# TRAINING EQUIPMENT FOR A BATTLEFIELD ENVIRONMENT

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Several weeks ago at an American Ordnance Association meeting, General Durrenberger, Commanding General of the Army's Weapons Command, succinctly summarized the demands of today's combat units in the field. Their needs, he said, are:

- More firepower
- Greater mobility
- Increased protection

These broad requirements are, of course, not new; we have heard them before, and we will continue to hear them in the future. But when we stop for a moment to think about the total implication—and problems—surrounding these demands, a number of basic truths and challenges become very obvious.

Combat requirements, such as firepower, mobility, and protection, are almost always tightly interdependent. For example, firepower and mobility are essential elements of protection. Or, conversely, protection is a function of your ability—and success—to shoot and scoot.

However, continually trying to satisfy demands with new tools takes us down the path of technological change, adaptation, application, and need. And herein lies the underriding challenge of the Government/Industry team—to be able to meet demand with technological prowess.

If this, then is the challenge, we—the Industrial team—must ask the question: "What do the requirements of the modern field army mean to us in our own technological terms?"

Before I discuss that question, let's take a look at what's behind us. Historically, the military forces have been the vanguard in terms of promoting and utilizing technological change, innovation, and advancement. We have only to stop for a second to consider the impetus the military has given to such monumental and far-reaching recent technological advances as the jet engine, nuclear energy, and the entire field of electronics, by their initial utilization and ultimate proving of feasibility of such advances. These, and other advances, were spawned by the military establishment as a direct result of their own requirements. And I submit that without this type of motivation, our technological progress, and the resultant benefits that are enjoyed by all segments of the economy, would still remain to be realized. But, like in all things, timing, balance, and complexity are important factors to be considered and understood. When we compare a field army to an air force or a navy, we find evidence that the combatant elements of any army sometimes lag the others in exposure to technological advance and its inherent complexities. Or, if advanced, complex equipment is made available, the balance necessary to have the manpower trained and adapted to its use is sometimes out of phase—or difficult to maintain. To be sure, there are pockets of exception; e. g., the artillery has been exposed to the complexities and problems surrounding the guided missile for a decade and a half. Yet, I think it would be safe to say that today they have gone through their growing pains and are no longer mystified by, or apprehensive about, having complex, sensitive, and expensive equipment to work and fight with. Tactical assault and support aircraft is perhaps another pocket of exception. And there are others.

However, to a very large body of our ground forces, technically advanced, complex equipment—especially that having an electronic base—is still unique. But there is no question that they must learn to accept it and use it, and to expect more and more of it as time goes on, if they are to have their everpressing demands of more firepower, mobility, and protection satisfied. This process of learning is where we, the Center and those of us who represent the training industry, have a challenge and a role to play. Let's examine that challenge.

Again, from a historical standpoint, we in the training business have been deeply concerned with satisfying requirements and delivering systems that find their place in the classroom environment. Through the years, the Government/Industry team represented in this room today have met past challenges and, I believe, have done a remarkably fine job. Simulators and complex training systems of a wide variety of forms have been produced to satisfy an even wider variety of requirements. Dealing with complexity and employing technical ingenuity—or creativity—equal to or surpassing that employed in the creation of operational hardware has been our way of life. We can and should be proud of what has been done and what is being done right now. But, again, our work has been pointed to the classroom. And that's the key word: the classroom. Virtually all of the beautiful systems that have been or are now being used, and those now under development or in the minds of our future planners, fall into this category. Characteristically, they are subjected to a gentlemanly environment and receive professional care and treatment. To be sure, there are seemingly harsh elements of the total environment that have to be satisfied. Accuracy, realism, availability (which is the product of reliability and maintainability) are but a few. But what happens and what type of problems do you face when you supply this delicate instrument to the real-world environment of a combatant unit, and are required to assure that the instrument does its job no matter where in the world or under what set of conditions this unit finds itself? I'll say here and now, unequivocally, the problems are big and altogether different from those we have known in the past. To think otherwise is foolish and begets fiscal irresponsibility.

To give you insight into what I am saying, I would like to briefly describe a current training system that fits this bill. First, however, let's consider the more classical systems: the classroom trainer, if you will. When you view them in their totality, they share common characteristics:

- Self sufficiency—They are complete and whole in themselves. They do not require a direct, positive coupling with the operational equipment for which training is being performed.

- Technical complexity—They reflect high utilization of the electronic, optical, hydraulic, pneumatic, and mechanical disciplines.

- Controlled environment—They are employed in the typically clean, airconditioned, heated, permanent-type facilities that are found at the camps, posts, stations, and educational centers of the military establishment.

- Operational application—They almost always command the assignment of the highest levels of trained instructors, operators, and maintenance personnel available to the using services.

Now let's look at a new breed of systems and assess the differences in character.

Nearly three years ago, Otis/Reflectone was assigned the task of developing a system to train tank gunners in the firing of Shillelagh guided missiles. The Shillelagh was an answer to the Army's demand for increased firepower; the employment of the system on new, highly sophisticated armor vehicles was an answer to the demand for mobility and protection. So here was evidence of positive action being taken to satisfy the basic law of demand and supply. I cannot discuss all the problems surrounding the development and fielding of the operational elements (the missile and the vehicle) to arrive at an advanced and effective total weapon system, but some of the problems were of a training nature and fell to the Center and Reflectone for solution.

You might ask why this is a problem. Certainly training a gunner doesn't appear any more difficult than training a pilot, a navigator, a helmsman, or an electronic warfare officer. While technical complexity would certainly be evident, the fundamental differences were that the denominators of self-sufficiency, controlled environment, and operational application would be totally different. In short, a delicate instrument would be called for, but it had to become part of and be used in the real world of a combatant field army no matter where that army found itself or what the conditions of its employment. Therein lay the challenge; what I will show you in Figures 17 and 18 reflect the solution.

These figures illustrate a training system known as the Conduct-of-Fire Trainer for the Shillelagh missile system. As applied to the Sheridan Weapon System, it has been designated the XM-35; applied to the M60A1E1 armor system, it carries a designation of XM-38.

Technically, the trainers are virtually identical. Only mountings and the specialized optical systems in the vehicles required minor differences in design. The trainer has three major hardware units in its makeup:

- A Visual Effects Simulator to demonstrate optically what the gunner would see during a missile firing.

- A Target Unit to provide ranging requirements and an optical data signal to the weapon systems guidance and control system.

- An Instructor's Control Unit to tie the trainer into a closed loop system and to provide to the tank commander the ways and means to train his crew and evaluate their performance.

In brief, Figures 19 and 20 show the elements of system design and explain its method of operation.

Although having three separate elements, the trainer should be viewed as consisting of two subsystems: the first mounted on the launch or missile-firing vehicle and the second mounted on a target vehicle. When the gunner "fires" a missile, signals transmitted optically from the target system to the launch vehicle are passed on to the tracker via the gunner's telescope. Here the signals are converted to electrical energy and fed via the data converter to the trainer's azimuth and elevation error computers. Azimuth and elevation errors are computed for each of the two light sources of the target system and, by triangulation, are converted by the range computer into a measure of target range. The miss-distance computer simulates missile dynamics, adds appropriate lags to the tracking errors computed above, and converts the resultant angular errors into orthogonal miss-distance components. Miss-distance is indicated to the instructor/commander by a dual-needle meter which "freezes" upon impact of the simulated missile with the plane of the target. If the impact point falls within a prescribed square about the target center of mass, the gunner is credited with a "hit," if outside the square, he is considered to have "missed."

In addition to the display provided to the instructor/commander, the trainer also generates a visual display of the missile image in the gunner's telescope. Azimuth and elevation errors, modified by missile dynamic lags, are used to deflect a simulated missile image, which is also made to appear to fly down range with the aid of a servo-operated iris/lens assembly.

Blossoming of the image prior to its disappearance at time of impact indicates to the gunner that he has hit the target. If the image disappears without blossoming, he knows he has missed. Impact time is computed as a function of the range computed by the range computer. To further illustrate my earlier statement that the trainer is indeed, a delicate, technologically advanced system in itself, let me mention a few of the features it contains:

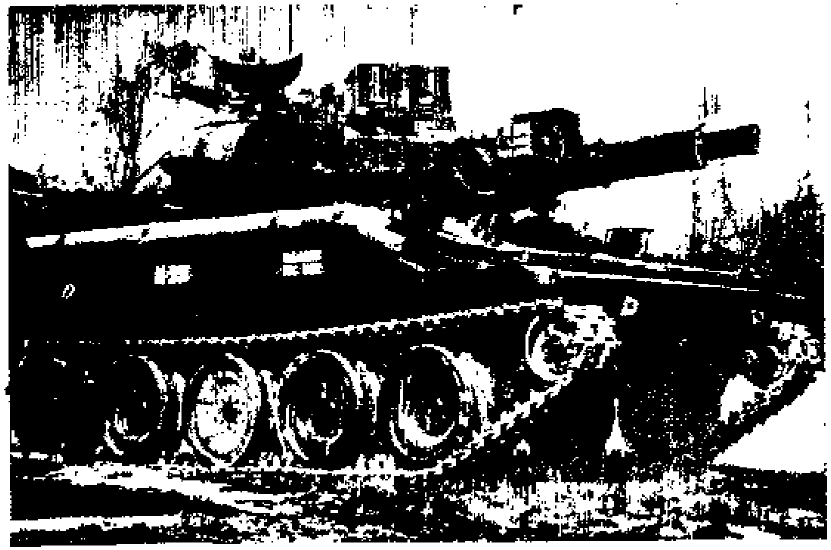
Figure 17. Conduct-of-Fire Trainer, XM35, on Sheridan Vehicle

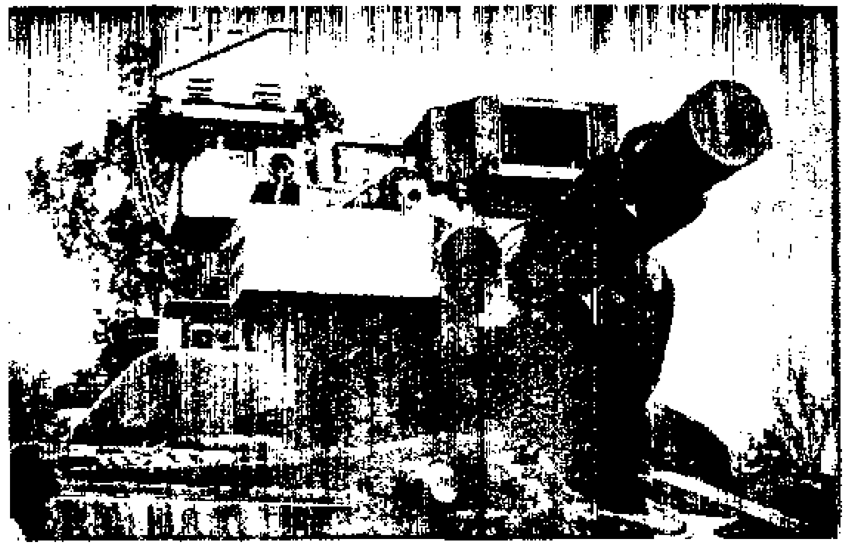
Figure 18. Conduct-of-Fire Trainer, XM38, on M60A1E1 Vehicle

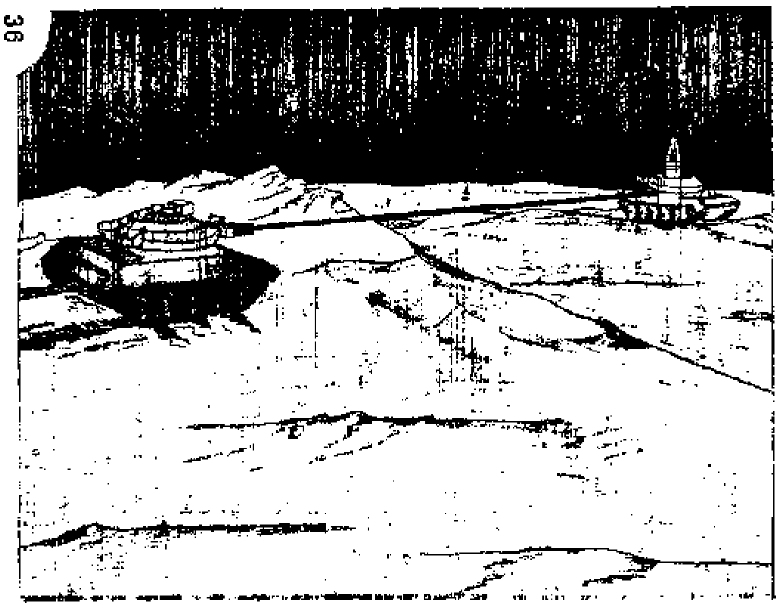
Figure 19. Battlefield Environment of Conduct-of-Fire Trainers

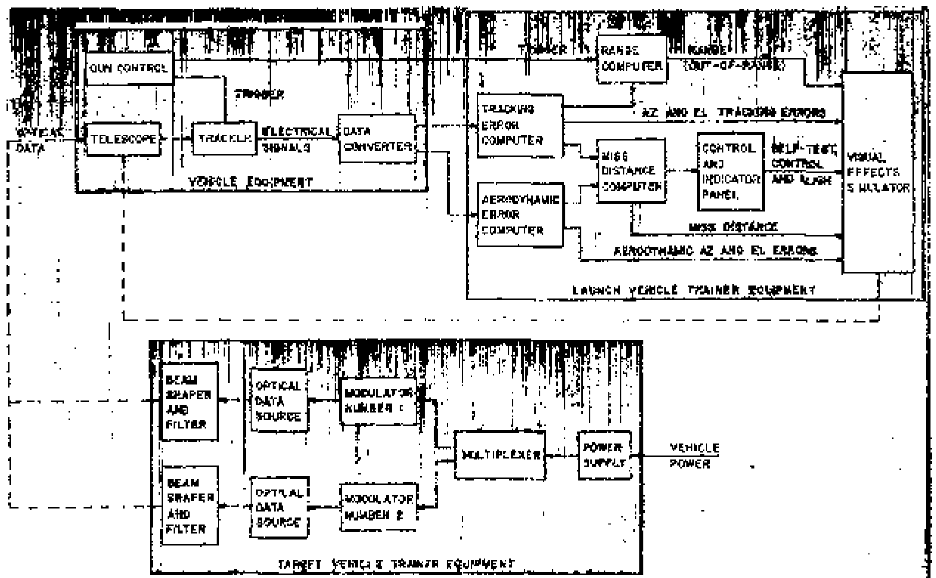

Figure 20. Conduct-of-Fire Trainer System Block Diagram

- All solid state
- Hybrid computer techniques
- Omnidirectional optical data sources
- High-efficiency, narrow-band optical filtering
- Solid-state, high-efficiency dc to dc conversion
- High current multiplex
- Modulated light sources
- Compact optical projection system
- Ruggedized
- Weatherproof

Against this technology, let me also illustrate by a short film the typical development testing the trainer has undergone to determine and understand the operational environment and to ensure that equipment reliability is achieved.

I think you will agree that the trainer reflects a high degree of technological sophistication; it employs state-of-the-art applications and reflects substantial engineering creativity. But, as I mentioned earlier, technical complexity was only part of the challenge. How does this trainer relate to the other common denominators we discussed? How and where is it different? And what new challenges do the differences pose?

First, the COF is to be issued to using armor units as a piece of TO&E equipment. Some of you may not be familiar with this term; it simply stands for Table of Organization and Equipment. What it means is this: the trainer will be issued to and become a part of the permanently carried equipment of a basic armor unit. Or in other words, it will be issued on the same basis as the armor vehicle itself or, to draw another comparison, the same as mess kits, shelters, and rifles are issued to using troops. It will be carried and used in daily training exercises, field problems, and maneuvers. For that matter, it may also be carried into a combat zone if and when Shillelagh is ever employed in such a situation. In short, the COF is not intended to enjoy the benefits of a controlled environment.

Second, the COF becomes a part of the total weapons system. It must derive power from the vehicle and must be coupled to the guidance and control elements of the missile system. It is no longer a self-sufficient piece of equipment; it must rely on other sensitive elements of the weapon and vehicle system, over which it has no jurisdiction or control. In short, it will not enjoy the benefits of independence.

Third, and perhaps most significantly, the trainer will be deployed over a considerably large base, both operationally and geographically. Successful deployment will, in great measure, be a function of the people involved. As mentioned earlier, the typical complex trainer system many times enjoys the best that can be obtained in terms of instructors, operators, and maintenance personnel. They could easily be classified as professionals in their respective fields.

Obviously, this factor contributes heavily to system effectiveness when performing its operational mission. But the COF faces a different set of conditions. Here the instructor as well as the student will both be combat soldiers, generally of low military rank and with limited experience or training. Coming from all walks of life, they will most likely be draftees with only months, not years, of service availability; perhaps they will have a high school education, although many will not; generally they will be very young, many still in their teens; they will represent all segments of economic-status and ethnic background--in summary, they will be a rather heterogeneous group of youngsters who have neither a common bond nor a motivation by any professional ethic. Consequently, the trainer, as well as all other equipments in their hands, must not only be rugged and reliable, but it must cope with this heterogeniety by appearing foolproof and simple and by being readily usable. But again this is only a piece of the story. Simplicity on the outside does not infer simplicity on the inside. I have already shown that the device is complex. How then are the interior mechanisms maintained, repaired, and serviced? The personnel available for this task, while having been exposed to some speciality training, in many ways fall into the very same heterogeneous pattern already outlined. And then when these factors are coupled with wide equipment deployment and the logistic considerations attendant thereto, one is faced with a real world situation that is not only many faceted, but one fraught with many interwoven and complex relationships. In short, the COF will never enjoy the luxury of a gentleman's approach to training, nor will it command specialist field support.

These differences in denominator cause problems, but they are not unsolvable.

As a team, the Army, the Center, and our Company have been working closely to develop solutions. It has been challenging and time-consuming. I doubt that we have answered everything yet, but we are working on them and we continue to show progress.

My message to you today then, is that there is emerging a new breed of trainers requiring advanced technology and the injection of that technology into areas which, in the past, have had little exposure. The requirements are real and will be increased as time goes on.

New systems will replace old ones in the process of satisfying the never ending demand for firepower, mobility, and protection. And with new systems and the applications of newer and more sophisticated technologies, new and more severe problems will be uncovered. And this is as it should be.

Let me leave you with one parting thought. Henry J. Kaiser used to say, "Problems are really opportunities disguised in work clothes." Reflectone has been wearing its work clothes and has no intention of changing.