally, although IOs are extensively tested on their knowledge of the COFT, they are not often tested in gunnery skills, either for retention, or on their initial comprehension. Consequently, incorrect or outdated information may be given.

Instructor/operator reassessment must be a continuous process in order to maintain the quality personnel needed. IO COFT behavior must be standardized, and then monitored by qualified persons, with some system of reward to motivate and encourage performance, to instill pride, and minimize the effects of burnout. Similarly, there must be an attempt to acknowledge, if not alleviate, human factors problems. The value of the Conduct of Fire Trainer as a Bradley Fighting Vehicle gunnery device is unquestioned. However, its value is diminished unless the instructor/operator is sufficiently trained to achieve and maintain a similar high quality performance. The combination of an excellent device and well trained personnel will insure the maximum potential effectiveness of the trainer, and ultimately, the Bradley gunner.

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APPENDIX A - FIRST SET OF EXERCISES

COMMANDER MATRIX EXERCISES - DESCRIPTIONS:

Exercise 41211: stationary BFV/short range single stationary targets/day

Exercise 41311: stationary BFV/short range single moving targets/day

Exercise 42221: stationary BFV/long range single stationary targets/night

Exercise 42511: moving BFV/long range single moving targets/day

GUNNER MATRIX EXERCISES - DESCRIPTIONS:

Exercise 51211: stationary BFV/short range single stationary targets/day

Exercise 51251: stationary BFV/short range single stationary targets/day/ auxiliary sight

Exercise 51311: stationary BFV/short range single moving targets/day

Exercise 51411: moving BFV/short range single stationary targets/day

Exercise 52211: stationary BFV/long range single stationary targets/day/ TOW malfunction

Exercise 52321: stationary BFV/long range single moving targets/dusk/ TOW malfunction

Exercise 53311: stationary BFV/short range multiple moving targets/day

Exercise 53321: stationary BFV/short range multiple moving targets/night

Exercise 54223: stationary BFV/long range multiple stationary targets/ night/battlefield conditions

Exercise 54233: stationary BFV/long range multiple stationary targets/day/ NBC/battlefield conditions

APPENDIX B - ADDITIONAL EXERCISES

COMMANDER'S MATRIX EXERCISES - DESCRIPTIONS:

Exercise 41411: moving BFV/short range single stationary targets/day

Exercise 42223: stationary BFV/long range single stationary targets/night/battlefield conditions

Exercise 42311: stationary BFV/long range single moving targets/day

GUNNER'S MATRIX EXERCISES - DESCRIPTIONS:

Exercise 51221: stationary BFV/short range single stationary targets/night

Exercise 51421: moving BFV/short range single stationary targets/night

Exercise 52212: stationary BFV/long range single stationary targets/dusk/TOW malfunction

Exercise 53233: stationary BFV/short range multiple stationary targets/day/NBC/battlefield conditions