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LITERATURE REVIEW--ARMY TRAINING:
M16A1 RIFLE, TOW, AND DRAGON WEAPON SYSTEMS

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FOREWORD

This report is one of a series on the research support provided by the Mellonics Systems Development Division of Litton Systems, Inc., to the Army Research Institute for the Behavioral and Social Sciences (ARI) under Contract Number DAHC 19-77-C-00-1. The report, as submitted, is a part of the final report of the total contractual support effort; it will be incorporated into that report by reference.

As set forth in the Contract Statement of Work, the Mellonics effort includes support to the Training Effectiveness Analysis (TEA) program, a research effort focusing on the analysis of training effectiveness for each of three weapon systems: M16A1 Rifle, TOW, and Dragon. This report reviews the literature of the three weapon systems and provides an annotated bibliography (266 references) of those systems.

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ABSTRACT

A literature review and annotated bibliography was compiled to provide an introduction to the three Infantry weapon systems (M16A1 Rifle, TOW, and Dragon antitank guided missiles) considering the three subsystems (training criteria, training content, and trainee selection) within each system. Two hundred sixty-six (266) documents were identified and abstracted. Of these, one hundred five (105) are variously cited in the review narrative. The review describes and discusses the hardware, hardware demands on the operator, current training programs, training criteria, measures of effectiveness, and training devices. The review showed that the current training for each weapon system (1) lacks continuity between institutional and unit training, (2) has no correlation between training device proficiency and operational equipment proficiency, and (3) has no validated training program. It was concluded that training for the M16A1, TOW, and Dragon can be effective only if complete training effectiveness analyses (TEAs) are conducted for each weapon system.

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ABBREVIATIONS

DIA	Defense Intelligence Agency
DoA	Department of the Army
HumRRO	Human Resources Research Organization
USACACDA	U. S. Army Combined Arms Combat Developments Activity
USACATB	U. S. Army Combat Arms Training Board
USACDEC	U. S. Army Combat Developments Experimentation Command
USAHEL	U. S. Army Human Engineering Laboratories
USAIB	U. S. Army Infantry Board
USAIS	U. S. Army Infantry School
USATRADOC	U. S. Army Training and Doctrine Command
USATRASANA	U. S. Army Training and Doctrine Command Systems Analysis Activity

LITERATURE REVIEW - ARMY TRAINING: M16A1 RIFLE, TOW, AND DRAGON WEAPON SYSTEMS

INTRODUCTION

BACKGROUND AND PURPOSE

Rapid technological advances in the twentieth century have resulted in the development of increasingly complex and sophisticated weapon systems. These systems are designed to yield high battlefield effectiveness against the similarly sophisticated weaponry of threat forces. Effectiveness of a weapon system, however, is not a simple function of the system's hardware capabilities. Rather, effectiveness emerges from the interaction between the man and his weapon and his training. Performance improvements, therefore, should follow most readily from a total systems approach to weapon system performance.

Experience teaches, however, that weapon system design typically fails to incorporate a total systems approach. Moreover, training data tells us that even "expert" firers usually fail to achieve the design capabilities of the weapon (e.g., M16A1 Expert Baseline, USAIB, 1976). The alternative solutions to this problem are weapon system redesign or improved training.

With rising costs of materiel development and tightening fiscal constraints, improved training may provide the cost-effective solution to improved weapon systems effectiveness. The systematic analysis and improvement of training, however, requires the rigorous application of a training evaluation and design methodology. The command emphasis to initiate and sustain such analyses has come from the U. S. Army Training and Doctrine Command (TRADOC).

USATRADOC (1975) describes battlefield effectiveness (E) as a function of three variables: the materiel capability (W), the proficiency of the soldier manning the weapon (P), and the tactic or technique of employment (T). The general model is expressed as $E=f(W, P, T)$. The systems approach recognizes the interdependency of the three antecedent variables. It also recognizes that each of these three variables is itself multivariate in nature. The simplicity of the general model, therefore, is deceiving.

TRADOC has charged the proponents to conduct Training Effectiveness Analyses (TEA) for each major weapon system. A general methodology is outlined in USATRADOC PAM 71-8, (1975) and the Cost and Training Effectiveness Analysis [CTEA] Handbook (USATRASANA, 1976). TRADOC's goals are to:

- "Win the first battle of the next war
- Achieve and maintain heightened readiness
- Redress institutional bias in training research
- Purchase and distribute training devices intelligently
- Convince training conservatives to adopt sound, cost-effective training techniques
- Justify to Department of the Army investments in training." (USATRADOC, 1975, p.1-13)

Assumptions are:

- "Accept current weapons and materiel as given and pursue ways to enhance their effectiveness through better training, instead of materiel modifications or replacement.
- Examine alternatives to current training methods which employ different mixes of operating costs; e.g., ammunition, petroleum, spare parts, real estate costs and temporary duty payments versus simulators, training time and other appropriate variables.

- Measure the effectiveness of alternatives in terms of dollars and manpower conserved, or anticipated battlefield effectiveness, as appropriate." (USATRADOC, 1975, p .1-13)

Thus, the objective of a CTEA is dual; increase battlefield effectiveness and/or reduce training costs. The TEA explicitly addresses the effectiveness of training and its contribution to both soldier proficiency (P) and tactics (T). Increases in battlefield effectiveness (E) are inferred from increases in P and T and an analysis of the W, P, T interactions.

A TEA can be conceptualized for any weapon system by referring to Figure 1, where the top curve represents the potential of a system (exclusive of human error) and the bottom curve represents the current effectiveness of the system. The hatched area is the performance gap which the TEA attempts to close. The ultimate product of a TEA should be the fielding of a total training delivery system for a weapon that is systems engineered with tasks, conditions, and standards criterion referenced to combat. That is, a soldier who achieves the training standard should be prepared to defeat the threat his weapon was designed to defeat (e.g., threat riflemen). Achieving such a level of readiness for the individual and his unit will require an integration of institutional and unit training. Moreover, the unit commander must be presented a sufficient span of training options to meet the standard within his local constraints (e.g., training time, classrooms, and ranges). Training simulation devices offer particular promise in this area.

The scope of the initial TEA effort at the U. S. Army Infantry School (USAIS) encompasses three Infantry weapon systems: the M16A1 rifle, the TOW, and the Dragon. A systems approach to TEA was adopted in which the three weapon systems of interest are analyzed in terms of three subsystems: criteria, training, and selection. In support of these analyses, this literature review provides: (a) a brief description of all three systems; (b) a review of current training as outlined in training circulars (TC), field manuals (FM),

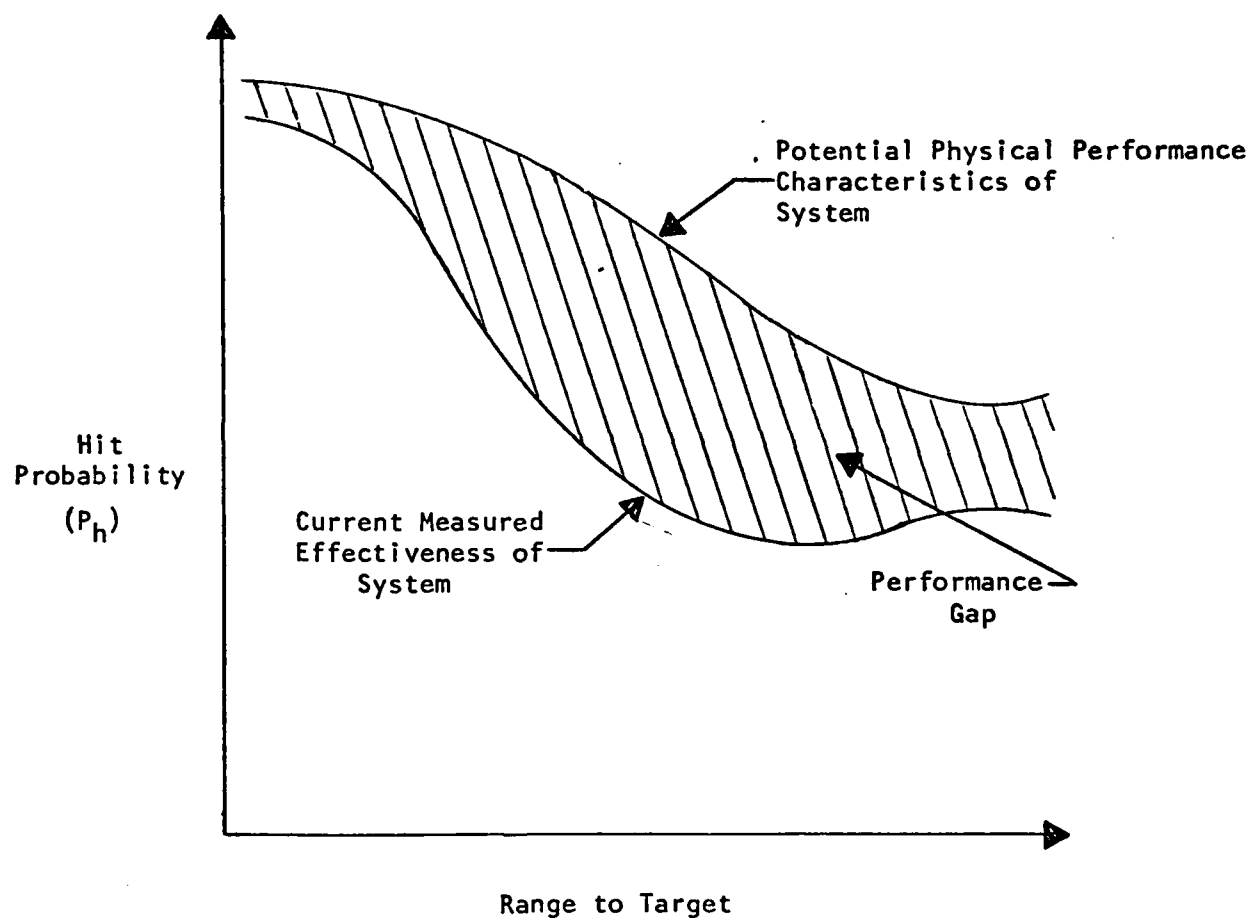


Figure 1. Conceptualization of performance gap for a hypothetical weapon system.

the Army Subject Schedule (ASubjScd), and descriptions by the principals involved in training; (c) identification of training problems; (d) criticisms of current and proposed training; and (e) recommendations.

It is intended that this literature review and annotated bibliography will serve in combination to provide an introduction to the three weapon systems and their training problems. The narrative section is not intended to be a thorough review of all prior testing and research on these systems. Rather, it should familiarize the reader with the systems and highlight the core problems that the TEAs for these systems must address. The annotated bibliography should serve as a guide to identifying articles of specific interest to the individual reader. Thus, it is an index to those articles judged to be of greatest significance in filling specific information needs. However, the use of research literature and after-action reviews requires the reviewer to attend carefully to two aspects of any study: findings and methodology. A common weakness in research literature review is the unqualified acceptance of findings. To be useful and credible, however, findings must be scrutinized in light of such methodological considerations as the use of adequate controls, sample size adequacy, and the appropriateness of statistical or descriptive techniques. Potential sources of bias must be documented so that the reviewer can judge the utility of the abstracted findings. Often, studies do not provide sufficient information to permit such a determination. In these cases, if study results are confirmed by other studies, this fact will be used to justify acceptance of results. Where confirmatory data do not exist, but the results are judged to be of significance, the need for confirmatory research will be indicated.

METHOD

Development of a classification scheme was the first step in preparing the literature search. Within each of the three weapon systems (M16A1 rifle, TOW, and Dragon), three subsystems pertaining to training were identified:

- (1) training criteria,
- (2) training content, and
- (3) trainee selection (i.e., predictors of trainee performance).

The search was conducted with emphasis on documents that satisfied two criteria: they involved one of the three weapon systems and they contained information relevant to one or more of the three subsystems of interest. Additional documents were consulted, however, that provided descriptions of the weapon hardware characteristics and capabilities. A number of documents were also reviewed that addressed one of the three subsystems (for weapon system training), but did not deal explicitly with M16A1, TOW, or Dragon.

Prior to conducting automated literature searches, descriptor synonyms were used to expand the classification scheme. The descriptors used were:

- measures of effectiveness
- cost effectiveness
- criterion-referenced testing
- threat
- simulators
- simulation
- transfer of training
- individualized training
- crew training
- teaching methods
- training devices

Two computer searches were conducted - A Defense Documentation Center (DDC) search and an Education Research Information Center (ERIC) search. The DDC search was intended to cover all documents produced on the weapon systems including classified material (CONFIDENTIAL and SECRET). ERIC was a more general search in that specific references to the three weapon systems were excluded. A 1966 cutoff date was used for both searches.

In addition to the two computer searches, five other sources were examined for relevant material. One was a 1975 Lockheed computer search that included references to the three systems. A second was the ARI library at Fort Benning, Georgia which had many relevant hard copy documents. The third (for the TOW and Dragon only) was the program manager files at the Combat Developments section of the U. S. Army Infantry Center. The fourth was a 1976 DDC search concerning only the TOW system (through SECRET). The fifth was a search of pertinent documentation available in the Library of the Washington Scientific Support Office of Litton Mellonics, Springfield, Virginia.

The seven sources were screened to select reports for documentation and assessment. Two hundred and sixty-six (266) documents were identified. They are listed in the annotated bibliography (See Appendix). Of those, one hundred five (105) were deemed particularly relevant and were incorporated into the narrative sections of this report, based mainly on reviews of the abstracts.

The literature review is divided into three sections, one for each weapon system (M16A1, TOW, and Dragon). Each section contains a description of the weapon system, current training programs for the system, and a discussion concerning the three subsystems (training criteria, training content, and trainee selection).

Finally, the appendix contains the annotated bibliography. Abstracts of all documents identified as relevant to the TEA for the three weapon systems are included. Tables are also provided that depict frequency counts of articles pertaining to each system and a locator which indexes each reference by subsystem classification.

M16A1 RIFLE

DESCRIPTION OF SYSTEM

Hardware. The M16A1 rifle is a 5.56mm magazine-fed, gas-operated, shoulder weapon. It is equipped with a flash suppressor. The barrel is surrounded by two aluminum-lined fiberglass handguards, notched to permit air circulation around the barrel and to protect the gas tube. A hard pad is attached to the butt of the stock to partially reduce the effects of recoil. An ejection port cover is provided to prevent dirt or sand from getting into the ejection port. Within the stock there is a storage compartment for cleaning equipment. The overall length of the rifle with flash suppressor is 39 inches; the firing weight with sling and a loaded 20 round magazine is 7.6 pounds. For a more complete description of the rifle's characteristics and operational capabilities see FM 23-9 (DoA, 1974).

Hardware Demands on Operator. The rifle can be fired in either a semiautomatic or automatic mode. The operation of the weapon requires the soldier to firmly grasp the weapon, view the target through the sights, obtain a good sight picture, and gently squeeze the trigger. To facilitate operation in the automatic mode the rifleman should have available and use a "clothespin" bipod. Fired in either mode the weapon produces perceptible recoil and loud noise. To avoid the effects of recoil the soldier must keep the butt of the rifle pressed firmly against his body. To protect against impairment of hearing because of exposure to continuous rifle noise soldiers in training use ear plugs (or covers). In battle, of course, a soldier's use of ear plugs could reduce his hearing potential and adversely affect his combat effectiveness. The effect of noise on combat effectiveness, however, is not well known.

The M16A1 is designed for right-handed operation. Although left-handed operation is not precluded, efficient performance as an integral system is more difficult because the forward assist assembly and the ejection port are located on the right side of the rifle. (The forward assist assembly permits the closing of the bolt when this is not done by the force of the

action spring.) Left-handed operation requires the soldier to reach his hand over the weapon when it is necessary to use the forward assist mechanism. The ejection port problem is offset by the addition of a deflector plate.

The M16A1 must be cleaned after use (as often as several times each day) and must have daily preventive maintenance to keep it in a condition that assures maximum operational readiness. This necessary periodic care of the weapon is the responsibility of the rifleman. In addition, the rifleman is expected to be able to locate and correct minor malfunctions in his weapon (FM 23-9, DoA, 1974).

Threat. The overall threat to the U. S. soldier comprises primarily the opposing force soldiers, weapons and equipment, and tactics. It is expected that the opposing force will be armor heavy and that in the initial period of conflict its numbers will be greater than the U. S. force. The enemy soldier will be steadfastly dedicated to his country, staunchly convinced of the right of his purpose, well trained, and very tough. Enemy force weapons and equipment largely parallel U. S. force weapons and equipment: e.g., rifles, machine guns, grenade launchers, mortars, artillery, rocket launchers, wire guided anti-tank missiles, air defense weapons, armored personnel carriers, amphibious vehicles, tanks, wheeled vehicles, night-vision devices, surveillance devices, and communications equipment. The enemy forces will mainly operate as combined arms teams with air and artillery fire support. They will employ electronic warfare, especially jamming and other sophisticated electronic means for the interruption of communications (TC 30-4, DoA, 1975).

For the most part the threat against which the U. S. rifleman can act or react is the individual enemy rifleman within the motorized rifle squad and platoon. For basic combat training (BCT) and in advanced individual training (AIT) this threat is represented on the firing ranges by materiel targets. The targets are of two kinds: stationary and moving (pop-up). To simulate realism these targets are concealed and placed at ranges from 25 to 300 meters. The pop-up targets come up into view at random intervals

and remain in view from 5 to 20 seconds. This exposure time range corresponds positively with documented exposure times for individual riflemen of a threat squad in the attack (Hall, 1975). In unit field training exercises, live mock aggressor troops are frequently employed to simulate this threat. A definite lack of documented evidence exists in the area called the micro threat or threat to the individual U. S. rifleman in the rifle squad. Though a considerable number of sources exist which deal with the threat in global, theater, division and battalion dimensions, few sources covered the threat at levels below the company organization.

Measures of Effectiveness. In general a measure of effectiveness (MOE) is something to be maximized (or, if appropriate, minimized) or brought as nearly as possible to ideal. A most important characteristic of a MOE is that it must measure the effectiveness of the system - a truism that cannot always be taken for granted. Other important characteristics of a MOE are that it be quantitative, efficient (in the statistical sense), complete, and simple. The ultimate aim, which is not always obtainable, would be to derive a single MOE which includes the effects of all the system performance objectives. Thus, the ultimate MOE for the rifleman should combine three factors: (1) his success in hitting the enemy in combat, (2) his success in avoiding being hit himself by the enemy, and (3) his ability to apply correct techniques of rifle marksmanship when he functions as a part of a unit in combat. Although the second factor presents difficulties of assessment during training, the first and the third, as well defined parts of the Basic Rifle Marksmanship (BRM) program, do not. The BRM program, however, appears to emphasize the "hit" as the sole measure of combat effectiveness.

Training Criteria. The training criteria are discussed in terms of measures of performance (MOP), individual training standards, and collective training standards.

Measures of Performance. Performance may be thought of as the execution of an action. Thus, relative to the M16A1, the rifleman's (or rifle squad's) performance would be the execution of those actions necessary to

the accomplishment of the tasks involved in the efficient employment of the rifle; and relative to the accomplishment of each task the MOP would be an answer such as yes or no, go or no-go, satisfactory or unsatisfactory to a question of the type, "Was the task accomplished at least at the level of the prescribed standard?"

In fact, however, the only MOP for the rifleman given in FM 23-9 (DoA, 1974) is the set of rifle marksmanship ratings and associated qualification scores, which can be achieved during "Record Fire":

Expert.	.75 - 100
Sharpshooter. . .	.66 - 74
Marksman.	.54 - 65
Unqualified . . .	.53 and below.

Record Fire qualification scores are on a 100 point scale. A maximum of 70 points may be achieved for daylight aimed fire; and maximums of 10 and 20 points may be achieved for daylight quick fire and night fire, respectively. To qualify, a soldier must complete the three parts of record firing and achieve a combined minimum score of 54 points (ASubjScd 23-72, DoA, 1974).

Daylight firing is accomplished in two parts. In the first part the soldier is presented both single and multiple targets. He is allowed five seconds in which to engage a single target in the range 50 to 200 meters; ten seconds for a single target more than 200 meters away. He is allowed ten seconds to engage double targets if each is less than 200 meters distant, or fifteen seconds if at least one is more than 200 meters distant. He is allowed twenty seconds when he is confronted with triple target exposures.

The second part of daylight firing is a repetition of the first part, with the addition of a requirement to employ quick fire techniques (within three seconds) against two targets exposed simultaneously at 25 meters.

Night firing also is accomplished in two parts. In the first part the soldier is presented ten targets at a distance of 25 meters, one target at a time exposed for twenty seconds, at which he fires three-round bursts using the rifle in the automatic mode. The second part of night firing is an exact

repetition of the first part, except that the ten targets are presented at a distance of 50 meters.

Individual Training Standards. The Soldier's Manual (FM 7-11B Series) is the most comprehensive training literature source for the individual rifleman. The Soldier's Manual (SM) replaces the Military Occupational Specialty (MOS) Army Subject Schedules (ASubjScds). Each soldier receives a personal copy of the SM which he is required to retain and maintain. The SM describes what the rifleman is required to do to perform his combat role. The SM includes a training and evaluation outline to facilitate the planning and conduct of training for the rifleman. The outline includes statements of training objectives in terms of tasks, conditions, and standards. The standards specify how well the rifleman must be able to perform his tasks.

FM 7-11B1 (DoA, 1976) describes nine tasks and associated standards for the soldier relative to the M16A1. For example, to maintain the rifle, magazine, and ammunition the soldier is allowed fifty (50) minutes to:

- Inspect weapon and magazine for proper functioning of all parts,
- Disassemble weapon and magazine,
- Clean weapon and magazine free of dirt, grease or carbon which will impair the operation,
- Reassemble weapon and magazine,
- Inspect and clean ammunition with dry cloth,
- Turn in dented rounds to supervisor.

As another example, given a M16A1 rifle with a mounted and zeroed AN/PVS-2 (night vision device), one magazine with 18 rounds of 5.56mm ammunition, during the hours of darkness on a M16 rifle range with three E-type silhouettes, one each at ranges of 50-100, 150, and 200-250 meters, the soldier is allowed 2 minutes to fire all 18 rounds and hit the targets a minimum of 9 times (two hits must be on each of the targets at ranges other than 150 meters).

Trained to criterion referenced standards such as the above the soldier should be ready for the Skills Qualification Test (SQT), since the SQT is based on the SM. The SQT is performance oriented and measures the same critical tasks described in the SM. The SQT is replacing the MOS test as the formal evaluation of the soldier.

Collective Training Standards. Similar to the SM for the individual, the Army Training and Evaluation Program (ARTEP) provides unit commanders and training officers (S3s in battalions) with descriptions of tasks their units are required to perform, statements of the conditions under which they are to be performed, and a list of standards which are to be met in the performance of the tasks. With ARTEP a unit may conduct sequential or concurrent training. ARTEP 7-15 (DoA, 1975) for Light Infantry Battalions replaces the unit Army Training Program/Army Training Test (ATP/ATT). ARTEP 7-15 includes Training and Evaluation outlines as guidance for the training of all elements of a light infantry battalion from the squad through the battalion echelon. For example, for a rifle squad one task involves the conduct of a forced march over a 6-km marked route and the conduct of a live fire exercise at a live fire site at the end of the march. The squad is required to complete the march in one hour or less with all personnel, weapons, equipment, and ammunition; to select the best available natural covered and concealed positions and prepare to defend within ten minutes after the platoon leader's fragmentary order; and when engaging remote controlled pop-up targets, to hit 80 percent of the targets in zone I, 70 percent in zone II, and 60 percent in zone III; or when engaging standard E and F silhouette targets, to hit 90 percent of the targets in zone I, 80 percent in zone II, and 70 percent in zone III.

Although the critical tasks to which the training standards apply have been soldier-validated, the extent to which the standards are combat referenced has been assessed only subjectively.

Training Content. According to FM 23-9 (DoA, 1974), the objective of the United States Army rifle marksmanship program are to:

- Develop in every soldier (during training) the confidence, will, knowledge, and skills required to fire a rifle and hit the enemy in combat, and the ability to apply correct techniques of rifle marksmanship when functioning as an individual in a unit engaged in combat;
- Insure that every soldier maintains a continuing degree of proficiency in combat rifle firing consistent with the mission of the unit to which he is assigned;

- o Provide in time of peace a large number of shooters from which potential precision marksmen can be selected and further trained to successfully compete in interservice, civilian, and international competition;
- o Provide in time of war an instructor base or cadre for sniper training, if it is required;
- o Insure that every soldier can properly maintain his weapon.

Training programs to achieve these objectives have been developed for the individual soldier and for organizational units.

Individual Training. The Basic Rifle Marksmanship (BRM) program, outlined in Table 1, is taught during Basic Combat Training (BCT) to all trainees (ASubjScd 23-72, DoA, 1974).¹ It forms the core of Army marksmanship training. It's overall goal, as stated in ASubjScd 23-72, is "to instill, develop, and maintain in the trainee the confidence and ability to detect and successfully engage, either as an individual or as a member of a unit, enemy targets within the range and capabilities of his weapon under combat conditions" (p. 2). This goal is consistent with the objectives given above.

For Infantry MOSs the BRM program provides for 84 hours of instruction and requires approximately 1,050 rounds of ammunition per trainee, for other MOSs it provides for 72 hours of instruction and requires slightly in excess of 750 rounds of ammunition per trainee. The program is divided into 24 time periods - three of 2 hours, six of 3 hours, twelve of 4 hours, and two of 6 hours duration. Only the first period (4 hours) does not involve the expenditure of ammunition. Periods 18, 19, 20 (a total of 12 hours) involve automatic rifle practice and qualification firing during Advanced Individual Training (AIT) with the expenditure of approximately 300 rounds of ammunition per trainee.

¹ Modified BRM programs were recently implemented at Fort Dix, New Jersey, Fort Jackson, South Carolina, and Fort Benning, Georgia. During 1977 these programs and a modified version of ASubjScd 23-72 (1974) were tested at Fort Jackson, South Carolina. Based on preliminary results the USAIS has recommended the adoption and use of the Fort Benning modified BRM program.

Table 1

BASIC RIFLE MARKSMANSHIP TRAINING PROGRAM

<u>Period</u>	<u>Hours</u>	<u>Range</u>	<u>Major Training Objectives</u>	<u>Rounds of Ammo</u>
1	4	Classroom	Orientation & Mechanical Training	0
2	3	25 meters	Introduction, Aiming, Steady Hold, Immediate Action, Prone Supported Firing	9
3	4	25 meters	Review of Period 2, Sight Aiming Adjustments, Prone Supported Firing	18
4	4	25 meters	Review Periods 2 & 3 Foxhole & Prone Firing	27
5	4	25 meters	Review Periods 2-4 Additional Firing Positions, Rapid Assumption of Firing Positions	27
6	6	25 meters	Review Periods 2-5 Progress Check, Battle Sight Zeroing	42
7	4	Field Fire/ 25 meters	Target Engagement, Review Immediate Action, Firing from Foxhole & Prone Position, (25 meter Corrective/Makeup Firing)	36
8	4	Field Fire/ 25 meters	Firing on Surprise Targets from Kneeling/Standing Positions, Target Detection (25 meters)	36
9	4	Field Fire/ 25 meters	Review of Aiming and Target Engagement, Techniques, Target Detection (25 meters)	36
10	4	Field Fire	Moving with a Loaded Weapon, Engage Multiple & Single Targets, Rapid Reloading	35

(continued)

Table 1 (concluded)

<u>Periods</u>	<u>Hours</u>	<u>Range</u>	<u>Major Training Objectives</u>	<u>Rounds of Ammo</u>
11	4	Field Fire/ 25 meters	Battle Sight Zero Conformation, Rapid Magazine Changing	42
12	4	Record Fire	Detecting/Engaging Single & Multiple Stationary Targets	40
13	2	Quick Fire	Principles/Methods of Engagement of Targets at 15/30 meters	40
14	4	Field Fire	Same as Period 11	48
15	4	Record Fire II	Period 12 Plus Quick Fire Engagement	40
16	2	25 meters	Fundamentals of Automatic Rifle (AR) Firing	36
17	3	AR Range	AR Marksmanship, Rapid Magazine Changing, Area Engagement & Fire Distribution	96
*18	3	AR Range	Practice I	96
*19	3	AR Range	Practice II	96
*20	6	AR Range	AR Qualification Firing and Maintenance Exam	96
21	3	Night Fire	Introduction to Principles of Night Firing	24 ball 8 tracer
22	2	Night Fire	Daytime Practical Exercise of Night Firing Techniques	64 ball 2 tracer
23	3	Night Fire	Review of Period 22 Plus Night Record Firing	68 ball 4 tracer

*Periods 18, 19, and 20 (Automatic Rifle Practice and Qualification Firing) are not fired during normal BCT; they are only fired during Infantry AIT.

Local option variations to this program are extant. Also, there are under study three programs of different length, one providing for as few as 35 hours.

Individual Training in Units. Active Army Units conduct individual marksmanship training in accordance with FM 23-9 (DoA, 1974), FM 23-71 (DoA, 1966), and AR 350-4 (DoA, 1976). The last requires individual qualification/familiarization training at a frequency determined by the unit commander. Table 2 shows the Standard Proficiency Courses A1 and A2 currently in use with Active Army units. The A1 course is for personnel having less than 10 years active service, and course A2 is for personnel having more than 10 years active service.

It is important to note that range facilities vary among Army installations, and that options are exercised to vary program implementation. As an example of the latter, units frequently forego prescribed field firing and move directly from battle sight zero to qualification in order to conserve ammunition and time.

Reserve Component (RC) units conduct biannual qualification and familiarization training under the same provisions cited above for Active Army units. A RC unit may see one of three Premobilization Readiness Proficiency "C" courses: (1) The standard course is conducted on either a 25-meter range or a 1,000-inch range; (2) An alternate course is designed for RC units which do not have access to, or sufficient area for constructing, standard 25-meter ranges. A 25-meter range must be specially constructed so each firing lane is inclosed. In this way ricochets cannot escape the immediate range area, thus eliminating the need for a large impact area; (3) A modified course is employed so that all firing is conducted from the 200-yard (184-meter) firing line of a known distance range. A Standard Course "C" is outlined in Table 3. The Premobilization Readiness Proficiency "C" Courses used by most RC units have remained unchanged since their inception in 1961.

Training Extension Course (TEC) lessons are available for use in both Active Army and Reserve Component units. TEC is a system of self-paced instruction that can be used by an individual or by small groups to train

Table 2*

STANDARD MARKSMANSHIP PROFICIENCY COURSE A1
(For Personnel Having Less Than 10 yrs Service)

<u>Period</u>	<u>Hours</u>	<u>Range</u>	<u>Rounds of Ammo</u>
1	1	Orientation	
2	1	Mechanical Tng	
3	4	25 meter	36
4	4	25 meter	48
5	6	25 meter/zero	36
6	4	Field Fire	56
7	4	Field Fire	56
8	4	Record Fire	40
9	2	Night Fire	32
TOTALS			
	30		304
	6	Target Detection	
	36 hrs		

STANDARD MARKSMANSHIP PROFICIENCY COURSE A2
(For Personnel With More Than 10 years Active Service)

<u>Period</u>	<u>Hours</u>	<u>Range</u>	<u>Rounds of Ammo</u>
1	4	25 meters/zero	42
2	4	Field Fire	56
3	4	Target Detection	
4	4	Record Fire I	56
		Record Fire II	40

*(USACATB, 1975).

(continued)

Table 2.(concluded)

<u>Period</u>	<u>Hours</u>	<u>Range</u>	<u>Rounds of Ammo</u>
5	2	Night Fire	32
TOTALS	18	With Record Fire I	186
		With Record Fire II	170

NOTE: In Period 4 (Record Fire) either Record Fire I or Record Fire II may be fired at the determination of the Commander.

NOTE: There are, in addition to Standard Courses "A1" and "A2", Modified "A1", "A2", "A3", and "A4" Courses, a Proficiency Course "B" which is for Active Army units with access to 25 meter and known distance ranges without the combat positions, and 2 Emergency Proficiency Courses which meet minimum marksmanship standards.

Table 3
STANDARD COURSE "C"

<u>Hours</u>	<u>Training</u>	<u>Rounds of Ammo</u>
1	Mechanical	0
3	Marksmanship Fundamentals	0
4	25 meter/zero	51
4	Record Fire	51
4	Target Detection	0
16		102

to desired standards. TEC materials are audiovisual (used with a Beseler Cue/See), audio only, or programmed written text. The lessons may be used as supplements to conventional training or, in some areas of training, as replacements. The lessons include tests that provide diagnostic information and assessment of trainee proficiency.

Collective Training in Units. The primary basis for collective training in units is the ARTEP (Army Training and Evaluation Program). ARTEP 7-15(DoA, 1975) for Light Infantry Battalions and ARTEP 7-45 (DoA, 1975) for Mechanized Infantry Battalion and Combined Arms Task Force describes critical unit mission and mission-essential tasks for all echelons from squad through battalion. The ARTEPs include training and evaluation outlines to be used as guides by commanders and trainers in developing training programs.

Two outlines in each ARTEP pertain specifically to the rifle platoon. One outline concerns the movement to contact/meeting engagement mission. The platoon is required to move to gain contact with the enemy (who is preparing to defend), to locate and make contact with the enemy, to eliminate enemy resistance, and to reorganize and prepare to assume a new mission upon receipt of orders. The other outline concerns the defense mission. The platoon is required to prepare a defensive position against the enemy (who is preparing to conduct an attack with motorized infantry and armor forces, supported by tactical air, mortar, and artillery fires).

Three outlines in each ARTEP pertain specifically to the rifle squad. The first concerns the movement to contact/meeting engagement mission. The squad is required to move to gain contact with the enemy (sniper teams left behind by a withdrawing enemy unit to harass those seeking to locate and fix the main enemy force), to locate and report the enemy, to eliminate enemy resistance, and to reorganize and prepare to continue the mission. The second concerns a reconnaissance patrol mission. The squad must conduct a night reconnaissance patrol over a distance of at least 2km to a specified location to obtain information about the enemy (e.g., size, disposition, weapons, activity, and equipment). The third concerns a forced march/live fire exercise. The exercise is conducted in two parts: (1) In daylight, dismounted squad personnel (carrying specified weapons, equipment, and ammunition) conduct a 6km march along a designated route to arrive at an

area/range suitable for a live fire exercise; and (2) still in daylight, the squad's platoon leader gives the squad leader an oral fragmentary order which requires the squad to tactically occupy (within 10 minutes) a hasty defensive position and to take under fire an attacking enemy force consisting of 20 to 30 dismounted infantry and 2 tanks (simulated by personnel and armor targets).

Clearly, the above described training is performance oriented and combat referenced. It provides the rifleman a very necessary supplement to his individual rifle marksmanship training.

In addition to the ARTEP, the units continue to employ tactical drills, tactical exercises, and field training exercises.

Training Devices. With a shortage of major training areas, inadequate ranges, and the rising cost of ammunition the need for training devices to assist trainees to gain proficiency in critical tasks is recognized. For M16A1 rifle marksmanship training there are three newly developed devices undergoing operational/developmental tests by the United States Army Infantry Board (USAIB) in conjunction with the United States Army Infantry School (USAIS). They are the 0.22 caliber Rimfire Adapter (RFA), the Lasertrain system, and the Weaponeer system.

Rimfire Adapter. The RFA is a replacement for the bolt carrier assembly of the M16A1 rifle. It is designed to permit the rifle to fire caliber 0.22 long rifle ball ammunition through the barrel of the M16A1 rifle. The RFA kit includes the adapter itself and two magazines. If a satisfactory level of training transfer can be determined and established, the adoption of the RFA for the Active Army and Reserve Components has the potential of effecting significant training cost savings from the difference in the costs of 5.56mm and 0.22 caliber ammunition.

Weaponeer. The Weaponeer is a rifle fire simulator. It consists of a target display, firing station, control console, and an unserviceable M16A1 rifle with barrel bored to prevent restoration and a specifically designed nonmilitary bolt (which altogether resemble a sophisticated pinball machine). It requires a space approximately 18 feet long and 6 feet wide. It operates on 115 volts AC, 60 Hertz.

The target display consists of one 25-meter zeroing target and two F-type silhouettes. The F-type silhouettes are scaled to represent how they would appear if viewed from 85 meters and the 25-meter zeroing target is scaled to represent how it would appear from 25 meters. The system does not provide moving target simulation. All targets are located 100 inches from the front sight of the rifle and may be raised or lowered from the control console.

The firing station consists of the unserviceable M16A1 rifle with recoil, and earphones providing sound simulation. The sound of a round being fired is transmitted through the earphones below the minimum level that might cause ear damage. The recoil and sound levels may be varied. Two different types of magazines are provided. One permits the rifle to fire indefinitely. The other contains 0 to 30 rounds. Firing can be done from any of the standard firing positions.

The control console is connected to the target display and firing station. It contains all the controls necessary to operate the system and raise and lower the targets. It also contains a cathode ray tube (CRT) display that shows the exposed target and locations of the cumulated simulated bullet impacts. The display automatically shows the location of previous bullet impacts when the rifle is pointed outside the target area and provides a continuous trace of where the rifle is pointed when the rifle is aimed at the target. A printer is a part of the console. Upon command, it furnishes a replica printout of the CRT display, including the target and up to 31 bullet impacts. As a final feature, the console includes an instructor's override that when activated allows all range activity to continue except that the weapon will not fire when the trigger is pulled; this simulates a malfunction and requires the firer to apply immediate action.

Lasertrain. The Lasertrain system, like the Weaponeer, is a rifle fire simulator. Unlike the Weaponeer, however, the Lasertrain does not simulate recoil.

Lasertrain consists of three parts: a gallium-arsenide laser transmitter mounted on a replica M16A1 rifle; a target console that comprises the

target screen, an imaging sensor, a television camera, and background lighting; a scoring console that comprises a scoring module and a display console.

The target console is set up 10 meters from the firing position. It is connected to the scoring console by an electrical cable. Three different types of targets are provided: a 25 meter zeroing target; a F-type silhouette scaled to represent how a regular F-type silhouette would appear if viewed from 50 meters distance; and five E-type silhouettes scaled to represent how five regular E-type silhouettes would appear one each from distances of 100, 150, 200, 250, and 300 meters.

The rifle part of the system can be operated in either the semi-automatic or full-automatic mode. The laser transmitter is activated via an electrical connection to the trigger mechanism. A laser pulse is produced each time the trigger is pulled. (In the full-automatic mode pulses are produced continuously, to the limit of the clip, as long as the trigger is depressed.) The target imaging optics detect laser impacts on the target screen. Each laser impact appears on the display console, and continues on display until it is succeeded by the next impact. At each impact the display console puts forth sound to simulate rifle fire. At the same time the scoring module records the impact. Up to eight successive impacts can be recorded before the module must be reset. At any time prior to resetting, all impact locations on the target screen can be viewed sequentially or simultaneously on the display screen.

The Lasertrain system can be used in a diagnostic mode which allows the instructor to follow the rifle user's sighting path on the target console.

Trainee Selection. As stated in a foregoing section the BRM program is taught during BCT to all trainees. How, then are riflemen selected?

The rifleman selection process is a natural one that works in reverse. To a large extent the rifleman is what's left after every other speciality slot has been filled. It has been true in Infantry units that after the company commanders and platoon leaders had selected their clerks and crew-served weapons personnel all others were given rifles, irrespective of their specific skills; and in non-Infantry units that individuals to carry rifles

were designated by position rather than by skill, mainly as a matter of providing for self-defense.

It is ultimately true that the company commander and the platoon leader are driven by the mechanics of the Enlisted Personnel Management System (EPMS) in selecting/assigning individuals. Thus, the company does not play a part in the rifleman selection process. For the most part it merely funnels its assigned replacements, individuals who already possess the 11B (rifleman) MOS. Such replacements, based on results of their Army Classification Battery and other initial selection tests and on information from personal interviews, are recommended for the MOS, and are then provided BRM and other appropriate training during BCT and AIT, respectively. Presumably, the Classification Inventory (CI), the General Information Test (GIT), and other tests are designed to identify an individual's aptitudes and to classify him accordingly. In reality, however, the "needs of the Army" in the form of quotas is a major determinant of an individual's assignment of an MOS and to a unit.

In general, then, the opinion that "anyone can carry and fire a rifle" prevails. At this time there exists no formal procedure for identifying an individual's particular rifle marksmanship skills and selecting him for training on that basis.

Summary. All the preceding serves as an introduction to the M16A1 Rifle System - a general description in terms of the hardware, demands on the operator, threat, measures of effectiveness, and training. The following presents a review of select literature relative to the same topics.

RESEARCH FINDINGS

Threat. It is generally accepted that training for combat should equate to training to defeat a threat. It is necessary, therefore, to identify those characteristics of threat forces which impact on the development of training for the use of the M16A1 rifle by the U. S. Army rifleman on the modern battlefield. The principal characteristics are personnel, equipment, and tactics. Although variables such as force ratios, weather, and geography are important, the large number of different situations based on them in combination with the principal characteristics is not properly the subject of

this review. The review, therefore, presents broad views of the threat force characteristics, and leaves the many specific threat situations to studies centrally concerned with training criteria.

According to Jehan (1976), the true threat element for the rifleman is the weapon system of the opposing force; and the individual soldier manning the weapon system is the rifle defeatable threat. In this vein, it is anticipated that the forces most likely to be encountered by the U. S. Army Infantry would be threat infantry (afoot or mounted in armored personnel carriers) or threat tank forces. Clearly, the former represents the less formidable and more inviting defeatable threat. These threat infantry are typically armed with the AKM assault rifle (in some instances with the older AK-47 model) which has an effective range of 470 meters and practical effective ranges of 200 meters in the automatic mode and 300 meters in the semi-automatic mode (Kornfield, 1976). Some threat infantry are equipped with a general purpose light machine gun (the PKM 7.62mm) which has an effective range of 1,000 meters (Gunsten, 1976). The implications for training are straightforward.

U. S. Army threat doctrine is replete with general training guidance for the infantryman, especially relative to tactics. For example, the doctrine holds that U. S. forces should be prepared for highly mobile offensive attacks and expect 24-hour battle days. The typical attack would involve an armored mass force prepared to accept losses as high as 60-70 percent (Daignault, 1975). The 24-hour battle day is possible since most threat forces have vehicles and weapons which are equipped with night vision devices. The following list is a synthesis of salient training implications in U. S. Army doctrine and the available review literature.

1. Infantrymen employing the M16A1 rifle should be able to effectively engage both single and multiple personnel and armored targets (as appropriate) as they are moving toward a given defensive position. Target areas composed of many (8 or more) personnel and vehicular targets should be engaged at some time during training.

2. Infantrymen employing the M16A1 rifle should be able to move rapidly from one defensive position to another, so that not only forward moving targets can be engaged but also targets moving from the flanks and to the rear.

3. Since threat targets will be moving quickly on the modern battlefield, it is appropriate for the infantryman to minimize the amount of time spent in the engagement of any particular threat target.

4. Since multiple threat targets will be available on the modern battlefield, first round hits should be placed so that the probability of a kill is assured. Because the ground mobility of threat forces is high, first round hits and kills are important since the infantryman may not have a second chance at such targets before they either fire on him or move to a position that masks them from his fire.

5. With the possibility that nuclear weapons might be employed on the modern battlefield, the infantryman must be able to effectively engage threat targets while wearing CBR (chemical, biological, and radiological) protective equipment.

6. Because threat forces are capable of maintaining a 24-hour battle day, the infantryman must be able to effectively engage threat targets at all levels of illumination. This means that he must be able to effectively employ his M16A1 rifle during daylight and twilight hours and at night, using whatever night vision devices are appropriate.

In addition to the few studies that concern the nature and the effects of the threat there are studies that examine training methods that might be useful in preparing for given threat situations. Hackett, Overby, Moreman, Klein, and Boren (1966) conducted a feasibility study of an instrumented small arms test facility. Although the primary purpose of the study was to test various weapons under combat conditions, such a facility would be useful for establishing combat criteria for the M16A1 rifle that would effectively represent requirements for withstanding/overcoming threat forces. HumRRO (1970) developed a training program for the detection and engagement of single and multiple stationary and moving targets under varying field conditions. USACDEC (1975) reports data collected on dispersion levels and suppression. The suppression data include a section on the ability of individuals to estimate the location of rounds fired overhead. Hall (1975) has investigated the use of moving man target systems in tests of rifle systems. A new approach to threat oriented rifle marksmanship training has been investigated by Jehan (1976). This approach first prescribes a meaningful threat in relation to a required training performance standard under given

conditions. A model is constructed in the form of a performance test and results compared to performance of personnel trained under established programs. Revisions of training programs follow until no significant differences are observed in test performance measures.

Measures of Effectiveness. MOE are generally useful in ascertaining whether operational system criteria have been met. They may also be used to assess both individual and team or crew performance with respect to specific criterion standards. Further, MOE are necessary for measuring training effectiveness. Thus, in studies by Siegel (1972), Osborn (1973), and Semple (1974), guidelines for employing MOE to evaluate training effectiveness were developed and implemented. In a report by Dieterly (1973), a model for assessing training effectiveness with emphasis on the use of criterion measurement was presented. Klein (1971), established a set of MOEs for the evaluation of competing weapon systems. One finding of this experiment was that repeated trials by the same riflemen improved their target acquisition performance, but were not necessarily correlated to improved system accuracy. It should be recognized, therefore, that models and strategems for predicting soldier performance in specific task situations are not always successful (Dees, 1970). Thus, the researcher planning to employ such techniques for the prediction of training effectiveness should be forewarned.

Although a revised, interim Basic Rifle Marksmanship (BRM) course has recently been introduced to the field by the Infantry School there remains doubt as to its utility in predicting soldier proficiency with the M16A1 rifle. Full implementation of this program is yet to be achieved, however, substantial dollar and training hour savings are predicted (USAIS, 1977).

Training Criteria. Once MOE have been identified they can effectively be used to establish training criteria. It then becomes essential to insure that criteria are adaptive to criterion-referenced testing, and are combat-referenced as well. The latter requirement should insure a positive level of skill transfer from the training environment to the combat situation. For a detailed discussion of guidelines for criterion-referenced testing, see Popham and Husek (1969) and Swezey and Pearlstein (1975). Further, in order to insure optimum criterion-referenced training, some measures of performance

must be devised in order to validate the established criteria. Hambleton and Norvick (1973) suggests a decision-theoretic approach to this problem.

There is confirming evidence which supports the assertion that current M16A1 training criteria are only marginally linked with combat-referenced criteria. Dees, Magner, and McCluskey (1971) found that present M16A1 criteria were extrapolated from studies using the M1 and M14 weapon systems. Critical MOP associated with the successful performance of individuals and units in combat are discussed by Kelly, Jacobs, and Taylor (1968). Current M16A1 performance measures are singularly associated with hit probabilities, or more appropriately expressed, as the capability of an individual rifleman to hit and "kill" a target. This measure is, with little doubt, combat referenced. However, Shirom (1976) clearly explains the difficulty in measuring the combat performance of individuals. Though individual training with the M16A1 appears to be of central importance in all combat-referenced basic rifle marksmanship training, some evidence exists to support the claim that "collective", or team training is beneficial, especially as it supports the theory of team interaction. Moreover, the team interaction thesis suggests a spill-over of benefits to the tactical fire-team approach to marksmanship training (Adams and Hayward, 1975; Hall and Rizzo, 1975).

A combat environment suggests a situation which is uncontrolled, or, at best, with little control over individual performance. Training environments in use today represent the opposite extreme. Any studies, therefore, which recognize and account for the control factor are particularly useful (Kern, 1966; Lunsford, 1972).

From the paucity of available data, it seems little has been accomplished in attempts to develop and validate combat-referenced criteria for the M16A1. What criteria are used appear to have been carried over from earlier systems such as the M1 and M14, and have not been up-dated to account for the massive use of the M16A1 during the Vietnam conflict. This void is critical and must be filled, particularly in light of the anticipated future dependence upon training devices for use in the rifle marksmanship training programs.

Training Content and Methods. The content of training programs and the methodology used to teach these programs should be directly supportive of the criteria selected as a foundation for the establishment of training

performance levels. Comprehensive reviews of this assertion are found in Montemerlo and Tennyson (1976), and Crawford and Eckstrand (1976). In identifying the critical tasks and skills needed to be taught in a weapons system training program, Arima (1969), establishes a method for using human factors analysis to evaluate the operational effectiveness of a weapon system. Root and Word (1970) emphasized task analysis in order to better understand human performance capabilities in accomplishment of Army job requirements. USATRADOC (1975) presents an analysis of the skills required to become proficient as a rifle marksman appears to be a prerequisite in determining adequate or sufficient content in M16A1 training programs. Such an analysis was performed by the U. S. Army Human Engineering Laboratory (USAHEL) in 1976. This study presents an in-depth analysis of the typical functions performed by a typical soldier while transporting, employing and maintaining the M16A1 weapon system. The results of this study could provide the basis of a content valid training program (USAHEL, 1976). Several studies have addressed the requirement for context/combat training for M16A1 infantry rifle squad leader in order to maintain an effective unit in combat. In a study by Dees, Magner, and McCluskey (1971), Army rifle marksmanship was analyzed to discover what should be taught and how it should be taught in order to be optimally effective. The need for combat-referenced (context/combat training) is further emphasized by Olmstead (1968), in his assertion that more self-confidence was expressed by trainees who were exposed to a BRM course which included rapid-fire (Quick-Kill) exercises than those who were not exposed to this type of training.

In a study by Jacobs, Salter, and Christie (1974) the impact of the physical environment on small arms training was assessed. Essentially, the study covered the effects of the environment (arctic, desert, and jungle) on small arms system performance. The analysis included weapon conditions of anticipated use and threat.

Training, if it is to be effective, is directly related to the quality of the teaching methodology employed. One approach is to require standardized

quality control for instructors (Melching and Whitmore, 1973; Melching and Larson, 1975). A selection of differing media presentations may also prove beneficial because the use of devices which combine audio and visual capabilities are thought to enhance motivation and produce a more stimulative learning environment (Spangenberg, 1971). Charles and Johnson (1972), suggest that with the increase in the sophistication of weapon systems, the use of automated, computerized instructional methods may present the potential for significant dollar and training time savings.

Training Devices. Multiple training devices are under development for the M16A1 marksmanship program. These devices are undergoing final development and operational testing (DT/OT) prior to deployment to the field.

The .22 caliber rimfire adapter (RFA) is a device which modifies standard M16A1 weapon systems in order to fire a cheaper ammunition. The drawback to the device is that the effective range is limited to 25 meters (USACATB, 1975). According to Oliver and Venti (1975) and Maule (1975), the RFA can be used as an effective training device with no significant differences between it and the actual M16A1 system. A complete TEA remains to be conducted in order to evaluate the RFA in relation to other available training devices.

LASERTRAIN is a more sophisticated device than the RFA and has the improved capability to diagnose the trainee's aiming pattern prior to firing the round. The system is compact and provides an absolute safe operational environment for the individual rifleman. LASERTRAIN permits complete freedom of movement and allows for the display of all hit locations, either individually or grouped. The device uses a replica of an M16A1 rifle (ILS, 1976).

The WEAPONEER is a highly sophisticated system which is considered to provide a high potential for self paced training and training transfer value. This device is uniquely electronic in that it can be operated in all firing positions while providing the sound and recoil simulations comparable to the operational system. It is diagnostic, and permits visual readout of aim as well as the number and placement of multiple shots (Spartanics, 1976).

Still under development is the Multiple Integrated Laser Engagement System (MILES). This device will permit a means of improving and evaluating individual and unit proficiency against a simulated infantry combat threat (Ball, Note 4).

Thus, for the M16A1, a need for more cost effective training has been recognized and simulation devices are being developed. Trade-offs, evaluations and comprehensive TEAs are still required for the operational systems and training devices.

Trainee Selection. There does not now exist a standardized trainee selection model for the M16A1 weapon system. This fact does not appear to represent a real-life problem for the Army in that all personnel are expected to meet qualification standards on the M16A1 rifle. However, it may prove cost-effective to establish a selection process which would discriminate between maximum effective (meeting all necessary combat referenced criteria) and minimal effective (a standard which meets less than all combat referenced criteria). The latter could be applied to such categories as female personnel or medics.

Fox, Taylor, and Caylor (1969) recommended a method which used aptitude level as a guide for implementing differential training. Sands (1971) suggests a model for optimal selection strategy for decisions which assist in minimizing the cost of selection. Regarding combat referenced criteria, a selection process differentiating between reaction to stressful situations would appear useful. Such an attempt was made by Boyles (1969) who developed measures of reaction to physical harm and the ability to cope with it. Olmstead, Caviness, Powers, Maxey, and Cleary (1972) validated selection tests that were successful in predicting the training effectiveness of small, independent combat forces.

Because there have been no detailed threat or task analyses, only a few studies have attempted to address selection processes for the M16A1 system. Caylor (1969) collected data which predicted the in-service success of Army recruits. Such a predictive process would be useful for manpower policy decisions in establishing selection prerequisites.

SUMMARY

Major Training Problems. There are several limitations in the current M16A1 BRM program which pose considerable doubt upon the satisfactory combat performance capability of the M16A1 rifleman. Studies conducted on the M16A1 weapon system clearly underscore the need for:

in ASbjScd 23-72 (DoA, 1974). This effort also contributed to the data base designed to aid in the development of a threat-oriented rifle marksmanship program. Four BRM programs, differing in scope (hours and rounds), were compared considering numerous demographic variables as a basis for analysis. Additional studies of this type are required, particularly those which examine the dynamic combat environment and the need for weapon system modification (FMC, 1975).

Needs such as those asserted by Jehan (1976) seem realistic and could contribute to an improved M16A1 BRM program. Jehan's recommendations include requirements for improved methods of target acquisition, engagement, suppression and hitting of tactically realistic targets. In the area of acquisition a test for identifying and acquiring threat targets remains to be defined and developed. Engagement requirements include the need to counter situations such as:

1. Threat force moving, friendly force stationary.
2. Threat force stationary, friendly force moving.
3. Both forces moving.

Future programs should train the rifleman to hit targets under multiple, changing conditions. These conditions should include targets:

1. Identified by sound.
2. Identified by muzzle flash.
3. Silhouetted against the sky.
4. Silhouetted against the moon.
5. Illuminated by the moon.
6. Illuminated by fire.
7. Illuminated by flare.

Finally, ranges need to be constructed and maintained which permit the individual to improve his proficiency with the operational equipment. Total reliance upon training devices should not be considered. Ranges should provide for:

- moving targets,
- identification of friendly versus threat targets,
- armor engagement,
- combat in cities marksmanship,

- a detailed task analysis of the individual M16A1 rifleman,
- development of a comprehensive "micro-level" threat analysis for the individual rifleman and the rifle squad,
- establishment of validated, combat-referenced/threat referenced criteria for the M16A1 rifle system,
- realistic standards and conditions based upon new, combat-referenced criteria,
- fielding of cost-effective training simulation devices which offer positive gains in the area of training transfer,
- development of a systematically integrated rifle marksmanship program which accommodates not only requirements for the M16A1 BRM program but also incorporates post-BRM individual, squad, unit and "special" marksmanship needs.

At present, limited quantifiable data are available to form a baseline source to develop a totally integrated M16A1 training program. It is assumed that present programs are costly and somewhat inefficient in the use of available training time. This assumption appears valid in that no detailed threat analysis has been conducted and no combat-referenced criteria have been established. The increased cost of rounds and weapon system complexity force abandonment of the old approach of providing the trainee with a sufficient number of rounds until he "learned" to hit the target. Additionally, qualifying as an expert gunner with the capability of hitting a pop-up target at a given range is not equivalent to the situation where a squad of riflemen defend against a threat assault of individuals who are firing back.

The interim M16A1 BRM program recently implemented by the Infantry School at Fort Benning is an attempt to solve some of the more immediate needs in the rifle marksmanship program. It does not go far enough. The new program does reduce costs and training time. However, other problem areas remain unsolved (USAIS, 1977). It is recognized that this program is interim in nature, pending the development of a family of threat-oriented programs for all MOSs and training environments.

Major Research Findings and Needs. One attempt to identify future training requirements was the BRM study (Ball, Note 4). This study compared proposed BRM programs and program modifications to the current BRM program as prescribed

- battlefield simulation of returned fire by threat forces,
- realistic threat targets to replace the standard silhouette series,
- multiple target engagements.

TOW HEAVY ANTITANK WEAPON SYSTEM

DESCRIPTION OF SYSTEM

Hardware. The TOW (tube-launched, optically-tracked, wire-command link guided missile) weapon system is a crew portable and vehicle mounted, heavy antitank weapon. It consists of six major components: tripod, traversing unit, launch tube, optical sight, missile guidance set, and battery assembly. The effective range is 65-3000 meters. The tactical missiles are fitted with high explosive antitank (HEAT) warheads. Vehicle mounting kits are supplied for attachment of the TOW to selected vehicles. All kits are designed for rapid dismount of the weapon for ground deployment.

The tripod weighs 21 pounds; the traversing unit 54 pounds; the launch tube 13 pounds; the optical sight 32 pounds; the missile guidance set 29 pounds; and the battery assembly 24 pounds. The encased missile weighs 54 pounds. A more complete description of the TOW weapon system, its assembly functioning and operating procedures may be found in TC 23-23 (DoA, 1974).

Hardware Demands on Operator. The TOW weapon system is designed to be operated by a four man crew: a squad leader, a gunner, an assistant gunner, and a vehicle driver. Squad members are assigned the following duties:

- The squad leader is in command of the squad and is responsible for its equipment. He observes, controls, and supervises the conduct of fire of the TOW weapon system. He employs the squad according to orders of the platoon leader and is responsible for selection of positions and for properly concealing the weapon. He keeps the platoon leader informed of the status of the ammunition supply and supervises his squad's ammunition resupply. When the TOW is hand carried, he carries the tripod and the optical sight.
- The gunner is responsible for acquiring, smoothly tracking, and firing upon designated targets. He performs system self-test, boresights, and maintains the weapon system. When the TOW is hand carried, he carries the missile guidance set and the launch tube.

- The assistant gunner's duties include preparation of the launcher for loading, preparation of the first encased missile for loading, loading and arming the weapon system, assisting the gunner in performing system self-test, acting as gunner if the necessity arises, carrying ammunition, and checking clearance of the backblast area before firing. When the squad is assigned the 1/4-ton/TOW which consists of two 1/4-ton trucks, the firing vehicle, and the missile carrier; the assistant gunner will drive and perform maintenance, conceal, and camouflage the firing vehicle. When the TOW is hand carried, he carries the traversing unit.
- The driver's duties include the maintenance, concealment, and camouflage of his vehicle. He also assists in ammunition resupply with or without his vehicle. He prepares subsequent encased missiles for loading on command. When the squad is assigned the 1/4-ton TOW, the driver will drive the missile carrier. When the TOW is hand carried, he carries the encased missile (USAIS, 1971).

As described in TC 23-23 (DoA, 1974): "The automatic missile tracking and/or capabilities of the TOW system provide for a high first-round hit probability. . . . To engage a target, the TOW gunner acquires the target and tracks it by operating mechanical controls to aline the crosshairs of the optical sight with the target. . . . The gunner does not apply lead, windage, or elevation. . . . When the target is within range, the missile is launched from a launch tube with which the optical sight is alined. Deviations of the missile from the intended line of sight trajectory of the optical sight are sensed automatically by an infrared (ir) sensor alined with the optical sight. The ir sensor receives radiation from a coded ir source mounted in the aft end of the missile and produces error signals proportional to the azimuth and elevation displacements of the missile from the intended trajectory. Flight correction commands derived from these error signals are generated in the missile guidance set and transmitted to the missile over a wire-command link dispensed by the missile. The flight correction commands are processed in the missile electronics unit. The missile maneuvers in response to these commands by deflection of the control surface activators. Upon contact with the target, the warhead detonates". (p. 3, 7-9)

The TOW backblast area extends to the immediate rear of the weapon for approximately 50 meters in an arc of 90°. An additional caution zone lengthens the 90° arc for another 25 meters. Depending upon the mount/mode in which the TOW is emplaced the backblast characteristics of the TOW restrict, to a certain degree, the firing capability of the weapon. For example, a launch-tube elevation of 20° above ground level is considered dangerous for any TOW mount, due to backblast effects and over-pressures (DoA, 1974).

It appears, therefore, that the critical demands placed upon the gunner are the variation of certain bodily states such as breath control, visual acuity in aiming and sight alignment in the maintenance of the crosshairs in the sight reticle on the target, and the gunner's ability to withstand both physical and emotional stress immediately prior to and during missile launching.

The TOW backblast area also poses considerable demands upon the gunner and the remaining crew members in the immediate vicinity of the weapon position, who are subject to the dust, debris and overpressure effects after missile launch.

The distinctive launch signature of the TOW (noise, dust, flash and smoke) places additional demands on the TOW squad leader for especial considerations in selecting proper tactical firing positions for the weapon.

Although procedures for properly dealing with TOW misfires are explained in detail in TC 23-23 (DoA, 1974) and the Infantry School's Weapon System Instructor Packet (USAIS, 1971), a possibly serious human factor demand upon the gunner exists in the 1.5 second delay-time between the trigger depression and the physical launch of the missile. It is conceivable that the newly trained gunner, may, under certain stress-related combat environments, become confused in experiencing a firing delay. The novice gunner may attempt to initiate misfire or hangfire clearance procedures, moving from his firing position and exposing himself to backblast effects or detection by threat forces. More likely, however, the gunner may attempt to depress the trigger repeatedly in order to initiate the missile launch sequence, increasing the risk of electronical malfunction within the system.

Threat. The overall threat to the TOW crew is generally the same as that associated with any combat soldier, and can be effectively compared to the threat facing the M16A1 rifleman. However, the TOW weapon system is designed to defeat the tank and mechanized vehicle threat between the ranges of 65-3000 meters. Specifically, TOW is a long-range (3000 meter) antitank defeating weapon (USATRADOC, 1976).

Although threat forces are known to maintain a wide variety of armor vehicles in their inventory, certain of these vehicles represent a more current as well as a more lethal threat to the TOW due to advanced engineering concepts. Some of the more universal threat armor vehicles in current supply are the T-54/55 tanks, the PT-76 amphibious tank, and the T-62 main battle tank. A relatively recent, technologically improved tank is the T-72 which has increased stability, torsion bar suspension and a rangefinder using the laser principle. The BRDM and the BMP represent two of the several threat force armored personnel carriers. The SU-76, ASU-85, SU-100 and JSU-152 are all versions of the threat antitank, assault gun capability. A formidable, self propelled anti-aircraft vehicle is also present in the threat arsenal - the ZSU-235. The SAGGER and SWATTER antitank missiles are included in the TOW threat as they represent weapons which are currently used by threat forces in conjunction with armor attacks (TC 30-4; DoA, 1975; USATRADOC, 1975; DIA, 1976). In general these systems are very accurate and highly lethal. Collectively they mesh to provide an impressive antiarmor capability out to 3500 meters (Maxey, Ton, Warnick, and Kubala, 1976). Since these weapons must be neutralized for effective operations by opposing forces, they will be priority targets for U.S. Army weapon systems in a future conflict with threat forces. Thus, it is appropriate that TOW gunners should be able to effectively engage tank and APC sized targets at relatively long ranges (*i.e.*, stand-off ranges in order to minimize their neutralization or destruction by threat forces).

Since the battlefield environment can be expected to be dynamic and totally situationally dependent the threat parameters selected for the TOW weapon system are equally dependent upon operational and environmental factors. However, based upon the review of available, current literature it was concluded that the TOW will more than likely face a threat force which consists of T-62 and T-72 tanks and BMP mechanized infantry personnel carriers on a

ratio of 3 to 1 (threat/friendly). These threat combat forces will be supported by self-propelled artillery of various caliber on a ratio of approximately 10 to 1 (threat/friendly); self-propelled assault guns, anti-aircraft vehicles and amphibious tanks operating in conjunction with reconnaissance forces. Threat forces can be expected to attack without lengthy preparation, in concentrations aimed at flanks or poorly prepared defensive positions. Antitank missiles such as the TOW, and tanks are regarded by the threat as primary targets (Defense Intelligence Agency, 1976).

Because the threat has a strong armor and mechanized infantry capability TOW crews are particularly vulnerable to threat forces on the battlefield. TC 7-24 (DoA, 1975) cautions that "a sound knowledge of the threat force - his intentions, capabilities, and tactics - is of vital importance in the planning and conduct of any operation." This fact portends a requirement for TOW training to be positively correlated to the combat environment, with all possible skills and tasks being combat referenced. This has not been and is not now the case. As indicated in the M16A1 section of this report, no systematic, validated "micro-level" threat assessment or TOW task analysis has been performed. In the absence of a data base generated through the performance of these analyses, the majority of current TOW training cannot be considered to be either realistically threat-referenced, or criterion referenced.

Measures of Effectiveness. Contrary to the primary mission of the rifleman, TOW gunners are assigned the critical objective of engaging and destroying tanks and other armored vehicles. Secondary objectives for the TOW missile system are the destruction or neutralization of threat field fortifications and support vehicles on the battlefield (TC 23-20, (DoA, 1975). In general, MOEs for the TOW system can be stated as: 1) success in destroying threat tanks, armored personnel carriers, assault guns, reconnaissance vehicles, field fortifications and other combat vehicles, and 2) success in avoiding being detected, engaged and destroyed or neutralized by threat forces.

Unfortunately, determination of combat effectiveness is a tenuous area. For one thing, the mission "to engage and destroy threat armor" implies that any armored vehicle which is destroyed is an achievement, or benefit, and any one which is not destroyed is a failure, or cost. A threat tank in isolation, while it may represent an immediate threat to a particular position, is only

effective as it contributes to the overall success of the combined arms effort of which it is a part, e.g., seizing a piece of terrain. Furthermore, destruction of threat armor cannot be judged independently as the sole criterion. It must be weighed against losses, i.e., a cost/benefit analysis.

Some form of cost/benefit analysis must be performed in order to derive an indicator of success and achieve some sort of criteria. Ideally, a numerical index which can be used to rank alternatives would be best. This may take any one of the following forms:

1. Maximize benefits for given costs.
2. Minimize costs while achieving a fixed level of benefits.
3. Maximize net benefits (benefits minus costs).

It should be obvious that, in absence of war, determination of such criteria is difficult, especially when considering the incommensurable nature of threat armor killed (benefits) and friendly casualties (costs). Any viable benefit versus cost analysis should also consider the additional factors of threat personnel casualties and ancillary equipment losses as a direct function of the primary destruction of the tank or other armored vehicle. The TETAM experiments conducted by CDEC provide insights as to the difficulty associated with casualty assessment in antitank missile testing and training (USACDEC, 1974). Taylor (1970) has devised a methodology which is applicable to the measurement of the combat effectiveness of tank and antitank missile weapons using firepower scores. This model may prove effective in measuring the effectiveness of TOW gunners in tactical training exercises.

Training Criteria. In establishing training criteria, a performance level and conditions surrounding the measurement of performance must be initially established. Once determined, the levels of performance can be set and used to identify standards and to classify an individual as belonging to certain performance categories or groups. TOW training criteria are described herein in terms of measures of performance (MOP) and performance standards for individuals and for TOW squads.

Measures of Performance. Several sources, including TC 23-23 (DoA, 1974), TC 23-20 (DoA, 1975), and the Infantry School's TOW Weapon System Instructor Packet (USAIS, 1971) describe measures of performance (MOP) for the TOW weapon system. Although there are slight variations in MOP among these documents, the

majority appear to be patterned after guidance contained in TC 23-23 (DoA, 1974).

As explained in TC 23-23 a MOP for the TOW weapon system is the TOW gunner's performance score obtained in the qualification firing exercise during training. The TOW Weapon System Instructor Packet (USAIS, 1971) and TC 23-20 (DoA, 1975) have added a proficiency test as an additional MOP. This test consists of a written test and a "hands-on" performance examination.

Performance scores which may be achieved during qualification firing of the TOW are shown in Table 4:

Table 4
TOW QUALIFICATION SCORES

PART ONE (Track left to right)

	<u>EXPERT</u>	<u>1ST CLASS</u>	<u>2ND CLASS</u>	<u>UNQUALIFIED</u>
Task A	449-375	374-325	324-275	274-0
Task B	500-450	449-413	412-375	374-0
Task C	449-375	374-325	324-275	274-0

PART TWO (Track right to left)

Task A	449-375	374-325	324-275	274-0
Task B	500-450	449-413	412-375	374-0
Task C	449-375	374-325	324-275	274-0

To qualify each gunner must pass each task with a minimum score of Task A - 550, Task B - 750, and Task C - 550. The lowest score achieved from the three tasks will be the overall qualification rating recieved by the gunner. (TC 23-20, DoA, 1975)

Qualification firing is conducted during daylight hours with the TOW in the ground mount mode, utilizing the M-70 training set, the blast simulator diaphragm and the infrared target source affixed to a panel target. The target panel is mounted on a vehicle moving perpendicular to the gunner's line of sight. The vehicle moves at constant speed in a path from left to right, then reverses its course in the opposite direction. The TOW gunner's performance is measured on his ability to track the target source, with unobstructed vision, for a percentage of time during a given tracking exercise. A measurement of the gunner's ability to maintain the crosshairs of the TOW sight on the cross painted on the target panel is made by the M-70 training set.

During each phase of the qualification firing exercise (A,B,C) two parameters are varied. These parameters are 1) target speed, and 2) simulated range

to the target. Utilizing meter settings on the M-70 training set, the range to the target is simulated by varying the amount of missile "flight time" provided during a firing run. Variations in target speed are simulated by altering the line of sight rate of movement of the target source (TC 23-20, DoA, 1975).

As earlier described, the written and "hands-on" proficiency test required of TOW gunners is an adjunct MOP for the TOW weapon system. Ideally, the TOW gunner is required to successfully pass the two-part examination before he is allowed to progress to qualification firing. In practice, however, this requirement may not always be the case due to higher training priorities, facility scheduling or lack of test materials. Regardless of the score obtained by the individual on the proficiency test, there is no correlation between his test score and his qualification rating. It can therefore be concluded that the proficiency examination is of little value as a MOP (TC 23-20, DoA, 1975).

Individual Training Standards. The individual performance standards prescribed for TOW gunners during their qualification firing, as extracted from TC 23-20 (DoA, 1975), are shown in Table 5.

Table 5
QUALIFICATION FIRING

Note:

1. Gunners will not fire more than five exercises at one time.
2. All launch excursions will be scored as a ZERO.
3. To qualify:
Each gunner must pass TASKS A & C with a minimum of 550 points (total per task).
Each gunner must pass TASK B with a task total of 750 points.
4. Compute qualification from table below. Lowest task rating will be overall gunner qualification rating.
5. Cant TOW launcher 10 degrees to left to right.

	SCORE RATING	TASK	EXPERT	1ST CLASS	2ND CLASS	UNQUALIFIED
TASK A		A	898-750	749-650	649-550	549-0
TASK B		B	1000-900	899-826	825-750	749-0
TASK C		C	898-750	749-650	649-550	549-0

SCORER'S SIGNATURE

QUALIFICATION RATING

VERIFYING OFFICER'S SIGNATURE

GUNNER'S SIGNATURE

These standards dictate that the gunner must obtain an average of 55% of tracking time on target for Tasks A and C and an average of 75% time on target for Task B in order to qualify. In addition, rather than averaging scores over the three tasks, the gunner achieves an overall qualification rating based upon his lowest task rating.

FM 7-11B1 (DoA, 1976) prescribes five tasks and related conditions and standards for the skill level one soldier to perform with the TOW:

- o Maintain the TOW weapon system.
- o Engage targets with TOW.
- o Prepare a range card for a TOW.
- o Construct TOW position.
- o Camouflage/conceal TOW position.

Two additional tasks are listed: 1) load, correct malfunctions, unload and clear the TOW; and 2) make a TOW launcher self-test and preoperational inspection. Although these tasks appear to be individual requirements, having individual performance standards, FM 7-11B1 describes them as "team tasks" performed with assistance. These statements are confusing.

The proficiency examinations outlined in TC 23-20 (DoA, 1975) and USAIS (1971) are similar in nature. Some variation in content is apparent. The test contained in TC 23-20 is shown in Table 6.

Collective Training Standards. The training standards associated with TOW crews/squads are contained in FM 7-11B1 (DoA, 1976), TC 23-20 (DoA, 1975), ARTEP 7-15 (DoA, 1975), and ARTEP 7-45 (DoA, 1975). As discussed earlier, FM 7-11B1 lists two tasks which are "team" related. In the first (load, correct malfunctions, unload, clear TOW) the gunner and assistant gunner are given a requirement to "engage a (simulated) enemy armored vehicle" with two TOW rounds within one minute, excluding any firing malfunction. In the second task (make a TOW launcher self-test and preoperational inspection) the individual trainee is provided an assistant in order to determine the operational readiness of the TOW system including: each battery assembly, missile guidance set, traversing unit and optical sight. No time limitation is stipulated. In order to develop teamwork within the TOW squad FM 23-20 stipulates that within two minutes the squad will "engage multiple armor targets moving at actual ranges

Table 6

PROFICIENCY TEST AND WRITTEN TEST

Proficiency Test

This performance examination is provided to the units to determine gunner's proficiency prior to the qualification tracking exercise. Trainers should use TM 9-1425-470-12, TM 9-6130-470-12, and TM 9-6920-470-12 to determine the proficiency demonstrated by each gunner. On written portion, gunner must answer 18 of the 23 questions.

NAME _____
RANK _____
SSAN _____
ROSTER # _____
DATE _____

(continued)

Table 6 (continued)

I. GENERAL

A. Before starting your qualification tracking exercise, you must demonstrate whether you have the desired proficiency. For the next 2 hours, you will participate in a performance examination consisting of a written test and a performance-oriented (hands-on) test. The proficiency test will be conducted using the "county fair" method of testing.

B. The examination requires you to complete a written test and move through nine different stations where your acquired skills will be tested.

II. INSTRUCTIONS

A. Move to designated testing area.

B. Print your name, rank, SSAN, roster number, and date in spaces provided on front cover and wait to begin the proficiency test.

C. Carry this grade sheet with you to all stations.

D. Return this grade sheet to Station One when you complete the test.

E. Do not leave Station One until your name is checked off the roster.

F. Move to break area and wait for qualification to begin.

III. TOW PERFORMANCE EXAMINATION

A. Written Exam.

B. Proficiency Test.

1. Station One: Assemble components of the tactical TOW weapon system.

Possible Points _____

Points Earned _____

(continued)

Table 6 (continued)

- | | |
|--|-----------------------|
| 2. <u>Station Two:</u> Conduct a system self-test. | Possible Points _____ |
| | Points Earned _____ |
| 3. <u>Station Three:</u> Demonstrate battery charging procedure. | Possible Points _____ |
| | Points Earned _____ |
| 4. <u>Station Four:</u> Hook-up of instructor console and proper setting of range and mode switch. | Possible Points _____ |
| | Points Earned _____ |
| 5. <u>Station Five:</u> Loading, arming, and safety precautions for use of blast simulator. | Possible Points _____ |
| | Points Earned _____ |
| 6. <u>Station Six:</u> Place target set into operation. | Possible Points _____ |
| | Points Earned _____ |
| 7. <u>Station Seven:</u> Disarm and unload a missile (firing not attempted). | Possible Points _____ |
| | Points Earned _____ |
| 8. <u>Station Eight:</u> Loading and arming of tactical missile. | Possible Points _____ |
| | Points Earned _____ |
| 9. <u>Station Nine:</u> Misfire procedure. | Possible Points _____ |
| | Points Earned _____ |

(continued)

Table 6 (continued)

WRITTEN TEST

1. After launch, the TOW missile will always be armed at _____ meters.
2. The backblast of the TOW weapon system extends 35 meters to the rear of the launcher. This includes a _____ meter danger area and a _____ meter caution area.
3. After leaving the launch tube, the missile will coast approximately _____ meters before the flight motor ignites.
4. The TOW weapon system has a _____ meter minimum effective range and a _____ meter maximum effective range.
5. The flight motor has a _____ second burn time which propels the missile to its maximum speed.
6. After pressing the trigger, there is a _____ second time delay, enabling the gyro to come up to speed, before the missile launch motor is ignited.
7. As the missile leaves the launch tube, the missile _____ and _____ surfaces extend for in-flight control.
8. When boresighting the TOW weapon system, the gunner is aligning the 13X _____ lens with the _____.
9. The 1/4-ton firing vehicle carries _____ encased missiles and the 1/4-ton missile carrier carries _____ missiles.
10. The APC TOW carries _____ encased missiles.
11. _____ battery assemblies are issued with each TOW weapon system.
12. Circle the six major components of the TOW launcher.
 - a. Instructor Console
 - b. Tripod
 - c. Traversing Unit
 - d. Launch Tube
 - e. Missile Simulation Round
 - f. Power Supply Modulator
 - g. Optical Sight
 - h. Battery Charger
 - i. Two Battery Assemblies
 - j. Missile Guidance Set
 - k. Blast Simulator
 - l. Encased Missile

(continued)

Table 6 (concluded)

13. There is a _____ meter danger area observed to the front of the energized target source on the board.

14. There is a _____ minute waiting period before removing the missile from the launcher, in the case of a misfire, after all checks have been made and two additional attempts to fire have failed.

TRUE OR FALSE QUESTIONS

15. _____ No maintenance, or repair, is performed on the encased missile at organizational maintenance level.

16. _____ Correction signals are transmitted to the missile electronics after launch by way of the optical sight infrared tracker.

17. _____ Operator maintenance on the TOW weapon system, at organizational level, includes limited cleaning, spot painting, and the exchange of mal-functional components.

18. _____ Crew drill develops teamwork, precision, and speed in placing the TOW weapon system into operation; however, practice for speed is the last phase.

19. _____ The system self-test cannot be performed until an encased missile is loaded into the launcher.

20. _____ The crosshairs will illuminate only if the reticle light switch is ON, arming lever raised, and the mode switch set to practice or qualify when using the training equipment.

21. _____ The refractive index of the optical sight should be set to +3 during the boresighting procedure for the tactical system.

22. _____ The optical sight should be turned in if water droplets are visible in the optical sight.

23. _____ When using only the tactical TOW weapon system (that is, assembled and given a good launcher self-test), the reticle light switch need only be turned to ON to illuminate the crosshairs.

of 1000 to 3000 meters with distraction of battlefield noise." Conditions for conducting this exercise include day and night firing.

Though general in nature, collective training standards prescribed for TOW squads/crews in ARTEPs 7-15 (DoA, 1975) and 7-45 (DoA, 1975) are designed to develop coordinated teamwork through training exercises. An example of this requirement is found in ARTEP 7-15 states that the battalion antitank platoon will meet the following standards:

- Prepare, by the time designated in the order, defensive positions organized to optimize the effectiveness of friendly fire power and minimize exposure and vulnerability to enemy fire and maneuver.
- Score an acceptable hit ratio over the attacking enemy force using REALTRAIN techniques.

Content and Methods. TC 23-23 (DoA, 1974) prescribes that current TOW training prepares individuals to track moving targets smoothly in preparation for qualification firing. Qualification firing will subsequently train gunners in the following skills:

- Rapid and accurate acquisition of targets.
- Proper tracking position, traversing, sighting, and trigger operation.
- Firing and a rapid, but smooth transient recovery.
- Smooth and steady-state point tracking.

Two primary courses comprise the instructional content of the TOW training program. Course A is designed to qualify a man as a TOW gunner; Course B is for familiarization and proficiency training in tactical units, and should be conducted "at least once a month."

Individual Training. The individual TOW gunnery training course consists of four and one-half days of training (36 hours of instruction). The course is designed to train selected advanced individual trainees to qualify as gunners on the TOW system. Successful completion of the course is required for award of MOS11B (Infantryman). Topics covered in the training program include: 1) TOW gunner and crew training, and 2) TOW field tracking exercises. A detailed outline of course content is shown in Table 7.

Individual Training in the Unit. In order to maintain individual proficiency in units TC 23-20 (DoA, 1975) prescribes a program designed to sustain skill

Table 7
SEQUENCE OF TOW TRAINING*

Day	Content Area	Hours
1	Place M220A1 TOW into operation	.5
	Place M70 training set into operation	.5
	Practical exercise on M70 training set	1.0
	Instructional Firing Table I	1.5
	Instructional Firing Table II	1.5
	Assemble M220A1 TOW vehicle carrier	.5
	Introduction to TOW crew drill	.5
	Perform TOW crew drill	2.0
		8.0
2	Perform TOW ground crew drill	1.0
	Instructional Firing Table III	2.0
	Perform TOW vehicle crew drill	1.5
	Introduction to the TOW missile	.5
	Perform operator maintenance	1.0
	Instructional Firing Table IV	2.0
		8.0

* (TC 23-20, DoA, 1975)

(continued)

Table 7 (continued)
SEQUENCE OF TOW TRAINING

Day	Content Area	Hours
3	Perform TOW ESC	1.0
	Identify tanks	1.0
	Perform TOW ground and vehicle crew drill	2.0
	Instructional Firing Table V	4.0
		8.0
4	Administer TOW Proficiency Test	3.5
	TOW field Tracking Exercise	8.0
<u>Daylight Phase</u>	Introduction to TOW range card	
	Prepare TOW range card	
	Track against long and short range targets (use APCs with target sets and tanks)	
	<u>STATION ONE</u> - Vehicle TOW tracking	
	<u>STATION TWO</u> - Ground TOW tracking	
	<u>STATION THREE</u> - Vehicle TOW tracking (rapid fire exercise)	
<u>Night Phase</u>	Introduction to night fire techniques	
	Prep for night tracking	
	Night tracking	
	<u>STATION ONE</u> - Vehicle tracking	
	<u>STATION TWO</u> - Ground tracking	
	<u>STATION THREE</u> - Vehicle TOW tracking (rapid fire exercise)	
		11.5

(continued)

Table 7 (concluded)
SEQUENCE OF TOW TRAINING

Day	Content Area	Hours
5	Morning open time - begin training in afternoon	
	Qualify with the TOW	
	Fire Qualification Table VII	4.0
	Graduation	
		4.0

SUMMARY OF TOTAL HOURS

DAY ONE	8.0
DAY TWO	8.0
DAY THREE	8.0
DAY FOUR	11.5
DAY FIVE	4.0

39.5

proficiency on antitank weapons including the TOW. This program includes the firing of instructional and qualification tables previously described, and is fundamentally based upon the recommended requirement for TOW gunners to reaffirm their weapon qualification proficiency on a quarterly basis. Table 8 shows the unit individual proficiency program.

Collective Training. During TOW training, crew drills and rotation of tasks permit each of the four squad members to become proficient in the duties of other crew members. Team training has, as its primary objective, the development of teamwork, precision and accuracy in selection and engagement of multiple targets. When conducted with the M-70 training set, a measure of tracking performance proficiency can be assessed for each squad member.

Training Devices. Currently, the majority of individual and team training is conducted utilizing the M-70 training set. This device consists of an instructor console, missile simulation round, and a target set (power source, target board, and infrared target source). The M-70 training set is a standard issue item and is used in conjunction with the TOW launcher (launch tube, tripod, traversing unit, optical sight, missile guidance set, and battery assembly).

An additional device used in TOW training is the blast simulation diaphragm. This simulator is the only item of ammunition used in conjunction with the M-70 trainer. The blast simulator is designed to produce a noise and blast similar to the gyro activation and blast of the TOW missile. The 1.5 second delay between trigger squeeze and physical launch is the same as the delay experienced with the live missile. Betts, Williams, and Thomas (1973) provide an informative chronology of the development, and design characteristics of this simulation device. Though not widespread, the use in TOW gunnery training of the Television Trainer (TVT) shows considerable promise in providing valid feedback to trainees and instructors during marksmanship training. The standard methodology for employing the TVT in conjunction with antiarmor training programs is described in change to TC 23-24 (DoA, 1974).

Trainee Selection. Present selection criteria for TOW gunners consists of high Army entrance qualification test scores, a drill sergeant's character evaluation and the future assignment requirements of the Army (USATRADOC, 1976).

Table 8
TOW UNIT TRAINING

Quarter	Content Area
1	Conduct Course A
	Conduct Familiarization Live Firing (Transition Training)
2	
<u>Course B</u>	Fire Instructional Table II (9-2), III (9-3), IV, V
	Administer Performance Test
	Fire Qualification Table VII
3	
<u>Course B</u>	Fire Instructional Tables II (9-2), III (9-3), IV, V
	Administer Performance Test
	Fire Qualification Table VII
4	
	Fire Instructional Tables II (9-2), III (9-3), IV, V
	Administer Performance Test
	Fire Qualification Table VII
	Fire Table 9-9 as indicated in TC 23-23 (Annual Service Practice)

NOTE: Realizing operational needs must be met, the above quarterly training can be arranged to fit into a particular unit's training requirements; however, qualification is a quarterly requirement. (TC 23-20, DoA, 1975).

A cursory review of these criteria finds them lacking. Although there appears to be some agreement on what traits, abilities, and attitudes comprise a successful TOW gunner profile, there is a corresponding lack of agreement on what elements constitute efficient gunner selection criteria. Stewart, Christie and Jacobs (1974) conducted a study which: 1) attempted to identify the critical knowledge and skills required for effective gunnery performance, and 2) sought to isolate which factors were key to the effective employment of training equipment versus operational equipment. A major assertion of this study effort was that major demographic descriptors of trainees were not directly related to the predictability of marksmanship scores, and that the selection program developed by the study was not useful in a general screening or selection program. Most of the study efforts in the area of trainee selection have been aimed at attempts to establish a positive correlation between a few traits, abilities and attitudes which "would stand in causal relationship to gunner qualification" (USATRADOC, 1976). Seemingly, none have been successful, to date.

Summary. It would appear that the TOW weapon system, and the training programs associated with the system:

- are not entirely combat referenced or threat related,
- should be the subject of a validation experiment which would correlate current training criteria with operational "live-fire" performance scores,
- lack sufficient training simulation devices to effectively measure the total performance skills required of TOW gunners,
- emphasize tracking skill to the detriment of other key individual and collective performance skills,
- lack valid selection criteria for members of the TOW squad, especially the gunner.

RESEARCH FINDINGS

Hardware Demands on Operator. Possibly the most serious demand placed upon the TOW gunner is the requirement to remain in the firing position with the weapon during the time period between missile launch and missile impact on the target. The distinctive launch signature of the TOW missile requires not only a high degree of skill on the part of the gunner to "re-capture" the target image in the sight immediately after launch, but also provides the enemy with

a source of identification as to the TOW launch position (USACDEC, 1974).

In addition to launch signature, of which backblast is a significant part, the design of the TOW weapon, when ground mounted, requires the gunner to fire from the kneeling position. This position may not necessarily be fully compatible with the tasks the gunner is required to perform before and after missile launch. These tasks include aiming, sight-alignment and tracking of the target. Though target identification and designation of targets to be fired upon are usually the responsibility of the TOW squad leader, the gunner must also insure that he has properly selected, through the optical sight, the proper target to be fired upon (USAIS, 1971).

Threat. Primary investigations which have contributed to the validity of current TOW training or have identified deficiencies in threat related training with the TOW weapon system consist of the tactical effectiveness testing of antitank missiles (TETAM) (USACDEC, 1974; USACACDA, 1973, 1974).

These studies provided data on the following relationships:

- line of sight/tank evasive maneuvers,
- detection of the TOW crews by the threat crews,
- launch signatures,
- kill ratios,
- detection and identification of armored vehicles.

It should be noted that data for this study were clouded by the fact that the antitank missile (ATM) positions were "selected" and were represented by a set of three tri-colored wooden panels erected at each selected position. Further, the tactical deployment was not set-up to represent any hypothetical threat force. Hence, the data derived from these series of studies should be used with caution in establishing threat criteria.

Little meaningful research has been done to identify and standardize threat parameters. No detailed threat analyses have been conducted at the company, platoon and squad level. There remains a critical need to validate those threat parameters which are most urgently needed at the TOW squad and TOW gunner levels. Only then can threat related training criteria be developed and combat oriented training programs be established.

Measures of Effectiveness. Few studies have addressed the need for or the existence of current measures of effectiveness (MOE). One study which may have applicability to effectiveness measures was conducted by Caviness, Maxey, and McPhearson (1972). This study was designed to establish a relationship in the distribution of detection times for moving targets by human observers. Additionally, the study was to investigate how the detections were affected by target speed, target range, and terrain variations. The authors asserted that target range and variable terrain conditions were positively correlated to detection time, while target speed was negatively related.

USACDEC (1976) has tried to assess TOW tracking requirements for engaging a vehicle executing swerves, fast turns, and serpentine maneuvers. A method for assessing combat effectiveness for antitank weapons was developed by Taylor (1970). Such methods may prove useful in contributing to the development of combat referenced criteria needed to insure training effectiveness.

USATRADOC (1976) conducted a study which assessed the adequacy of the current training criteria used for the TOW weapon system. Based upon analyses made by the Army Materiel Systems Analyses Agency (AMSAA), high hit probabilities were predicted for TOW. Field reports supported this assertion. However, according to TRADOC, only well qualified and/or experienced gunners were given the opportunity to fire live missiles with operational TOW systems. Using AMSAA data to establish criterion qualification scores may be beneficial for norm referenced gunnery competition, but seems of little value for establishing combat referenced criteria linked to existing or potential training devices. The need for validating current effectiveness criteria through the conduct of a live fire versus M-70 tracking score experiment appears critical. The present training device, measuring tracking skills only, with no hit/miss feedback capability, is capable only of engaging single, cooperative targets in a sterile training environment (Naumann, 1975).

Training Criteria. Currently, with two exceptions (operational set-up and preoperational checks), TOW training criteria are primarily achieved through the use of the M-70 training set. This equates to the measurement of the tracking performance (MOP) capabilities of the gunner. Proficiency tests and performance examinations are administered. However, they bear little more than

an indirect relationship to the primary criterion of tracking.

Contrary to current criteria, the TOW system is designed to be operated by a crew of four soldiers (squad leader, gunner, assistant gunner and driver). Objective training criteria would seem to dictate, or at least emphasize, the effective operation of the TOW system, which is assumed to mean all members of the system. Unfortunately, current criteria is designed only to accommodate the evaluation of the TOW gunner through the use of the M-70 training set. Further, there is considerable doubt as to whether or not the set-up and operation of the training set with the TOW launcher attached equates to the same task and related skills when the operational equipment is used separately.

The shortcoming in this approach is two-fold, particularly when consideration is given to the sterile environment predominantly used when firing live missiles. In the institutional setting, usually only the top members, or best tracker in each class is permitted to fire a single missile. In field units, assigned gunners are allocated one operational missile per year to maintain proficiency. Unfortunately, assigned TOW gunners are not always selected to fire the allocated live missiles (USATRADOC, 1976). Rationale for this inconsistent practice is abundant. Training facilities are either not available or are configured to accommodate a slow-moving target vehicle at ranges of 2200-2400 meters (Jasiak, Note 1). Operational missile costs approach \$3,500.00. These rationale translate into the following scenario:

If a unit is allotted ten missiles for maintaining annual proficiency, then ten hits are reasonably expected because of the high predictable, probability of hit of the system. Given an expectation of ten hits, the unit commander can be expected to insure ten hits by issuing missiles to the units' best TOW trackers who, in some cases, are not the assigned TOW gunners.

The second disturbing aspect of the TOW training programs currently employed is the apparent lack of analysis used to formulate them. As earlier described, there has been no formal analysis or experimental study which would confirm or reject the relationship between qualification score performance on the M-70 TOW training set and live missile firing (USATRADOC, 1976). Additionally,

it has not been established that the MOP (tracking scores) have any systematic relationship to threat parameters at any level.

Training Content and Methods. From the lack of available literature, it is obvious that little has been attempted in efforts to improve the training content of the TOW system since its deployment in the early seventies (USATRADOC, 1976). One study offering related information impacting upon training content examines training in the tropic phase of the TOW service test (Hope, 1972). Severe environmental conditions and their impact on the TOW system are examined. If a detailed threat analysis should indicate the need for training in severe climatic conditions as a standard for TOW squads, this study should prove beneficial. Additionally, Naumann (1975), analyzed the TOW training program. Although subjective in nature, an understanding of some of the deficiencies of the current TOW training program were surfaced. Among the several study recommendations, the following are highlighted:

1. A hit/miss indicator should be added to the M-70 training set.
2. Multiple moving targets are needed on firing ranges.
3. A field test should be conducted to determine which training should be emphasized to insure maximum retention of proficiency.

Except for one available study, little has been done to evaluate the optimum teaching methods for TOW training. While conducting the service test for the TOW system, Castro and Small (1969) found that neophyte gunners could be trained within two hours and obtain hits (assumed to be on the M-70 training set). This assertion suggests that the TOW Program of Instruction (POI) could be altered with less emphasis on operational system characteristics. These findings may be attributable to the physical stability of the TOW weapon.

Training Devices. During the 1968 TOW system service test, Seitz (1968) found that the current TOW training program resulted from measures employed in the training of gunners for the conduct of the service test (Naumann, 1975). Studies which explore the need for training devices that provide simulations of the threat environment are the minimum needed. In a study by Betts, Williams, and Thomas (1973) a TOW blast simulator which is safe, highly reliable, and low in cost was developed and evaluated.

For any training device to be effective, training should be transferable. Various approaches to this problem have included task indices (Caro, 1970;

Mirabella and Wheaton, 1974), modeling (Wheaton, Fingerman, Rose and Leonard, 1976), and simulation (Stark, 1971). Andersen and Jeantheau (1966) and Blaiwes and Regan (1970) have developed criteria for evaluation of training devices. Although degree of transfer of training is recognized as an index of training effectiveness, no studies have attempted to measure the degree of fidelity for the training that is needed to insure positive transfer. For example, McCluskey, Haggard, and Powers (1976) found that the TOW blast simulator added realism to the training environment, but, the relationship between firing proficiency and use of the blast simulator has not been established.

Simulation within the area of training effectiveness analysis is of potential value, particularly with the TOW system and the relatively high cost associated with live missile firing. Simulation is especially appropriate when used to compare effectiveness of various training devices. Although it appears that no computer simulation has been developed for the TOW system, McCluskey (1972) reviewed research areas where cost-effectiveness simulation methodologies for training were expressly needed. Such an approach may prove viable for high missile cost systems such as TOW.

Trainee Selection. Selecting personnel who are thought to possess certain characteristics required of effective TOW gunners is currently based upon doubtful methodology. Gunners are selected according to the following criteria (Jasiak, Note 1; Bradley, Note 2):

1. General technical score of 90 or better on the Classification Inventory.
2. Future assignment - is the individual going to a unit where TOWs are employed?
3. Commander's recommendation - has the individual stayed out of trouble, etc., ?

Additionally, when the initial training period for TOW has been completed, 80 percent of the gunner class is eliminated (Bradley, Note 2). This is because the TOW selection criteria are derived from tracking skills needed for Dragon gunners on the assumption that skills needed to operate both systems are similar. However, the similarity is questionable.

For identifying prerequisite skills several methods are available. Braunstein (1976) has presented techniques which may be useful in determining

what processes are needed or should be trained to facilitate distance estimation. Monty and Senders (1976) provide experimental results that may be useful for identifying skills such as target detection and perception of position. Poulton (1974) is a comprehensive source for information on tracking which may be useful for assistance in identifying potential TOW and Dragon gunners. Clearly there is a definite need to establish valid selection criteria for the TOW weapon system, especially if the often recommended establishment of a separate MOS (11H) for TOW squad members is fully implemented (USATRADO, 1976)

SUMMARY

Major Training Problems. The lack of an integrated training effort for the TOW system is evidenced from field reports. Jasiak (Note 1) surveyed TOW gunners in USAREUR and found that of 145 questioned only 32% had received any formal (instructional) TOW training. The prevailing comment related in the survey was that within TOW units, TOW gunners wanted more information on the system but were unable to identify what information was available or where to obtain it. The expansion of the Training Extension Course (TEC) and subsequent distribution of TOW TEC lessons may assist in partially resolving this problem.

According to USATRADO (1976) TOW gunners typically engage single, cooperative targets (i.e., nonevasive). At night targets are identified by beacon lights. The skills of target acquisition, target identification, intervisibility, and the decision to fire are not taught. The M-70 trainer is used only to measure a gunner's ability to track.

The TOW may indeed be an effective weapon system, but confidence in gunner's ability with the system rests with qualification scores obtained with the M-70 trainer. Performance on the trainer has not been adequately correlated with system performance under simulated combat conditions using live fire. Further, the device uses proficiency measures of tracking a single, cooperative target in a sterile environment to determine qualification levels for gunners. A better return on training investment could be realized by: (a) investing in a live fire/trainer correlation study, and (b) adding realism to the approach similar to the BRM study plan.

Major Research Findings and Needs. Perhaps the most significant research finding has been the discovery of the paucity of empirical data available on the TOW weapon system. With the exception of the service tests (Seitz, 1968); (Castro and Small, 1969); and the CDEC experiments (USACDEC, 1974), little, valid data exist to support current TOW training criteria, conditions, standards, MOE or MOP. Studies and subjective examinations of closely related subjects having only marginal application to TOW training abound. The indirect approach is not needed here. What is needed are studies, field experiments and valid information which can be directly applied to the TOW weapon system in its' entirety. Suggested areas for investigation are:

- live-fire/M-70 tracking score correlation experiment,
- cost-effectiveness study on modifying the M-70 training set to include a hit/miss feedback indicator,
- standardized use of the TVT in conjunction with the M-70 training set,
- development of total squad/crew training for the TOW system,
- detailed threat analysis for use at the company "and below" level, especially for antiarmor elements such as the TOW,
- complete task analysis for all members of the TOW squad,
- development and implementation of a TOW gunner selection criteria model,
- greater emphasis on human factor problems associated with the TOW weapon system (i.e., backblast, firing, mechanism delay).

DRAGON MEDIUM ANTITANK WEAPON SYSTEM

DESCRIPTION OF SYSTEM

Hardware. The Dragon weapon system is a medium antitank weapon (MAW) which is man portable and shoulder-fired. Each Dragon system consists of a gunner, a round (launcher and missile in a single unit), and a tracker. With an effective range of 65-1000 meters, the Dragon can be employed in all weather conditions in which the gunner can effectively track the target. As described in TC 23-24 (DoA, 1974), the Dragon:

"... is a command to line of sight guided missile system. . .
launched from a smooth bore, fiberglass tube, recoilless launcher.
The missile is automatically and continuously guided along the
gunner's line of sight by a sensor device which tracks the missile's
course and transmits correcting signals via a wire link." (p. 3)

The Dragon round (launcher and missile) is an expendable part of the system. The launcher serves as a means for carrying as well as for firing the missile. The tracker is a reusable component and is used in tracking targets, primarily in determining deviations of the missile from the line of sight of the gunner. Through this determination, it also performs the function of initiating correction signals which are transmitted to the missile control system through the wire link. The weight of the Dragon weapon is 31.8 pounds (with the tracker attached to the round). The Dragon operational missile is a high explosive antitank (HEAT) missile (TC 23-20, DoA, 1975). A more detailed description of the operating procedures, characteristics, safety, assembly, and functioning of the Dragon weapon may be found in TC 23-24 (DoA, 1974), and the Dragon Weapon System Instructor Packet (USAIA, 1974).

Hardware Demands on Operator. On the surface, and due mainly to the efficiency of the command to line of sight guidance system of the weapon, the Dragon is reported to be a relatively simple weapon to operate, providing a very high expected probability of first round hit (TC 23-20, DoA, 1975). In support of this claim, field unit commanders and trainers sometimes express the attitude that "anyone can fire the Dragon" (USATRADOC, 1976). This attitude may have provided rationale for establishing the Dragon weapon as a "designated"

system rather than dedicated as in the case of the TOW. Simply stated, the Dragon is designed to be operated by one man and when the need for employment of the system is imminent (enemy armor is present) the squad leader will designate an available soldier to fire the weapon. While this perception of the simple operation of the Dragon may persist, it remains to be tested or proven.

Some factors which would tend to disprove the "anyone can fire" theory center upon the human element within the Dragon weapon system. Since the gunner is an integral part of the Dragon system, the operation of the command link to line of sight missile guidance system is a direct function of the gunner's physical ability to operate that system. In all firing positions the Dragon launcher rests on the gunner's right shoulder, as close to the neck as possible. The gunner's left hand grasps the left portion of the tracker while the right hand is placed on the trigger assembly. The weapon is fired by depressing the trigger safety with the right thumb and squeezing/holding the trigger with the fingers of the right hand. Thus, the Dragon is designed to be fired by right handed gunners. No data is available to support the safe operation of the system by left handed gunners. Current training programs emphasize three firing positions (standing-supported, kneeling and sitting). The Dragon can be fired from the prone position, (USAIS, 1974) however, it is not recommended due to the awkward position required of the gunner. An extreme body angle, (almost 90°) in relation to the launcher must be assumed by the gunner for protection from backblast effects. The gunner must lean in the direction of target movement, applying constant downward and rearward pressure on the tracker in order to hold the launcher firmly on his shoulder. He must also keep in mind that he is "part of the weapon" and that any distraction which causes unnecessary body movement will affect the path of the missile in flight. Current firing procedures applied in training programs emphasize that in firing the Dragon missile the gunner is expected to keep a firm posture and rigid contact between himself and the weapon - conditions which habitually cause discomfort to the gunner (TC 23-24, DoA, 1974).

Considering the requirement that the gunner become part of the weapon, proper breathing procedures become a direct demand upon the gunner while firing the missile and during tracking. Current procedures dictate that the gunner

take a breath of air, let part of it out, and hold the remainder while he presses the trigger. In addition, the gunner is admonished not to breathe during missile flight while he is tracking since any body movement will cause the missile to deviate from its target path. The maximum flight time of the Dragon missile is 10 seconds (1000 meter target). While 10 seconds is not an unreasonable length of time for a gunner to hold his breath, consideration must be given to the length of time prior to firing the missile which the gunner has already suspended his breathing, the fact that only about one-half a breath is retained by the gunner after aiming, and the other stress and distraction factors which are present before and after missile launch. When all conditions are examined, proper breathing becomes a stringent operator demand, and directly affects his tracking performance. Improper breathing could result in a lost missile (TC 23-24, DoA, 1974).

Other factors which may impact on operator/system performance appear to be somewhat less critical, but noteworthy. The Dragon has several design features which may affect efficient combat performance of the system. The distinctive launch signature which is accompanied by flying debris, smoke and flash clearly identifies the Dragon firing position to enemy forces. Backblast effects accompany missile launch and extend 50 meters to the rear of the launcher in a 90° cone. The blast and overpressure effects of the missile launch are sufficient to cause a hearing loss to some individuals, including the gunner, in the immediate area of the firing position. Ear protection during training is required (USAIS, 1974; TC 23-24, DoA, 1974).

Additionally, the infrared (ir) source attached to the target, used during tracking exercises while training, emits infrared radiation which could cause serious eye burn if viewed directly while in the operating mode, particularly at close ranges.

Threat. Very few differences characterize the threat facing the Dragon weapon system when compared with the TOW threat. The Dragon remains an antiarmor weapon designed to defeat armor and mechanized vehicles at medium ranges out to 1000 meters. Dragon targets are identical to those identified for TOW:

- T-54/55 and T-62 tanks,
- recently introduced T-72 tank

- BRDM and BMP armored personnel carriers (optionally armed with antitank missiles),
- SU-76, SU-100, ASU-85, and JSU-152 antitank assault guns,
- ZSU-23/4 self propelled anti-aircraft vehicle,
- Sagger and Swatter antitank missiles.

Those armored and mechanized vehicles not engaged and destroyed by long range antitank systems such as the TOW will automatically become a major threat to the Dragon weapon system at ranges of 65-1000 meters (USATRADOC, 1976; DIA, 1976; TC 7-24, DoA, 1975).

Emphasis must be made concerning the fact that no detailed threat analysis has been made which would serve as a basis for formulating threat referenced or criterion-referenced training programs. Consequently, current training with the Dragon weapon system is not necessarily related to conditions which could be expected in a combat environment. The major study efforts which might be related to the combat (threat-related) environment, and might have a direct relationship to criterion referenced training are described in test reports of the Tactical Effectiveness Testing of Antitank Missiles (TETAM) (USACDEC, 1974).

Measures of Effectiveness. As with the TOW weapon system, effectiveness of the Dragon is measured by the degree of success or failure demonstrated by the Dragon gunner in destroying armor and mechanized vehicle targets on the battlefield. The system's ability to perform by engaging and destroying or neutralizing enemy bunkers and other field fortifications as well as avoiding detection and destruction by the enemy is, of course, secondary to the Dragon's primary antiarmor mission. As previously explained, in the absence of war, operational effectiveness is very difficult to measure. Taylor (1970) provides a model which, as with the TOW, could prove useful in measuring combat effectiveness of the Dragon system in tactical training exercises.

Training Criteria. Dragon criteria are achieved and measured through the use of training devices. Contrary to the M-70 training set used with the TOW, the Launch Effects Trainer (LET) provides a hit/miss feedback to the gunner and trainer so that at least this criterion can be measured. According to Operational Test IIIA (OT IIIA) of the Dragon weapon system (Wohlman, Griffard, and Shockey, 1976), there is evidence that individual qualification data from

the LET is related to hit probability with live rounds. In particular, as related in TC 23-20 (DoA, 1975), it was found that a gunner qualifying as expert on the LET during training has a 28 percent greater probability of obtaining a live fire operational hit with the Dragon missile than a gunner selected at random after like training.

TC 23-20 (DoA, 1975) states that emphasis for gunnery training criteria should include individual, unit, and combat proficiency. For the gunner, training should emphasize range estimation, tracking over tactical terrain out to maximum range, and tracking of moving targets. By including tactical exercises, the ability of the crew to work as a unit can be facilitated. To insure combat ready gunners, Dragon training should not be limited, as it currently is, to tracking exercises in a sterile environment. Simulation of battlefield conditions including engagement of multiple targets, enemy suppressive fires and extended night firing exercises with artificial illumination would measurably assist in the effort to train Dragon gunners under realistic combat referenced criteria.

Measures of Performance. Measures of performance (MOP) for the Dragon weapon system consist of the gunner's performance score obtained in the qualification firing exercises during training. This score measures the tracking performance of the gunner over 60 trials, on a prescribed tracking range, during daylight hours, utilizing the Dragon tracker, launch effects trainer, M64 blast simulator, and target vehicle with an infrared source. Table 9 outlines the Dragon gunner qualification course as prescribed in TC 23-24 (DoA, 1974):

Table 9

DRAGON GUNNER QUALIFICATION FIRING

TASK	POSITION	MODE	NO. OF FIRINGS	BLAST SIMULATOR	SCORE
A	Sitting	Ground	20	M64	0-20
B	Kneeling	Ground	20	M64	0-20
C	Standing	Ground	20	M64	0-20

The gunner is required to fire at the target source which is mounted on a vehicle at ranges of either 250 or 450 meters. The target vehicle moves from left to right on a straight line course for approximately 300 meters, reversing its course upon completion of the run. The gunner's line of sight is perpendicular to the target vehicle's course and is without obstruction. The gunner is scored on a hit or miss basis during each firing exercise.

Two target parameters are varied during Dragon qualification firing exercises: 1) range to target, and 2) target speed. One half of the 20 trials in each task (A,B, and C) are conducted at a target range of 450 meters, the remaining half are conducted at the 250 meter range. Target vehicle speeds are varied between 5, 10, and 25 miles per hour (mph). Further, simulation of target ranges are varied within the LET during each of the firing exercises. A detailed explanation of this simulation process is found in Change 1, to TC 23-24 (DoA, 1974), and in TC 23-20 (DoA, 1975). Table 10 shows the LET/monitor set range settings required to attain simulated target speeds of 17 and 35 kilometers per hour (kph) (TC 23-24, DoA, 1974).

In addition to qualification firing, a Dragon gunner proficiency test, similar to that prescribed for TOW gunners, is included as a MOP. Both TC 23-24 (DoA, 1974) and TC 23-20 (DoA, 1975) contain examples of this test. Table 11 shows the proficiency test outlined in TC 23-24. As with the TOW gunner, the satisfactory completion of the proficiency test is prescribed as a requirement for Dragon gunners prior to eligibility for qualification firing. Again, practice, in fact, indicates that this requirement is not mandatory and the test scores probably should not be relied upon as a true MOP.

TC 23-24 (DoA, 1974) draws attention to the fact that once a Dragon gunner is trained, retention of proficiency is not possible without monthly refresher training. A degradation of approximately 25 percent in accuracy can be expected unless retraining, or sustained training is accomplished. From the Dragon OT IIIA (Wohlman, Griffard, and Shockey, 1976) it was found that the effectiveness (probability of hit, Ph) of both expert and first class gunners deteriorates over time. This study suggests that a valid criterion might be to require Dragon gunners to qualify as experts. A special analysis of M47 Dragon training, (USACATB, 1975), substantiates these findings. Figure 2 illustrates the proficiency degradation assertion.

Individual Training Standards. Standards for Dragon gunners prescribed in TC 23-24 (DoA, 1974) and TC 23-20 (DoA, 1975) are identical. In the proficiency test the Dragon gunner is required to correctly answer 17 of 20 questions in order to successfully pass the examination. No standards are prescribed for the "hands-on" proficiency portion of the performance examination. However, TC 23-24 recommends that the gunners who fail the proficiency test should be retrained prior to taking the examination a second time. Those

Table 10

TARGET VEHICLE SPEED

(Required to attain an apparent rate of speed of 17 kph)

Range to Target Road (meters)	Monitor Set Range Setting	Target Vehicle Speed (mph)
200	2	10
250	2	15
400	2	20
450	2	25
200	2	5
250	5	5
400	5	10
450	5	10
700	5	15
900	5	20
1000	5	20
400	10	5
450	10	5
500	10	5
800	10	10
900	10	10
1000	10	10

(continued)

Table 10 (concluded)

TARGET VEHICLE SPEED

(Required to attain an apparent rate of speed of 35 kph)

Range to Target Road (meters)	Monitor Set Range Setting	Target Vehicle Speed (mph)
200	2	20
250	2	25
200	5	10
250	5	10
350	5	15
450	5	20
550	5	25
200	10	5
250	10	5
400	10	10
450	10	10
650	10	15
700	10	15
900	10	20

Table 11

PROFICIENCY TEST AND WRITTEN TEST

Proficiency Test

This performance examination is provided to the units to determine the gunner's proficiency prior to the qualification tracking exercise. On the written portion, the gunner must answer 17 of the 20 questions.

NAME _____
RANK _____
SSAN _____
ROSTER # _____
DATE _____

STATION ONE - Launch effects trainer and monitoring set hookup and preparation.

STATION TWO - Charging, loading, and arming of the launch effects trainer.

STATION THREE - Battery charging procedures for the monitoring set (24 volt/DC).

STATION FOUR - Place the launch effects into operation (preparation of LET for firing, using the tracker).

STATION FIVE - Place target set into operation.

STATION SIX - Boresight alignment of monitoring set with tracker (target at 250 meters).

STATION SEVEN - Hangfire misfire procedures for the tactical round and launch effects trainer in a training environment.

STATION EIGHT - Disassembly and assembly of the launch effects trainer for cleaning.

STATION NINE - Gunner pre-operational check of the tracker and round.

(continued)

Table 11 (continued)

Written Test

1. After launch, the Dragon missile will always be armed at _____ meters.
2. The backblast area for the Dragon weapon system extends 50 meters to the rear of the launcher. This includes a _____ meter danger area and a _____ meter caution area.
3. After leaving the launch tube, the missile velocity is _____ meters per second and at full range has increased to _____ meters per second.
4. The Dragon weapon system has a _____ meter minimum effective range and a _____ meter maximum effective range.
5. The missile has _____ pairs of rocket motors which provide thrust to sustain missile flight and control the flight path.
6. When the target is at maximum range, it must be _____ meters long to fill the area between the stadia lines.
7. There is a _____ meter danger area observed to the front of the energized target source on the target board.
8. To prevent damage, the lamp start switch on the power supply modulator should not be held in the UP position for more than _____ seconds.
9. The monitoring set TRACKER POWER switch should be in the _____ position during tracking engagements.
10. If capture is certain and the round cannot be fired, the gunner should first destroy the _____ and then the _____.

Multiple Choice

11. While using the monitoring set in tracking operations, the batteries may be:
 - a. charged from the 230 VAC source.
 - b. charged from the 24 VDC source.
 - c. charged from the 115 VAC source.
 - d. charged from any of the above sources.

(continued)

Table 11 (concluded)

12. How is the LET firing safety disengaged?
- a. Manually.
 - b. Automatically when the breech is opened.
 - c. Automatically when the breech is closed.
 - d. Automatically when the breechlock release lever is moved to the downward direction.
13. As the Dragon flies down range the tracker guides the missile to the target because the:
- a. tracker sees the target.
 - b. gunner sees the target and the tracker guides the missile along his line of sight.
 - c. tracker sees infrared energy radiated by the target.
 - d. tracker sees the heat energy radiated by the target and the missile.
14. When should the LET dummy projectile be reset?
- a. After loading a fresh cartridge into the cartridge chamber, but before the firing safety is placed in the fire position.
 - b. After the spent cartridge is removed from the cartridge chamber, but before loading a fresh cartridge.
 - c. Before the spent cartridge is removed from the cartridge chamber.
 - d. Immediately before giving the gunner permission to fire.
15. What cleaning agent may be used to moisten lens tissue when cleaning tracker lenses?
- a. Distilled water.
 - b. Ethyl alcohol.
 - c. Denatured alcohol.
 - d. None of the above.

True or False Questions

16. ____ Team drill develops teamwork, precision, and speed in placing the Dragon weapon system into operation. However, practice for speed is the last phase.
17. ____ Direct sunlight or other strong lights will damage the tracker optics.
18. ____ The TARGET SIZE switch on the monitoring set is used to select the time period of a tracking run.
19. ____ Electrical power from the monitoring set batteries is used to fire the LET
20. ____ No maintenance or repair is performed on the Dragon missile at organizational maintenance level.

5 PH IS FOR FIRST ROUND

6 CONCLUSIONS ARE TENTATIVE BECAUSE OF SMALL SAMPLE SIZE (11-2-10).

7 RATE OF EFFECTIVENESS DEGRADATION GREATER FOR FIRST CLASS THAN FOR EXPERT.

8 REFRESHER TRAINING MANDATORY.

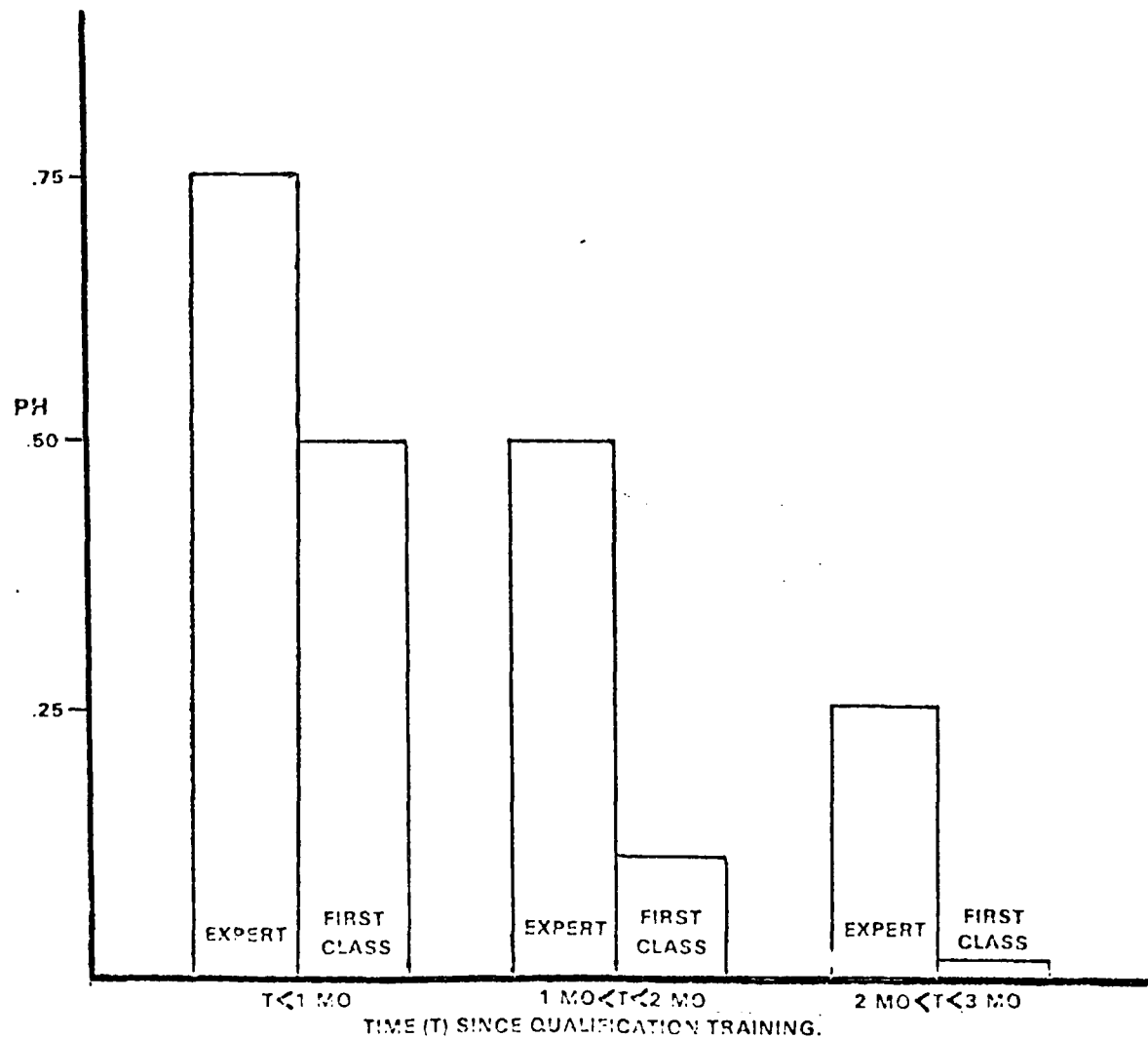


Figure 2. Comparison of effectiveness between expert and first class Dragon gunners. (Wohlman, Griffard, and Shockey, 1976)

who fail for a third time are to be considered for elimination from further Dragon training. During qualification firing the gunner is scored on a dichotomous standard - hit or miss, as registered on the LET. Gunners must score a total of 14 or more hits out of 20 trials in each of the three tasks/positions during his firing exercises. The scores achieved during the 60 trials are summed after completion of the exercise and the gunner is awarded an overall classification based upon the following criteria:

- | | |
|---------------------|---------------|
| 1. Expert | 57 to 60 hits |
| 2. 1st Class Gunner | 51 to 56 hits |
| 3. 2nd Class Gunner | 43 to 50 hits |
| 4. Unqualified | 42 and below |

Although there are provisions for attaining and recording LET monitoring set scores indicating tracking error performance and percent of time on target scores, these feedback indicators are not included in individual training standards as applied to qualification proficiency.

Collective Training Standards. Considerable confusion exists in available literature concerning whether or not the Dragon weapon system is a one-man weapon or should be considered as a two-man system. Both TC 23-24 (DoA, 1974) and the Infantry School's Dragon Weapon System Instructor Packet (USAIS, 1974), describe, in a few instances, the Dragon as being operated by a two-man crew. Theoretically the gunner fires the weapon while his assistant carries extra rounds and is presumed to be available for target identification, clearing of firing areas and position preparation. The brief descriptions referring to the two-man Dragon crew are highly inconsistent with the majority of training literature, including these two primary sources, and TC 23-20 (DoA, 1975) as well. In addition, the two-man Dragon crew principle runs contrary to the designated gunner concept. Since the Dragon system, including the tracker and a single round is a one-man portable load, and because all training performance measures are designed for individuals, this apparent ambiguity should be corrected as soon as possible to alleviate any doctrinal conflict.

Training Content and Methods. There are two primary training programs prescribed for the Dragon system: a basic one for users and a longer one for potential Dragon trainers. The Dragon user course is outlined in TC 23-20 (DoA, 1975) and TC 23-24 (DoA, 1974) and consists of a 35.5 hour instruction block distributed over 5 days (see also USAIS, 1974). It is illustrated in Table 12.

Table 12
SEQUENCE OF DRAGON GUNNER QUALIFICATION PROGRAM*

Day	Content Area	Hours
1	Introduction to the M47 Dragon	.5
	Introduction to the Dragon Training Equipment	.5
	Practical Exercise with Dragon Training Equipment	1.0
	Familiarization Table I	2.5
	Operator Maintenance and Battery Charging Procedure with Training Equipment	1.0
	Conference/demonstration	.4
	Practical Exercise I	.6
	Instructional Table II	2.5
	Maintenance of Training Equipment	.5
		8.5
2	Practical Exercise I on Dragon Training Equipment	.5
	Instructional Firing Table III	2.0
	Tank Identification and Vulnerabilities	1.5
	Introduction to the M222 Missile	.5
	Instructional Firing Table IV	1.5
	Technique of Fire	1.0
	Prepare Subsequent Rounds for Firing	
	Maintenance of Training Equipment	.5
		7.5

(continued)

Table 12 (continued)

SEQUENCE OF DRAGON GUNNER QUALIFICATION PROGRAM

Day	Content Area	Hours
3	Practical Exercise on Dragon Training Equipment	. 5
	Prone Familiarization Firing Table VII	.5
	Instructional Firing Table V	1.5
	Instructional Firing Table VI	1.5
	Maintenance of Training Equipment	.5
	Administer Dragon Proficiency Test	3.5
		8.0
4	Practical Exercise on Dragon Training Equipment	.5
	Qualification Table VIII (Sitting)	1.5
	Qualification Table IX (Kneeling)	1.5
	Maintenance of Training Equipment	.5
	Qualification Table X (Standing Supported)	1.5

Day Field
Tracking

STATION ONE - Tracking
(From APC and two-man separated foxhole) 2.5

STATION TWO - Tracking
(From sitting and kneeling positions)

STATION THREE - Dragon range card

STATION FOUR - Dragon battle drill (preparation
of subsequent rounds for firing working in two-
man teams)

(continued)

Table 12 (concluded)
SEQUENCE OF DRAGON GUNNER QUALIFICATION PROGRAM

Day		Hours
4		
<u>Night Field</u>	Introduction to Night Firing Techniques	2.5
<u>Tracking</u>		
	<u>STATION ONE</u> - Tracking from APC	
	<u>STATION TWO</u> - Tracking from foxhole	
	<u>STATION THREE</u> - Tracking from sitting position	
	<u>STATION FOUR</u> - Tracking from kneeling position	
		10.5
5	Graduation	1.0
		1.0

SUMMARY OF TOTAL HOURS

DAY ONE	8.5
DAY TWO	7.5
DAY THREE	8.0
DAY FOUR	10.5
DAY FIVE	1.0
	35.50

NOTE: This program as written is compressed to minimum time. Scheduling should consider time allowances for holidays, poor weather, training equipment availability, or instructor/student ratio greater than 1:4, any of which will require additional time. Recommend normal scheduling of 5 days.

The Dragon trainer course is conducted in order to provide qualified trainers at the unit level to initiate Dragon training within the unit. It lasts three weeks and covers basic teaching skills and tactical aspects, as well as the basic Dragon course content. Both courses are conducted at Ft. Benning, Georgia and are part of the prescribed program of instruction at the Infantry School. The users course, as contained in TC 23-20 (DoA, 1975), is provided as guidance to field units in order to sustain Dragon gunner proficiency and to train new gunners who have not received institutional Dragon training.

TC 23-24 (DoA, 1974) outlines the training objectives, intermediate training objectives, conditions and training standards for training and evaluating Dragon gunners in all components of the Army. The purpose of this training program are threefold:

- qualify individual gunners,
- develop and maintain gunner proficiency,
- train gunners in the engagement of multiple armor targets.

This training program is used in Advanced Individual Training (AIT) Centers and in Unit training in field units. Table 13 shows the content of this program in detail.

TC 23-20 (DoA, 1975) prescribes a program of training recommended for the maintenance of Dragon gunner proficiency in Army field units. Table 14 shows this abbreviated outline.

Training Devices. Dragon gunnery criteria are obtained through the use of the LET training device. Although some studies have attempted to correlate training performance with missile firing on operational equipment (Donlon and Mason, 1974), there remains doubt as to the effectiveness of the current devices in achieving the required criteria. Regardless of the cost associated with live missiles (approximately \$3,500.00) the need exists for a live fire versus LET tracking experiment to validate the transfer of training issue.

Regardless of the need to conduct a validation experiment the LET training equipment does represent a standard issue item in current use in field units. The LET is used in conjunction with the monitoring set, the infrared transmitter, the Field Handling Trainer (FHT), and the Television Trainer (TVT). Two other devices, the Launch Signature Simulator (LSS), and the Dancing Dragon have been

Table 13

DRAGON TRAINING PROGRAM*

a. TRAINING OBJECTIVE I - Gunner Preparation and Proficiency Training.

TASK: Engage armor vehicles.

CONDITIONS: On a tracking range, during daylight, given:

- (1) Dragon training equipment to include launch effects trainer (LET) monitoring set, and infrared transmitter M89 (target set - Dragon).
- (2) Target vehicle (truck 1/4-ton).
- (3) Cartridge, grenade, caliber 7.62mm (NATO) M64 - 125 per student.
- (4) Tracker, Dragon, SU-36/P - 1 per LET.
- (5) Familiarization and instructional firing tables I-VIII score-cards (1 set per student).

TRAINING STANDARD: Achieve 14 of 20 possible hits on each of instructional firing tables V, VI, AND VII.

NOTE: Instructional firing tables IV through VI are identical to qualification tables VIII through X. Evaluation of these tables provides trainers with a means of determining a gunner's level of proficiency prior to gunner qualification. (Retrain gunners in weak positions and tracking exercises as time is available.)

INTERMEDIATE TRAINING OBJECTIVE #1

TASK: Inspect the Dragon weapon system M47.

CONDITIONS: During daylight, given the tracker, field handling trainer, and TM 9-1425-480-10.

TRAINING STANDARD: Equipment is complete and serviceable in accordance with TM 9-1425-480-10.

(continued)

* (TC 23-24, DoA, 1974)

Table 13 (continued)

DRAGON TRAINING PROGRAM

INTERMEDIATE TRAINING OBJECTIVE #2

TASK: Place the M47 Dragon weapon system into operation.

CONDITIONS: Acting as a Dragon gunner during daylight, given a tracker and field handling trainer. Gunner is told to place weapon into operation and to assume in succession the sitting, kneeling, and standing supported positions.

TRAINING STANDARD:

- (1) The bipod legs are extended and locked into place.
- (2) The tracker is mated to the round.
- (3) The bipod legs are adjusted.
- (4) The firing position directed by the trainer is assumed by the gunner in accordance with chapter 7, section 11, this TC.

INTERMEDIATE TRAINING OBJECTIVE #3

TASK: Inspect the Dragon training equipment.

CONDITIONS: During daylight, given the tracker, launch effects trainer, monitoring set, field handling trainer, target set, TM 9-1425-480-10, TM 9-6920-480-12-1, and TM 9-6920-480-12-2.

TRAINING STANDARD: Equipment is complete and serviceable in accordance with TM 9-1425-480-10, TM 9-6920-480-12-1, and TM 9-6920-480-12-2.

INTERMEDIATE TRAINING OBJECTIVE #4

TASK: Place the Dragon training equipment into operation.

CONDITIONS: During daylight, on a Dragon tracking range, given the launch effects trainer, monitoring set, tracker, infrared transmitter M89, 1/4-ton target vehicle, TM 9-6920-480-12-1, TM 9-6920-480-12-2, and TM 9-1425-480-10.

TRAINING STANDARDS:

- (1) The cables are connected, switches are positioned, tracker mated to the launch effects trainer, the target set is installed on the target vehicle, and all equipment operates in accordance with TM 9-6920-480-12-2, chapter 2, sections 11 and 111.

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

(2) Monitoring set is aligned to the ir transmitter of the tracker in accordance with TM 9-6920-480-12-1, chapter 2, section III, table 2-7.

(3) The launch effects trainer is loaded, armed, and weight reset in accordance with paragraph 5-4, this TC.

NOTE: Upon successful completion of INTERMEDIATE TRAINING OBJECTIVES 1 through 4, each gunner should complete familiarization firing table I.

INTERMEDIATE TRAINING OBJECTIVE #5

TASK: Perform operator maintenance on the Dragon training equipment.

CONDITIONS: During daylight, on a Dragon tracking range, given the Dragon training equipment, tracker, TM 9-1425-480-10, TM 9-6920-480-12-1.

TRAINING STANDARD: The student will:

- (1) Charge monitoring set using a vehicle with a 24-volt power source in accordance with TM 9-6920-480-12-1.
- (2) Disassemble, clean, and assemble the launch effects trainer in accordance with TM 9-6920-480-12-1.
- (3) Clean the tracker in accordance with TM 9-1425-480-10.

NOTE: Upon successful completion of INTERMEDIATE TRAINING OBJECTIVE #5, students are ready to fire instructional firing tables II-VI and familiarization firing table VII.

b. TRAINING OBJECTIVE 2 - Dragon Gunner Qualification.

TASK: Engage armor vehicles.

CONDITIONS: On a tracking range, during daylight given:

- (1) Dragon training equipment to include launch effects trainer, monitoring set, target set M89 complete, and tracker.
- (2) Target vehicle (1/4-ton truck).
- (3) Cartridge, grenade, caliber 7.62mm (NATO) M64 - 60 per student.
- (4) Qualification firing tables VIII, IX, and X scorecards.

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

TRAINING STANDARD: Achieve 14 Of 20 possible hits on each of qualification firing tables VIII, IX, and X.

NOTE: Prior to each student firing the qualification tables, the performance test should be administered to determine the student's level of skills acquired. Students who fail the performance test should be retrained prior to a second attempt. If another failure results, the students' training will be discontinued.

c. TRAINING OBJECTIVE 3 - Engagement of Multiple Targets.

TASK: Engage multiple armor targets.

CONDITIONS: Acting as a Dragon gunner, alternate gunner, or squad lead during a daylight and night field tracking exercise, given:

- (1) A tracker and two field handling trainers.
- (2) Launch effects trainer and monitoring set.
- (3) Multiple armored vehicles with target sets mounted (tanks/APCs/w/target sets) moving at varying ranges from 200 meters to 1000 meters.
- (4) Cartridge grenade caliber 7.62mm (NATO) M64 - 10 per student.

TRAINING STANDARD:

- (1) The squad leader directs the Dragon gunner to fire at two selected targets in sequence within 45 seconds.

NOTE: Time starts with trigger squeeze of first missile and ends with hit or miss of second missile.

- (2) The alternate gunner prepares subsequent rounds for firing to include setting bipod legs at appropriate height.
- (3) The gunner engages the two targets as directed by the squad leader.

NOTE: This training is designed to develop teamwork, coordination, precision, accuracy, and subsequent speed in multiple target engagement techniques. This objective cannot completely evaluate gunner accuracy; however, when this training is integrated with smoke on the battlefield, artillery simulators, blank fire, tracking against multiple targets in varying formations and ranges, and firing under 81mm mortar illumination at night, it provides an excellent training vehicle to assist in increasing gunner proficiency.

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

B-3. General Training Notes. The Dragon Gunner Qualification Program must not be compressed to less than 4 days, and it is desirable to conduct the training on a half-day basis, over a period of 8 days. Regardless of scheduling, no more than 30 M64 cartridges should be fired per half training day, except during qualification. The following is the sequence of the Dragon Gunner Qualification Program:

a. Day One.

- (1) Introduction to the M47 Dragon (into operation/firing positions/safety). 5 hrs
- (2) Introduction to the Dragon training equipment (infrared transmitter/monitoring set/launch effects trainer/field handling trainer tracker) 5 hrs
- (3) Practical exercise on training equipment (hands-on training). 1.0 hrs
 - (a) Place LET into operation.
 - (b) Mount tracker to LET.
 - (c) Place monitoring set into operation.
 - (d) Boresight alinement.
 - (e) Correct aiming point.
 - (f) Safety.
- (4) Familiarization table 1 (30-round table-dry fire). . . 2.5 hrs
- (5) Operator maintenance and battery charging procedure with training equipment (conference and PE with hands-on training . 1.0 hrs
 - (a) Disassembly of the LET.
 - (b) LET cleaning procedures.
 - (c) Installation of batteries in LET.
 - (d) Charging monitoring set from DC current on tactical vehicle.
 - (e) Maintenance on tracker.
 - (f) Assembly of the LET.

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

(6) Instructional firing table II (30-round table, with M64)	2.5 hrs
(7) Maintenance of training equipment	.5 hrs
	8.5 hrs

b. Day Two.

(1) Practical exercise on Dragon training equipment . . .	.5 hrs
(a) Set up firing line.	
(b) Place training equipment into operation.	
(2) Instructional firing table III (30-round table, with M64)	2.0 hrs
(3) Introduction to tank identification and vulnerabilities (conference and PE).	1.5 hrs
(4) Introduction to the M222 Missile (conference, functioning, hangfire/misfire, safety).	.5 hrs
(5) Instructional firing table IV (20-round table, with M64)	1.5 hrs
(6) Technique of fire (Practical exercise. Work in two-man teams. Prepare subsequent rounds for firing, using trackers and field handling trainers)	1.0 hrs
(7) Maintenance of training equipment	.5 hrs
	7.5 hrs

c. Day Three.

(1) Practical exercise on Dragon training equipment . . .	.5 hrs
(a) Set up firing line.	
(b) Place training equipment into operation.	
(2) Prone familiarization firing table VII (5-round table, with M64)	.5 hrs

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

(3) Instructional firing table V (20-round table, with M64)	1.5 hrs
(4) Instructional firing table VI (20-round table, with M64)	1.5 hrs
(5) Maintenance of training equipment	.5 hrs
(6) Administer Dragon proficiency test.	3.5 hrs
(a) Proficiency test.	
(b) Written test.	

8.0 hrs

d. Day Four.

(1) Practical exercise on Dragon training equipment . . .	.5 hrs
(a) Set up firing line.	
(b) Place training equipment into operation.	
(2) Qualification table VIII (sitting) (20-round table, with M64).	1.5 hrs
(3) Qualification table IX (standing supported) (20-round table, with M64)	1.5 hrs
(4) Maintenance of training equipment	.5 hrs
(5) Qualification table X (kneeling) (20-round table, with M64).	1.5 hrs
(6) Dayfield tracking ¹	2.5 hrs
(a) Station One - Tracking (from APC and two-man separated foxhole).	
(b) Station Two - Tracking (from sitting and kneeling position).	

(continued)

Table 13 (continued)

DRAGON TRAINING PROGRAM

(c) Station Three - Dragon range card.

(d) Station Four - Dragon battle drill (preparation of subsequent rounds for firing, working in two-man teams).

¹TRAINING NOTE: Throughout the tracking exercise, students will rotate through the above stations with the following actions integrated:

1. Tracking APCs with target set mounted and tanks moving in various formations at ranges varying from 200 meters to 1000 meters.
2. Smoke (30-pound smokepots and hand smoke grenades) on student positions and in vicinity of APCs and tanks.
3. Artillery simulators.
4. Firing of small arms blank ammunition to simulate battlefield noise.

(7) Nightfield tracking² 2.5 hrs

- (a) Introduction to night firing techniques.
- (b) Station One - Tracking (from APC).
- (c) Station Two - Tracking (from foxhole).
- (d) Station Three - Tracking (from sitting position).
- (e) Station Four - Tracking (from kneeling position).

²TRAINING NOTE: Throughout the tracking exercise, students will rotate through the above stations with the following actions integrated:

1. Bent tracking.
2. Tracking APCs and tanks moving in various formations at ranges varying from 200 meters to 1000 meters.
3. 81-mm mortar illumination.
4. Tank xenon searchlight.

10.5 hrs

(continued)

Table 13 (concluded)

DRAGON TRAINING PROGRAM

e. Day Five - Graduation (1.0 hr).

f. Summary of total hours.

(1)	Day One	-	8.5 hrs
(2)	Day Two	-	7.5 hrs
(3)	Day Three	-	8.0 hrs
(4)	Day Four	-	10.5 hrs
(5)	Day Five	-	1.0 hr
(6)	Total	-	35.5 hrs

Table 14

DRAGON UNIT TRAINING PROGRAM

This training program is a guide to assist you in maintaining Dragon gunner proficiency within your unit. Training goals are divided into monthly, quarterly, semi-annual, and annual training requirements.

MONTHLY REQUIREMENTS

- Fire Familiarization Table I - Dry
- Instructional Table III - Dry

QUARTERLY REQUIREMENTS

- Fire Instructional Table IV, V, and VI
- Conduct Performance Exam
- Fire Qualification Tables VIII, IX, and X
- Fire Refresher Table II (TC 23-24)

SEMI-ANNUAL REQUIREMENTS

- Conduct advance field tracking contained in Dragon Gunner Qualification Course during training at MTA (OCONUS) and parent installation (CONUS).
- Conduct Basic Dragon Gunner Course for new gunners.

ANNUAL REQUIREMENTS

- Each gunner fire one live missile.
- Conduct ARTEP

SPECIAL NOTE: New gunners qualifying will be awarded the ASI of C2.

developed but are no longer in use as standard devices.

The LET consists of a tracker and launch tube, with internal components capable of producing recoil and weight shift. It may be used in a simulated tactical environment and will operate in all weather conditions in which the gunner can see the target. Being the basic training device for developing gunner proficiency, its use in conjunction with the monitoring set is mandatory for the qualification of Dragon gunners. When used in conjunction with associated items of Dragon training equipment, i.e., the FHT, an infrared transmitter, and a monitoring set, the LET is used to evaluate a gunner's performance not only with regard to "hits" or "misses", but also to judge his tracking techniques. With explosive power provided by the M64 grenade cartridge, the LET is supposed to simulate live Dragon missile launch. The explosive power of the grenade cartridge drives a dummy weight forward in a pressure tube contained within the launcher, thus simulating weight loss and recoil. Several problems specific to the LET and its use have been identified:

- It requires an infrared source as the target, which limits the number of targets that can be made available for meaningful multiple engagements.
- In evaluating the performance of a gunner, certain tracking judgements must be made by an instructor/evaluator who, in many cases, has never fired a live missile. In essence, he is scoring the gunner on his (gunner's) ability to track with the LET.
- The design limitations of the LET restrict electrically scored exercises to flat, open terrain and nearly perpendicular launcher-target orientation. Tracking the target board with its large cross at actual ranges varying between 250 and 450 meters, and moving laterally is considerably easier than tracking an armored vehicle moving tactically over varied terrain at realistic combat related speeds.
- The LET does not realistically simulate the launch environment of Dragon, thus precluding the gunner from experiencing the blast, flame and smoke obscuration, and flying debris that are a part of the normal environment.

- The LET launch effect is more severe in most cases than that experienced with the Dragon. The gunner is conditioned to make inappropriate compensating movements.
- The LET recoil differs characteristically from a live missile fire. (It is in the opposite direction from a live missile launch.)
- The M64 grenade cartridge is supplied as a separate ammunition item and is subject to the logistic problems associated with ammunition allocations.

The monitoring set is used to monitor and evaluate the tracking performance of the Dragon gunner. It is powered by self-contained, rechargeable, nickel cadmium batteries. The housing for the monitoring set contains the monitoring set control and display panel for training, and the electrical cables necessary to operate and recharge the monitoring set.

The infrared transmitter, mounted on the target board, is used in conjunction with the monitoring set and emits an infrared signal received by the LET tracker.

The FHT consists of an expended launch tube with weight added so as to approximate the weight of the missile system and a tracker. It is used in lieu of the Dragon tactical round and LET when conducting field exercises to prevent unnecessary damage to the tactical round and LET. The FHT, with tracker, can be used to aid gunners in learning and performing their duties and to assist trainers in evaluating gunner positioning, sighting, aiming, breathing, and tracking. It lacks any capability to familiarize gunners with the salient aspects of the Dragon launch environment; e.g., feedback.

The Television Trainer (TVT) capitalizes on the fact that each active Army combat battalion has been issued two Sony TV cameras for training use. By mounting the TV camera on the right front of the FHT, an instructor can view a gunner's tracking ability on the Sony video screen equipped with crosshairs to replicate the sight picture. The TVT provides trainers with a means of observing, recording, and playing back the performance of Dragon gunners while sighting and aiming the weapon, breath control during tracking, and provides an immediate response in the cause/effect relationship of momentary gunner distraction during and after simulated missile launch. Limitations associated with the TVT are:

- field units require that users of the TVT complete a formal course of instruction in the operation of the device,
- reliability, availability and maintainability (RAM) for the TVT is marginal,
- only two TVT sets are available within most battalions,
- the equipment is cumbersome, sensitive, and easily damaged, thus it is not habitually used in field tactical tracking exercises.

Trainee Selection. The Dragon, as earlier explained, is fired by a designated rather than a dedicated gunner, as in the case of the TOW weapon system. Designation equates, in most units, to an "additional duty" for selected personnel assigned to rifle platoons. Designated gunners may be assigned an assistant gunner in tactical situations where extensive employment of the Dragon is anticipated. The assistant gunner's primary responsibility is to carry additional missiles and assist in preparing firing positions for the Dragon. Normally, one Dragon tracker is assigned to each rifle squad. Thus, three Dragon per rifle platoon and 27 per battalion is the average assignment.

Specific guidelines structure the platoon leader's and company commander's assignment of personnel to Dragon duties. For one thing, leaders must assign an individual to his primary or secondary MOS, provided a position is available. An 11B not already possessing the additional skill identifier (ASI) assigned to Dragon duties must go through the Dragon training program and receive the commander's recommendation prior to being administratively awarded the ASI. The platoon leader and company commander rarely utilize formalized selection criteria to select and assign such personnel. Because there are command pressures to maintain preestablished unit Dragon qualification quotas, leaders are left with no alternative other than to fill the position(s) and try to train the individual(s) to function effectively.

Dragon gunners, once trained, are awarded an (ASI) of C2, and usually serve in MOS 11B (Infantryman) within the rifle platoon. The platoon leader, having basic responsibility for personnel assignment within the platoon, has two alternatives with respect to designation of Dragon gunners:

- He may assign those personnel already possessing MOS 11B and ASI C2 to the position of designated Dragon gunners; or,

- He may assign other platoon members who lack the ASI to perform Dragon duties and initiate training programs designed to qualify the individuals appropriately.

The gunner selection process for the Dragon follows the same general procedure as discussed under TOW gunner selection. Individuals are selected for institutional training based upon recommendations of commanders, the individual's test scores, records and reports, and the immediate and future needs of the Army (Byers, Note 3). Since Dragon gunners are designated and not dedicated the selection process at the unit level is, in all probability, minimal at best. This fact may be responsible, in part, for the general attitude in many units that: "anyone can fire the Dragon." It is a simple fact that no detailed task or skill analysis has been performed for the Dragon gunner. In the absence of this analysis, no selection process is valid. Thus, no rational selection criteria currently exist.

Not only are procedures for identifying individuals with Dragon, critical skills nonexistent within units, but training individuals to become proficient Dragon gunners presents a problem. To insure retention of proficiency, gunners must receive specified monthly, quarterly, semi-annual, and annual training. This becomes especially difficult because the Dragon gunner has other primary duties he must be trained to perform. All these factors, viewed either separately or as a whole, provide sufficient rationale for an analysis of critical skills and the development of a viable selection process (TC 23-20, DoA, 1975).

Summary. The similarities between the criteria, conditions and standards now contained in Dragon gunnery training programs and those associated with the TOW weapon system are many. Deficiencies exist in both. Perhaps the most meaningful, and positive, aspect of the Dragon training program is the availability of hit/miss feedback on the LET. This single advantage provides, at least in the task of tracking targets, some meaningful combat/threat referenced relationship.

Regardless of the advantage afforded Dragon gunners by the availability of hit/miss feedback, certain other conclusions may be appropriate concerning the effectiveness of current Dragon training:

- There exists an unvalidated relationship between the hit/miss scores attained on the LET device and scores achieved in firing operational equipment.
- All Dragon training, including collective, unit tactical training remain, essentially, noncombat-referenced.
- Selection criteria, in the absence of a detailed task and skill analysis, are not systematically applied and are, at best, currently invalid.
- Current Dragon training over emphasizes tracking skills, while training in such critical tasks as range determination, target identification, tactical employment, and fire control are neglected.
- A detailed threat analysis, keyed to the needs of the rifle squad and platoon, would provide a base point for the development of standardized Dragon threat referenced criteria.
- References in current literature which allude to the Dragon weapon system as being a two-man system cause confusion and should be eliminated, or clarified.

RESEARCH FINDINGS

Hardware Demands on Operator. As with the TOW system the Dragon gunner, by virtue of the wire link associated with the command to line of sight guidar - system, must remain in position after firing the missile until impact with the target. This single requirement, (USAIS, 1974) is undoubtedly the most critical demand placed upon the Dragon gunner. TC 7-24 (DoA, 1975) emphasizes that providing protection for antitank weapon crews, including Dragon is extremely critical, because of the gunner tracking requirement throughout the entire flight of the missile to target. Any small arms or automatic weapon fires, not to mention artillery or main gun suppressive fires from armored vehicles, which cause the gunner to flinch or move his eye from the sight or target image, will normally neutralize the effectiveness of the Dragon missile.

Restrictions on the firing angle for the Dragon are directly related to the backblast and overpressure effects of the system. For instance, a launch tube elevation greater than 20° in relation to the ground could prove extremely dangerous to the gunner due to pressure waves and secondary debris

which accompany missile launching. The Dragon system cannot safely be fired from enclosed areas such as bunkers or rooms. Structural damage will result from such firing which could injure the gunner and other occupants of the inclosure (TC 23-24, DoA, 1974).

Preparation of firing positions in order to minimize launch signature, safely, and the effects of backblast upon Dragon gunner effectiveness are currently under emphasized in Dragon training.

Threat. The major threat facing the Dragon weapon system can be stated simply: tanks and other armored vehicles on the battlefield which have not been engaged and neutralized by longer range (over 1000 meters) friendly antitank weapons. These vehicles, generally, are described as:

- T-54/55, T-62, and T-72 tanks,
- BRDM/BMP armored personnel carriers,
- ZSU-23/4, and ZSU-57-2 self-propelled anti-aircraft weapons.

The TETAM studies (USACDEC, 1974; and USACACDA, 1973, 1974) provide data which could form a base line of sufficient quantity and quality to allow a detailed, combat-referenced threat analysis to be performed. Once completed, this analysis should be used to establish threat referenced training criteria.

Measures of Effectiveness. For the Dragon weapon system, the original source for developing MOE of the parent system and the subsequent interpolations for training criteria came from Dragon OT III (Operational Test III) (e.g., Ellis and Bright, 1973; Herren, Jones, and Reynolds, 1975; and Perkins, Melton, Lytle, Barron, and Lutx, 1975). Perkins, et al., provided little usable criteria because only optimal conditions (i.e., single, slow moving, cooperative targets) were evaluated. Realistic tactics were excluded as were considerations of threat. Analysis of the results did provide some useful points that have implications for training criteria. After the first live fire, gunner confidence increased and individual ability stabilized (i.e., intrasubject differences). The study also indicated that differences exist between expert and first class gunners in qualification (on the LET) and for probability of first round live fire hits (see Figure 2). Larson (1975) found that a second daylight live fire significantly improved performance while cumulative hit probabilities reached an asymptotic level after the second round for day fire and after

the first round for night fire. An additional finding indicated that the percent of first round hits dropped significantly the longer the lapse between initial qualification (LET) and first live firing.

One of the most definitive studies was conducted by Stewart, Christie, and Jacobs (1974). The purpose of the study was to correlate performance on the Dragon training equipment with the Dragon weapon system. The results indicated that the skills and abilities needed to qualify on the Dragon training equipment are different from the skills and abilities needed to be a successful Dragon gunner. The critical knowledge, skills, and abilities needed to maximize performance on the Dragon weapon system include maintaining system stability, launch environment familiarity, different fire techniques, the capability to engage different types of targets from different firing positions, and tracking ability. Other problem areas were also implied, e.g., range estimation and intervisibility.

As previously discussed, the development of the Dragon training program has been based on subjective estimates with no objective threat analysis. The inadequacy of the training criteria is documented in a McDonnell Douglas Astronautics Company report (1974):

"Since an in-depth analysis of the tasks and skills required to develop an effective training program was not funded for Dragon, the essential requirements for indoctrination, training, and training evaluation were generated on the basis of experience gained during the development of the training equipment. For example, during the training set design concept feasibility test conducted in October and November of 1968, five Army and Marine Corps personnel were used as test subjects to evaluate the training equipment. The data obtained during this evaluation indicated that the gunner tracking exercises should be limited to 30 firings of the LET per day with 20 firings being a good compromise for optimum learning. This data also indicated that a training program should include at least 80 to 100 LET firing exercises over a broad scope of ranges, target postures, and gunner positions in order to develop trained gunners with high proficiency." (p. 35)

In other words, training requirements were, at best, an afterthought for the Dragon weapon system. To base all initial training POIs on an $n=5$ provides a gross overestimation, or inadequate measurements, of gunner skill and ability for any combat referenced criterion. Again, problems of target identification capability, and correlating target speed and target range with time of missile flight were identified.

A final point of this study asserted that while Army qualification tables simulate different distances by altering tracking time, the sight picture never changes. Thus, it appears questionable to assume that engaging a target of constant size with variable tracking times is the same as engaging the same target at various distances.

An analysis of second generation Dragon training equipment (USAIS, 1974a, b ; and Quinn, 1974) discovered that (a) live missile firings were enhanced when the LSS was used, and (b) the use of the LET with the effects mechanism teaches poor gunnery techniques. Hence, the optimum training program would include the LET (without the launch effects mechanism) and its monitoring set, and the LSS. This retrofitting tactic arose from failure to consider the training criteria that should be achieved in the training program. Originally the LET with the monitoring set was designed to simulate missile launch and provide a means by which operator performance could be evaluated. However, training on the LET followed by live missile firings produces negative transfer and prevents effective live missile performance. The original LET with the launch effects mechanism produces physical characteristics different from live firings. This effect causes the operator to learn recovery techniques which are incompatible with a live launch.

A recent survey (USATRADOC, 1976) stated that no Dragon training program can be validated because no combat referenced criteria have been developed. The primary reason for this is that no analysis of the threat which Dragon may encounter has been conducted. Without the threat analysis, combat referenced criteria cannot be identified. The combat criteria are necessary in order to establish the critical tasks that have to be taught and learned during training.

Training Criteria. The most significant finding relating to Dragon training criteria concerns the requirement to establish combat referenced criteria. Only criteria associated with gunner tracking performance can currently be considered as remotely associated with combat criteria (USATRADOC, 1976). Simply stated, the primary need is to design combat-referenced criteria, including realistic conditions and standards, which could reasonably be expected to be found in the combat environment. At the same time resource constraints such as cost, training time and availability of training facilities must be considered - cost effective training being the prime objective.

Content and Methods. In Dragon training, gunner qualification standards do not necessarily reflect a gunner's true capability. USACATB (1975) found that the following target engagement capabilities were not emphasized during during gunnery training:

1. Night firing with artificial illumination.
2. Moving targets on undulating terrain.
3. Targets located at the maximum range.
4. Intervisibility of targets.
5. Tracking through obscuration.
6. High speed targets.

In another study, Wohlman, Griffard, and Shockey (1976) found that gunner proficiency decreased by approximately 50% if refresher training was not conducted at least once per month. Proficiency was also advanced if field training was included in monthly training. A recommendation of the study was to include training exercises in: a) preparing range cards, b) target identification, c) two-man battle drills, d) the use of the TVT to videotape live missile firing for critique purposes, e) environmental conditioning (e.g., day, night, rain, snow, cold, hot, etc.), and f) engagement of multiple, uncooperative targets.

Training Devices. When compared to other weapon system training devices, the state of the art has probably been most advanced with those devices available for Dragon gunnery training. Apparently, an effective training program for the Dragon can be materially assisted through the tandem use of all the presently available Dragon system devices (USAIS, 1974b; Graves, Jones, and Russell, 1976). Although the LET and its monitoring set were intended

to offer a realistic training environment. The net effect, however, was that inappropriate firing techniques resulted from its use (Donlon and Mason, 1974). The system has deficiencies which are related to unrealistic target vehicle speeds, and an inability to simulate realistic launch effects. Recommendations for modification of the LET have been made.

Trainee Selection. The McDonnell Douglas study (1974) reported that selection for the Dragon would be difficult until after training and evaluation with the LET. This approach is very inefficient. Thus, any selection method that discriminates between trainees who will qualify with the training equipment and subsequently become expert gunners, and trainees who will not qualify would presumably be training and cost effective.

Stewart, Christie, and Jacobs (1974) developed a selection program which was to identify those psychomotor, motor, and psychological variables that can be used to predict success in Dragon gunners.

The tests used for the predictor variables were:

1. Paper and pencil
 - a) confidence - despair scale
 - b) Taylor manifest anxiety scale
 - c) IPAT anxiety scale
 - d) Internalizer - Externalizer scale
 - e) aiming test
2. Psychomotor abilities
 - a) selective attention
 - b) arm-hand steadiness
 - c) simple reaction time
 - d) choice reaction time/response orientation
 - e) rate control - tracking ability
3. Motor abilities
 - a) trunk and shoulders flexion
 - b) gross body coordination

The results were six predictor equations that identified individuals who would be successful trainees and qualify with the LET. Unfortunately, Dragon trainees who have qualified with the LET were not necessarily good gunners.

Stewart, et. al. concluded that the skills needed to qualify with the LET are not those that are needed to be a successful gunner. The results were clouded by the fact that the number of live firings (36) used for comparison may have been too small.

SUMMARY AND CONCLUSIONS

Major Training Problems. The Dragon weapon system uses a wire guided missile similar to the TOW. It is inevitable, therefore, that the two systems are compared. The result is that the Dragon is usually considered a simple, stable system. The Dragon, like the TOW, is an antitank weapon. Other than that, the weapon systems are different. Training programs should reflect these differences. One of the most important differences are the functions attributable to the human in the soldier-weapon interface. The stability and the control of the system is more dependent on the operator for the Dragon than for the TOW.

Indications that the present Dragon training is grossly inefficient and ineffective are evident. Consider the deficiencies in the following list of statistics identified by a survey of 743 Dragon gunners (USATRADOC, 1976):

1. 91% have not qualified during the last quarter.
2. 61% have not qualified in over one year.
3. 47% have never trained in their unit.
4. 56% are uncertain of ability to hit a live target.
5. 32% are uncertain of ability to determine 1000 meters range.
6. 63% do not know missile time of flight.
7. 53% never practice preparation of second missile for firing.
8. 78% have not conducted night training during past year.
9. 47% identified a US/NATO tank as an enemy vehicle.

Current training programs for the Dragon lack credibility when consideration is given to realism and combat referenced criteria.

Major Research Findings and Needs. Instead of providing realistic, viable combat referenced training, the current Dragon Program of Instruction produces gunners which must be considered only marginally effective in tracking skills. It is presumptuous to assume that an individual who qualifies with a LET expert score is capable of identifying and acquiring a high speed, intervisible target moving over undulating terrain at a range of 900-1000 meters

at night under artificial illumination, as well as tracking through smoke obscuration. Even if a "qualified" Dragon gunner could do all of the above, the question remains as to whether he can do the same when several threat elements are within range and if the threat decides to fire at or near the gunner. Because of the nature of the systems, both TOW and Dragon gunners are supposed to launch missiles at a target which generate a very visible and distinctive signature at the time of launch, and continue tracking the target from the same, no-longer-concealed position. This may put the operator in a stress situation that may affect his proficiency. How his performance is affected has yet to be determined.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

It is apparent from the foregoing literature review that the concept of weapon system TEAs has not met its full potential. The piecemeal analysis of integral system components of the M16A1, TOW, and Dragon weapon systems have produced conflicting, uncoordinated and often invalid conclusions as to their effectiveness. A far more efficient approach would have been to implement a coordinated, long-term, programmatic analysis based upon standardized research and development efforts which recognized the "total system" concept currently being emphasized. Exigencies and production priorities associated with the Vietnam conflict prevented such analyses for the M16A1 rifle system. The requirement to field reduced-cost antitank system to replace massive production of tanks in the 1970s probably contributed to the uncoordinated introduction of the TOW and Dragon systems.

For the TEA concept to reach full fruition, its implementation must be viewed as requiring a long-term, centrally controlled, total systems analysis strategy. This approach to determining weapon system effectiveness, within a realistic combat environment, is essential if the objective is to provide for the implementation of cost-effective training programs and devices. The cost and complexity of modern military weapon systems preclude training to a simply stated norms referenced proficiency level, e.g., "expert." Expert gunners do not habitually equate to effective gunners. Total effectiveness for a weapon system cannot be expressed in terms of hardware performance potential or training program developmental efforts. Instead, combat referenced criteria, established very early in the developmental process, and integrated with human (operators) performance measures must be determined. These elements can then provide the base for the follow-on analyses associated with training effectiveness.

Generally, efforts to insure training effectiveness should begin with an extensive threat analysis. This analysis would address the total threat facing the weapon system in question. To examine the primary threat or secondary threat in isolation is not enough. To establish a threat on a

one-time basis is also insufficient - the threat is an evolving, dynamic entity, and should be treated as such. In the past, threat development has been general in nature and frequently guised in qualitative terms which are especially addressed to organizational levels for above the infantry rifle squad. What is required is a threat which can be translated into specific, quantitative terms for each weapon system at the squad, platoon and company levels. Once identified and quantified, threat-oriented criteria can be established. Threat-oriented criteria can then be translated into combat referenced criteria necessary to defeat or neutralize the threat. From this base, training tasks conditions and standards may be established which are needed to achieve the combat criteria. The critical task equate to those skills and knowledge needed to be achieved and maintained by individuals in all phases of the specific training program. With individual and collective skills identified, a selection model can be developed as appropriate. The final step of the process requires measurement tools in order to assess the proficiency of the training. Training devices, in many instances, are logical candidates for these tools. However, for training devices and simulators to provide accurate predictive measurements of individual and crew proficiency on the tactical system, training performance be correlated with proficiency on the operational system. This requirement has been satisfied for the M16A1 rifle, but not the TOW and Dragon systems. Therefore, any system performance studies available to date on the TOW and Dragon must be viewed as less than totally valid.

The final product generated by the above process should be a completely integrated, systems engineered training package easily adaptive for both institutional and unit environments, and which specifically outlines both individual and collective skills required by system operators. Moreover, the package should promise the local unit commander with a range of empirically validated training options which provide flexibility, in meeting mandatory training standards imposed by higher command echelons. Such a training regimen should facilitate optimal use of training time within various training environments, e.g., institution, garrison, local, and major training areas.

A schematic summary of the TEA concept is presented in Figure 3. Having examined what has been accomplished to date, it is apparent that much remains

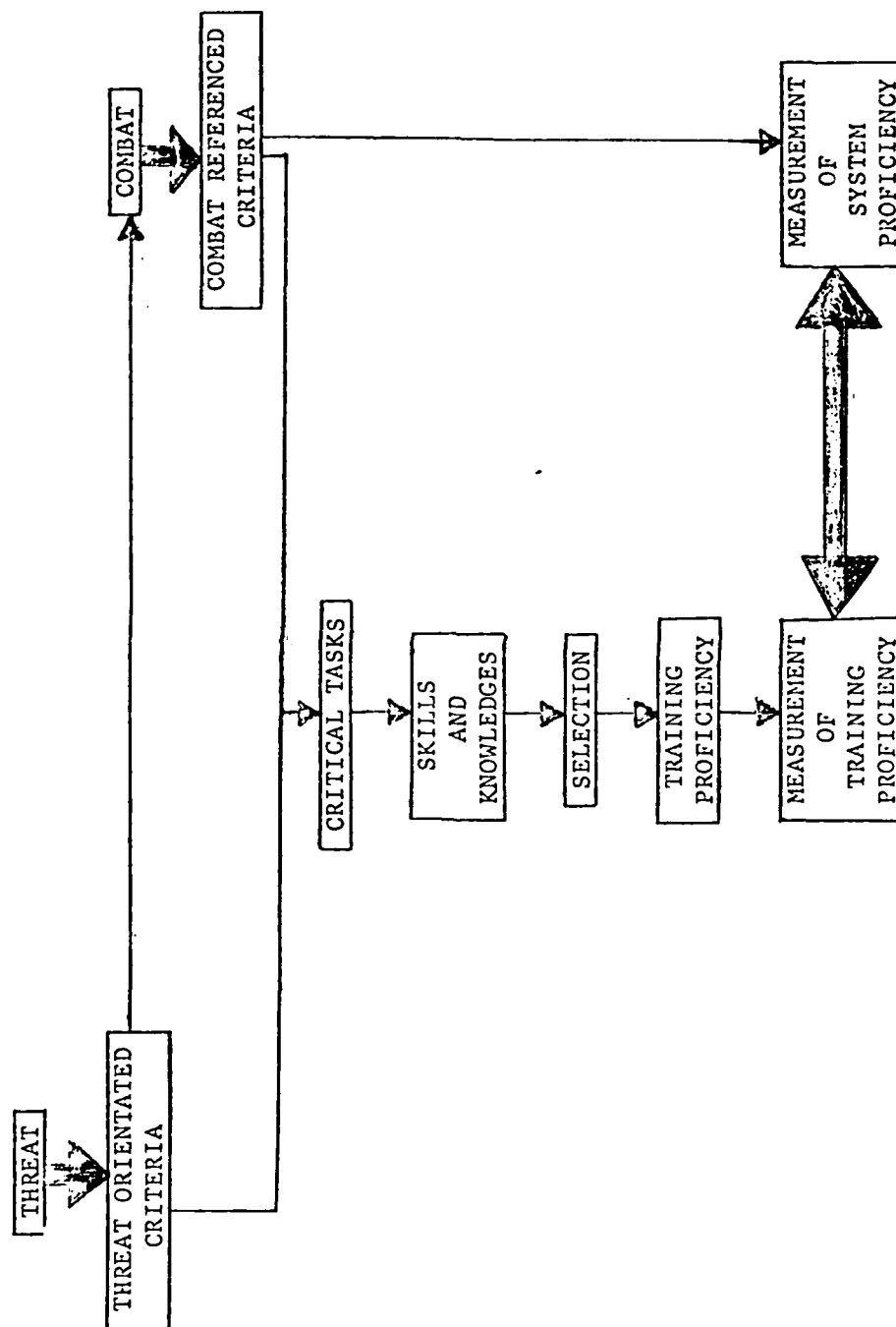


Figure 3. A flow diagram for the TEA concept.

to be done in the way of a complete TEA for the M16A1, TOW and Dragon. If it is determined that the total systems analysis approach would be cost-effective if conducted for these three systems, since they have been fielded for a considerable time, the conduct of such an effort should still be pursued in order to provide a model for future systems development.

RECOMMENDATIONS

In the short term, if training effectiveness for the M16A1, TOW and Dragon is to be maximized, concentrated, complete TEAs must be conducted for each weapon system. These TEAs must be designed to "plug the gaps" in the current training programs such as: 1) lack of continuity between institutional and unit training, 2) absence of correlation between training device proficiency and operational equipment proficiency, and 3) overall use of unvalidated training programs for the three systems. Recommendations for overcoming these short-falls are:

- conduct a complete threat analysis,
- determine and prescribe threat-oriented criteria and subsequent combat-referenced training criteria,
- establish standard procedures for the conduct of a detailed task analysis to determine critical tasks, skills and knowledges required to meet combat referenced criteria,
- develop proficiency measures to test whether or not the required skills and knowledges are acquired during training and whether or not they are transferrable from training devices to operational equipment,
- develop cost effective trainee selection model,
- examine the need for a cost/benefit trade-off analysis for currently available and proposed training devices,
- develop an integrated, progressive approach to proficiency standards for each of the three systems which is initiated at the fundamental level in institutional training and continues with increasingly realistic proficiency exercises in field units.

The needs appear obvious. The use of the on-going approach now being considered for the M16A1 system could result in a feasible, cost-effective solution if adopted for all three weapon systems.

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U.S. Army Combat Developments Experimentation Command. Antitank missile test (ATMT). Fort Ord, California: April 1976a. (AD-B010 576L)

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APPENDIX - ANNOTATED BIBLIOGRAPHY

Exhibit 1 is a Subject Identification Matrix for the two hundred sixty-six (266) reports with the major systems along the vertical axis and the subsystem components along the horizontal axis. Each cell within the matrix lists all document numbers that fall under the heading for that cell. For example, twenty-six (26) documents were found to relate to M16A1 criteria, but, only ten (10) of those (38, 54, 56, 73, 77, 94, 99, 126, 224, and 227) fell under the heading of threat. Since the subject matter of each document may be applicable to more than one cell, multiple listings are possible.

Figures A-1, A-2, and A-3 present a frequency count of the 266 documents according to each of the three major systems. Again, because of the varied subject matter within a single report, a single document may be counted more than once. Figure A-1 presents a frequency count by major system. Figure A-2 gives a count by subsystem. Figure A-3 is a summary bar chart that presents a frequency count of each of the three systems and subsystems within each system.

CRITERIA

	Threat	Measures of Effectiveness	Criterion Levels
GENERAL	41 175	31 147	63 155
	45 234	74 162	79 172
	49 248	75 169	84 174
	126 249	96 173	100 183
	158 251	97 176	120 186
	164 252	118 247	145
	166 253	123	
	170 254		
M16A1	38 94	66 110	20 93
	54 99	105 111	25 101
	56 126	107 226	35 244
	73 224	108 244	62
	77 227	109	
TOW	7 68 199 208 217 230	27 119 199 207 215 223	26
	29 91 200 209 218 231	29 121 200 208 216 228	62
	30 124 201 210 219 232	30 144 201 209 217 229	225
	32 167 202 211 220 233	32 154 202 210 218 230	255
	36 187 203 212 221 256	72 190 203 211 219 231	258
	37 188 204 213 222 259	80 193 204 212 220 232	
	38 190 205 214 223 260	88 194 205 213 221 233	
	45 195 206 215 228	106 198 206 214 222	
	49 198 207 216 229		
	7 68 201 209 217 229	27 119 201 209 217 229	11 185
	29 124 202 210 218 230	30 121 202 210 218 230	61 189
	30 167 203 211 219 231	106 154 203 211 219 231	62 225
	36 190 204 212 220 232	112 190 204 212 220 232	85 241
	37 195 205 213 221 233	113 193 205 213 221 233	117 255
	38 198 206 214 222 256	114 194 206 214 222	184 258
	45 199 207 215 223 259	115 199 207 215 223	
	49 200 208 216 228 260	116 200 208 216 228	
DRAGON	7 68 201 209 217 229	27 119 201 209 217 229	11 185
	29 124 202 210 218 230	30 121 202 210 218 230	61 189
	30 167 203 211 219 231	106 154 203 211 219 231	62 225
	36 190 204 212 220 232	112 190 204 212 220 232	85 241
	37 195 205 213 221 233	113 193 205 213 221 233	117 255

Exhibit 1. Subject Identification Matrix
(continued)

SELECTION			TRAINING CONTENT				
Prerequisite Skills	Cost Effectiveness	Task Analysis	Teaching Methods	Context/ Combat Training	Training Devices/ Transfer of Training	Future Training Requirements	General
GENERAL	15 17 27 65 143 156	67 165 179	157 163	19 137 21 142 76 161 128 178 136 261	48 58 81 87 151 191	5 14 23 139 181 263	1 47 2 55 3 102 4 122 40 244 6 53 141 16 78 177 17 86 182 18 103 235 28 104 236 33 129 244 34 131 246 39 134 262 46 138 266
M16A1	27	244	69 227 237	35 99 105 107 111 145	95 180 125 196 132 250 148 256	99 192 244	41 43 44 244
TOW	255	10 71 135 140	24 169	8 42 69	12 69 82 88 130 136	22 64 88 89	50 92 51 152 59 171 90 234
DRAGON	134 135 255	57 238	133 149 265	32 42 241	13 160 245 57 161 264 60 184 70 185 122 197 149 241 150 242	9	50 171 52 240 59 243 153

Exhibit 1. Subject Identification Matrix
(concluded)

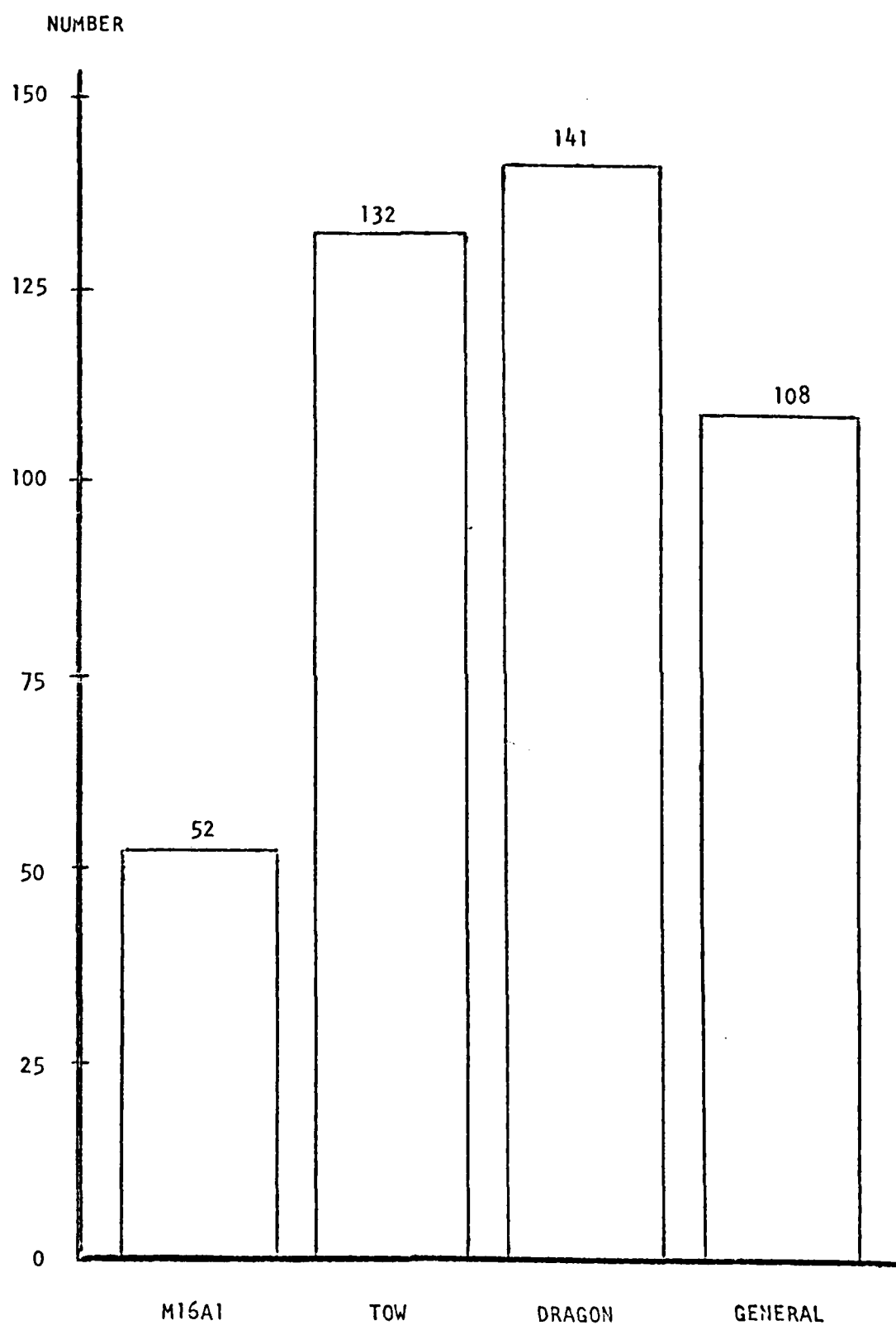


Figure A-1. Document frequency count for each of the major systems.

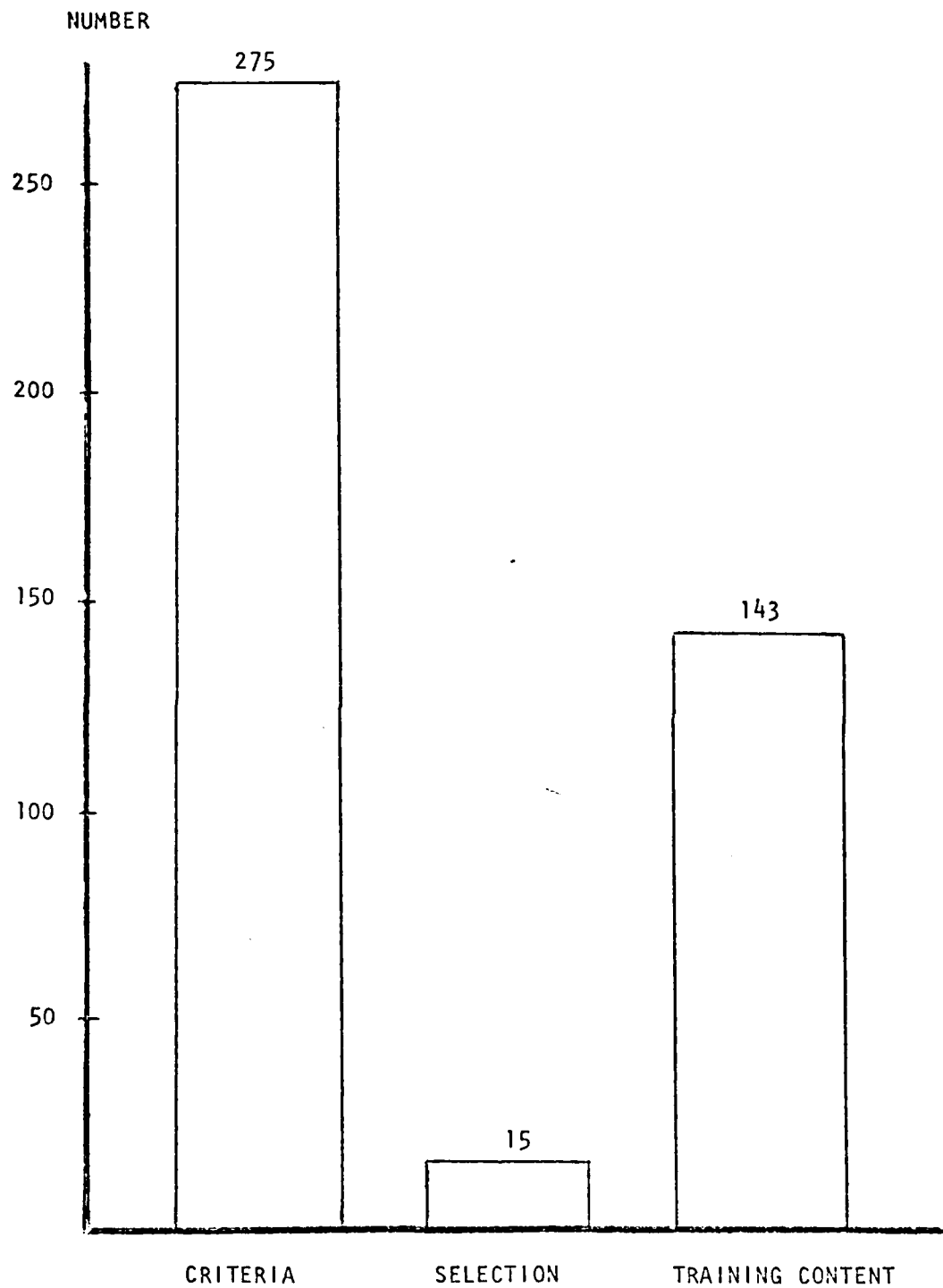


Figure A-2. Document frequency count for each of the three subsystems.

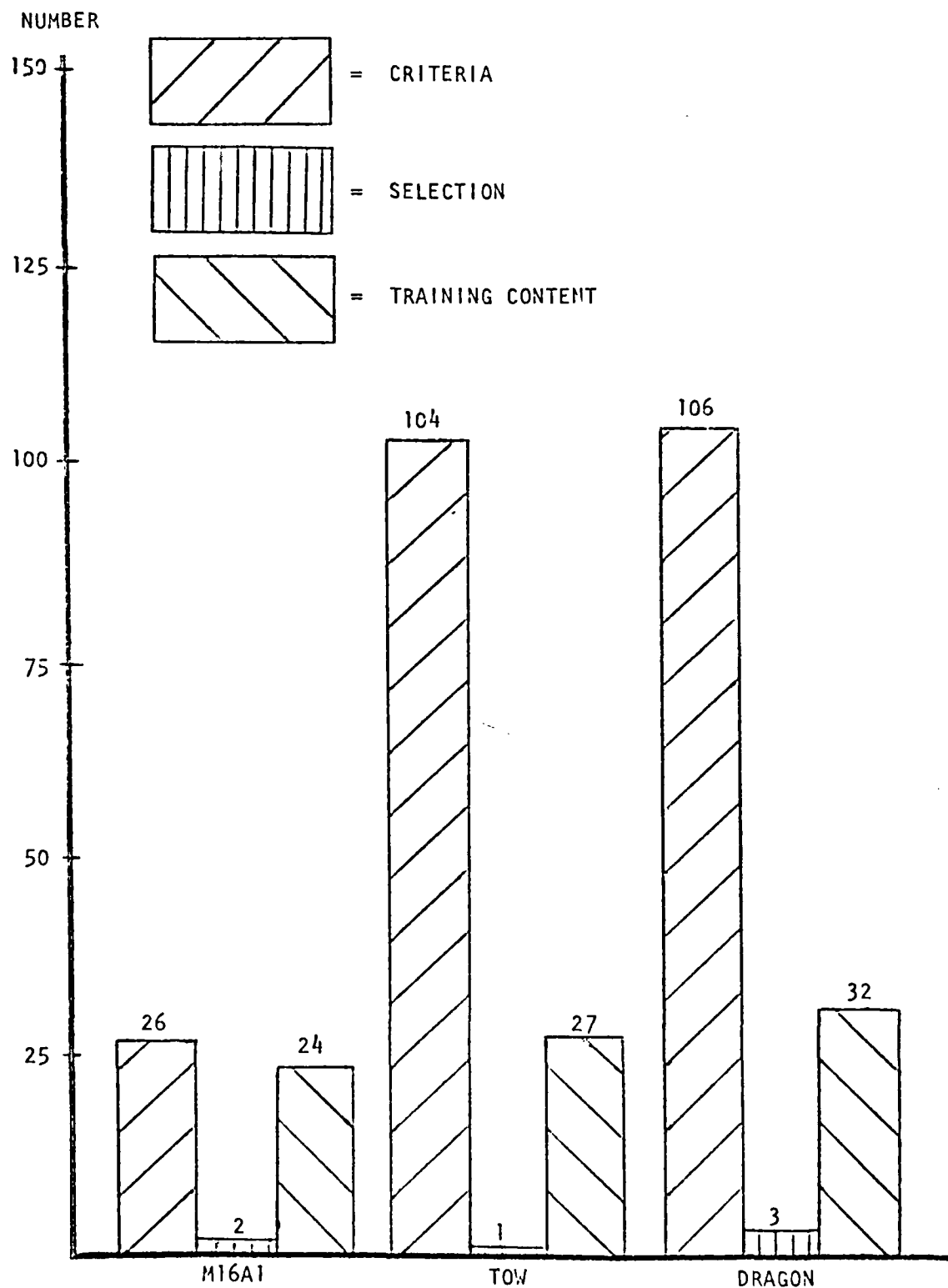


Figure A-3. Summary graph of documents grouped by system and subsystem.

ABSTRACTS

1. Adams, H. E. & Hayward, G. E. Organization of the tank battalion, FMF (1975-1982) study (Vol. 1). Mclean, Virginia: Potomac General Research Group, February 1975. (AD-B008 585L)

The purpose of this report was to determine the most effective corps tank battalion organization, including a TOW unit, for the 1975-1982 time frame.

2. Adams, H. E. & Hayward G. E. Organization of the tank battalion, FMF (1975-1982) study, Phase I: TOW unit organization (Vol. II). Mclean, Virginia: Potomac General Research Group, April 1974. (AD-B008 587L)

Since the phasing-out of the M-50 'ONTOS', the Marine Corps has not had an organization with the primary mission of providing antimechanized support to the division. To fill this void, the USMC is planning procurement of the TOW weapon system. TOW (tube, launched, optically tracked, wire command link guided missile system) delivers a heat round accurately at ranges up to 3 kilometers. The Marine Corps is presently planning to purchase 144 TOW systems to be organic to the active tank battalions and 72 TOW systems to be organic to the reserve tank battalions. The systems to be purchased will consist of TOW launchers mounted on M-15/A1 quarter-ton vehicles. Each launcher will be served by a two-man crew.

3. Adams, H. E. & Hayward, G. E. Organization of the tank battalion, FMF (1975-1982) study, Phase II: Tank battalion organization (Vol. III - interim report). Mclean, Virginia: Potomac General Research Group, November 1974. (AD-B008 588L)

To provide a heavy antimechanized capability, the Marine Corps has planned procurement of the TOW weapon system. The ground version of TOW (tube-launched optically-tracked, wire command link guided missile system) delivers a heat round accurately at ranges up to 3 kilometers. The TOW weapons system to be obtained by the Marine Corps consists of a TOW launcher mounted on an M151A1 quarter-ton vehicle. Each launcher will be served by a two-man crew. The weapon can be

fired from the vehicle or dismounted and fired from the ground. The TOW system will be organic to the tank battalion.

4. Adams, H. E. & Hayward, G. E. Organization of the tank battalion, FMF (1975-1982) study, Phase III: Tables of organization and equipment (Vol. IV - interim report). McLean, Virginia: Potomac General Research Group, January 1975. (AD-B008 589L)

The purpose of the tank battalion organization (TBO) study is to determine the most effective organization (within specified manpower and vehicular constraints) for the tank battalion, FMF, in the mid-range period. This study has been conducted for the U.S. Marine Corps by the Potomac General Research Group (PGRG).

5. Anderson, B. G. & Jeantheau, G. Training system use and effectiveness evaluation. Darien, Connecticut: Dunlap and Associated, Inc., July 1966. (AD-640 423)

Criteria for evaluation of training device effectiveness have been developed. The report examines methods of evaluation with particular emphasis on the problems of objective evaluation in the ongoing training situation. Consideration is given to problems of measurement, experimental design, and analysis in the field setting. Further, attention is given to the issues of utilization and design of training devices and their influence on training effectiveness. An evaluation of the Aetna Drivotrainer was made and consequent recommendations are included for the 11H54 driving improvement trainer. A criterion-referenced measurement system was developed for the 1BZ2 maneuvering tactics trainer for possible subsequent use in evaluating that device.

6. Arima, J. K. Human factors in weapon system evaluation. Fort Ord, California: Litton Scientific Support Laboratory, March 1969. (AD-689 299)

Weapon systems have at the least a material component and a human component. Evaluation of the operational effectiveness of weapon systems must fully involve both components. The evaluation situation must be tactically realistic; personnel who normally man the system should be used; and there should be an attempt to stress the

participants. To accomplish these goals, adequate information and response loads must be provided participants; over-control should be avoided; and player and instrumentation personnel quality control should be assured. Suggestions are developed for simulating two-sided combat, the concept of nonreactive testing is introduced, and the role of incentives and rewards to motivate and control performance is discussed.

7. Attinello, J. S., Henry, I. G. & Okamoto, P. Y. Antiarmor studies program. Arlington, Virginia: Institute for Defense Analyses, Systems Evaluation Division, February 1973. (AD-527 598L) SECRET

The report presents results of a study of U.S./NATO antiarmor systems and the Warsaw Pact organization armor threat. The armor threat to NATO defenses is identified by numbers and types of WPO armor were limited to conventional weapons that could be available by 1980. Problem areas and deficiencies of US/NATO antiarmor systems are identified. A brief historical review of tank battles is presented to show correlation of successes or defeat with force ratios. An analysis of costs and an effectiveness measure for selected US/NATO antiarmor weapons is presented.

8. Austin, J. W., Mueller, B. H., Tanimoto, D. H., Green, R. R., & Mahoney, J. P. Vulnerability study: Phase II. Culver City, California: Hughes Aircraft Co., Laser Division, July 1975. (AD-C006 934L) SECRET

Report has section on vulnerability of TOW weapon system.

9. Barkofsky, E. & Jensen, A. R. Engineering test of XM47 (Dragon) weapon system. White Sands, New Mexico: U.S. Army Missile Test and Evaluation Directorate, September 1972. (AD-522 832L) CONFIDENTIAL

The Dragon weapons system was fired under two separate environmental extremes, a desert situation and an arctic situation. The results of the firings indicated that the Dragon system could be operated successfully under both temperature extremes. In both cases the tracking mechanism was maintained at the ambient temperature of the test site.

10. Battelle Labs. Antitank weapon systems. Columbus, Ohio: Battelle Labs, June 1973. (AD-527 601L) SECRET

This report analyzes antitank weapons, which includes the TOW weapon system.

11. Bauer, R. W. & Pettit, G. D. Dragon night sight. Aberdeen Proving Ground, Maryland: Human Engineering Laboratory, February 1974 (AD-917 790L)

Following the training of Dragon gunners in the spring of 1973, an experiment was conducted to test target acquisition, tracking accuracy and the advantages of the viscous-damped bipod mount over the Dragon bipod in tracking with the Dragon night sight. Gunners acquired 175 of the required targets. Since only two gunners were used and a small number of trials run on this test, large algebraic mean errors obscured any differences in tracking between the two mounts used. Study of the means and standard deviations of errors and the actual tracking plots indicated uncertainty in the gunner's selection of center-of-mass for tracking. The degraded images offered by thermal displays such as the Dragon night sight may require additional research on aim-point selection against obscured or distorted figures.

12. Betts, R. E., Williams, N. P. & Thomas, W. E. Evolution and development of a TOW blast simulator. Redstone Arsenal, Alabama: Army Missile Command, August 1973. (AD-769 596/8)

The report covers the work performed in developing a noise-simulation device for use in TOW training. Items covered are: background information on an original design, its problems and causes of failures, an interim quick-fix design which improves performance reliability, and a new firecracker design which is safe, highly reliable, and much lower in cost.

13. Bjorn, E. D., Bosking, W. H., French, S. & Chinn, A. Independent evaluation of the Dragon training equipment. Fort Belvoir, Virginia: U.S. Army Operational Test and Evaluation Agency, March 1974. (AD-529 658L) CONFIDENTIAL

An assessment was made of the Dragon launch effects trainer, the launch signature simulator, the field handling trainer, and the dancing Dragon attachment in order to determine their effectiveness as Dragon training equipment.

14. Blaiwes, A. S. & Regan, J. J. An integrated approach to the study of learning retention and transfer: A key issue in training device research and development. Orlando, Florida: Naval Training Device Center, August 1970. (AD-712-096)

A summary was made of the approach, rationale, and some of the results of an effort being made at the Naval Training Device Center Human Factors Laboratory to acquire information on learning, retention, and transfer which can be applied to help solve military training problems. Various psychological theories were reviewed, and 181 relevant research reports were analyzed. It was found that research on transfer of training on military tasks essentially involved one or more of the following issues:

- (1) Which subtasks, uncovered operationally, should be included in or excluded from a training simulation?
- (2) Which variations in training system stimulus and response characteristics should be incorporated?
- (3) Which instructional devices, materials, and methods should be introduced to improve learning and transfer?
- (4) How much generalization should be built into training devices?

Reports were also characterized according to whether they pertain to learning, retention, and/or transfer; whether the tasks discussed could be described as verbal, motor, perceptual, signal monitoring, complex, or procedural; and any other kinds of independent variables (if any) which were manipulated.

15. Boyles, W. R. Measures of reaction to threat of physical harm as predictors of performance in military aviation training. Alexandria, Virginia: Human Resources Research Organization, May 1969. (AD-688 817)

This paper reports efforts to develop measures of reaction to physical harm threat and measures of change of confidence in ability to cope with that threat for use in secondary selection process in U.S. Army aviation.

16. Branson, R. K. Interservice procedures for instructional systems. Phase I: Analyze. Tallahassee, Florida: Florida State University Center for Educational Technology, August 1975.

This document is the first of a five-part series focusing in minute detail on the processes involved in the formulation of an instructional systems development (ISD) program for military interservice training that will adequately train individuals for a particular job. The Analyze phase consists of five steps, diagrammed by flow charts. The first step, Analyze Job, establishes what constitutes adequate on-the-job performance, focusing on what tasks, performed in what manner, under what conditions, in response to what cues, and to what standards, make up the job. The second step, Select Tasks/Functions, focuses on the selection of tasks that need training and those that do not in order to ensure some form of instruction for important tasks. The third step, Construct Job Performance Measures, provides measures to test whether individuals are performing their tasks. The fourth step, Analyze Existing Courses, presents procedures for reviewing the documentation of how existing courses were developed and validated and to determine whether the methods used are likely to have produced a course that will meet present training needs. The fifth step, Select Instructional Setting, focuses on providing adequate and appropriately timed training resources.

17. Branson, R. K. Interservice procedures for instructional systems development. Phase III: Develop. Tallahassee, Florida: Florida State University Center for Educational Technology, August 1975.

This document is the third of a five-part series focusing in minute detail on the processes involved in the formulation of an instructional systems development (ISD) program for military interservice training that will adequately train individuals to perform a particular job. The Develop phase consists of inputs, procedures, and outputs presented for five steps. The first step, Specify Learning Events/Activities, focuses on the classification of learning

objectives by learning category in order to identify learning guidelines necessary for optimum learning to take place. The second step, Specify Instructional Management Plan and Delivery System, focuses on media selection to determine the manner in which instruction is to be packaged and presented to the student. Instructions management plans are developed to allocate and manage all resources for conducting instruction. The third step, Review/Select Existing Materials, focuses on the evaluation of materials for their appropriateness to the learning objectives, learner characteristics, and selected learning guidelines and management plan. The fourth step, Develop Instruction, assists the instructional designer in using available resources to produce instructional materials. The final development phase is Validate Materials, to ensure that the instruction works and students achieve the learning objectives.

18. Braunstein, M. L. Depth perception through motion. New York, New York: Academic Press, 1976.

These studies provide information useful in determining processes that ought to be considered in training programs designed to assist individual development of distance estimation with reasonable accuracy.

19. Briggs, G. E. & Johnston, W. A. Team training (final technical report) (report number NAVTRADEVCE-1327-4). Orlando, Florida: Naval Training Device Center, June 1967. (AD-660 019)

This is the final report of a four-year program of laboratory research on team training in a combat information center (CIC) context. The research literature on team training is reviewed, and a set of conclusions is drawn with regard to team performance as a function of task, training, and communications variables. In addition, the implications from this research are presented with regard to a specific team training device -- the 15F5 device which is used to teach tactical skills in the context of an airborne tactical data center. The appendices contain full descriptions of three laboratory studies not reported previously in the literature.

20. Brown, F. L. & Jacobs, T. O. Critical combat performances, knowledges, and skills required of the infantry rifle squad leader: Human maintenance under campaign conditions. Alexandria, Virginia: Human Resources Research Organization, January 1969. (AD-713 759)

The paper covers the performances, skills, and kinds of knowledge demanded of an infantry rifle squad leader to maintain an organized and effective fighting unit under campaign conditions and to set an example as a leader for his men. It covers personal hygiene and field sanitation, the maintenance of minimal fighting and existence loads, water supply and consumption, combat feeding and nutrition, sleep requirements and the effects of sleep loss, prevention of malaria, prevention and treatment of motion sickness, prevention and recognition of combat exhaustion, and maintenance of vigilance under fatigue and stress.

21. Bushnell, D. S. The impact of instructional technology on training in the U.S. Army. Alexandria, Virginia: Human Resources Research Organization, July 1976.

The Human Resources Research Organization (HumRRO) has applied human factors and behavioral science principles to improve the training and performance of Army personnel. Military training now emphasizes decentralized decision-making, use of individualized instruction, and increased flexibility in training approaches. Research conducted by HumRRO has resulted in the development of a generalizable procedure for structuring training sequences and organizing and evaluating programs.

22. Callicotte, J. D. Engineering test (Desert phase) of heavy antitank assault weapon system, TOW. Yuma Proving Ground, Arizona: Army Missile Test and Evaluation Directorate, February 1971. (AD-517 455) CONFIDENTIAL

This report describes the operation of the TOW weapon system during desert weather conditions.

23. Caro, P. W., Jr. Equipment-device task commonality analysis and transfer of training. (HumRRO-TR-70-7). Alexandria, Virginia: Human Resources Research Organization, June 1970.

Army researchers developed a system of procedures designed to enable training personnel to assess the utility of an existing flight training device for new training purposes. Such adaptations became a salient feature of military training due to the continuous modification of operational equipment. Using a candidate device for rotary wing training, they produced a system of procedures called the Task Commonality Analysis (TCA), which allowed training personnel to: (1) identify task elements associated with the criterion performance in the operational and training equipment; (2) compare the two sets of tasks; (3) estimate the extent to which task commonality is required for transferable training; and (4) specify the synthetic training program most likely to result in maximum positive transfer of training from device to operational equipment. Information derived from the TCA was used to predict transfer of training. Results indicated that the TCA provided an effective basis for assessing the potential value of a training device. They also showed the particular training device employed in this study to be of little use.

24. Castro, O. J. & Small, D. J. Integrated engineering and service test of TOW heavy antitank/assault weapon system. White Sands Missile Range, New Mexico: U.S. Army Test and Evaluation Command, August 1969. CONFIDENTIAL

The results of this engineering/service test of the TOW weapon system indicated that new TOW gunners can be trained within two hours to obtain hits on targets. For example, out of nine rounds fired by new gunners, seven were hits, i.e., the hit rate was 78 percent. Further, only one of the hits could be attributed to gunner error.

25. Caviness, J. A. & Maxey, J. L. Detection of human targets (TR-74-4). Alexandria, Virginia: Human Resources Research Organization, February 1974.

The objective of this study was to generate data in a form that could be readily used to provide an empirical base for the construction of a "target acquisition" routine for a computer simulation of an encounter between two opposing forces under various battlefield conditions. The research problems posed by this objective were two fold: first, to identify the determinants of detection performance under field conditions, and second, to empirically relate the determinants of detection performance to the indices of

detection performances. Four classes of determinants were investigated: organismic, experimental, target, and environmental characteristics. Three classes of measures of detection performance were taken: time detection, range at detection, and estimated range at detection.

The following target characteristics were shown to be significant: (a) uniform color (contrasted with the background), (b) target lighting (shadow casting), (c) target speed (walk or double-time, advancing) and (d) size of target complex (number of men).

The following environmental characteristics were shown to be significant: (a) illumination available (time of day) and (b) terrain (avenue of approach). The organismic variables tested, observer height and observer movement, were significant. The only experiential variable tested, observer experience in detection (first vs. second observation), was significant.

26. Caviness, J. A., Maxey, J. L., & McPherson, J. H. Target detection and range estimation (TR-72-34). Alexandria, Virginia: Human Resources Research Organization, November 1972.

The present research was designed to determine whether a negative exponential distribution of detection times was adequate for describing the detection of moving human targets by human observers, and whether the detection behavior of stationary observers searching for a moving human target was affected by (a) speed of the target, (b) range of the target, and (c) denseness or complexity of the terrain in which the target appeared.

The ability to detect human targets is significantly affected by the target's speed, the target's distance from the observer, and the complexity of the background in which the target appears. As the terrains studied became more complex, or as the magnitude of the target-to-observer range increased, the magnitude of the detection times increased. However, as the targets speed increased, these times decreased in magnitude. Therefore, terrain complexity and target range were positively related with the time to detection, while target speed was negatively related with the time to detection.

27. Caylor, J.S. Relationship between army recruit characteristics and first tour performance (TR-69-5). Alexandria, Virginia: Human Resources Research Organization, April, 1969.

Data were collected on 1,782 volunteers and 2,620 draftees in 30 BCT companies by means of questionnaires inserted in the 201 files of the recruits with the request that they be returned to the researchers when the men involved were terminated in 1963 and 1964. The questionnaires were completed by the Personnel Officer at the trainee's out-processing station, and included information on: MOS, grade and time-in grade, conduct and efficiency ratings, awards and commendations, courts-martial convictions, service schools attended, reason for termination of committed period of active duty (including reenlistment action), extensions of tour and reenlistment eligibility.

Data were expressed by means of a single composite criterion score (CCS) a summary of the soldier's success in and contribution to the Army in his first tour. Analyses were conducted to determine the relationship of several recruit characteristic variables to the criterion. Recruit characteristic variables were: age, education, General Technical Aptitude Area (GT) score, BCT proficiency measures, sociometric peer ratings, attitude toward the Army, and career orientation.

Data analyses were conducted separately for the volunteer and draftee subjects. Unless otherwise noted, the same pattern of results was found for both groups.

The GT level, educational level, and age of recruits were indicative of their success in the Army during their first tour of duty. The older recruit with more education and higher aptitude had a better record on the criterion measure of success and contribution to the Army.

Performance in BCT was also indicative of later contribution to the Army. The better a recruit performed in BCT, the better he did during the rest of his initial tour, as reflected by the scores of both draftees and volunteers on the BCT Graded Proficiency Test and by volunteers on weapons performance. BCT Physical Combat Proficiency Test scores did not give any indication of later Army performance.

Recruits who received the higher evaluations from their peers also performed better in subsequent Army service.

The attitudes of recruits toward a career in the Army related to their subsequent contribution to the Army during their first tour, but in a negative sense. Recruits with stronger career orientation got lower scores on the criterion measure of Army success. Volunteer recruits who demonstrated higher levels of general reactions to the Army and Army life also got lower scores on the criterion measure.

A statistical (multiple correlation) comparison of the combined recruit characteristics (age, education, GT scores, BCT proficiency scores, peer ratings, attitude, and career orientation) with the criterion scores verified the findings of the comparisons made on individual variables. Only a slight increase in the relationship resulted from the joint comparison over the comparison obtained with the most effective single predictor characteristic.

The conclusions drawn from the results of the follow-up study apply to the personnel input of the Army as it was at the time of data collection, completed in 1964 with the termination of the draftees and volunteers studied:

- (1) Data on recruit characteristics, available prior to entry into service, were predictive of Army success over the first day tour.
- (2) Recruits from the lower ranges of age, education, and GT were more likely than other recruits to encounter difficulty in adapting to the Army and to be promoted at a less than standard pace.
- (3) Early Army performance (BCT proficiency and evaluation by fellow trainees although not by commanders) was predictive of later Army success.
- (4) Early attitudes toward the Army and career orientation were negatively related to later Army performance.
- (5) There was consistency of recruit performance from the pre-service educational system through both the early Army experience of Basic Combat Training and the subsequent duty performance throughout the first tour. In general, it was the older recruit with higher

aptitude, within both the volunteer and draftee components, who had continued his education further, fared better in BCT, was more highly evaluated by his trainee peers, and was accorded greater responsibility and reward by the Army.

The Composite Criterion Score developed in this study provides a prototype measure of the overall quality of performance of first-tour soldiers. Such a measure could be used routinely to monitor the effects of input standards and of general personnel policies in the areas of selection, training, and assignment. Component data for such a measure are standardly available in existing Army personnel records and require no added effort to generate data.

28. Charles, J. P. & Johnson, R. M. Automated training evaluation (ATE) (final report) (report number NAVTRADEVCCEN-70-C-0132-1). San Diego, California: Logican, Incorporated, January 1972

The automation of weapons system training presents the potential for significant savings in training costs in terms of manpower, time, and money. The demonstration of the technical feasibility of automated training through the application of advanced digital computer techniques and advanced training techniques is essential before the application of such techniques is warranted. The advanced computer techniques include the incorporation of real time performance monitoring and course scheduling. The advanced training techniques center on the feasibility of adaptive training based on performance measurement reflecting operational performance requirements. Automated Ground Controlled Approach and emergency procedures tasks were implemented on the Naval Training Device Center-Training Device Computer System (TRADEC system) and tested with operational pilots. The results demonstrated the feasibility of automated training as well as the acceptance of the training technique by operational personnel. Recommendations for the testing of the effectiveness and efficiency of the techniques are presented.

29. Clark, D. B., Marchi, R. P., Sargent, J. D., Vanarsdall, D. & Weaver, B. D. TETAM, extended analysis (Vol. II), (Chapter XIII). Leavenworth, Kansas: BDM Services Co., Leavenworth, Kansas: Combined Arms Research and Analysis Facility, December 1974. (AD-C001 616L)

This report covers extended analysis of the TETAM (CDEC field experiment 11.8) data base on the tactical effectiveness of antitank weapons. Significant analyses contained are: line of sight-engagement relationships, determination of antitank missile (ATM) basic loads, firer cued target acquisition, terrain clutter effects on acquisition, variation of ATM performance parameters, artillery effects on ATM systems, terrain and multiple intervisibility effects, and comparison of one-sided vs two-sided field experiments.

30. Clark, D. B., Sargent, J. D., Weaver, Wm. B., Marchi, R. P. & Vanarsdall, D. TETAM extended analysis (final report) (Vol. 1). Fort Leavenworth, Kansas: Combined Arms Research and Analysis Facility, December 1974. (AD-B003 157L)

This report covers extended analysis of the TETAM (CDEC field experiment 11.8) data base on the tactical effectiveness of antitank weapons. Significant analyses contained are: line of sight-engagement relationships, determination of antitank missile (ATM) basic loads, firer cued target acquisition, terrain clutter effects on acquisition, variation of ATM performance parameters, artillery effects on ATM systems, terrain and multiple intervisibility effects, and comparison of one-sided vs. two-sided field experiments.

31. Corbisiero, J. V. Evaluating weapon system accuracy from a classical bayesian approach. Wright-Patterson Air Force Base, Ohio: Air Force Institute of Technology, June 1970. (AD-874 194)

A real-world weapon system test situation is used to show how circular error probability (CEP) point estimates may be obtained. The discussion includes the use of the Kolmogrov-Smirnov test for normality, chi-square confidence intervals, non-parametric confidence intervals, a priori sample size determination, stop or continue decision making during testing, and a method for combining classical and Bayesian techniques for estimating CEP. Confidence intervals involving the use of the chi-square distribution are presented in graphical form for ease of implementation.

32. Cordesman, T. H. Lessons of the October War: The views of the Israeli Generals in January 1975. Washington, D.C.: Assistant Secretary of Defense (Intelligence), January 1975. (AD-C005 730L) SECRET

Summary and detailed texts of conversations with key members of the Israeli High Command on their views of the strengths and weaknesses of Israeli and Arab tactics, equipment, force strengths, organization, and training before and during the October War are reported. Includes detailed views on major U.S. and Soviet weapons systems, success of U.S. and Soviet aid, U.S. and Soviet tactics, and the future Arab-Israeli balance.

33. Crawford, M. P. Research in military training (report number HumRRO-TR-19-74). Alexandria, Virginia: Human Resources Research Organization, November 1974.

The Human Resources Research Office (HumRRO) has undertaken research and development activities to improve Army training. Factors involved in the Army climate for training research relate to the structural characteristics of the Army itself. The several kinds of efforts and the wide variety of subject matter covered by HumRRO for the Army include exploratory studies, work units, advisory services, and basic research. Studies were undertaken in the areas of: improving individual performance of both officers and enlisted men; unit training and performance, training for leadership, command and control; language and area training; training technology and training management.

34. Crawford, M. P. & Eckstrand, G. A review of contemporary military training research--the state of training technology and studies of motivation and attitudes in learning. Washington, D.C.: Behavioral Science Research Laboratory, June 1967. (AD-661 301)

Part of a larger review of recent psychological research relating to national defense, this section covers studies on training for leadership, command, and team functions, and on the effects of psycho-physiological factors on military performance. Studies in the first chapter of this section are divided between interpersonal aspects (leadership) and organizational and technical responsibilities, and are subdivided into research and development and by commissioned and noncommissioned officer personnel. The other chapter,

largely an overview of the current state of training technology, presents studies on the determination of training objectives and requirements. Development of training environments (application of training principles, training media, simulators, programmed instruction, computer assisted instruction), evaluation techniques (criterion-referenced measures and the problem of forming proficiency measures), and promising areas of research.

35. Dees, J. W., Magner, G. J. & McCluskey, M. R. An experimental review of basic combat rifle marksmanship: Marksman, Phase I. Alexandria, Virginia: Human Resources Research Organization, March 1971. (AD-722 394)

The report describes a series of 21 experiments addressing both "what" should be taught and "how" it should be taught. A number of conclusions were reached concerning such matters as the use of automatic fire, aimed fire vs. pointing fire including Quick Fire, night firing techniques, firing positions, carry positions, aiming points, night sights, multiple targets, area targets, surprise targets, sight calibration, and other issues.

36. Defense Intelligence Agency. Defense intelligence handbook: Soviet ground forces, night operations (DDI-1100-128-76). Washington, D.C.: Author, March 1976.

The handbook examines Soviet concepts of night combat operations including night marches, night offense, night defense and related material. Emphasis is placed upon the Soviet belief that night operations afford combat units and added tactical advantage and provide an opportunity to: increase their rate of advance, achieve surprise, maintain continuous pressure, concentrate forces at decisive locations, and gain time. Summary remarks include reference to the fact that Soviet night operations are often extensions of offensives begun during the day and carried over into the night to allow an opportunity to retain the initiative and to dictate battle conditions to the enemy.

37. Defense Intelligence Agency. Defense intelligence report: Soviet tank company tactics (DDI-1120-129-76). Washington, D.C.: Author, May 1976.

This study of Soviet tank company tactics is presented in a format designed to typify, in some detail, the combat

fighting style of Soviet "tankers". Tactical information is preceded by data on equipment, tank crew training and organization. The study is primarily intended to provide useful, documented reference material to instructors at schools and in field units. Only the techniques and tactics of the Soviet tank component of a combined arms operation are analyzed. The study concludes that the Soviet tank company is employed in such a manner that deficiencies in equipment, training standards and the command and control system can be compensated for by concentration of force. Within this context the Soviet tank company is an effective fighting force with a high combat potential.

38. Department of the Army. Army regulation 350-2: Opposing force (OPFOR) program. Washington, D. C.: Author, 25 October 1976.

The regulation establishes Department of the Army policies, objectives, responsibilities and guidance for the conduct of opposing force training for the Active Army and Reserve Components.

OPFOR objectives outlined in this regulation focus on the need to create a competitive peacetime training effort which provides a self-evaluation of readiness for battle through the employment of independent, opposing, uncooperative and when practicable, a large-size threat force. The regulation stipulates further that OPFOR will be an integral part of all individual and collective training in which a knowledge of potential adversary doctrine, tactics, weapons systems, or field fortifications is basic to the effective application of US tactical skills and techniques.

39. Department of the Army. Army regulation 350-4: Qualification and familiarization with weapons. Washington, D. C.: Author, 28 October 1976.

This regulation establishes Department of the Army policies, objectives, responsibilities, and guidance for conducting Army training relative to qualification and familiarization with weapons and weapon systems.

40. Department of the Army. Army regulation 381-11: Threat analysis. Washington, D.C.: Author, 20 August 1974.

Assigns responsibilities and establishes policy and procedures for threat analysis operations within Department of the Army. Provides guidance in all areas of threat analysis as applies to concept studies, research and development, combat development, and planning.

41. Department of the Army. Army subject schedule 23-71: M16A1 rifle marksmanship.

This army subject schedule provides uniform guidance for M16A1 rifle marksmanship training in all components of the Army.

42. Department of the Army. Field manual 23-2: Tactics, techniques, and concepts of antiarmor warfare. Washington, D.C.: Author, August 1972.

Illustrations and descriptions of most of the current armored vehicles of the world's major fighting forces are contained in this manual. The means and techniques used by infantry foot soldiers to defeat these vehicles are included. Historical combat examples of armor defeating activities provide added realism to this volume.

43. Department of the Army. Field manual 23-9: M16A1 rifle and rifle marksmanship. Washington, D.C.: Author, June 1974.

This field manual describes and teaches the basic skills that are needed in order to become a "good" marksman, i.e., instruction in aiming and steadiness. In addition, information is provided on the topics of maintenance, trouble shooting, and safety considerations when employing the M16A1 rifle.

44. Department of the Army. Field manual 23-71: Rifle marksmanship. Washington, D.C.: Author, December 1966.

This manual provides training guidance in developing and maintaining the rifle marksmanship proficiency of the individual soldier and is applicable to both nuclear and nonnuclear warfare.

The objectives of the United States Army rifle marksmanship program are to --

- (1) Develop in every soldier during basic combat training --
 - (a) The confidence, will, knowledge, and skills required to fire a rifle and hit enemy personnel in combat.
 - (b) The ability to apply correct techniques of rifle marksmanship when functioning as an individual in a fire unit engaged in combat.
- (2) Insure that every soldier maintains a continuing degree of proficiency in combat rifle firing, consistent with the mission of the unit to which he is assigned.
- (3) Provide in time of peace a large number of shooters from which potential precision marksmen can be selected and further trained to successfully compete in interservice, civilian, and international competition, and in time of war to provide an instructor base or cadre for sniper training, if it is required.

This manual contains detailed information on conducting training in the fundamentals of individual rifle marksmanship, battlesight zero, field firing, target detection, record firing, individual night firing, and sniping. Information on the mechanical operation functioning, and nomenclature of rifles may be found in the field manuals appropriate to the particular weapon.

45. Department of the Army. Field manual 30-40: Handbook of Soviet ground forces. Washington, D.C.: Author, June 1975.

This manual describes in narrative and pictorial form the organization, personnel, basic tactical concepts and capabilities of Soviet Ground Forces. Information on Soviet combat arms units as well as combat support and logistical forces are also presented. Included are organizational charts, an equipment guide table and pictures of Soviet uniforms and insignia.

46. Department of the Army. Field manual 100-5: Operations. Washington, D.C.: Author, July 1976.

A broad, doctrinal discussion of the principles involved in the execution of strategic, tactical, service, training and administrative military missions. Special operations such as airmobile, amphibious, unconventional, etc., are

explained. Antiarmor techniques are outlined briefly.

47. Department of the Army. Training circular 6-4-1: The threat. Fort Sill, Oklahoma: U.S. Field Artillery School, May 1976.

This document describes, primarily for the use of U.S. Army Artillery personnel, the organization, equipment, doctrine and vulnerabilities of potential enemy forces. Enemy offensive and defensive tactics are depicted. Fire support methodology is included. Measures for defeating the threat and suggestions for incorporating threat related instruction into training programs are described.

48. Department of the Army. Training circular 7-3-1: How to defend with mechanized infantry and light infantry platoons. Washington, D.C.: Author, June 1975.

This circular is divided into five parts:

Part I describes how squad and platoon leaders organize the defense based on the factors of METT: MISSION, ENEMY, TERRAIN, and TROOPS available.

Part II discusses the TECHNIQUES necessary for platoons and squads to employ their weapons properly.

Part III gives two examples describing HOW TWO TYPICAL PLATOONS DEFENDED CERTAIN TYPES OF TERRAIN.

Part IV describes the CONDUCT OF THE DEFENSE by the platoon in one of the examples. This section describes those actions required of platoon and squad leaders during and after an enemy attack both during daylight and during periods of limited visibility.

Part V discusses what small unit leaders must do after the initial assault is repelled.

49. Department of the Army. Training circular 17-12-1: Tips for tankers on defeating soviet armor. Fort Knox, Kentucky: U.S. Army Armor School, May 1973.

A review of Soviet armor capabilities and U.S. Army gunnery techniques designed to defeat Soviet tanks is outlined. Information is descriptive of one-on-one

engagements rather than unit versus unit battles.

50. Department of the Army. Training circular 23-20: Unit antiarmor training program. Washington, D.C.: Author, August 1975.

The purpose of this document is to provide training personnel with sufficient information about the threat on the modern battlefield and with individual training programs for the LAW, Dragon, and TOW antiarmor systems so that these personnel can plan and implement programs of instruction for these weapon systems at the unit level. In particular this document presents information in the following areas:

- (1) Development of individual weapons proficiency for the M72A2 66mm Heat Rocket (LAW), the M47 Dragon, and the TOW,
- (2) maintenance of individual weapons proficiency for the LAW, Dragon, and TOW,
- (3) training devices or techniques currently available or which will be available in the future to assist the military trainer with respect to the LAW, Dragon and TOW, and
- (4) guidance concerning the operational employment of the LAW, Dragon, and TOW.

51. Department of the Army. Training Circular 23-23: TOW, heavy antitank weapon system. Washington, D.C.: Author, July 1974.

This training circular covers the description, assembly, function, operating procedures, ammunition, maintenance, techniques of fire and marksmanship training for the TOW weapon systems and its associated training equipment. In addition, it addresses basic considerations for the tactical employment of the TOW system.

52. Department of the Army. Training circular 23-24: Dragon, medium antitank assault weapon system M47. Washington, D.C.: Author, August 1974.

This training circular covers the description, assembly, function, operating procedures, ammunition, maintenance, technique of fire, and marksmanship training for the M47 Dragon weapon system and its associated training equipment. In addition, it addresses basic considerations for the tactical employment of the M47 system.

53. Department of the Army. Training circular 30-3: Soviet equipment recognition guide. Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, April 1975.

Booklet, designed to provide U.S. soldiers with a reference guide for easy recognition of weapons, vehicles and equipment associated with a Soviet maneuver battalion. The expected combat role of each item is described.

54. Department of the Army. Training circular 30-4: The motorized rifle regiments. Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, June 1975.

This training circular portrays information, in graphic form, of the organization, missions, doctrine, tactics, and equipment of a Motorized Rifle Regiment of a Motorized Rifle Division. The circular emphasizes descriptive data on a Reinforced Maneuver Battalion of a Motorized Rifle Regiment of a Motorized Rifle Division. Regimental combat resources are depicted, when appropriate, to describe the maneuver and firepower capabilities of the Battalion.

55. Department of the Army. Training circular 30-21: A guide to writing scenarios and intelligence plans. Fort Huachuca, Arizona: U.S. Army Intelligence Center and School, June 1976.

This document provides an orientation and a step-by-step process on the principles procedures, and techniques for use in planning, preparing and developing training exercise scenarios, including variations caused by different echelons of commands. Examples of combat related scenarios, intelligence plans and supporting documents are included.

56. Department of the Army. Training circular 30-102: The motorized rifle company. Fort Monroe, Virginia: U.S. Army Training and Doctrine Command, September 1975.

This training circular provides descriptive information

concerning "enemy" forces, weapons, equipment, and tactics for use by U.S. Commanders in portraying realistic "enemy" situations in all training exercises.

57. Department of the Army. Training manual 9-6920-480-12-1: Operator and organization maintenance, guided missile system, surface attack, M47; training equipment, consisting of - monitoring set, guided missile system, training, AN/TSQ-T1; trainer, field handling dummy, M8; trainer, launch effects, guided missile, M54. Washington, D.C.: Author, 1974.

This manual describes the operation of the Dragon system training equipment and provides operator and organizational maintenance instructions for the monitoring set, guided missile system and the launch effects trainer. Detailed identification diagrams and parts lists are included.

58. Dieterly, D. L. The evaluation of training with specific emphasis on criteria. Wright-Patterson Air Force Base, Ohio: Air Force Institute of Technology, October 1973. (AD-771 009/8GA)

Training evaluation literature was reviewed and a model for assessing major training systems with emphasis on criterion measurement was presented.

59. Disner, J. The antitank weapons of tomorrow have already arrived. Charlottesville, Virginia: Army Foreign Science and Technology Center, September 1973. (AD-B000 795L)

Antitank weapons have been developed faster than anyone dared hope. The first generation weapons are being replaced by second generation systems. Certain terminology is defined with an indication of the basic operating principles of the new systems. The primary difference involves a maturity from guiding the missiles into the new phase of aiming them. Training is much more easily performed. The ranges are more useful to tactical situations. The ammunition is described and several tactical options are listed for the employment of the new systems.

60. Donlon, R. H. C. & Mason, J. R. Development test III of Dragon launch effects trainer (LET). Fort Benning, Georgia: U.S. Army Infantry Board, November 1974. (AD-C000 402L)
CONFIDENTIAL

This test was conducted to determine the training value of the Dragon launch effects trainer (LET) without the effects mechanism. The test soldiers utilized during the troupe training and firing accuracy phase were trained using the LET without the effects mechanism. Results of this training and first-round hit probability of the live missile firing were compared with results obtained from those trained on LET with effects mechanism. Two LETs with the old type heat shields were cycled 8000 times each, and two LETs with the modified heat shields were cycled 6300 times each. USAIB concluded that: (a) the LET without effects mechanism has less training value than the LET with the effects mechanism, and (b) the LET without effects mechanism does not provide as realistic a launch as the LET with the effects mechanism.

61. Ellis, A. & Bright, H. Performance risk analysis for the surface attack guided missile system, XM47 "Dragon". Redstone Arsenal, Alabama: U.S. Missile Command, February 1973. (AD-525 299) CONFIDENTIAL

This independent evaluation examines the data obtained from gunner qualification tests and live firings during the expanded service test (EST) conducted in 1972 at Fort Benning, Georgia, and conclusions based on that data. It is concluded that the launch effects trainer (LET) qualification scores can be utilized to predict the gunners' performance with the live round. It is further concluded that multiple firings of live rounds do not improve the hit probability over that of the the first round even though these multiple firings do provide useful information. Results which indicate the value of selectively picking gunners based on LET qualification firings are presented. Also, results which indicate the single shot kill probability (SSKP) that could be expected from the Dragon system as a function of the degree of gunner selectivity are presented.

62. Fendrikov, N. M. & Yakovlev V. I., Methods for calculating combat effectiveness of armament. Arlington, Virginia: Joint Publications Research Service, July 1972.

The book deals with the selecting and computing of fundamental criteria in fire effectiveness, and is broken down into five chapters: combat effectiveness, small arms and antitank weapons, field artillery, missile strikes, and computation rules and tables.

63. Ferguson, R. L. Computer-assisted criterion-referenced testing. Pittsburgh University, Pennsylvania: Learning Research and Development Center, March 1970. (AD-704 824)

A test model for a computer-assisted branched test was developed and implemented for a unit of mathematics for which a hierarchy of prerequisite relationships among objectives existed. A computer was used to generate and present items and then score the student's constructed response. Using Wald's sequential probability ratio test, the computer determined whether the examinee was or was not proficient in the skill being tested. If such a decision could be made he was branched to another objective according to specified criteria based upon the hierarchy. Otherwise, another item was generated and the cycle repeated. Results showed that the computer test was highly successful in providing reliable information in substantially less time than that which was required by the conventional paper-and-pencil test.

64. FMC. TOW/bushmaster turret study MICV-scout. San Jose, California: FMC Corporation, October 1975. (AD-B010 220L)

This contract was initially awarded to investigate concepts of an integrated TOW/bushmaster turret and an elevated TOW launcher for the mechanized antitank vehicle (MATV) which is an adaptation of the MICV. Early in the program, work performed under the original scope of the contract was redirected to consider turrets for the MICV scout vehicle instead of the MATV due to a shift in user priorities. Both one-man and two-man weapon stations were studied. The major objective was to integrate the TOW missile system into a turret with a bushmaster cannon and a 7.62 coaxial machine gun. The ground rules specified that no changes were to be made to the missile and that TOW system accuracy must be maintained. The required turret design allows the commander/gunner to sight and fire any of the weapon systems from a protected position under armor. Efforts were also directed toward using as many common MICV silhouette as practical to avoid immediate identification of the vehicle in the field.

65. Fox, W. L., Taylor, J. E., & Caylor, J. S. Aptitude level and the acquisition of skills and knowledges in a variety of military training tasks. Alexandria, Virginia: Human Resources Research Organization, May 1969. (AD-688 263)

This study was conducted to determine the relation between recruit aptitude level and the ability to acquire military skills and knowledges. Eight training tasks -- ranging in complexity from simple stimulus-response association to learning concepts and principles -- were selected; 183 high, middle, and low aptitude recruits were trained on these tasks. Data were also gathered on performance on psychometric test, scholastic achievement, BCT attainment, and personnel information. Results showed that mental aptitude as measured by AFQT consistently related to various psychometric and operational criteria, including performance on the Army's psychometric classification and assignment tests, scholastic achievement, and Army basic training performance. It was also shown that speed of learning relates directly to aptitude level. This relation holds true across a variety of training tasks varying in complexity and indicates that efficient training across aptitude levels requires both recognition of the effects for individual differences in aptitude and design of instructional systems compatible with differences in rates of learning of individuals.

66. Gardner, B. L., Mares, E. A. & Shusterman, N. Analysis of infantry, tank and antitank weapons performance data (interim report). State College, Pennsylvania: HRB-Singer Inc., December 1967. (AD-394 076) SECRET

A pilot study was conducted to collect, identify and classify exigent weapon systems' performance data; trace the origin and basis of data; and report on the validity of the data. Weapon systems analyzed include the M14 and M16 rifles, the Shillelagh and TOW missile systems, and the M68 105-mm gun. For each of these weapons, this report presents reviews of several significant documents found to contain performance data, and provides a comparative analysis of these performance data. Conclusions and recommendations are presented.

67. General Accounting Office. Military training time and cost should be reduced through improved management (FPCD-76-4). Washington, D.C.: General Accounting Office, September 1975.

The report addresses the management of recruit and initial skill training and identifies delays in training cycles, their causes, and resultant costs. In visits to four recruit training centers, eight initial skill training

schools, and various headquarters offices, the General Accounting Office (GAO) identified 1,979,000 man-days per year that new members of the Armed Forces and Reserve components spent unnecessarily in training status at a cost of about \$48.1 million. Described are: delays in Army and Marine Corps recruit training systems due to inflexible starting times; the immediate start of training in the Navy and Air Force; management of initial skill training and resulting delays in all the armed services; and delays due to orientation of new members and use of them in work crews. Costs of these delays are reported for each of the services in terms of dollars and man-days.

68. General Research Corporation. Comparability and adequacy of data on tank/antitank weapons. Fort Mclean, Virginia: General Research Corporation, Mclean, Virginia Washington Operations, March 1976. (AD-C005 653)

The data reported by the U.S. Army on U.S. tank/antitank weapons is compared with the data reported by the U.S. Intelligence Community on corresponding threat and allied weapons systems. The adequacy of the reported data is examined in terms of the data requirements of the studies and analysis community. Discrepancies and perceived gaps in the reported data are presented.

69. Governmental Affairs Institution. Conduct-of-fire training set, XM70, for TOW missile system (interim report). Washington, D.C.: Governmental Affairs Institute Research Division, August 1968. (AD-394 419L)

The development of a conduct-of-fire training set for the TOW heavy antitank/assault guided missile system is briefly described in this report. The training set, designated XM70, provides a highly realistic environment for training TOW weapon crews in the handling and loading of missile rounds, in target acquisition and tracking, and in firing the weapon. The training set, used in confiring a TOW missile. The set consists of an instructor's console, a missile-simulation round, an IR target lamp and its electronics, and a target board. The target lamp and board are easily mounted on an M151 or M113 vehicle. The console enables the instructor to monitor each firing continuously, providing him with visible and audible indications of the gunner's performance as well as a percentage score on a meter that integrates all the gunner's steady-state tracking

errors.

70. Graves, F. V., Jones, M. D., & Russell, C. T. Independent evaluation of the guided missile system, surface attack, M47 (Dragon). Falls Church, Virginia: U.S. Army Operational Test and Evaluation Agency, April 1976.

Informal interviews were conducted with military personnel who had trained with both the LET and LSS systems. One finding from these interviews was that the gunners felt that neither the LET or LSS was completely duplicated in the actual firing of the Dragon weapon system. It was indicated that a hybrid of the two systems was preferable to either system by itself.

71. Greene, M. J. L. & Roach, H. K. Systems engineering of mechanized infantry battalion unit training (Vol. IV). Fort McLean, Virginia: General Research Corporation - Analysis Division, June 1974. (AD-920 904L)

This report covers the antitank platoon including the training task inventory for a TOW unit.

72. Gregory, W. & Tibuni, R. Engineering test of training set guided missile, XM70 for TOW heavy antitank/assault weapon system. White Sands, New Mexico: Army Missile Test and Evaluation Directorate, June 1972. (AD-903 948L)

The purpose of the engineering tests was to determine the suitability of the TOW production trainer for U.S. Army use under a variety of temperate zone conditions and environmental limits defined primarily by the small development requirement (SDR). For training in practice loading, tracking, and firing, the trainer design is satisfactory. Scoring, while not meeting the SDR as stated, does qualify satisfactory gunners and provides a needed and safe means for screening gunners. It is recommended that the deficiencies and as many as possible of the shortcomings be corrected. Certain changes in the training literature are also recommended.

73. Hackett, P. T., Overby, L. M., Moreman, M. D., Klein, R. D. & Boren, J.E. Pilot experiment. Attack experiment I. Small arms service test facilities and methods. Fort Benning, Georgia: U.S. Army Infantry Board, April 1966. (AD-816 080)

This study was designed to study the feasibility of an instrumented small arms test facility to test infantry weapons under combat test conditions. The experiment was set up so that it could be determined if an experimental attack facility could provide data to support the concept of testing weapons under combat conditions and to determine instrumentation requirements for such a facility. The experiment was conducted by sequences of attack trials involving one or three players and a squad leader/controller in each trial. Data derived from these live fire attacks included information on hit probabilities, miss distances, movement times, malfunction rates, weapon performance by range, firing techniques, group effects, firing modes, magazine change times and instrumentation reliability. Two rifles, the M14 and XM16A1, were used as test weapons during the experiment.

74. Hakansson, N. H. An adaptive method of test selection in system development. Santa Monica, California: Rand Corporation, April 1967. (AD-653 942)

Experience indicates that the major source of uncertainty in weapon system development can be traced to activities involving testing and redesign, yet surprisingly little of conceptual nature has been done to improve the decisionmaking process involved in performing these activities. An adaptive model of the testing process is constructed that is designed to provide the project director and his staff with a means of determining the best test to perform at a given stage in the development of a system and to enable the same decisionmakers to choose intelligently among the available redesign actions once the test results are known. Although the model is presented in terms of relatively simple systems and tests, it should be capable of handling those of a highly complex nature.

75. Hale, D. R. E. The selection of measures of effectiveness for small arms experiments. Monterey, California: Naval Postgraduate School, March 1974. (AD-917 924L)

The assessment of the effectiveness of combat systems is discussed. A definition of measures of effectiveness is rationalized and a methodology for the development of such measures is presented. This methodology is then applied to the small arms weapon system within the context of field experimentation. Aggregation of several incommensurable

measures of effectiveness is investigated and practical approaches are explained.

76. Hall, E. R. & Rizzo, W. A. An assessment of U.S. Navy tactical team training (final report) (report number TAEG-R-18). Orlando, Florida: Naval Training Equipment Center, March 1975.

A study was conducted to compile resource information for planning regarding Navy tactical team training. The specific objectives were to describe the current status of team training within the fleet; review and evaluate the findings in the technical literature regarding team training; develop and recommend potential solutions to team training problems. Information required for the study was gathered from two principal sources: Navy units where team training is conducted and the technical literature pertaining to team training.

77. Hall, R. W. Moving man target methodology study. Fort Benning, Georgia: U.S. Army Infantry Board, April 1975. (AD-B004 846L)

The purpose of this study was to develop methodology for the daylight employment of moving man target systems (MMTS) in future tests of infantry rifle systems. The report presents a description of the developed methodology and its application.

78. Hallman, R. E. Design of training systems phase III (final report) (report number TAEG-28). Cape Canaveral, Florida: International Business Machines Corporation, September 1975.

The Design of Training Systems (DOTS) model was conceived to provide Naval Education and Training Command management with computerized mathematical models to assist in predicting the quantitative impact of training resource decisions. During Phase III of the project, the three models were operationally tested. An evaluation team concluded that it was feasible to apply the models to Navy training problems. This document provides background information on the project and describes in detail the evaluation strategy and the results of the tests.

79. Hambleton, R. K. & Norvick, M. R. Toward an integration of theory and method for criterion-referenced tests. Journal of

Educational Measurement, 1973, 10 (3), 159-170.

Views criterion-referenced testing from a decision-theoretic viewpoint and suggests approaches to reliability and validity estimation consistent with this philosophy. Also, to improve the decision-making accuracy of criterion-referenced tests, a Bayesian procedure for estimating true mastery scores is proposed. This Bayesian procedure used information about other members of a student's group (collateral information), but the resulting estimation is still criterion-referenced rather than norm referenced in that the student is compared to a standard rather than to other students. In theory, the Bayesian procedure increases the "effective length" of the test by improving the reliability, the validity, and more importantly, the decision-making accuracy of the criterion-referenced test scores.

80. Harrell, B. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II - Part 1). Fort Belvoir, Virginia: U.S. Army Combat Developments Command, May 1967. (AD-509 610L) SECRET

This report covers requirements for tank and antitank weapon systems including the TOW system.

81. Haverland, E. M. Transfer and use of training technology: A model for matching training approaches with training settings (report number HumRRO-TR-24-74). Alexandria, Virginia: Human Resources Research Organization, October 1974.

The report describes a project designed to facilitate the transfer and utilization of training technology by developing a model for evaluating training approaches or innovations in relation to the requirements, resources, and constraints of specific training settings. The model consists of two parallel sets of open-ended questions -- one set concerning the characteristics of the training approach under consideration and one set concerning the requirements, resources, and constraints in the specific training setting. When these questions have been answered, the information needed to evaluate how well the training approach fits the training setting is available and arrayed in a convenient format. The model can be used: when the training setting is given and the problem is to select training approaches; to analyze and describe training approaches in terms relevant to

the concerns of the training designer and developer; and to make an inventory of the characteristics of a training setting, without any particular training approach in mind. The report also includes chapters on: background; description of the model (including its development and initial testing); field evaluation and revisions; discussion of the model; applications; and conclusions and implications. An appendix presents an application of the model to a peer instruction training approach.

82. Heatherington, B. W. Test evaluation report - TOW weapon system, qualification test program for the redesigned TOW instructor console cable (technical report). Redstone Arsenal, Alabama: U.S. Army Missile Command, Redstone Arsenal, Alabama Test and Evaluation Directorate, January 1973. (AD-908 6622)

This report presents the results of a qualification test program conducted on four new configuration cable assemblies for the TOW instructor console. The cable was redesigned to correct a wire breakage problem that has been observed in the field on the current configuration cable assembly. The test program was conducted to determine whether the redesigned cable is qualified for use with the TOW XM70 training set.

83. Heatherington, B. W. Test evaluation report TOW weapon system qualification test program for the XM70 training set blast simulators (technical report). Redstone Arsenal, Alabama: U.S. Army Missile Command Test and Evaluation Directorate, November 1972. (AD-908 664)

This report presents the test procedures and results of a qualification test program conducted on 202 new blast simulators for the TOW XM70 training set. The blast simulators were subjected to a sequence of extreme environments that may be encountered in storage, shipping, and worldwide deployment. The objective of the test program was to determine whether the blast simulator is qualified for use in the XM70 training set.

84. Henrysson, S. & Wedman, I. Some problems in construction and evaluation of criterion-referenced tests. Scandinavian Journal of Educational Research, 1974, 18 (1), 1-12.

Discusses problems in establishing the goals of criterion-referenced tests, specifying short- and long-term

learning objectives, insuring the homogeneity of test items, and determining appropriate score cut-off levels. The rationale behind different item analysis procedures for criterion-referenced data is examined, recent empirical data on the evaluation of these tests is presented to demonstrate the inter-correlations between these various analysis procedures, and the future of criterion-referenced testing is considered.

85. Herren, T. W., Jones, M. D. & Reynolds, S. C. Independent evaluation of the guided missile system, surface attack, M47, Dragon. Fort Belvoir, Virginia: U.S. Army Operational Test and Evaluation Agency, May 1975. (AD-C001 877) CONFIDENTIAL

This evaluation of the guided missile system, surface attack M47 (Dragon weapon system) is based on observations during Operational Test III conducted July-October 1974 by MASSTER, Fort Hood, Texas. The evaluation assesses: operational performance; reliability, availability, and maintainability (RAM); training; tactics and organization; and logistics. Conclusions are presented in the above major areas. Operational Test III was a company size test conducted in accordance with TRADOC tactical scenarios. Targets were manned target tanks (MTTS); 204 inert warhead Dragon missiles were expended during this test of production equipment.

86. Hoehn, A. J. Military training research in the engineering of training programs for technical personnel. Alexandria, Virginia: Human Resources Research Organization, February 1969. (AD-684 206)

Rapid technological change makes it necessary to train and retrain personnel as man-machine systems and associated jobs are altered. Because of the continuing rise in required skill levels, the demand for high aptitude, highly trained manpower outruns the supply while it is hard to use lower aptitude men. Recent advances in training technology should, if implemented, help to solve training and manpower problems. Major direction indicated by military research in this area include (1) improved methods for describing required human performance outputs and for deriving training content, (2) better design of informational job aids, and (3) new techniques and devices for guiding the learning process.

87. Hoehn, A. J. Operational context training in individual

technical skills. Alexandria, Virginia: Human Resources Research Organization, December 1969. (AD-703 515)

Four papers were presented at a conference dealing with the objectives and problems of operational context training (OCT) sponsored by HumRRO in June 1958. The first paper (by William McClelland) outlines the objectives of the conference and its general goals. The second paper (by Arthur J. Hoehn) describes the use of operational context training to increase job performance of military skills through the development of materials and techniques specifically designed to fit the characteristics of the operational setting. The third paper (by Myron Woolman) describes the rationale and gives an illustration of OCT. The illustration consists of developing and testing a method of a site training of inexperienced Nike integrated fire operators. The fourth paper (by Robert Glaser) discusses operational context training in terms of the human component -- its readiness, logistics, and cost of OCT. The appendix includes statement of five immediate issues to be considered in research of OCT.

88. Hope, A. C. Integrated engineering and service test of TOW heavy antitank/assault weapon system, tropic phase. White Sands Missile Range, New Mexico: U.S. Army Missile Test and Evaluation Directorate, February 1972. (AD-520 2100)
CONFIDENTIAL

This report covers the tropic phase of the TOW Integrated Engineering and Service Test conducted in the Panama Canal Zone beginning with 1-year storage in August 1970 terminating in firings with the stored test items in September 1971. The tests were conducted by White Sands Missile Range and the U.S. Army Tropic Test Center.

The purpose of this test was to determine the effects of tropic environment on the TOW system during 1-year storage and subsequent firing, firing performances in rain and over water, and whether any unsafe conditions result from tropic storage or performance tests.

One launcher, eight rounds of overpacks, and overpacks with baggies were subjected to open storage. Eight other rounds in overpacks were stored in a bunker. After 1 year, all but four of the bunker-stored rounds were fired. Additionally, two nonstored telemetry rounds were fired. The rain objective was waived because of lack of rain in the time

available for firings.

With the test items maintained at the organizational level per the technical manuals, no significant failures could be attributed to the 1-year storage, the round baggie showed deterioration. The rounds in the open, without the sealed baggie, showed no important increase in internal humidity.

89. Hope, A. C. & Yoblonski, L. F. Artic integrated engineering and service test of TOW heavy antitank/assualt weapon system. White Sands Missile Range, New Mexico: U.S. Army Missile Test and Evaluation Directorate, July 1971. (AD-517 694)
CONFIDENTIAL

This report describes the operation of the TOW weapon system during artic weather conditions.

90. Huber, C. C. TOW night sight tests (technical report). Redstone Arsenal, Alabama: U.S. Army Missile Command - Test and Evaluation Directorate, April 1973. (AD-910 308L)

This report presents the test procedure and results of tests conducted on five different night sights for the TOW weapon system. All firings were conducted at night against stationary and moving targets at various ranges.

91. Huber, C. C. TOW engineering change evaluation missile firings (technical report). Redstone Arsenal, Alabama: U.S. Army Missile Command, June 1973. (AD-912 533L)

This report presents the test procedure and results of tests conducted on 18 TOW engineering change evaluation and three extended range missiles. Twelve of the engineering change evaluation missiles were fired with the launcher unmanned and elevated to obtain maximum flight. Six engineering change evaluation and three extended range missiles were fired by a gunner at moving and stationary targets at ranges from 3500 to 3694 meters.

92. Hughes Aircraft. TOW heavy assualt weapon. Culver City, California: Hughes Aircraft Comapny, March 1968. (AD-389 847L)

This report addresses various aspects of the developmental cycle of the TOW missile system: (1)

reliability requirements of the missile and launcher systems, (2) flight tests and analyses, (3) missile vulnerability, (4) missile system laboratory test and evaluation, (5) missile system reliability/verification test, and (6) XM70 training set.

93. Human Resources Research Organization. Critical combat performances, knowledges, and skills required of the infantry rifle platoon leader. George Washington University, Alexandria, Virginia: Author, March 1968. (AD-704 993)

The document is one of a series of research by-products that details the critical skills, knowledges, and performances the infantry rifle platoon leader must possess for effective individual and unit combat performance. The overall goal of the research is to improve officer training in these critical combat skill areas necessary for effective leadership. This document concerns the critical skill requirements in the area of use of the rifle, 5.56mm, M16, such as range estimation, zeroing, etc.

94. Human Resources Research Organization. Training for small independent action forces. Program description No. 9. Use of individual weapons. Alexandria, Virginia: Author, 1970. (AD-922 312L)

This program provides training to qualify SIAF members in the detection and engagement of single and multiple stationary and moving targets with the M16A1 rifle and M79 grenade launcher under varying field conditions, and includes the use of automatic and semiautomatic fire with the rifle, direct and indirect fire with the grenade launcher, and care and maintenance of both types of weapons.

95. International Laser Systems. LASERTRAIN marksmanship trainer. Technical manual. Orlando, Florida: International Laser Systems, Incorporated, 1976.

The LASERTRAIN Marksmanship Trainer, Model LT-100 provides a safe and effective means for developing rifle marksmanship skills while reducing training costs. This easy-to-use system can be set up quickly in almost any location, thereby allowing informal periodic proficiency maintenance sessions to be conducted without implementation of rigid weapon control procedures. The system's compact size and absolute operating safety make it ideal for

permanent day-room installation where it can be informally used at any time to maintain or improve marksmanship proficiency.

The trainee fires at a target console located 10m from the firing line. Targets, scaled to represent the standard M-16 Canadian bullseye at a range of 25m, an F-type at 50m and an E-type at ranges of 100 to 300m in increments of 50m, are silhouetted on the target console's lighted screen.

A harmless pulse of invisible laser light simulates the path of the rifle bullet, with one laser pulse being produced for each simulated weapon round. The rifle can be operated in either the semiautomatic or full-automatic mode. In either mode, an optional ROUNDS SELECT accessory permits the instructor to select, by means of a screwdriver operator switch on the laser transmitter, a clip load of 3 to 30 rounds in 10 increments of 3 rounds each. In the full-automatic mode, the actual number of rounds fired, up to the clip load limit, is determined by the length of time the trainee depresses the trigger. In this manner, the technique of firing limited bursts can be taught and practiced.

A 9-in. diagonal monochromatic scoring console TV display of the target is provided at the firing line. The display can be positioned so as to be visible to both the trainee and the instructor or, alternatively, to the instructor alone. As each simulated round strikes the target, the location of the hit is displayed on the control console TV screen and is accompanied by an audible sound. The accuracy of scoring is such that at least 16 distinct hits can be resolved across the width of an E-type silhouette at a simulated range of 300m. Rounds that strike the white area surrounding the black silhouettes also are displayed so that near misses can be recorded.

As successive rounds strike the area surrounding the target, the previously displayed hit is dropped from the display, but is retained in memory for subsequent recall. Memory locations are provided to accommodate eight rounds; optional accessory storage is available to extend the memory capacity to a full clip of 30 rounds. At the conclusion of firing, the hit location of any round within the storage capacity can be recalled selectively and displayed. In addition, to analyze the grouping achieved by the trainee, the locations of all hits within both the target and the

surrounding background can be displayed simultaneously to the limit of the storage capability of the system.

The LASERTRAIN Marksmanship Trainer System also can be operated in diagnostic mode to observe the trainee's aiming pattern prior to firing the round.

96. Intrec. The evaluation of small arms effectiveness criteria (Vol. I). Santa Monica, California: Intrec, Incorporated, May 1975. (AD-B004 382L)

This study includes (1) a description of the various small arms tests, the agencies responsible for ordering, planning, and conducting them, and an assessment of the test management structure, (2) a description of the basic steps in designing, conducting, and analyzing operational tests (field experiments) of small arms, with the 1965-1966 small arms test at CDEC presented as a case study, and (3) an evaluation of the conduct of current small arms testing and the facilities and equipment for its use at CDEC-HLMR and USAIB.

97. Intrec. The evaluation of small arms effectiveness criteria (Vol. II). Santa Monica, California: Intrec, Incorporated, May 1975. (AD-B004 383L)

This volume of the overall report concerning small arms effectiveness criteria (see prior reference) presents a bibliography, a review of small arms lethality testing, a format for engineering tests, information on the ranges at which small arms targets are engaged, information on how soldiers fire small arms in combat, data from CDEC and USAIB test range firings, and information about new range equipment that is now in the U.S. Army inventory.

98. Jacobs, T. O., Salter, M. S. & Christie, C. I. The effects on training requirements of the physical and performance characteristics of weapons (report number HumRRO-TR-74-10, Alexandria, Virginia: Human Resources Research Organization, June 1974. (AD-920 040L)

The purpose of this research was to provide information from literature search and judgmental evaluation on: (1) the minimum level of performance qualifying an individual to operate a weapons system; (2) the impact of the physical and performance characteristics of weapons on training required

to reach this level; (3) the impact of post-1985 environments on training requirements; (4) identification of training requirements that cannot be expedited, and (5) priorities for allocation on resources for training, in terms of weapon performance characteristics. The findings demonstrated that weapon controllability is the ASARS characteristic with highest impact on training requirements, and the highest potential for return on resource investment.

Although beyond the scope of this study, it could be concluded that improved weapon controllability might offer the best opportunity for increased operational effectiveness as well.

99. Jehan, H. I., Jr. Threat oriented evaluation: A new approach to training with applications to rifle marksmanship training. Fort Benning, Georgia: U.S. Army Infantry School, February 1976.

Although intended primarily for use in conjunction with rifle marksmanship training, this proposal develops a threat related model which has direct application to any man/weapon training program. Sequentially the paper describes the process of identifying a union between the threat and a given required training performance. The establishment of a viable threat is the initial step in the process, followed by development of a threat model in the form of a test; exclusive of training. The threat model test is then administered to personnel who have been trained under the old, established training program. Observed levels of performance are recorded and analyzed. Substandard areas are noted and the training program is revised. Succeeding cycles of training use the revised program of instruction. The training program is further revised as needed, until modifications in the program offer no significant change in the test performance measures.

100. Johnson, M. S. & Kress, R. A. Task analysis for criterion-referenced tests. Reading Teacher, 1971, 24 (4), 355-359.

Criterion-referenced tests can be constructed and used by individual teachers as well as by professional test makers. In either case, however, they must be relevant to the learning opportunities which have been provided for the child. When adequately constructed to reflect the actual steps of the learning process and appropriately used,

criterion-referenced tests appear to offer real promise for the guidance of instruction.

101. Kelly, H. E., Jacobs, T. O., & Taylor, R. A. Critical combat performances, knowledges, and skills required of the infantry rifle squad leader. Rifle, 5.56mm, M16. Alexandria, Virginia: Human Resources Research Organization, December 1968. (AD-713-821)

This is one of a series of 41 research by-products that details the critical skills, knowledges, and performances the infantry squad leader must have for effective individual and unit combat performance. This particular volume addresses the skills, knowledges and performances required for the effective use of the M16A1 rifle (5.56mm) in operational combat situations by the infantry squad leader.

102. Kern, R. P. A conceptual model of behavior under stress, with implications for combat training (report number HumRRO-TR-66-12). Alexandria, Virginia: Human Resources Research Organization, June 1966.

On the basis of reported observations of the behavior of individuals under various prolonged physical harm conditions, a sequential pattern of behavioral reactions is described, reflecting the behavioral manifestations of a stress process. This sequential pattern of behavior would be expected, over time, to apply to any individual in any severe physical harm threat. The rate of development of this behavioral pattern under a given set of environmental stressor conditions represents the individual's stress resistance. A conceptual model was developed to describe the mode of operation of key attitudinal variables and environmental stressor variables in producing this behavioral pattern as well as the individual differences in stress resistance. Design of training to increase stress resistance in combat or other hazardous jobs is discussed from the basis of this conceptual framework.

103. Kille, B. R. Improving training assistance from any schools to army training managers. Carlisle Barracks, Pennsylvania: U.S. Army War College, December 1972. (AD-760 455)

U.S. Army service schools have been responsible for providing instructional reference materials to training managers of the Active Army and Reserve Components for many years. Regardless of what the service schools did however,

it was apparent that far too many of those in charge of training were not aware of the assistance available to them. Research into current management and operational procedures, training directives, and training studies established that a viable communications link can be established. The service schools must take the initiative and "sell" their training products to all who have a need for them. The service schools must look outside their academic walls, and provide training assistance to every individual, unit, or staff that needs help in those subject areas for which they have proponency.

104. Klein, R. D. Human factors in aircraft survivability. (Unpublished report), 19 August 1964.

This paper discusses sources of human variability (stress, fatigue, leadership, experience, etc.) which may be magnified in a combat situation and which are generally (on purpose) minimized in experimentation aimed at establishing parametric characteristics of weapon systems. It was concluded that the sources of human variability that can be reproduced are: (a) greater freedom and permissibility in individual responding, (b) sustained and prolonged combat activity, (c) extreme uncertainty, (d) the energizing and driving effects of combat stress, and (e) the fatigue and exhaustion associated with maintaining an excessively high level of attending and responding. In addition, a firing range and target system for M60 machinegun crews is proposed which will permit the simultaneous play of above factors on a crew in definable, measurable ways.

105. Klein, R. D. Infantry weapons test methodology study quick-fire experiment I (final report). Fort Benning, Georgia: U.S. Army Infantry Board, 27 June 1969.

The purpose of this experiment was to: (a) determine factors critical to weapons evaluation in a quick-fire combat-type situation, (b) test instrumentation for required quantitative measurement, and (c) evaluate the test methodology as a means of discriminating between man/weapon systems.

Sixty military personnel who were representative of those who could be expected to be used during Infantry weapons service testing were trained in the quick-kill technique of fire and used during the experiment. Two rifles

were used for methodology evaluation. Half of the test soldiers were armed with each rifle and each fired the test course once using semiautomatic mode of fire and again using automatic mode. Firing was done at range distances of 20, 40, 60, and 80 meters with target exposure times of 4 to 6 seconds.

It was found that measures of effectiveness not previously measured by the Infantry Board were critical in rifle evaluation: time to first round fired, cumulative exposure time, time between rounds (semiautomatic mode), time between bursts, and time to shift fire to adjacent targets. Also several test facility design factors were isolated and were considered critical in the evaluation of the measures of effectiveness: target cuing, range to target, angle of fire, target presentation, and target exposure time.

106. Klein, R. D. Project analysis: Antitank weapons test methodology. Fort Benning, Georgia: U.S. Army Infantry Board, 27 November 1970.

The purpose of this report was to establish basic test concepts for the operational evaluation of antitank weapon systems. The concepts include the development of test facilities, test methods and procedures, instrumentation requirements, and data collection and processing requirements. To provide general guidance for this study, an attempt is made to identify critical factors which should be considered as the methodology study continues. Each critical factor (weapon employment, use at night, vulnerability to enemy weapon systems, training, nature of threat, nature of terrain in which system is employed, and human factors associated with weapon use) is discussed and recommendations for elimination or inclusion of the factor in a given test are presented.

107. Klein, R. D. Infantry weapons test methodology study (final report) (Vol. I) Small arms test methodology. Fort Benning, Georgia: U.S. Army Infantry Board, 1 June 1974.

This paper contains a summary of the progress made in the area of small arms weapon system test methodology. The first four years of the Infantry Weapons Test Methodology study were oriented toward improvements in test procedures and instrumentation for small arms performance evaluation. The basic assumption underlying the methodology study was

that candidate weapon performance must be assessed in the environment for which it was intended to be used. This report discusses the development of test facilities that provide representative tactical situations with realistic targets designed to represent activities and movement of threat personnel. To the extent possible, quantitative data are identified for collection to answer questions concerning weapon system performance.

108. Klein, R. D. Defense experiment I (final report). Fort Benning, Georgia: U.S. Army Infantry Board, 22 November 1971.

The purpose of this experiment was to: (a) identify valid and viable measures of effectiveness for comparison of rifle performance in the defense and (b) determine capabilities and limitations of the test facility. Eighty-four test soldiers were scheduled in groups of 3 soldiers each to defend their position against an attack by the maneuver element of a simulated platoon size force. The duration of the firefight was approximately 14 minutes. The experiment was designed to provide data for the following subtests: comparative rifle performance, instrumentation reliability and capability, the effects of varying target/background contrast and exposure times on soldier rifle performance, learning effects, and a compatibility test of the Defense Facility instrumentation and the XM-19 rifle. Two rifles, designated Rifle A and Rifle B, were used as test weapons.

A set of measures of effectiveness for the evaluation of competing weapon systems was established, each indicating a significant performance differences in one or more subtests. Target background contrast was found to have a possible effect on hit probability, but had no observed effect on target acquisition. Reducing target exposure times did not provide an increased capability to isolate performance differences between the competing weapons used in the experiment. Finally, repeated trials by the same soldiers was associated with improved target acquisition performance, but was not associated with improved man/weapon system accuracy.

109. Klein, R. D. & Brown, R. M. The development of combat related measures of effectiveness for small arms weapon systems. Fort Benning, Georgia: U.S. Army Infantry Board, November 1969.

This report describes a new analytic technique called the Scaler Principle of Automatic Rifle Evaluation (SPARE) for comparing automatic rifle performance. The technique was developed during an indepth analysis of quick-fire data. It has established a direct relationship between normally available measures of effectiveness from field testing and combat effectiveness. Selected measures were shown to have demonstrable effects on combat tasks. In particular, the SPARE technique relies on the detection of interaction effects between influencing variables and appears to have a good potential for identifying areas of sensitivity in small arms performance evaluation.

110. Klein, R. D. & Brown, R. M. Intergrated operational test and analysis procedures for small arms weapon systems evaluation. Fort Benning, Georgia: U.S. Army Infantry Board, April 1972.

The purpose of this document was to summarize the findings of the Small Arms Methodology Study in terms of a working format for weapon system evaluation using the three small arms test facilities. The first section of the report discusses the major parameters of an integrated test procedure. The second section of the report describes procedures for training and scheduling test soldiers through the facilities taking into account two major test variables, weapons and modes of fire. Also, a rationale is provided for estimating the sample size appropriate for a weapons test and the selection of test soldiers for a weapons study. Finally, the third section of the report describes an analytical procedure to be used on field-general data. This procedure emphasizes the selection of the superior weapon system at the earliest possible point, consistent with a thorough evaluation of operational performance, in order to maximize the time available for improving the selected weapon's performance.

111. Klein, R. D. & Thomas, C. B. The development of combat related measures for small arms evaluation. Fort Benning, Georgia: U.S. Army Infantry Board, June 1969.

This paper discusses the U.S. Army Infantry Board's five-year Infantry Weapons Methodology Study. The approach of the study was to cast test procedures in terms of the environment in which candidate weapon systems and support equipment will be used. Since a realistic evaluation of weapon performance cannot be undertaken with validity in a

laboratory situation, the movement in recent years has been towards tactical or operational testing. In this paper the results of several weapon systems studies are presented with an emphasis on the presentation of a variety of new measures of effectiveness which reflect soldier/weapon system performance under combat conditions. The new measures are shown to provide definitive descriptions related to weapon performance which can assist the decisionmaker in selecting the best of several competing weapon systems.

112. Lamothe, R. H. Dragon cost and operational effectiveness analysis (COEA) (Vol. I) (Executive Summary). Fort Benning, Georgia: U.S. Army Infantry School, May 1975. (AD-C004 900L) CONFIDENTIAL

This analysis is the fourth in a series of quantitative studies of the medium antitank weapon (MAW). This study was conducted to determine the impact of changes in Dragon cost and performance estimates on the cost effectiveness of the system in comparison with other feasible alternatives. Findings of the study addressed the desirability of each alternative of the MAW role and identified the sensitivity of antitank effectiveness to changes in cost and performance. Conclusions and recommendations identified the MAW system of choice and suggested means of increasing the effectiveness of the system.

113. Lamothe, R. H. Dragon cost and operational effectiveness analysis (COEA) (Vol. II - main report). Fort Benning, Georgia: U.S. Army Infantry School, May 1975. (AD-C004 901L) CONFIDENTIAL

For abstract see Executive Summary AD-C004 900L.

114. Lamothe, R. H. Dragon cost and operational effectiveness analysis (COEA): Threat (Vol. III - Appendix II). Fort Benning, Georgia: U.S. Army Infantry School, May 1975. (AD-C004-902L) SECRET

For abstract see Executive Summary AD-C004 900L.

115. Lamothe, R. H. Dragon cost and operational effectiveness analysis (COEA): Breakthrough threat force analysis (Vol. VI - addendum). Fort Benning, Georgia: U.S. Army Infantry School, May 1975. (AD-C004 909L) SECRET

For abstract see Executive Summary AD-C004 900L.

116. Lamothe, R. H. Dragon cost and operational effectiveness analysis (COEA) (Vol. IV). Fort Benning, Georgia: Army Infantry School, May 1975. (AD-C004 908L) SECRET

This appendix examines the findings of three recent studies wherein the Dragon antitank weapon was subjected to a cost and operational effectiveness analysis (COEA) and compares them with the present Dragon COEA.

117. Larson, J. A. Training implications for Dragon medium antitank assault weapon system M47. Fort Hocd, Texas: Modern Army Selected Systems Test Evaluation and Review, April 1975. (AD-B003 756L)

The purpose of this report is to evaluate the impact of training on the effectiveness of the Dragon weapon system. The analysis conducted in this report is based on data generated during the Dragon OT III Test. This analysis primarily investigates hit performance during the conduct of simulated tactical scenarios in which the Dragon weapon system is fired against manned target tanks. Hit performance is evaluated during day and night firings occurring in offense, defense, retrograde and armor-killer operations. By evaluating hit performance in terms of the training undergone by Dragon gunners, conclusions and recommendations are made which will allow maximum system effectiveness to be achieved.

118. Larson, O. A., Sander, S. I. & Steinemann, J. H. Survey of unit performance effectiveness measures (report number NPRDC-TR-74-11). San Diego, California: Navy Personnel Research and Development Center, January 1974. (AD-774 919/5GA)

Measures of unit performance effectiveness were surveyed and methods for assessing systems were discussed.

119. Lepold, F. A., Jr. & Yates, N. I., Jr. An effectiveness study of infantry antitank weapons. Aberdeen Proving Ground, Maryland: U.S. Army Materiel Systems Analysis Agency, August 1968. (AD-392 365) CONFIDENTIAL

This report presents a summary of effectiveness data for various infantry antitank weapons. Trajectory and accuracy information as well as lethality against the Soviet T54 tank

with skirting plates are presented. Weapons considered are: 66mm M72 LAW, 3.5-inch M20A1 rocket launcher, 57mm M18 recoilless rifle, 75mm M20 recoilless rifle, 90mm M67 recoilless rifle, 106mm M40 recoilless rifle, MAW (Dragon) antitank-guided missile (ATGM), and TOW-ATGM.

120. Livingston, S. A. Criterion-references applications of classical test theory. Journal of Educational Measurement, 1972, 9 (1), 13-26.

A reliability coefficient for criterion-referenced tests, developed from the assumptions of classical test theory, is based on deviations of scores from the criterion score, rather than from the mean. The coefficient is shown to have several of the important properties of the conventional norm-referenced reliability coefficient, including its interpretation as a ratio of variances and as a correlation between parallel forms, its relationship to test length, its estimation from a single form of a test, and its use in correcting for attenuation due to measurement error. Norm-referenced measurement is considered as a special case of criterion-referenced measurement.

121. Lockheed. Tank, antitank and assault weapons requirements study (Phase III) (Vol. XIV). Sunnyvale, California: Lockheed Missiles and Space Company, December 1968. (AD-500 636L) SECRET

This study describes the requirements for tank, antitank, and assault weapons systems including the TOW system.

122. Lunsford, P. R. Physiological effects of weather on basic trainees during rifle marksmanship training. Carlisle Barracks, Pennsylvania: U.S. Army War College, March 1972. (AD-765 656/4)

Cyclical fluctuations in mean rifle marksmanship scores among units administering basic training give rise to a need to determine their cause. Because in many instances these fluctuations correlate strongly with seasonal changes in the weather this facet among the variables bearing on results obtained during qualification firing warrants investigation. This paper examines the qualification scores of three cycles of basic trainees at Fort Jackson, South Carolina, acquired during hot, moderate and cool weather. Detailed

climatological data pertaining to the exact times that firing was conducted is examined along with the scores. Certain statistical differences of significance emerge which lead to the conclusion that climatic conditions may have an appreciable effect on the physiological condition of the basic trainee to the extent that it affects significantly his qualification score in rifle marksmanship training.

123. Mannen, H. A. & Willing, R. C. Current research techniques in military personnel assessment. Springfield, Virginia: National Technical Information Service, Operations Division, September 1970. (AD-717 028)

Twenty-eight papers were presented covering numerous aspects and ramifications of personnel evaluation research methodology in military training. Attention was focused on such concerns as job analysis, testing of knowledge and performance, predictive ability of biographical inventories and psychiatric interviews, course evaluation techniques, identification of relevant civilian skills, test construction, problems in peer rating, officer job evaluation research, and use of the Military Occupational Data Bank as a personnel evaluation resource.

124. Mannschreck, W. A. & Crider, J. F. U.S. shaped charge weapons effectiveness against Soviet tank armor. Dahlgren, Virginia: Naval Weapons Laboratory, September 1974. (AD-531 657L) CONFIDENTIAL

This is a report on the impact effectiveness of shaped charge weapons.

125. Maule, M. M. Development test (DT II) of rimfire adapter (RFA) for M16A1 rifle. Aberdeen Proving Ground, Maryland: Material Testing Directorate, May 1975. (AD-B004 717L)

The development Test (DT II) of three types of caliber .22 rimfire adapters for the M16A1 rifle was conducted by U.S. Army Aberdeen Proving Ground from 30 September 1974 to 24 April 1975. The purpose of this test was to determine if the adapters met the training-device requirements with respect to safety and physical and operational characteristics. The following subtests were conducted to determine the performance of the test item: initial inspection, safety, extreme temperature, humidity, accuracy and endurance, water spray, dynamic sand and dust, mud, rough

handling, maintenance evaluation, and human factors. Two of the three types of test items satisfied the applicable criteria with the exception of operation at low-temperatures, durability, accuracy, battle-sight zero, and safety in the rough-handling test phases; the third type was withdrawn from testing early.

- 126. Maxey, J. L., Ton, W. H., Warnick, W. L., & Kubala, A. L. Target presentation methodology for tactical field evaluation. Fort Hood, Texas: U.S. Army Research Institute for the Behavioral and Social Sciences, May 1976.

This developmental effort was directed toward the accomplishment of the following tasks:

- (1) The identification of the factors which influence the target acquisition process.
- (2) The determination of the effects of these factors on the acquisition process in a ground environment.
- (3) The identification of the targets and tactics likely to be encountered in A European battlefield environment.
- (4) The integration of the results of the above tasks into a standard, general-purpose presentation methodology suitable for employment in field test evaluations.

The principal findings of the effort were:

- (1) Analysis of the military and psychological research yielded 24 variables (eight target, seven environmental, five task, and four observer variables) which are likely to affect the visual acquisition process for ground-to-ground target situations.
- (2) Threat forces are basically composed of armored and mechanized infantry units with tanks, armored combat vehicles, and self-propelled, tracked air defense weapon systems constituting the primary targets on the modern battlefield.
- (3) Threat forces employ a wide variety of antiarmor weapon systems which are designed to form an interlocking defense system effective over ranges from 0 to 3500 meters. These limits basically define the kill zone of

the modern battlefield with respect to threat antiarmor weapons.

- (4) Threat forces stress the attack and will resort to the defense only as a temporary expedient.
- (5) Threat forces train for and plan to operate on a 24-hour battleday. Quick Attacks may be expected during the day, while Deliberate Attacks may be expected during the night.
- (6) Field tests of target acquisition systems should employ the targets and study operational situations that correspond to the threat targets and situations likely to be encountered on the modern battlefield.

127. McCaslin, J. K., Jr. The BMP in Combat. Infantry, 1977, 62, 16-21.

The author presents a compendium of current Soviet military thought regarding the tactical employment of the Russian Armored Personnel Carrier (BMP). Doctrine pertaining to the role of the BMP in the offense, location of vehicles in attack formations relative to tanks, supporting fire capability, and the role of the BMP in the "pursuit", raid and meeting engagement are discussed. Two controversial subjects which are argued among current Soviet military tacticians are explained: conditions requiring and optimal distances from enemy positions for dismounting of infantry from the BMPs, and the proper scheme of maneuver to be followed by BMP vehicles in the attack so as to maximize their mobility. The article concludes with the notation that Soviet military officers have been, and will continue to search for better ways to employ the BMP in modern combat.

128. McClelland, W. A. Individualized training and the training of individuals (report number PP-24-71). Alexandria, Virginia: Human Resources Research Organization, December 1971.

Two current instructional research efforts relating to the problem of an individual student's learning and personal needs are reported. Characteristics of individualized instruction (e.g., terminal course objectives, remedial materials, measurement procedures), administrative constraints (e.g., fixed time, cost of equipment, lack of skilled instructors), training strategies and goals are discussed. The APSTRAT (Aptitude Strategies) research involves peer instruction and provides for self-pacing, rapid

feedback, and practice. Project IMPACT is an effort to provide the U.S. Army with an effective, efficient, and economical computer-administered instructional system.

129. McCluskey, M. R. Perspectives on simulation and miniaturization (report number PP-14-72). Alexandria, Virginia: Human Resources Research Organization, June 1972.

In this report training applications of simulation and miniaturization are examined, as are areas where research is needed to develop cost-effectiveness simulation methodologies for training. In order for simulation and miniaturization techniques to reach maximum levels of effectiveness, systems analysis is needed to define physical and psychological dimensions, relationships, and aspects. Among the aspects of this system to be considered for simulation are equipment components, personnel, organization, system procedures and processes, input data, output data, and environment. Application of this approach to military training is made.

130. McCluskey, M. R., Haggard, D. F. & Powers, T. R. Survey of army weapons training and weapons training devices (research memorandum 76-8). Alexandria, Virginia: U.S. Army Research Institute for the Behavioral and Social Sciences, April 1976.

The overall goal of the study was to provide information concerning the most effective and efficient methods of training Army personnel to required levels of proficiency in weapons firing. The examination of training methods focused on the contribution of training devices and live firing to weapons proficiency.

The report described the results of the first phase (Task 1) of the project. This task consisted of surveying current Army weapons training. The basic information collected for the surveys was contributed by numerous groups and agencies at each of the combat arms schools. This interim report summarizes the results of those surveys.

131. McCluskey, M. R., Jacobs, T. O. & Cleary, F. K. Systems engineering of training for eight combat arms MOSSs. Alexandria, Virginia: Human Resources Research Organization, January 1974. (AD-782 195/2)

The basic objective of this project was to develop task inventories and job task data for duty positions in eight of

the key combat arms MOSs using systems engineering procedures. Field evaluation by job incumbents, senior NCOs, and officers resulted in a complete definition of each duty position in an MOS in terms of common and noncommon tasks at various levels of organization. The information on commonality of tasks that is contained in this report and the by-product report may be directly utilized by curriculum planners, training administrators, and training developers at each of the combat arms schools.

132. McDonald, R. D. Retention of military skills acquired in basic combat training (TR-67-13). Alexandria, Virginia: Human Resources Research Office, December 1967.

Performance data over time were collected in the three general BCT proficiency areas, which are evaluated by the performance portion of the Army Training Test 21-2 (1). These evaluations are: the Basic Rifle Marksmanship (BRM) weapons qualification test, the Physical Combat Proficiency Test (PCPT), and the end-of-cycle test, a series of two paper-and-pencil and six motor-skill subtests.

Performance was sampled (a) during BCT, (b) during Advanced Individual Training (AIT) and Combat Support Training (CST), and (c) for permanent-party personnel (clerical and Ordnance MOSs) who have been in the Army for 6 to 12 months. Different groups of soldiers were sampled at each of the cited levels of training. Some additional data on rifle marksmanship were collected on a small sample of soldiers, a few weeks prior to their separation from the service.

Data were collected at three Army Training Centers (ATCs), under comparable weather conditions. Achievement was sampled during regular Army test administration, carried out by the appropriate committee group at each ATC, according to established criteria. The soldiers to be tested were selected randomly (from available rosters), by research personnel, who also monitored each test administration. With some exceptions, 60 enlisted men made up each group tested. Comparisons were then made between groups within each proficiency area.

In general, results on the three tests indicated somewhat lower performance levels at later testing points than in the original BCT testing. While these performance

decrements were statistically significant over time, the percentage decrements from the basic trainee level were relatively small.

It was concluded that, on a practical basis and as measured by regular Army tests and procedures, the training received in BCT in the three proficiency areas was effective in terms of remembering or recalling these skills, at least for the time period and the MOSSs sampled.

133. McDonnell Douglas Astronautics Company. Review of Dragon training concepts (final report). Titusville, Florida: McDonnell Douglas Astronautics Company, December 1974.
CONFIDENTIAL

This report presents the results of a MDAC TI-CO review and evaluation of Dragon gunner training concepts, programs of instruction, and the performances of gunners who have successfully completed training courses and qualified for firing live Dragon rounds. It covers the period from the early development of the Dragon weapon to the October 1974 training program and firing tests conducted by the Swiss army. The purpose of the review was to provide:

- (1) background information on the development of Dragon training concepts and equipment,
- (2) analysis of training programs conducted through October 1974,
- (3) a compilation of all available data on manned Dragon firings through October 1974, and
- (4) evaluation of training program effectiveness, including recommendations for changes and/or improvements (where necessary).

134. McFann, H. H. Training strategies and individual differences. Alexandria, Virginia: Human Resources Research Organization, June 1971. (AD-731 915)

Various training strategies are examined in this paper and the implications of each for handling individual differences are considered. Some research findings pertinent to the strategies are given. Instructional procedures and techniques, especially for use with low-ability students, are included.

135. McGinnis, J. M. Compatibility of Army arctic clothing, footwear and handwear during contractors cold chamber tests of the TOW launcher and guidance systems (research study report). Natick, Massachusetts: U.S. Army Natick Labs, Pioneering Research Division, October 1965. (AD-804 939L)

A complete ensemble of standard Army arctic clothing was fitted to each man to eliminate any incompatibilities which might have resulted from nonstandard or improperly fitted clothing. During the test, each crew member was permitted to wear as many items from the ensemble as he considered appropriate for the conditions. The principle technique used for studying compatibility was direct observation. A Natick Labs representative observed the behavior of crew members during test operations. These observations were supplemented by interviews with crew members and by a few measurements of the system equipment.

136. Melching, W. H. & Larson, S. M. Improving the classroom performance of army instructors (report number HumRRO-TR-75-6). Alexandria, Virginia: Human Resources Research Organization, May 1975.

Using "A Model of the Functions of Master Instructor" (HumRRO-TR-73-23) as a guide, procedures and materials for training Army instructors to improve their classroom effectiveness were developed. In constructing the model, various materials on instructor characteristics and responsibilities in four main areas (training programs, classroom behaviors, professional growth, and innovative practices) were gathered from civilian and military sources. Special attention was given to materials devoted to classroom management techniques. Each of the 40 tasks described in the model was carefully reviewed considering three aspects: performance situation, kinds of information needed, and sources of information. The report elaborates on the activities and experiences an instructor would undertake to acquire or update the skills described in the model. The main emphasis is on description of recommended activities to

be undertaken in connection with the performance of each instructor task cited in the model. The document includes a 12-item bibliography and five appendixes: a model of the functions of a master instructor, a sample system analysis, a sample of matrix terminal and enabling objectives, a sample observation form, and videotaping objectives.

137. Melching, W. H. & Whitmore, P. G. A model of the functions of a master instructor (report number HumRRO-TR-73-23). Alexandria, Virginia: Human Resources Research Organization, October 1973.

After completing a search of educational and training literature, and reviewing practices and criteria employed by 18 Army schools in evaluating instructors, a model of the functions of a master instructor was developed. Based upon two main rationales (systems engineering and a behavioristic concept of learning), the model encompasses four areas of performance:

- (1) training programs
- (2) instructor classroom behaviors
- (3) professional growth, and
- (4) innovative practices.

The areas were apportioned into 17 functions and 40 tasks. Task statements were phrased in the form of instructor performance objectives. The model can provide guidance in the development of prototype procedures and materials for the training instructor, and it can aid in devising procedures and forms for the evaluation of instructors.

138. Miller, R. B. & Duffy, L. R. Design of training systems, phase II, a report (final report) (report number TAEG-12-3). Orlando, Florida: Naval Training Equipment Center, July 1975.

Study results and the design for an Educational Technology Assessment Model (ETAM) are outlined, and conclusions and recommendations of the study are summarized. An eight-task procedure is provided to guide the assessor of a training innovation through the required data collection and analysis steps leading to a decision to accept, reject, or continue to study the innovation. Step-by-step application of the ETAM procedures is also provided. Proposed portions of the ETAM amenable to computerization are identified, and validation results are given. Additionally, a review of relevant literature is included.

139. Mirabella, A. & Wheaton, G. R. Effects of task index variations on transfer of training criteria (final report) (report number NAVTRAEQUIPCEN-72-C-0126-1). Silver Spring, Maryland: American Institutes for Research in the Behavioral Sciences, January 1974.

The concluding series of a research program designed to validate a battery of task indexes for use in forecasting the effectiveness of training devices is described. Phase I collated 17 task indexes and applied them to sonar training devices. In Phase II the 17 index battery was validated using skill acquisition measures as criteria. The training of procedural skills was carried out in a modularized, synthetic sonar trainer. Significant multiple correlation coefficients were obtained for performance time and errors during skill acquisition. Phase III validated the index battery against transfer of training criteria. The result of this phase demonstrated that quantitative variations in task design were related to variations in transfer of training measures. A set of predictive equations was constructed. It was concluded that these equations could be used to compare trainer prototypes, although additional field validation was recommended. It was also concluded that the battery could be used in research on the interaction of task and other variables. Training method as a function of task complexity was studied, with the results indicating that the effectiveness of dynamic versus static procedural training varied with a change in task parameters.

140. Mitchell, J. W. Test and evaluation directorates support to the TOW project office (summary report for fiscal year 1973). Reston Arsenal, Alabama: U.S. Army Missile Command Test and Evaluation Directorate, August 1973. (AD-914 140L)

The test and evaluation directorate has been involved in TOW weapon system testing since 1962. This report presents a brief summary of the major tasks performed by the test and evaluation directorate during FY73. The test support included system, subsystem, and component testing. Subjects covered in this report are technical support, flight tests, and environmental tests at the system, subsystem, and component level production phase of the TOW program.

141. Montemerlo, M. D. & Tennyson, M. E. Instructional systems development: Conceptual analysis and comprehensive bibliography (report number NAVTRAEQUIPCEN-IH-257). Orlando, Florida: Naval Training Equipment Center, February 1976.

A bibliography of about 4,000 entries was compiled as a first step in assessing the state of the art of the systems approach to training (SAT). It was concluded that the voluminous SAT literature reveals an underlying confusion concerning the nature of SAT. The same terms are used to refer to different methodologies, thereby yielding the illusion of a greater degree of agreement than actually exists. A great deal of empirical research is needed to further refine and articulate the SAT concept. The bibliography which forms the bulk of this document is divided into 13 sections, each covering a topic important to training program development. The topics include those which are considered by proceduralized SAT manuals, such as: task analysis, specific behavioral objectives, sequencing, media selection, methodology selection, and evaluation. Also included are topics which must be considered in the design of efficient training programs but which are neglected by the proceduralized manuals: instructor training, instructional management, cost, human engineering, simulation, innovation, and educational technology. The remaining sections are: instructional systems development, programed and computer-assisted instruction, job analysis, task taxonomy, and systems analysis/operations research.

142. Montague, E. K. & Showel, M. A review of combat support training. Alexandria, Virginia: Human Resources Research Organization, December 1969. (AD-703 196)

This report presents a review of current training practices and problems as they relate to the broad spread of individual ability among soldiers, and to the increasing need

for functionalization of training. Combat support training was observed at four Army training centers, with particular reference to training objectives, methods, and student evaluation, especially as these relate to increasing individualization of training. Two courses were selected and observed for two weeks with particular attention to the characteristics of the student population, spread of abilities, attrition patterns, suitability of training method to student ability, use of facilities, instructor capabilities, types and processes of student evaluation efforts, individualized training, and the general administrative support of training efforts. Class coverage was made at 15% of sampling level with all phases of training represented. Study findings indicated that the training system worked against the less literate students and was not optimally oriented toward the handling of a wide range of abilities. Key elements in improving the range of abilities were greater emphasis on job related and behaviorally stated training objectives, functionalization of instruction, and evaluation based on job performance capabilities.

143. Monty, R. A. & Senders, J. W. (Eds) Eye movements and psychological processes. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Incorporated, 1976.

Eye movement related to perception of motion, perception of position, target detection and scanning was studied. Good inspectors had more fixations and less duration between fixations. Use of benzodioxepines decreases saccadic velocity, the effects of which are unknown. Differences in saccadic fixations existed between pilots having 3000 flying hours and those with 7000 hours. The authors suggest that saccadic movement is a learned skill.

144. Naumann, T. K. Special analysis of TOW training. Fort Benning, Georgia: U.S. Army Combat Arms Training Board, March 1975. CONFIDENTIAL

Information gathered from various Army agencies and interviews and results of recent field surveys raise serious questions concerning the level of combat effectiveness U.S. units may obtain with the TOW. Although cumulative Army-wide TOW hit probabilities are very close to those probabilities predicted by AMSAA, evidence suggests that the hit probabilities obtained by line divisions are considerably lower than AMSAA predictions. Evidence also suggests that

this situation continues to deteriorate rather than improve. It would seem that the primary cause for this deterioration is the lack of effective and efficient training. The analysis contained in this paper was initiated to determine the most effective standards to establish for TOW training and the courses of action required to achieve them in the most efficient manner.

145. Nuy, M. J. Psychometrical aspects of criterion-referenced tests. Catholic Pedagogical Center, 1972, 27 (10), 648-477.

Outlines the differences in testing in terms of criterion-referenced (CR) versus norm-referenced (NR) tests. The first represent absolute and the second relative measurement. With CR tests the objective is to learn how well the student has learned the subject matter regardless of the performance of the remainder of the class. With NR tests the objective is to compare the performance of a student in terms of the performance of others in the class. When the objective of testing is to select students, NR is preferred to CR. When the objective is the diagnosis of student performance, CR is preferred to NR. Differences between the two are not identical with the problem of validity versus nonvalidity of a test. Variation in test scores is very pertinent with NR although it is not with CR. A problem of CR testing is not only whether a student can remember specific information measured by the test but also whether he can incorporate such information in relatively novel situations. Several suggestions are offered to measure this ability to use acquired information in varied situations.

146. Olmstead, J. A. The effects of "Quick Kill" upon trainee confidence and attitudes (TR-68-15). Alexandria, Virginia: Human Resources Research Organization, December 1968.

This study was performed in order to determine (a) effects of "Quick Kill" training on the confidence of basic combat trainees in their ability to use the service weapon, (b) attitudes of trainees toward basic rifle marksmanship (BRM) training, and (c) attitudes of trainees and their drill sergeants toward Quick Kill training itself.

Quick Kill training is a method for teaching a person to effectively engage a target without first aligning the sights of his weapon. Quick Kill instruction begins with an air

rifle and enables trainees to rapidly learn to hit moving targets in the air. It is assumed this provides a helpful introduction to marksmanship training by developing positive attitudes toward firing a rifle and confidence in marksmanship ability.

The study was designed to provide comparisons between groups that differed in terms of the presence or absence of Quick Kill instruction in BRM training. Subjects were 824 basic trainees at five U.S. Army training centers, selected by platoons within each center. Trainees participated either in a control group, which received BRM training without Quick Kill, or in one of two experimental groups, both of which received BRM training with Quick Kill.

Trainees were administered questionnaires intended to elicit expressions of confidence in firing the service weapon, and of attitudes toward specific phases of BRM training, and toward Quick Kill where relevant. Trainees in the control group and one experimental group were administered questionnaires both before and after training. Contamination of post-training responses due to exposure to a pre-training questionnaire was controlled by the use of a second experimental group which did not receive the pre-training questionnaire. For this group, pooled pre-training scores of the other two groups were used to provide a less contaminated measure of the effects of training.

Control and experimental groups were compared on the basis of (a) gains in confidence over the BRM training period, and (b) differences in both confidence and attitudes toward BRM training. In addition, post-training attitudes of Quick Kill trainees and drill sergeants were obtained.

The results were:

- (1) All training groups gained significantly in confidence during BRM training.
- (2) Trainees who received Quick Kill training gained more confidence than trainees who did not receive this training. The difference in favor of Quick Kill is statistically significant.
- (3) For most aspects of BRM, Quick Kill trainees showed more favorable attitudes than trainees who did not receive

Quick Kill, and reported they found the various phases of BRM less difficult.

- (4) Trainees who received Quick Kill training reported that they did not find it especially difficult and that they enjoyed the training. They did not believe that they encountered any difficulty in changing from air rifle to service weapon. Trainees also believe that Quick Kill helps develop skill with the service weapon but that other phases of BRM are equally important.
- (5) Some divergence of opinion concerning Quick Kill was found among drill sergeants, but most were cautiously favorable toward Quick Kill. Some differences among training centers were found in drill sergeant attitudes.

147. Osborn, W. C. Developing performance tests for training evaluation (report number HumRRO-PP-3-73). Alexandria, Virginia: Human Resources Research Organization, February 1973.

This paper describes the major action points in the course of developing a test for training evaluation. The author gives a brief summary of the 14 action points he considers basic for a test developer:

- (1) obtain a list of terminal objectives with skill and knowledge requirements,
- (2) determine criticality of objectives to military mission,
- (3) determine adequacy of objective: presence of task behavior, conditions and standard,
- (4) review objective with job/training analyst,
- (5) determine feasibility of duplicating the objective's conditions and task behavior in test situation,
- (6) develop a substitute method of testing: simulating conditions or task behavior,
- (7) determine number of replications or variations of test behavior necessary for reliable measurement,
- (8) determine controls on test conditions necessary to

insure standardization over trainees,

- (9) develop objective pass-fail scoring procedure for trainee qualification,
 - (10) develop diagnostic scoring procedures for training evaluation,
 - (11) prepare detailed instructions for tester, trainee, and scorer,
 - (12) determine feasibility of testing on all terminal objectives,
 - (13) determine a relevant sample of test items (terminal objectives) for inclusion in test, and
 - (14) prepare final specifications for test administration.
148. Oliver, E. L. III, & Venti, G. W., Jr. Development test II (service phase)/operational test II of rimfire adapter (RFA) for the M16A1 rifle. Fort Benning, Georgia: U.S. Army Infantry Board, February 1975. (AD-B004 754L)

The objective of the test was to evaluate and compare the degree to which the three RFA kits met the training device requirement with respect to technical and physical characteristics and capability as a training device for the M16A1 rifle. In addition the test studied their performance in regard to compatibility, representative battle-sight zero as compared to service ammunition, accuracy, marksmanship techniques, training in terms of target hits, maintenance, and human factors. It was concluded that all the RFA's are capable of being utilized as a training device for the M16A1 rifle, with no significant differences between systems. However, adapter C lacked sufficient reliability and had a potential safety hazard.

149. Patrick, B. D. Expanded service test of medium antitank/assault weapon surface attack guided missile system, XM47 Dragon. Fort Benning, Georgia: U. S. Army Infantry Board, November 1972. (AD-523 499L)

The purpose of the expanded service test was to determine the suitability and safety of the Dragon system for U.S. Army use when employed in a variety of field conditions.

Testing provided for the evaluation of the Dragon system during three phases. Each phase was characterized by controlled testing and employed soldiers representative of those who would normally operate the test equipment in the field. The first phase covered preoperational inspection requirements associated with the evaluation of the Dragon system to insure proper functioning, completeness, and suitability for testing. The second phase covered training requirements associated with the evaluation of the Dragon system to include an examination of the adequacy of the training equipment and proposed training program. The third phase covered operational testing requirements associated with the evaluation of the Dragon system.

150. Perkins, J. L., Melton, W. D., Lytle, W. L., Barron, R. C. & Lutz, W. G. Dragon operational test III (Dragon OT III). Fort Hood, Texas: Modern Army Selected Systems Test Evaluation and Review, April 1975. (AD-C001 882L)
CONFIDENTIAL

The operational performance of the Dragon weapon system was assessed during both live fire and maneuver events in the field. Dragon effectiveness was assessed by analyzing hit performance including the capability to engage multiple target arrays, and by analyzing the relationship of variables during live fire exercises. An assessment was also made of operational reliability, availability, and maintainability of the Dragon weapon system and of the training package for the system. The adequacy of proposed doctrine, tactics, and organization for the mechanized infantry company equipped with the Dragon system was analyzed in three subobjectives. The proposed tactics and techniques of employment were subjectively analyzed. Military judgment was heavily relied upon when considering the multiple variable inputs for all subobjectives. The adequacy of the proposed logistical (supply and maintenance) support for the Dragon weapon system employment was also evaluated.

151. Pieper, W. J. Instructional strategies for a performance oriented technician course (final report) (report number AFHRL-TR-72-74). Valencia, Pennsylvania: Applied Science Associates, Incorporated, March 1973.

Strategies for instruction in performance oriented tasks were developed in three phases. Phase one was the preparation of appropriate strategies for a performance-

oriented technician course. This phase (determination of current course status, current strategies, relevant characteristics of students and instructors, the course environment, and innovative strategies) emphasized innovative uses of training techniques with attention to knowing course problem areas. In phase two, the 56 strategies generated during the first phase were assigned to one of nine application groups (student selection and career field introduction, cognitive skill instruction, individual manual skills, team training, evaluation, incentive management, games, course development, and miscellaneous), and five strategies were selected for development for the course. During phase three, the feasibility of using the five different strategies was demonstrated by developers in brief oral presentations and illustrations with the materials.

152. Pittsburgh University. Heavy antitank/assault weapon system (TOW) (interim report). Washington, D.C.: Pittsburgh University Research Staff, February 1968. (AD-389 634L)

This is a report on the development of the heavy antitank/assault weapon system known as TOW, which is an acronym for the tube-launched, optically and automatically tracked, wire-command-linked missile system. It has a solid-propellant, surface-to-surface missile for the defeat of tanks, other vehicles, and fortifications. The system will replace the Entac missile system, the SS-11 missile system in helicopters, and the M40A1 106-mm rifle. Fired from a launcher that can be emplaced either on the ground or in any of several standard military vehicles, the missile has a boost-coast-boost trajectory controlled by four extensible wings and control surfaces. The gunner at the launcher keeps the cross hairs of his optical sight trained on the target. A source of infrared energy on the base of the missile is tracked by a sensor on the launcher, and guidance correction commands are sent to the missile through the wire link.

153. Pittsburgh University. Surface attack guided missile system, XM-7, Dragon (interim report). Washington, D.C.: Pittsburgh University Research Staff, May 1968. (AD-390 802)

A new medium antitank/assault weapon, Dragon, is being developed to replace the M67 90-mm recoilless rifle (MAW), now organic to infantry platoons. This new weapon, which can be carried and operated by one man, consists of a recoilless launcher firing a guided missile with a high-explosive

antitank warhead. A wire link over which guidance commands go to the missile connects the missile with the launcher. Guidance of the missile is automatic.

154. Poe, A.C., III An effectiveness study of infantry antitank weapons (technical report). Redstone Arsenal, Alabama: U.S. Army Missile Command Aeroballistics Directorate, September 1970. (AD-516 471) CONFIDENTIAL

This effectiveness study involves TOW, Dragon, and LAW. The antitank/assault weapons are played in a systematic series of computer-simulated hypothetical encounters with the enemy. Results are shown for the effectiveness in defense of various weapon mixes under a variety of terrain assumptions.

155. Popham, J. W. & Husek, T. R. Implications of criterion-referenced measurement. Journal of Educational Measurement, 1969, 6 (1), 1-9.

This article explains and discusses the distinction between "norm-referenced" and "criterion-referenced" approaches to measurement. More traditional, a norm referenced measure is used to identify an individual's performance in relation to the performance of others on the same measure. A criterion-referenced test is used to identify an individual's status with respect to an established standard of performance. This discussion examines the implications of these two approaches to measurement, particularly criterion-referenced measurement, with respect to variability, item construction, reliability, validity, item analysis, reporting, and interpretation.

156. Poulton, E. C. Tracking skill and manual control. New York, New York: Academic Press, 1974.

The immediacy of feedback was related to the improvement of visual tracking skills. It was shown that a few hours of training can result in increased tracking skills lasting for months or years. (An extensive list of references is included).

157. Powers, T. R. & McCluskey, M. R. Task analyses of three selected weapons systems (research memorandum 76-20). Alexandria, Virginia: U.S. Army Research Institute, October 1976.

This report outlines the task analysis procedure that was employed to examine the functioning of three U.S. Army weapon systems (M60-A1 tank, 81mm Mortar, 155 Howitzer--self-propelled). The major finding of this study was that leadership positions within these systems have more generalizable skills across systems than the more technical crew jobs.

158. Pretty, R. T. (Ed) Jane's weapon systems. London, England: Paulton House, 1977.

Extensive compilation of weapons system data for each nation in the world. Includes characteristics of main and secondary armament systems for armored and mechanized vehicles, antitank missiles and exploratory development programs. Known and predictive assignment and use of various systems to type military units of nations and allied powers is included.

159. Quinn, R. L. Check/operational test of Dragon training equipment. Fort Benning, Georgia: U.S. Army Infantry Board, January 1974. (AD-528 970L) CONFIDENTIAL

The check/operational test of the modified Dragon training equipment was conducted to evaluate the equipment for correction of deficiencies and shortcomings identified during the expanded service test. Also a training program that would qualify a maximum number of gunners was developed. The training value of launch signature simulator concept and the dancing Dragon as an in-flight missile simulator was determined. In addition, training gunners without the LET and monitoring set was evaluated.

160. Quinn, R. L. Dragon second generation training package (Vol. II) (extract from check/operational test draft final report). Fort Benning, Georgia: U.S. Army Infantry School, January 1974. (AD-C005 239L) CONFIDENTIAL

Four groups of military personnel who had previously completed the LET qualification tables were retested on these firing tables at 2, 4, 6 and 8 week intervals. No statistically significant differences were found between the original qualification scores and the scores derived from the second firings. This finding indicates for intervals up to 8 weeks that there is no retention loss of LET firing skills for personnel who have completed the LET training course.

161. Reidel, J. A. A comparison of adaptive and nonadaptive training strategies in the acquisition of a physically complex psychomotor skill (report number NPRDC-TR-76-24). San Diego, California: Navy Personnel Research and Development Center, December 1975.

Results of research to determine if an adaptive technique could be used to teach a physically complex psychomotor skill (specifically, performing on an arc welding simulator) more efficiently than the skill could be taught with a nonadaptive technique are presented. Sixty hull maintenance technician firemen and fireman apprentice trainees were selected randomly to perform on the simulator and were given pre- and post-training tests. Analysis of covariance was used on the data, and results indicate no significant difference between the effectiveness of adaptive and fixed schedules in training the skill studies. An introduction discusses the problem, purpose, and background of the study, as well as presenting a rationale for adoption and a history of adaptive applications. Research methodology is examined in terms of the subject, apparatus, experimental setting and design, and procedures. A discussion of the results, conclusions, and recommendations are presented. It is recommended that since there may be a relationship between physical task complexity and the utility of adaptive/fixed training strategies, further research to understand the potential interaction between these two variables be undertaken.

162. Rich, N. R., Wise, M. M., Greene, L., Howerton, J. & Mark, C. K. Time series analysis of gunner tracking error. Redstone Arsenal, Alabama: U.S. Army Missile Command, October 1973. (AD-771 933/9)

The report includes the time series analysis of gunner error data and the formulation of a simulation model to be used in future applications.

163. Root, R. T., & Word, L. E. Development of a test bed for evaluation of small unit doctrinal alternatives in the combat arms. Arlington, Virginia: U.S. Army Research Institute for the Behavioral and Social Sciences, 1970. (AD-785 668)

To gain an understanding of human performance in Army jobs it is necessary to study men on the job in a systematic manner in a realistic setting. The reported research program

provides a basis for field research and a test bed for simulating the tactical environment.

164. Rumsfeld, D. H. Annual defense department report, FY 1978. Washington, D.C.: U.S. Government Printing Office, 17 January 1977.

This report, in part, identifies U.S. and Soviet Union Defense Program trends, efforts and capabilities in force development technology, and resource allocation. Net defense posture assessments include numbers of tanks, armored personnel carriers artillery pieces and anti-tank weapons systems for both the U.S. and the Soviet Union. Force ratios are also discussed. Soviet capabilities related to current changes in quantities of military equipment are explained. Of note, is the following information directly quoted from this report: "Because of the resources allocated to the Soviet defense effort during the past decade, the Soviets have consistently outproduced the United States in tanks, armored personnel carriers, artillery, submarines, and minor naval combatants". A substantial, highly accurate, unclassified data base is the major contribution of this report.

165. Sands, W. A. Determination of an optimal recruiting-selection strategy to fill a specific quota of satisfactory personnel. Washington, D. C.: Naval Personnel Research and Development Laboratory, April 1971. (AD-723 569)

Managers of military and civilian personnel systems justifiably demand an estimate of the payoff in dollars and cents, which can be expected to result from the implementation of a proposed selection program. The Cost of Attaining Personnel Requirements (CAPER) Model provides an optimal recruiting-selection strategy for personnel decisions which minimizes the total cost of recruiting, selecting, inducting and training a sufficient number of persons to meet a specified quota of satisfactory personnel.

166. Savkin, V. Ye. The basic principles of operational art and tactics (A Soviet view). Moscow, U.S.S.R., 1972. (Translated from the original and published under the auspices of the United States Air Force, Washington, D.C. Document available from Superintendent of Documents, U.S. Government Printing Office, 1976.)

This book analyzes the views of Soviet military leaders and theoreticians concerning tactics and operations from a position of Marxist-Lenist philosophy. The book is designed for officers of the Soviet Army. Particular detail is expressed with regard to maintenance of the principle of mobility in military operations. The means for increasing mobility of troops and achieving high-speed battle maneuvers are fully investigated. Attention is also given to the development of initiative and creativity in the actions of commanders at all levels, traits which many documentary sources on the threat find lacking in Soviet armed forces.

167. Schaffer, M. B., Taylor, G. I. & Wise, R. A. NATO and Warsaw pact tank and antitank systems (technical report). Santa Monica, California: Rand Associates, September 1974. (AD-C000 090) CONFIDENTIAL

This is a background paper comparing tank/antitank strengths of NATO/Warsaw pact forces in Central Europe. All tank models and antitank weapons comprising the major elements of the two forces were considered. Both qualitative and quantitative values are included. Qualitative characteristics of weapons in advanced phases of development are also included. The relative imbalances in strengths are discussed with suggested actions for consideration to reduce NATO vulnerabilities and to explore and exploit pact weakness in the near time period.

168. Seitz, Q. L., Jr. Service test of the TOW heavy antitank/assault weapon. Fort Benning, Georgia: U.S. Army Infantry Board, October 1968. CONFIDENTIAL

This study reported the results of the TOW service test. Training used for the test was the basis of the TOW training program. One of the results found no significant difference in live fire hit probabilities between a school trained group and a field trained group.

169. Semple, C. A. Guidelines for implementing training effectiveness evaluation (final report). Northridge, California: Manned Systems Science, Incorporated, April 1974. (AD-778-349)

The document presents guidelines for planning, implementing, and documenting training effectiveness evaluations. The guidelines are intended to assist

researchers in coping with many of the constraints associated with executing empirical research in operational settings.

170. Senate Committee on Armed Forces. United States/Soviet military balance - a frame of reference for Congress. Washington, D.C.: U.S. Government Printing Office, January 1976.

A detailed listing of comprehensive and current, unclassified data on the relative strengths and weaknesses of the Soviet Union and the United States. The study compiles and applies a set of force sufficiency factors for ascertaining "how much is enough". Part II of the study identifies some Soviet/U.S. force imbalances and examines the match between U.S. ends and means. A positive identification of a strong shift in the quantitative military balance toward the Soviet Union over the past 10 years is concluded.

171. Shank, E. B. & Garinther, G. R. Firing from enclosures with LAW, Dragon, and TOW (final report). Aberdeen Proving Ground, Maryland: U.S. Army Human Engineering Lab, June 1975. (AD-B005 980L)

Firings were conducted from various enclosures (including masonry and frame buildings) with LAW, Dragon, and TOW missiles. The purpose of these tests was to determine the environmental hazards from back blast to personnel which would be in an enclosure when missiles are fired out of the enclosure; also, the purpose of the tests was to identify any problems which might result in reduced effectiveness for those systems which require post-launch tracking. The environment of firing from enclosures was much less hazardous than anticipated. The primary hazard appears to be a chance of hearing loss which is greater than that which would be encountered with firings of the LAW, Dragon, and TOW in the open.

172. Shavelson, R. J., Block, J. H., Ravitch, M. M. & Livingston, S. A. Criterion-referenced testing: Comments on reliability. Journal of Educational Measurement, 1972, 9 (2), 133-140

This article examines a recent attempt to develop a theory of reliability for criterion-referenced (CR) measures. It also discusses considerations for determining their reliability. Conventional reliability statistics (e.g.,

coefficient alpha, standard error of measurement) are found appropriate for CR measures satisfying the assumptions of the measurement model underlying classical test theory. For measures with underlying multidimensional traits, conventional reliability statistics may be used at the homogenous subscale level. When the confidence interval about a student's "below criterion score" includes the criterion, additional evidence about the student should be obtained. A rejoinder by S. A. Livingston points out that the CR reliability is useful since it provides a single number indicating the reliability of a group of scores should depend heavily on the difference between the group mean score and the criterion score and asserts that a single criterion score should be established for a test only if all the items on the test can be considered to measure the same factor.

173. Shirom, A. On some correlates of combat performance. Administrative Science Quarterly, 1976, 21, 419-432.

Several hypothesized correlates of combat performance were tested in this study. Infantrymen were interviewed, rated by peers, and completed a questionnaire at outposts in a battlefield situation. Contrary to expectations, combat performance was not related to the respondents' commitment to the objectives of the war, to their evaluations of their unit's morale, and to their perceptions of personal and unit combat preparedness. The hypothesis that combat performance was associated with favorable evaluations of one's commanders and the social integration of one's unit were supported by the data. Social support provided by a soldier to others in the units was found to be highly related to his combat performance, while social support received by a soldier from others in the unit was not. The results suggest that, in a combat unit, characteristics of the interpersonal relationships might be the most powerful predictors of individual soldiers' combat performance in future studies.

174. Shoemaker, D. M. Improving criterion-referenced measurement. Journal of Special Education, 1972, 6 (4), 315-323.

This article presents guidelines for the use of criterion-referenced tests for individual and group assessment. Issues in selecting items for an individual criterion exercise are discussed, and three types of scores which should be obtained are identified (scores defining the minimum level of performance, the level of achievement in

excess of this minimum, and a high level of achievement). Implications of these guidelines for sequential testing using several criterion exercises are considered. Two uses of multiple matrix sampling to measure group achievement are discussed, and applications of these procedures to special education situations (e.g., with hyperactive students having short attention spans) are briefly noted.

175. Sidorenko, A. A. The offensive (a soviet view). Moscow, U.S.S.R., 1970. (Translated from the original and published under the auspices of the United States Air Force, Washington, D.C., Superintendent of Documents, U.S. Government Printing Office, 1975.)

Colonel Sidorenko, a faculty member of the Frunze Military Academy, discusses the characteristic forms of the offensive in nuclear war. He emphasizes the fact that offensive operations will: be conducted night and day, in any weather, without delay until the enemy is defeated; and maneuver with nuclear weapons will assure attainment of surprise. Troop dispersal, due to nuclear weapons is a mandatory edict. Use of the term "front-line" will be replaced by the phrase "the line of fighting contact of troops". Great expenditures of material, massive losses of troops and equipment can be expected. Sidorenko's observations totally embrace the more modernistic view of Soviet emphasis on continual offensive pressure in the tactical context of battlefield operations.

176. Siegel, A. I. Some techniques for the evaluation of technical training courses and students. Wayne, Pennsylvania: Applied Psychological Services, Incorporated, February 1972. (AD-753 094)

This handbook presents methods, concepts, and considerations to be held in mind in planning and implementing a student measurement or training evaluation program. Techniques are presented, procedures are discussed, and computational examples are included. The test places its principal emphasis on basic techniques, but certain more advanced approaches are also considered.

177. Sisson, R. L. Organizing and planning for engineering improved training systems. Mathematics, March 1971, 101-124. (AD-733 701)

Based on the results of a short study of the process by which training systems are improved, it is recommended that the Navy create a training improvement engineering function. This function would have the capability, responsibility and funding to design and implement improved training systems on the basis of need or as a result of new technology. This function would focus especially on situations where a change in technology leads to facility and resource requirements which cut across training programs. The use of computers to aid in training management or to deliver instructional materials is an example of such a change. A program for developing new, theory-based formalized approaches to the design of training programs is presented. A definition of the overall Navy training system is developed as a basis for discussing organizational and functional change.

178. Spangenberg, R. W. Selecting methods and media to achieve training objectives: A preliminary manual. Fort Knox, Kentucky: Human Resources Research Organization, February 1971.

This manual is designed to help Army training personnel select and implement a specific approach for achieving specific training goals. Following a generalized learning model, general training principles are summarized. The rest of the manual shows how specific learning principles are associated with groups of learner performances. Training goals include recall of facts and procedures, acquisition of motor skills and reactive skills, concept acquisitions, problem solving, decision making, and putting attitudes into practice.

179. Spangenberg, R. W. The state of knowledge pertaining to selection of cost-effective training methods and media (report number HumRRO-TR-73-13). Alexandria, Virginia: Human Resources Research Organization, June 1973.

A program was conducted to prepare a plan for research toward empirical determination of criteria and procedures for optimum selection of cost-effective methods and media. The procedure followed was a review of pertinent literature, analysis of findings, identification of problems for further research, and formulation of new approaches to resolution of the problems. Results fell into two categories:

- (1) those pertaining to methods-media definition and

classification

- (2) those pertaining to training cost-effectiveness and analytical procedures

The literature review yielded little of immediate value. The empirical data on the relative cost-effectiveness of methods and media are insufficient as a basis for reliable selection of methods and media for specific training tasks.

180. Spartatics. Weaponer: M16A1 rifle simulator project
FASTER. Rolling Meadows, Illinois: Spartatics, LTD., 1976.

The purpose of Weaponer is to provide a "hands on" training device that realistically simulates all the features of the actual field firing of small arms weapons. It can be utilized in a space as small as 13 feet long by 30 inches wide. A carpeted firing pad is provided which allows the trainee to assume all firing positions utilized in field firing. This pad may be quickly transformed into a foxhold whenever this position is required. In this mode, space to accommodate an additional 4 feet in length by 4 feet in width is required.

The Weaponer is designed to provide marksmanship training with the standard military service weapon. Sound and recoil are adjustable for the new recruit to allow a gradual build up to standard rifle specifications. Instantaneous visual readout of aim allows for rapid analysis and correlation of trainee errors. A cable connected Remote Control Box is provided to allow the trainee to practice alone and to control the main functions of operation without having to leave the firing position. It is also a valuable aid to the instructor enabling surprise changes to be made out of view of the trainee. The rifle is a non-restorable M16A1 and uses no live ammunition. However, all precautions that are required in firing live ammunition should be employed to emphasize realistic training with the Weaponer.

181. Stark, E. A. Study to determine the requirements for an experimental training simulation system (report number NAVTRADEVCEEN-64-0208-1). Binghamton, New York: Singer-General Precision, Incorporated, February 1971.

A simulation system capable of supporting human factors experiments in the development of military training devices

is described. The first phase of the study consisted of:

- (1) a review of tasks performed by the operators of different types of military simulation systems,
- (2) an analysis of problems experienced in the development of devices for such training tasks, and
- (3) the identification of design areas in which experimentation is required.

The second phase of the project resulted in the formulation of design recommendations and a five-year implementation plan to permit system procurement in five relatively discrete incremental modules. Each of the five modules can be employed independently, and each can also be integrated with the preceding module to provide additional, supplemental functions. Procurement of all five modules will provide for the total capability necessary for the support of future human factor experiments in military training.

182. Stephenson, R. W. & Burkett, J. R. An action oriented review of the on-the-job training literature (report number AFHRL-TR-74-66). Washington, D.C.: American Institutes for Research in the Behavioral Sciences, December 1974.

On-the-job training literature from both civilian and military sources was reviewed. Selected references from the study are organized under the following headings: literature reviews and bibliographies, handbooks and manuals, cost effectiveness literature, technique comparison studies, systems analysis of training, approaches to program evaluation, and military documents. Many of the items are annotated, some rather extensively. In addition, a number of references were selected that were thought to contain innovative ideas that should be considered for improving on-the-job training programs. The list of possible innovations is organized under the following topics: Administration, audiovisual presentation, computer-assisted techniques, evaluation, incentives/motivation, instructional techniques, periodic surveys, and program design. The various ways in which these innovations might address current problems in the Air Force on-the-job training program are described and commented on. Estimates are also made of the resource requirements involved if possible modifications in existing procedures were to be implemented.

183. Stewart, J. D. The usefulness of task analysis in the evaluation of military training. Monterey, California: Naval Postgraduate School, September 1970. (AD-713 051)

Asserting the importance of a proper emphasis in curriculum content, this paper investigated some of the problems of present day training evaluation techniques, and described methods for analyzing training effectiveness through valid task analysis inventory data. Parametric and nonparametric statistical procedures were discussed, as well as a matrix method of evaluation. A general methodology embracing the operational significance of the data was also included. The matrix approach showed signs of being the most flexible task analysis procedure. Results were also presented from a small scale experiment to determine the most valid questionnaire associated data collection method. (The document includes seven references.)

184. Stewart, R. S., Christie, C. I., & Jacobs, T. O. Identification of the knowledges, skills, and abilities necessary to maximize performance on the Dragon weapon system (interim report II). Fort Benning, Georgia: Human Resources Research Organization, January 1974. (AD-C005 240L)
CONFIDENTIAL

(See Stewart, S. R., Christie, C. T., and Jacobs, T. O. Performance correlates of the Dragon training equipment and the Dragon weapon system for the abstract.)

185. Stewart, S. R., Christie, C. I., & Jacobs, T. O. Performance correlates of the Dragon training equipment and the Dragon weapon system (report number NAVTRAEQUIPCEN N61339-74-C-0056-1). Alexandria, Virginia: Human Resources Research Organization, March 1974.

The purposes of this study were to:

- (1) develop a selection program for Dragon gunner trainees,
- (2) identify the critical knowledges, skills, and abilities needed for optimal performance with Dragon, and
- (3) determine the discrepancies between those factors required to effectively employ the Dragon training equipment and to effectively employ Dragon.

The subjects were 225 enlisted men participating in a test of the Dragon training equipment. Expert judges, trainee interviews, and judgmental analyses were used to identify potential correlates of gunner trainee performance. With measures of these variables as predictors, stepwise multiple regression analyses were performed using training and live missile firings and post-live-fire interviews were conducted with gunners.

Although it was possible to reliably select individuals with the greatest probability of becoming successful trainees, it was not possible to predict success with the actual weapon system. Moreover, all investigated parameters of performance during training failed to correlate significantly with performance on Dragon. Analysis of the videotapes suggested that discrete random errors (e.g., flinch-startle responses), rather than the lack of tracking ability and other performances covered in training, appeared to be accounting for misses.

It was concluded that the selection program developed should not be used for general screening purposes - an exceptional trainee was not necessarily an exceptional Dragon gunner. Also, the current training devices failed to meet at least some of the requirements identified. However, a combination of these devices with modifications was judged suitable for use as interim training equipment.

186. Swezey, R. W. & Pearlstein, R. B. Guidebook for developing criterion-referenced tests (contract number DAHC-19-74-C-0-18). Reston, Virginia: Applied Science Associates, Incorporated, 1975.

This guidebook presents a step-by-step procedure for developing criterion-referenced tests.

187. Swisher, J. A., Iten, M. W., Groff, J. N., Hilkemeyer, E. J. & Benton, A. A target acquisition study of various pattern-painted armor vehicles (II) (technical report). Aberdeen Proving Ground, Maryland: U.S. Army Materiel Systems Analysis Activity, July 1975.

This study attempts to quantify the tactical advantages of camouflage pattern-painting combat vehicles to determine what type of pattern is the most effective in increasing a moving vehicle's survivability. Six M60 tanks, painted with

different camouflage color schemes, performed simple maneuvers at ranges of approximately 2,000 and 3,000 meters from stationary antitank weapons (i.e., M60 tanks and a TOW trainer). Each weapon was equipped with a gun camera for recording the engagement. The time to search for and acquire the target was recorded for each trial. The resulting aim point at the time of weapon release and theoretical missile impact for the TOW weapon system is reported for each camouflage pattern.

188. Swisher, J.A., Groff, J. N., Harrington, E. S., Jr. & Andrese, J. A. A target acquisition study of various pattern-painted armor vehicles (technical report). Aberdeen Proving Grounds, Maryland: U.S. Army Materiel Systems Analysis Activity, July 1975. (AD-C004 988L) CONFIDENTIAL

The purpose of this field test was to investigate the tactical advantages of camouflage pattern-painting combat vehicles. The test was conducted in two parts. In the first, detection ranges were recorded for six camouflage painted parked vehicles (M577) in order to determine which pattern was most effective against unaided visual acquisition. In the second, simulated 'shot-patterns' were measured with a TOW trainer engaging pattern-painted M60 tanks. The goal of this effort was to investigate the increase in armor survivability that could be attributed to camouflage paint techniques.

189. Taylor, C. O. Test evaluation report: Simulated tactical tests of the Dragon antitank rocket (XM-47 system). Redstone Arsenal, Alabama: U.S. Army Missile Command, September 1971. (AD-519 486L) CONFIDENTIAL

The MOE's for Dragon missile flights were investigated. Under ideal ambient conditions, 12 of 15 missiles were accurately guided to their targets.

190. Taylor, J. B. Weapon firepower potential. Monterey, California: Naval Postgraduate School, September 1970. (AD-712 792)

Methods are proposed for measuring the combat effectiveness of the main armament of tank and antitank

weapons using firepower potential scores. A comparison of these scores can be used as a simplified screening process to decrease the number of candidate options that must be evaluated by simulation or detailed analysis.

191. Taylor, J. E. Establishing the concepts and techniques of performance oriented training in army training centers. (report number HumRRO-TR-75-21). Alexandria, Virginia: Human Resources Research Organization, June 1975.

The specific objective of Work Unit ATC-PERFORM was to provide technical research and development assistance to the Army agencies involved in the review, evaluation, and refinement of performance-based training techniques in Army Training Centers. It continued and extended the Army's effort to accomplish major training innovations that had been initiated in 1971-1972, during conversation to an all-volunteer status. A brief background to Work Unit ACT-PERFORM is provided and an overview of the work unit's activities and priorities is sketched. The report describes the work unit's activities and accomplishments in basic training, advanced individual training, advanced individual training (combat support), self-pacing individualized instruction, and Reserve and National Guard training and noncommissioned officer leadership/instructor training. Performance training and testing principles and techniques in those areas were instituted and reflected in Army training documents, pamphlets, instructional and assessment materials, and Army staff policy decisions.

192. Tierney, T. J., Cartner, J. A. & Clayton, M. S. The role of demographic variables in field tests of training systems. Proceedings of the Fifteenth Annual Army Operations Research Symposium at Fort Lee, Virginia. October 28, 1976.

The Basic Rifle Marksmanship (BRM) Test was conducted during Spring 1976 at the Fort Jackson, South Carolina, Army Training Center. The test compared four Programs of Instruction (POI) for Basic Rifle Marksmanship training. BRM is a required course of instruction for all Basic Combat Training (BCT) male trainees and Basic Training (BT) for female trainees. The four POI in this test varied in length from 77 instructional hours (the current Army Subject Schedule POI) to 35 hours and from 720 rounds of ammunition to 262 rounds. The primary purpose of the test was to determine the training effectiveness of the alternative POIs

and to perform a cost and training effectiveness analysis on the programs. A matrix of the basic test design and a dendritic diagram with approximately n in each cell is presented. The cells labelled "ERF vs. NERF" represent limited training control groups for each program and regular training groups for each program respectively. The ERF groups received a record fire Post Test immediately after fundamentals training and then continued through the rest of the BRM program. All trainees, both ERF and NERF, received the record fire Post Test after the completion of the program's day Record Fire tables. The test included both male and female trainees in each program. The total test sample was approximately 4400 BCT/BT trainees.

There were 37 demographic variables collected for each trainee. All but 10 of these variables were collected using the same data collection instrument in individual interviews with trainees. Interviews were conducted at the reception station by station personnel who were trained to collect these data. Enlistment component was taken from company rosters. Finally, information on 8 individual difference variables was collected using two separate questionnaires administered to trainees prior to the start of BRM training. Trained data collectors administered these questionnaires to company sized groups.

193. U.S. Army Armor School. Tank, antitank and assault weapons requirements study (TATAWS - III) (Vol. I). Fort Knox, Kentucky: Author, June 1969. (AD-502 712)

The USCONARC portion of this study examines the impact upon training that will occur as a result of the introduction of tank, antitank and assault weapons into the U.S. Army. Included are evaluations by USCONARC schools responsible for MOS training of individuals in skills necessary to operate and support these vehicles and their weapons systems, a compendium of requirements for table of allowance of major end items, training aids and ammunition, and an evaluation of problem areas expected with the introduction of these weapons systems. Individual training costs have been included.

194. U.S. Army Armor School. Tank, antitank and assault weapons requirements study (TATAWS - III) (Vol. III). Fort Knox, Kentucky: Author, June 1969. (AD-502 714)

This annex is a reference handbook published as an aid in the identification and description of training devices presently being used or recommended for use with the TATAWS III weapons systems. It is not to be used as authorization for requisitioning, stockage, or issue of this equipment. Many of the training devices depicted herein have been produced in limited quantities to meet specific training requirements and have not been generally distributed, while others are developmental or proposed. For each training device, there is an illustration (where available) and description, together with other pertinent data, which may be utilized in determining if the device can be used to support a training requirement.

195. U.S. Army Armor School. The Threat (ST 30-40-1). Fort Knox, Kentucky: Author, November 1975.

This text is prepared primarily to support U.S. Army Armor School instruction. Contents were compiled from current Department of the Army, foreign publications and other openly published material. The text addresses threat doctrinal concepts, organization and tactics for tank and motorized rifle units from company to division and includes descriptions of vehicle and weapons characteristics. Focus is on how the threat fights, breakthrough attack, frontages, echelons and the employment of artillery and reserves.

196. U.S. Army Combat Arms Training Board. Simulation in M16 rifle training. Fort Benning, Georgia: Author, January 1975.

During Basic Rifle Marksmanship (BRM), each Infantry trainee fires 1050 rounds of 5.57mm ammunition; all others fire 778 rounds. The rationale for firing this number of rounds originates with 1952-53 studies which found that only 50 percent of trainees in BCT could expect to fire at least Marksman. Only increased firing of the M1 rifle raised the percentage. Present record scores for BRM are: Marksman 54-65; Sharpshooter 66-74; and Expert 75-100. These scores are expected to result in the following distribution: Expert 15 percent; Sharpshooter 40 percent; Marksman 40 percent; and Unqualified 5 percent. However, the average qualification score at Fort Jackson, for example, is Sharpshooter for male trainees and Marksman for WAC trainees who volunteer to complete the BRM program. Of interest is the fact that WACs spend 62 percent less time on BRM training and 65 percent fewer rounds. Relating hit probabilities to the performance characteristics of the M16A1 rifle and ammunition is difficult since existing AMSAA data is based on 1965 tests of the M16 rifle firing six round bursts. Annual qualification/familiarization firing (biannual for the Reserve Components) is accomplished via a wide variety of courses and ranges at the discretion of unit commanders.

197. U.S. Army Combat Arms Training Board. Special analysis of M47 Dragon training. Fort Benning, Georgia: Author, April 1975. CONFIDENTIAL

In order to identify inherent deficiencies in the Dragon training program, the Combat Arms Training Board (CATB) conducted a special analysis of Dragon training during 1975. Example findings of CATB were: (1) Expert gunner proficiency decreases at the rate of 25 percent per month, while first class gunner proficiency decreases at the rate of 40 percent per month; (2) The qualification test for Dragon gunners does not include provisions for evaluating a gunner's ability to engage a) targets at right under artificial illumination, b) targets traveling over undulating terrain, c) targets located at the maximum engagement range of the Dragon system, d) targets partially obscured by smoke, fog, dust, etc., e) targets traveling at high speeds, or f) targets which become intervisible aperiodically during the course of an engagement; and (3) Additionally, the qualification test does

not provide an opportunity to evaluate the gunner's ability to engage multiple targets, to track targets through distractions such as artillery fire, to estimate range, to prepare range cards, or to identify/recognize armored vehicles.

Based on the findings of other special analyses of the Dragon training program a number of recommendations were made concerning improvements that should be made in the current program. Examples of these recommendations were : (1) Only expert gunners should be designated as Squad Dragon gunners and that they should be required to complete a monthly refresher training program; (2) Standards should be established that will require Dragon gunners to be both trained and tested in realistic simulated tactical environments that duplicate as closely as possible the conditions under which the gunner will be required to operate during combat.

198. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II) (Part 1) (Vol. 1 - summary). Fort Knox, Kentucky: Author - Armor Agency, April 1967. (AD-509 563L)

The purpose of this study is to provide the rationale and data to support the total tank, antitank and assault weapons requirements as requested in 23 July 1965 memorandum from the Director of Defense Research and Engineering. Phase II is divided into two parts. Part 1 develops the necessary analysis to support adjustments in the FY 68 budget and to support FY 69 program change proposals.

199. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II) (Part 1) (Vol. II) (main report), Fort Knox, Kentucky: Author-Armor Agency, April 1967. (AD-509 564L)

The scope of this study is such that it impacts on every echelon of the US Army - from the soldier in the platoon to the force planner exercising his influence in the course of Army organization and employment. Because of this all-encompassing impact on the US Army, it is essential that the reader of this report understand the constraints placed upon the study, the analytical and objective nature of the processes used in arriving at the conclusions and recommendations, and the limitations of the data and tools

used in these processes. A fundamental part of this study is the development of an improved methodology for use in providing data to support annual budget submissions in addition to providing data to support current budget apportionments and program change proposals. For this reason, throughout Part 1 an approach has been taken to identify problem areas and weaknesses which must be solved or improved upon in the development of the methodology in Part 2.

200. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II - Part 1) (Vol. V). Fort Knox, Kentucky: Author - Armor Agency, April 1967. (AD 509 608L) SECRET

This document provides a compendium on the characteristics and performance of selected U.S. Army weapons systems that are current or could be available during the 1968-1972 period.

201. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II) (Part 1) (Vol. X). Fort Knox, Kentucky: Author - Armor Agency, April 1967. (AD-509 574L)

The purpose of this annex is to display the basic cost input data and to provide a detailed description of the processing of this data for use in the cost effectiveness analysis portion of the study.

202. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase II) (Part 1) (Vol. XI). Fort Knox, Kentucky: Author - Armor Agency, April 1967. (AD-509 611L)

The purpose of this annex is to present the contractor source documents of the Combined Arms Research Office (CARO) and the Lockheed Missiles and Space Company (LMSC) pertaining to the computer simulations employed in the conduct of the tank, antitank and assault weapons requirements study.

203. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase II) (Part 1) (Vol. XIII). Fort Knox, Kentucky: Author - Armor Agency, April 1967. (AD-509 613L)

This appendix presents the sustained combat simulation (SCS) scenario, rules and other related data which comprise the SCS model and documents those considerations, assumptions, and Armor Agency guidance upon which the development of the SCS was based.

204. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (TATAWS) (Phase II) (Part 1). Fort Knox, Kentucky: Author - Armor Agency, June 1967. (AD-509 577L)

This volume addresses ground and airborne antitank weapons systems. Cost and quantitative data for TOW, Dragon, AAFSS/TOW, and LAW are appropriately displayed. Shillelagh data are included.

205. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase III) (Vol. I) (main report). Fort Belvoir, Virginia: Author, December 1968. (AD-500 591L)

Volumes I through IX provide extensive analyses and basic data concerning tank and antitank systems and their possible contribution to the defeat of a threat in the general time frame 1975 in three areas of the world. The study explores a wide range of possibilities offered by the capabilities of the weapons systems under consideration through the unrestrained development and design of doctrine and organizational alternatives. The alternatives selected provide a sound basis for the programming of current and new systems into the Army. These alternatives provide the decision makers with the basis for choice required to maximize effectiveness, minimize cost, or strike the required balance between the two factors.

206. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase III) (Vol. VIII) (Annex G). Fort Belvoir, Virginia: Author, December 1968. (AD-500 632L)

This annex examines organizational and doctrinal aspects inherent in the tank, antitank and assault weapon systems recommended by this study. Specific areas of interest explored in this annex include: (1) conversion to TOE maneuver battalions of the candidate combinations which emerged as the best representatives of the tank and

mechanized infantry battalions under study; (2) the bases of issue of tanks, antitank, and assault weapons systems for maneuver battalions and other appropriate units by geographical area; (3) the risks which accrue with the selection of alternatives to the maneuver battalions recommended in the study; (4) the tactical and/or doctrinal changes implied by or deduced from the recommended TOE structures or the finding of this study; and (5) the role of the M551 Sheridan/Shillelagh armored reconnaissance/airborne assault vehicle.

207. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase III) (Vol V) (Appendix I and II to annex F). Fort Belvoir, Virginia: Author, December 1968. (AD-500 594L)

Contents: analysis of combinations and weapons, Europe; analysis of initial selections; selection of combinations for sensitivity tests.

208. U.S. Army Combat Developments Command. Tank, antitank and assault weapons requirements study (Phase III) (Vol. XI). Fort Belvoir, Virginia: Author, December 1968. (AD-500 634L)

This report is a listing of the raw data for TATAWS.

209. U.S. Army Combat Developments Command. Antitank weapons systems requirements study (ATMIX-INF) (Vol. I). Fort Benning, Georgia: Author - Infantry Agency, July 1970. (AD-511 334L) SECRET

This work will provide the Department of the Army with information to be used as a basis for future decisions on the development, procurement, and authorization of antitank weapons. Through the use of computer simulation, the relative combat effectiveness of different mixes of antitank weapons within the pure mechanized infantry battalion will be determined.

210. U.S. Army Combat Developments Command. Antitank weapons systems requirements study (ATMIX-INF) (Vol. II). Fort Benning, Georgia: Author - Infantry Agency, July 1970. (AD-511 332L) SECRET

This volume provides an in-depth analysis of the

antitank weapons mixes evaluated in the antitank weapons systems requirements study (ATMIX-INF).

211. U.S. Army Combat Developments Command. Antitank weapons systems requirements study (ATMIX-INF) (supplementary report). Fort Benning, Georgia: Author - Infantry Agency, August 1970. (AD-511 333L) SECRET

This report covers requirements for antitank weapons systems including the TOW system.

212. U.S. Army Combat Developments Command. The Dragon cost and effectiveness analysis. Fort Benning, Georgia: Author - Infantry Agency, February 1972. (AD-520 092L) SECRET

This work is a continuation of the antitank weapons systems requirement study for the purpose of examining the cost and effectiveness of selected mixes of antitank weapons within the pure mechanized infantry battalion. Examination was limited to equal cost and equal effectiveness alternatives to the current mechanized infantry battalion antitank weapons mix. Foreign weapon systems are excluded. Combat simulations were utilized to determine the relative combat effectiveness of selected alternative mixes of antitank weapons. Cost comparisons of the various mixes of antitank weapons are provided. This study will provide the Department of the Army with information to be used as a basis for further decisions on the development, procurement and authorization of antitank weapons.

213. U.S. Army Combat Developments Experimentation Command. Tactical effectiveness testing of antitank missiles (final report) (Vol. II). Fort Ord, California: Author, October 1972. (AD-905 635L)

For the abstract see the Executive Summary.

214. U.S. Army Combat Developments Command. Independent evaluation of Dragon XM47. Fort Benning, Georgia: Author - Infantry Agency, December 1972. (AD-C005 569L) CONFIDENTIAL

((No abstract available))

215. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (final report) (Vol. III). Fort Ord, California: Author, February 1973. (AD-909 209L)

For the abstract see the Executive Summary.

216. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (final report) (Vol. IV). Fort Ord, California: Author, February 1973. (AD-909 214L)

For the abstract see the Executive Summary.

217. U.S. Army Combat Developments Experimentation Command. Tactical effectiveness testing of antitank missiles (data package) (Vol. V). Fort Ord, California: Author, February 1973. (AD-909 215L)

For the abstract see the Executive Summary.

218. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (final report) (Vol. VI). Fort Ord, California: Author, September 1973. (AD-913 472L)

For the abstract see the Executive Summary.

219. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (TETAM (USACDEC) (Vol. VI) (Addendum 1) (Phase II B and Hit Data)). Fort Ord, California: Author, September 1973. (AD-927 229L)

This document contains the confidential hit data of TOW, Shillelagh, Dragon, Milan, and Swingfire antitank missile systems firing inert missiles against stationary target panels and a manned evasive target tank. This data was obtained during the execution of Phase II, USACDEC experiment 11.8 (TETAM) described in detail in Volume VI of the final report of that experiment.

220. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (data package) (Vol. VII). Fort Ord, California: Author, September 1973. (AD-917 911L)

For the abstract see the Executive Summary.

221. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (final report) (Vol. VIII). Fort Ord, California: Author, February 1974. (AD-917 266L)

For the abstract see the Executive Summary.

222. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (data package) (Vol. IX). Fort Ord, California: Author, February 1974. (AD-917-267L)

For the abstract see the Executive Summary.

223. U.S. Army Combat Developments Experimentation Command.
Tactical effectiveness testing of antitank missiles (final report) (Vol. I - Executive Summary). Fort Ord, California: Author, February 1974. (Ad-918 132L)

U. A. Army CDEC Experiment 11.8, Tactical Effectiveness Training of Antitank Missiles, was a Major DOD directed field experiment phased over a two-year period and covered many aspects of tank-antitank missile system battle. Phase I obtained intervisibility data between defensively emplaced antitank missile systems and attacking armor elements on selected sites in both the U.S. and the Federal Republic of Germany. It also obtained data on the performance of defensively emplaced antitank missile systems in acquiring attacking armor elements. Phase II obtained data on the performance of attacking armor elements in acquiring defensively emplaced antitank missile systems. In this phase the firing of inert missiles was featured. Finally, in Phase III (the concluding phase) data were obtained from a two-sided free play exercise between armor elements and antitank missile systems in which an experimental real-time casualty assessment technique was employed. The major conclusions from the various phases of this study are summarized below:

(1) Phase I

- (a) The probability of an evasive maneuver by a tank causing line-of-sight to be broken with an ATM system increases from 20 percent to 70 percent as the range increases from 100 meters to 3000 meters, if no allowance is made for tank reaction times and the probability of detection of an ATM system.
- (b) The median time from initiation of line-of-sight to detection of an armor element by an ATM crew was 20 seconds.

- (c) The median time from detection of an armor element to the subsequent firing by an ATM system is approximately 9 seconds.
- (d) Handing off an armor element target requires approximately 25 seconds and is successfully accomplished 60 percent of the time.

(2) Phase II

- (a) Threat crews detected ATM systems approximately once for every three firings.
- (b) The probability of detection of an ATM system due to a launch signature cue is approximately 10 percent.
- (c) Cues associated with a launch signature were responsible for about 40 percent of the detections.
- (d) Cues due to the missile in flight did not increase the detection of ATM systems.
- (e) Given that they have detected an ATM system, threat gunners can lay on the ATM with an accuracy of approximately one mil for the vehicle mounted systems and several mils for the manportable systems.
- (f) The exposure time (exclusive of missile flight time, but including time to move to and from a defilade position) of an ATM system during its firing cycle was approximately 20 seconds for the TOW and Shillelagh and about 12 seconds for the Milan and Dragon.
- (g) The motion of a vehicle moving to and from a firing position was a significant cue leading to its detection.

(3) Phase III

- (a) The ratio of kills inflicted to kills sustained was approximately 2.4 to 0.3 for the TOW.
- (b) The ratio of kills inflicted to kills sustained was approximately 1.3 to 0.8 for the Shillelagh.

- (c) The ratio of kills inflicted to kills sustained was approximately 0.7 to 0.3 for the Dragon
- (d) Comparison of the Swingfire with gunner and launcher separated and hypothetical direct fire ATM system with a higher missile speed showed the latter system to inflict more kills but sustain about the same number as the separated system.
- (e) The use of Dragons to provide flanking fire increased the performance of the defense force.
- (f) Under conditions of artificial illumination and without the use of night vision devices, a stationary defense was favored over an advancing threat.
- (g) The use of scatterable mines appeared to force the threat into using the fire and movement tactic at a greater distance from the defense than was optimal for the threat weapons. The net result is an advantage for the defense due to the long range accuracy of their ATMs.

224. U.S. Army Combat Developments Experimentation Command.
Dispersion against concealed targets. Fort Ord, California:
 Aurhor, July 1975. (Ad-B005 701L)

This experiment was conducted to provide data to the U.S. Army Infantry School to assist in determining the impact of various dispersion levels on the effectiveness of the future rifle system. Standard (5.56 mm) M16A1 and modified (4.32 mm) M16 rifles were used in semiautomatic, controlled burst, and full automatic modes. Data were collected on the effectiveness of both individual firers and fire teams operating against both visible and concealed, moving and stationary targets. This report presents the results of the experiment with a minimum of analysis. Data on the phenomenon of suppression induced by small arms fire were also collected and are included. Data from two sided tests are also included. A one sided test addressed the utilization of terrain by members of an attacking fire team, and the second sided test addressed the ability of individuals to estimate the location of rounds fired over their heads and at various lateral distances from them.

225. U.S. Army Combat Developments Experimentation Command.

Antitank missile test (ATMT). Fort Ord, California: Author, April 1976. (AD-B010 576L)

This experiment was conducted to provide antitank weapon gunner tracking data on selected vehicular targets maneuvering in an operational environment. These data will be analyzed to assess hit probabilities and apparent antitank systems degradation as a result of target maneuver. This experiment specifically evaluated the Dragon, TOW, Shillelagh (M60A2 and M551) and M60A1 tank weapons while tracking M601A, XM800, and twister vehicles executing swerves, fast turns, and random serpentine maneuvers. A non-live fire experiment used a sophisticated analog signal recording system to record the command guidance signal taped from the ATM system's IR tracker during dry firing. Synchronization of this signal with the USACDEC position location and event recording system yielded high resolution operational gunner tracking data. The final task of combining simulated missile flight profiles, gunner tracking errors, and target maneuver data to calculate hit probabilities will be accomplished by USAMSAA and USACACDA.

226. U.S. Army Combat Developments Experimentation Command.
USACDEC suppression experimentation data analysis report.
Fort Ord, California: Author, April 1976. (AD-B010 579L)

This report provides results of an analysis of data from four CDEC suppression experiments: SASE II, SUPEX I, SUPEX II, and ACES. The results outlined in this report are estimates of the relationships between suppression and the proximity and volume of fire. These results can be included in models and studies which include consideration of the suppression phenomenon in ground combat. The weapons addressed include: The M3 (.45 cal) submachinegun, M16A1 (5.56mm) rifle, M60 (7.62mm) and M2 (.50 cal) machineguns, M139 (20mm) cannon, MK19 MOD1 (40mm) high velocity grenade launcher, 2.75-in. rocket, 90mm recoilless rifle, 105mm tank gun (HEP), 60mm Mortar, 81mm Mortar, 4.2-in Mortar, 105mm Howitzer, 155mm Howitzer, 8-in. Howitzer. Players were placed in a situation requiring performance of certain tasks in the face of incoming live fire.

227. U.S. Army Combat Developments Experimentation Command.
Evaluation of the parapet foxhole (Part 7) (final report).
Fort Ord, California: Author, October 1976.

This experiment was conducted to collect data in a realistic combat environment in order to comparatively evaluate the frontal parapet foxhole, the split parapet foxhole, and the standard foxhole. A total of 72 data collections trials were run. During each trial an infantry platoon attacked a squad in a prepared defensive position. Instrumentation systems were employed which permitted two-sided, real time casualty assessment and suppression. This experiment marked the first time that a force-on-force infantry experiment had been conducted with realistic real-time casualty assessment. Methodology for simulating rifles, automatic weapons, grenade launchers, antitank weapons, hand grenades, and indirect fire weapons was employed. The technology developed for this experiment opens up almost unlimited possibilities for future infantry field experiments.

228. U.S. Army Combined Arms Combat Developments Activity.
Tactical effectiveness testing of antitank missiles (TETAM) evaluation (Part II) (Vol. III). Fort Leavenworth, Kansas: Author, September 1973. (AD-921#724L)

This TETAM final report was prepared to determine the ability of antitank weapon systems to engage maneuvering enemy tanks advancing on defensive positions in various types of terrain. The analysis is organized in two general areas, intervisibility and engagement ability of antitank weapons. Antitank guided missile systems considered are the TOW, Dragon, and Shillelagh. The 106mm recoilless rifle is also considered for comparison purposes. Terrain sites evaluated include two areas in the Federal Republic of Germany, one area on Fort Lewis, Washington, and one area on the Hunter-Liggett Military Reservation in California. Study results are presented in answer to essential elements of analysis, and study findings and conclusions are developed.

229. U.S. Army Combined Arms Combat Developments Activity.
Tactical effectiveness testing of antitank missiles (TETAM) evaluation (Part I) (Vol. III). Fort Leavenworth, Kansas: Author, November 1973. (AD-914 961L)

This report prepared as chapter 12 of the TETAM final report, describes part 1 of the TETAM effectiveness evaluation. Part 1, based upon data developed by Phase I of CDEC experiment 11.8, was performed to determine the ability of antitank weapon systems to various types of terrain. The

analysis is organized in two general areas, intervisibility and engagement ability of antitank weapons. Antitank guided missile systems considered are the TOW, Dragon, and Shillelagh. The 106mm recoilless rifle is also considered for comparison purposes. Terrain sites evaluated include two areas in the Federal Republic of Germany, one area on Fort Lewis, Washington, and one area on the Hunter-Liggett military reservation in California. Study results are presented in answer to essential elements of analysis.

230. U.S. Army Combined Arms Combat Developments Activity. Tactical effectiveness testing antitank missiles (TETAM) evaluation (Vol. 9). Fort Leavenworth, Kansas: Author, April 1974. (AD-531 069L) SECRET

This report contains sections on general scenario; threat force organization; threat force tank division doctrine and tactics; threat force field artillery; threat force battlefield surveillance and target acquisition; threat force electronic warfare; and environmental intelligence.

231. U.S. Army Combined Arms Combat Developments Activity. Tactical effectiveness testing of antitank missiles (TETAM) evaluation (Part II) (Vol. IV). Fort Leavenworth, Kansas: Author, May 1974. (AD-919 166L)

This report contains the military and technical analysis of the experimental data collected during Phase II of CDEC field experiment 11.8. The primary purpose of the Phase II tests was to determine the ability of attacking tank crews to engage antitank weapons. Study results are presented, along with: probabilities of acquisition of TOW, Shillelagh, and Dragon as a result of launch signatures; and probabilities of random detection under simulated battle conditions. In addition this report contains an analysis of performance parameters affecting the engagement ability of antitank crews against advancing tanks. Parameters considered are missile flight times, missile reload times, and the time required by crews to detect an armor element.

232. U.S. Army Combined Arms Combat Developments Activity. Tactical effectiveness testing of antitank missiles (TETAM) evaluation (Vol. 1) (Executive summary). Fort Leavenworth, Kansas: Author, October 1974.

The objective of the tests determine the effectiveness

of the Dragon, TOW, and Shillelagh missile systems against realistic targets under simulated combat conditions, and either confirm high levels of effectiveness for these missiles in their present configuration or uncover weaknesses which should be corrected through further developmental effort. A limited evaluation of the Milan (French/German) and Swingfire (United Kingdom) antitank systems was also conducted. Three high resolution simulation models (individual unit action (IUA), DYN-TACS, CARMONETTE) were also tested.

233. U.S. Army Combined Arms Combat Developments Activity. Tactical effectiveness testing of antitank missiles (TETAM) evaluation (Part 1) (Introduction) (Vol. II). Fort Leavenworth, Kansas: Author, October 1974. (AD-B002 080L)

The tactical effectiveness testing antitank missiles (TETAM) program is a five-part analytical evaluation of a three-phase instrumented field experiment supported by a high resolution model effort. The evaluation is to confirm high levels of effectiveness of the Dragon, TOW and Shillelagh antitank missile systems or to identify system weaknesses which should be corrected through product improvement. This report summarizes the background, objectives, purposes, conclusions and recommendations of the analytical program. Field experiment findings and the supporting modeling results are reported on in other volumes.

234. U.S. Army Command and General Staff College. Selected readings in tactics - the 1973 Middle East War. (RB 100-2, Vol. II). Fort Leavenworth, Kansas: Author, May 1975.

Presents an in-depth analysis of the 1973 Middle East War. The reference book was prepared to support instruction at the Command and General Staff College. Illustrations and text are designed to explain how the war was fought. A general discussion of the several campaigns in the 1973 was is followed by a more detailed analysis of the Syrian, Egyptian and Israeli offensive and defensive operations which supported the campaigns. Organizational data for opposing forces is explained in detail. The use of antiarmor tactics is fully related. Conclusions reflect that the Israelis employed the tank to great advantage and are satisfied that the tank remains the best killer of other tanks. The Egyptians and Syrians, on the other hand, will probably conclude that infantry antitank weapons are to be favored,

while continuing to improve the training of their tankers.

235. U.S. Army Human Engineering Laboratories. Outline of human engineering guide for small arms design (Contract number DAAD05-76-0753). Arlington, Virginia: Century Research Corporation, December 1976.

The extent to which a book is universal or is limited needs to be delineated. This guide is not a "stand alone" book; rather it assumes that the user (in most cases a small arms designer) will have available to him a variety of small arms and human engineering literature. The guide is primarily a "How To Make It" book; it is not a textbook or a discursive essay and it often does not explain WHY things are done or made a certain way.

The guide has little concern with tactics and logistics. It deals largely with small arms use in a temperate and good weather environment, but gives some attention to more extreme environmental situations. It does not, however, provide for an optimum weapon to be used in, for example, a freezing rain at night.

Further, although "small arms" is generally accepted as including a range of weapons from pistols to submachine guns, the emphasis here is on a rifle carried by the walking soldier.

In summary then, the guide is not all things to all people but it does provide helpful guidelines for incorporation of the human element into the design of many man-carried infantry weapons.

236. U.S. Army Human Engineering Laboratories. An annotated bibliography of documents pertaining to human engineering studies and small arms design. Arlington, Virginia: Century Research Corporation, November 1976.

This bibliography is a collection of summaries of technical reports dealing with human engineering studies specifically related to small arms. "Small arms" is defined as including pistols, rifles, automatic rifles, light man-portable machineguns and automatic or semi-automatic 40mm grenade launchers.

237. U.S. Army Human Engineering Laboratories. Task analysis of

the infantryman armed with the M16A1 rifle (contract number DAAD05-76-C-0753). Arlington, Virginia: Century Research Corporation, November 1976.

This document presents an in-depth analysis of the infantryman's interaction with the M16A1 rifle. It is a personnel behavior task description of the task elements or step-by-step procedure of a typical soldier as he performs the functions of transporting, using, and maintaining his M16A1 rifle with accessories and the M203 grenade launcher. While it is a descriptive analysis of observable activities, it implies that there is a requirement or need for each step to be performed properly, usually in the order given, to satisfactorily complete the tasks which were selected for analysis.

238. U.S. Army Infantry Human Research Unit. Analysis of Dragon training and first round hit performance (memo). Fort Benning, Georgia: Author, June 1972. CONFIDENTIAL

(Memo - No Abstract)

239. U.S. Army Infantry School. TOW: Weapon system instructor packet. Fort Benning, Georgia: Author, April 1971.

This packet of material is designed to provide a basis for TOW weapon training. It is organized in accordance with the Army Subject Schedule for TOW and contains the following information: sample training schedules, a list of training aids, and lesson outline. This material is sufficient such that the instructor can put together and present the 33 hours of instruction required for qualification on the TOW weapon system.

240. U.S. Army Infantry School. Dragon second generation training package study group (memo). Fort Benning, Georgia: Author, December 1973. CONFIDENTIAL

(Memo - No Abstract)

241. U.S. Army Infantry School. Dragon second generation training package (Vol. IV) (other supporting research reports). Fort Benning, Georgia: Author, January 1974. (AD-C005 241L) CONFIDENTIAL

This report addresses the determination of the minimum

gunner proficiency requirements for the Dragon second generation training equipment. It also discusses the correlation of trainer and system performance and the problem of improving system performance.

242. U.S. Army Infantry School. Dragon second generation training package (Vol. I) (executive report). Fort Benning, Georgia: Author, January 1974. (AD-C005 238L) CONFIDENTIAL

This report presents the recommendations of the Dragon second generation training package study group. The study group found that:

- (1) the Dragon training program and equipment as tested in the check/operational test should be used, initially, for fielding the Dragon system,
- (2) development of a device to satisfy the LSS concept should be expedited,
- (3) changes in firing techniques and equipment necessary to make the training equipment and program compatible with the weapon system be included in the development program of the LSS concept,
- (4) development of Dragon training equipment beyond that recommended above not be undertaken at this time,
- (5) Department of the Army determine a positive way of insuring that Dragon gunners are assigned to infantry platoons, and
- (6) TRADOC formally establish a USAIS resident course of approximately two weeks duration to train selected personnel as Dragon gunners.

243. U.S. Army Infantry School. Dragon weapon system instructor packet. Fort Benning, Georgia: Author, September 1974.

This packet of material is designed to provide a basis for Dragon weapon training. It is organized in accordance with Army Subject Schedule for Dragon and contains the following information: sample training schedules, a list of training aids, and lesson outlines. This material is sufficient such that the instructor can put together and present the 35.5 hours of instruction required for

qualification on the M47 Dragon weapon system.

244. U.S. Army Infantry School. Weapons systems training effectiveness analysis report: M16A1 basic rifle marksmanship. Fort Benning, Georgia: Author, 30 August 1977.

The report summarizes the results of the weapon systems training analysis (WSTE) performed on the M16A1 Basic Rifle Marksmanship Program. A new 37-hour, 334-round program of instruction for basic rifle marksmanship is explained which forecasts savings of 6.5 million per fiscal year. The new program was fielded in May 1977 and is intended to serve as an interim program pending the development and integration of new training devices and training methodology into a proposed new Threat-Oriented rifle marksmanship program. The report contains implementing instructions as well as time, ammunition and monetary savings data.

245. U.S. Army Missile Command. Dragon launch effects trainer (special In Process Review). Redstone Arsenal, Alabama: Author, July 1972. CONFIDENTIAL

(IPR - Planning Document -- No Abstract)

246. U.S. Army Operational Test and Evaluation Agency. Operational test and evaluation simulation guide (Vol. I). Fort Belvoir, Virginia: Author, March 1974. (AD-A001 692/3ST)

The U.S. Army Operational Test and Evaluation Agency (USAOTEA) Simulation Guide presents, in four volumes, the results of an operational test-oriented survey of hardware simulators and computer simulations available within the Department of Defense of the Armed Services. The simulators and simulations are related to types of weapons systems. The status, availability, location, and controlling agency is given for each. The Summary (Volume I) presents an overview and provides a means to quickly determine what is available and its applicability to systems under test.

247. U.S. Army Test and Evaluation Command. Tracking and hitting performance stationary gun mount - moving target. Aberdeen Proving Ground, Maryland: Author, June 1970. (AD-872 084)

The Army service test procedure describes test methods

and techniques for evaluating the tracking and hitting performance of weapons systems (combat vehicle mounted), and for determining their suitability for service use by the U.S. Army.

248. U.S. Army Training and Doctrine Command, TRADOC bulletin No. 2 - Soviet ATGMs: Capabilities and countermeasures. Fort Monroe, Virginia: Author, April 1975.

The bulletin discusses Soviet antitank guided missile capabilities and limitations - focusing primarily on the SWATTER and SAGGER ATGMs. Details of the use and effectiveness of these missiles in offensive and defensive roles is highlighted. Proposed countermeasures are based on the combat results of Israeli techniques in the 1967 and 1973 Arab/Israeli Wars.

249. U.S. Army Training and Doctrine Command TRADOC bulletin No. 8 - Modern Weapons on the modern battlefield. Fort Monroe, Virginia: Author, December 1975.

Presents supplementary doctrinal material designed to assist commanders in their understanding of "how to fight" on the modern battlefield. Information such as weapon lethality, armor, infantry, artillery, air defense, close air support and electronics warfare trends are presented. This data is derived from tests, recent intelligence and other legitimate sources. Probability of hit data, range and accuracy information of current equipment likely to be found on today's battlefield are included.

250. U.S. Army Training and Doctrine Command. Training and Doctrine Command pamphlet 71-8: Analyzing training effectiveness. Fort Monroe, Virginia: Author, December 1975.

This pamphlet describes methods used by TRADOC to increase the effectiveness for selected combat materiel through improved training. TRADOC has directed that service school commandants undertake analyses of training which employ, where practical, operations research methodology, which are supported by reliable data on cost-effectiveness, and which recommend courses of action, with resources identified, that he might take, or that he can recommend to Department of the Army for adoption. In particular, this paper seeks to formulate the problem, to construct

generalized models applicable to a resolution thereof, to describe how models might be tested, to show examples of model use, and to illustrate the sort of recommendations desired.

251. U.S. Army Training and Doctrine Command. Threat force guidance. Fort Monroe, Virginia: Author, 27 February 1976.

An unclassified compilation of data characterizing offensive and defensive threat doctrine is presented. Stated purpose of this document is to synthesize published threat material and to identify and resolve known variances in the presentation of threat offensive and defensive tactics. Conduct, types of attack, formations, distances, frontages and overall missions of threat forces are presented.

252. U.S. Army Training and Doctrine Command. Threat force guidance. Fort Monroe, Virginia: Author, 14 May 1976.

An expanded analysis of threat force tactics and techniques for conducting offensive and defensive operations. This publication does not supersede guidance published by Hq. U.S. Army Training and Doctrine Command on 27 February 1976. This document, instead, amplifies earlier guidance and concentrates heavily on graphic presentations of threat tactics.

253. U.S. Army Training and Doctrine Command. Threat force guidance. Fort Monroe, Virginia: Author, 30 August 1976.

Though similar to threat guidance documents previously published by Hq. U.S. Army Training and Doctrine Command on 27 February and 14 May 1976, this paper portrays threat organization and equipment considerations pertinent to offensive and defensive threat tactics. A wide range of combat and combat support capabilities is discussed.

254. U.S. Army Training and Doctrine Command. Training and Doctrine Command range and lethality of U.S. and Soviet anti-armor weapons. Fort Monroe, Virginia: Author, 30 September 1976.

Presents basic data on the principal U.S. and Soviet tank guns, antitank rockets, and antitank guided missiles. Probability of hit data, first round hit percentages over range for moving and stationary targets and general system

effectiveness data are included for the Soviet T-62 Tank and the SNAPPER, SWATTER, SAGGER and RPG-7 antitank missiles.

255. U.S. Army Training and Doctrine Command. Anti-armor systems study (final report). Fort Monroe, Virginia: Author, December 1976. CONFIDENTIAL

This study reports that anti-armor systems possess a high probability for hits (AMSAA). Ninety-eight percent of the TOW and Dragon missiles used are fired in daylight by well qualified or experienced gunners. Operator selection criteria are discussed, and the complexity of TOW and Dragon operations are accented.

256. Viilu, A. Parametric analysis of armor/antiarmor trends (contract report). Mclean, Virginia: General Research Corporation, September 1974. (AD-C001 924) CONFIDENTIAL

Small units in the attack, in the defense, and in meeting engagements are analyzed. U.S. 1970 and 1980 state-of-the-art antiarmor weapons are evaluated against a Soviet 1975 state-of-the-art armor force. Reinforced battalions in the attack and reinforced companies in the defense are the principal force elements evaluated in the study. Emphasis is on direct fire battle and the effects of artillery suppressive fire on infantry weapons.

257. Voss, H. A., Boney, W. B., & Rankin, W. C. Prototype instinctive firing training device for small arms. Orlando, Florida: Naval Training Device Center, April 1970. (AD-873 014)

A prototype device for training skill in the rapid firing of small arms by simply pointing the weapon at the target has been developed. The instinctive firing device (IFD) projects a beam of light which provides the trainee with immediate knowledge of results. Skill with the IFD is acquired quickly and transfers positively to the live ammunition situation. Safety, convenience, and cost effectiveness of the IFD are readily demonstrable.

258. Walton, L. D. Developmental test II (sp) of night vision sight. Fort Benning, Georgia: U.S. Army Infantry Board, March 1974. (AD-529 857L) CONFIDENTIAL

The developmental test II of the night vision sight,

infrared, AN/TAS-3 for use on Dragon and TOW weapon systems, was conducted by the U.S. Army Infantry Board (USAIB) from 14 August 1973 through 14 February 1974 at Fort Benning, Georgia and Redstone Arsenal, Alabama, to evaluate the performance, reliability, availability, and maintainability of the AN/TAS-3 night sight under realistic field conditions. In addition the test provided a comparison between the AN/TAS-3 night sight and the daylight tracker during target acquisition. The night hit probability of Dragon and TOW with the AN/TAS-3 night sight during periods of reduced visibility was determined. A comparison of the night hit probability and the daylight hit probability for Dragon and TOW was conducted also. The adequacy of the developer's recommended training program was investigated. Additionally, it was verified that the AN/TAS-3 night sight was safe for use by U.S. Army personnel.

259. Warren, W. F. A preliminary analysis of antitank warfare in the Republic of Viet Nam. San Francisco, California: Scientific Advisory Group (Navy), June 1972. (AD-C007 752) CONFIDENTIAL

This report describes the effectiveness of antitank weapons.

260. Warren, W. F. Antitank warfare in Viet Nam. San Francisco, California: Scientific Advisory Group (Navy), May 1973. (AD-C003 286) CONFIDENTIAL

This study describes the role of antitank weapons in Viet Nam.

261. Weingarten, K. Development and implementation of a quality-assured, peer-instructional model (report number HumRRO-TR-72-35). Alexandria, Virginia: Human Resources Research Organization, November 1972.

This report describes the development and pilot testing of a low-cost, generalizable, quality-assured, peer-instructional model suitable to the training needs of men of varying measured aptitude. The report presents a brief overview of the project, followed by a detailed description of the APSTRAT model and the considerations that led to its development. The model is discussed in terms of the instructional principles incorporated and the practical constraints accommodated. The data comparing the performance

proficiency, academic attrition and recycles, and costs of the conventional and APSTRAT systems indicate that APSTRAT students achieve greater proficiency with a reduction in the rate of academic attrition and a considerable savings in cost.

262. Weingarten, K., Hungerland, J., Brennan, M., & Alfred, B. The development of a low-cost performance-oriented training model. HumRRO Professional Paper 32-70. Alexandria, Virginia: Human Resources Research Organization, December 1970.

This paper addresses the problem of the development of individualized instruction and criterion-referenced tests. A proposed model for the development of low-cost performance-oriented training is described and discussed. In addition, a number of broad guidelines for training development are presented along with a number of recommendations for implementing the proposed training model.

263. Wheaton, G. R., Fingerman, P. W., Rose, A. W. & Leonard, R. L., Jr. Evaluation of the effectiveness of training devices: Elaboration and application of the predictive model (research memorandum 76-16). Pittsburgh, Pennsylvania: American Institutes for Research, July 1976.

The purpose of this paper was to develop and evaluate a behavioral model which can be used to predict and evaluate the effectiveness of training devices. The paper discusses the development of the model and presents an application of the model.

264. Withers, L. P. Follow-on analysis of Dragon training equipment. Fort Belvoir, Virginia: U.S. Army Operational Test and Evaluation Agency, December 1974. (AD-C001 048)
CONFIDENTIAL

This technical note addresses the effect of training method, target mode, firing position and range on hit performance by Dragon gunners. It also examines the prediction components of the launch effects trainer (LET) scores that best characterize live missile firing results.

265. Wohlman, M., Griffard, B. F., & Shockey, D. F. Surface attack guided missile system, M47, operational test IIIA. Falls Church, Virginia: U.S. Army Operational Test and

Evaluation Agency, April 1976. CONFIDENTIAL

This report documents and describes the results of Operational Test IIIA for the Dragon weapon system. For this test the instructor to student ratio was 1:4 and no more than two firing tables or 60 target engagements were completed per day. It was recommended that observed deficiencies in gunner performance may be corrected through individualized instruction. Additionally, it was found that a 50% loss in hit accuracy could be expected if monthly refresher training was not accomplished. Further, it was found that this refresher training was most effective if it was included with the soldier's annual field training. Finally, it was suggested that Dragon gunners should be trained to fire the Dragon system under all environmental conditions that could be reasonably expected to occur on the modern battlefield.

266. Wood, M. E. Improved crew member training through a new philosophy toward training. Williams Air Force Base, Arizona: Air Force Human Resources Laboratory, August 1970. (AD-723 313)

New emphasis on the total learning process is bringing about significant changes in both educational and training communities. The process-oriented, systems approach to training integrates behavioral objectives, media, and instructors in such a way that increased training effectiveness is realized through a greater ability to deal with the learning requirements of the individual student. Based on current United States Air Force efforts to employ and evaluate this general approach to training, new efficiencies in instruction are indicated. This system will provide a basis for defining the characteristics of future multi-media systems. The basic principles inherent in the newlook in training appear to be generally applicable to all phases of crew-member training.