MOVING TARGET

MARKSMANSHIP TRAINING

JOEL D. SCHENDEL

Traditionally, rifle marksmanship training has emphasized the engagement of stationary targets from defensive positions. Yet, moving targets are the type most frequently encountered on the battlefield.

Few would argue that there is no need for moving target marksmanship training. Moving targets are easier to detect than stationary targets but can be much harder to hit, depending on the conditions under which they appear. However, this training also would create additional demands on training resources when these resources already are tightly constrained.

What do we know about shooting moving targets? Can this skill be trained in a reasonable period of time and at a reasonable cost?

Concerns over moving target marksmanship training came to the forefront during the mid-1970s when the Army decided to pursue the Remoted Target System (RETS) concept for ranges. The idea was to provide realistic, threat-oriented marksmanship training for all soldiers, with moving target training being included as part of the Basic Rifle Marksmanship (BRM) program of instruction (POI). Following a series of tests, however, it was concluded that moving target engagement is an advanced skill, one that should be taught, but probably not to all soldiers. In 1982, moving target training was included as part of the Advanced Rifle Marksmanship (ARM) POI, and it remains an important part of training for soldiers with the military occupational specialties (MOSs) of 11B (Infantryman) and 11M (Fighting Vehicle Infantryman).

The Fort Benning Field Unit of the Army Research Institute (ARI), working with the U.S. Army Infantry School (USAIS), also began research on marksmanship training in the mid-1970s, and this research has been used to help establish the current BRM and ARM POIs. More recently, it was used to support the preparation of Field Circular (FC) 23-11, Unit Rifle Marksmanship Training Guide.

A portion of the research effort has been aimed at developing effective, low-cost ways of training soldiers to shoot at moving targets. This article summarizes many of the issues and concerns that surfaced during our research on moving target training and describes what we did to help address them. It also includes a number of recommendations for improving training in this area. (The views expressed are my own.)

When we began our research, it became evident that the Army's existing doctrine on moving target engagement did not relate directly to combat firing. Most of the literature we reviewed had been developed to help competitive shooters hit running targets. Nevertheless, this literature, coupled with numerous trips to the field and discussions with subject matter experts, led us to conclude that the same four fundamentals of rifle marksmanship that apply to stationary targets—steady position, correct aiming, smooth trigger squeeze, and controlled breathing—also apply to moving targets. If anything, these fundamentals are even more important for the engagement of moving targets, because there is an inherent instability in shooting at moving targets and because these targets frequently are exposed only for brief periods of time.

Steady position. The results of tests conducted by ARI and the U.S. Army Combat Developments Experimentation Command (CDEC) indicate that a good firing position is a key factor in hitting moving targets. The position must provide for balance and as much support as possible without being too rigid. Too much support inhibits flexibility and makes it virtually impossible for a firer to engage moving targets without shifting about.

As noted in FC 23-11, targets that have no lateral movement—targets moving directly toward or away from the firer—can be treated in the same manner as stationary targets. These targets are engaged most effectively from a fully supported position. At the other extreme, targets that have signifi-

cant lateral movement—targets moving rapidly, close up, and at right angles to the firer—are easiest to engage if the rifle and the entire upper body are free to swing with the target.

In general, when moving targets are likely to appear, it is probably best to start from a partially supported position (Figure 1). The non-firing hand is placed on a sandbag support and used as a pivot point for the rifle. The rest of the upper body is held free from external support. This position affords both stability and freedom of movement, and it can be modified quickly if more or less support is needed.

In one experiment, we focused on two frequently used methods of engaging moving targets—tracking and trapping. Our goal was to determine the conditions under which one or the other method would prove superior. Tracking involves moving the muzzle of the rifle at a rate that matches the rate of the target. The firer then tries to shoot the moment the target is in proper relation to the sights, continuing the movement of the rifle until after the shot is away. Trapping involves holding the muzzle slightly in front of the target and firing the moment the target passes through the aiming point.

In the experiment, we found that shooters generally perform better trapping against slow-moving distant targets and tracking against fast-moving close-up targets. We also discovered that low-ability shooters prefer to trap targets and perform better trapping. Trapping is easier than tracking for these shooters because it entails little muzzle movement and can be accomplished with external body and weapon supports.

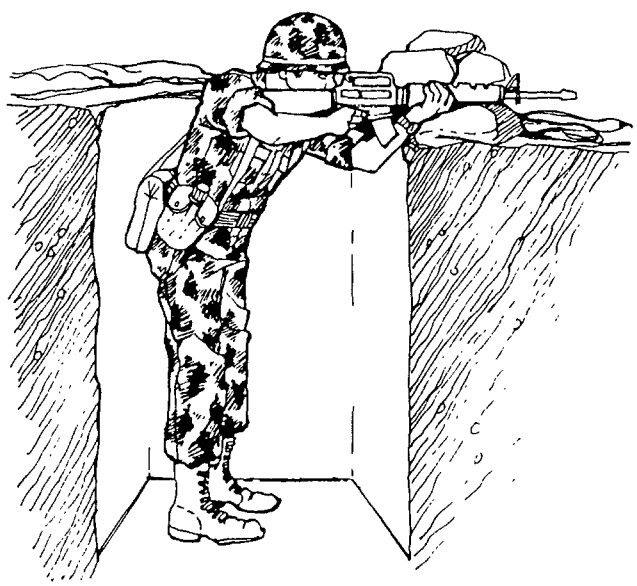

Figure 1. Partially supported firing position.

In contrast, our data showed that high-ability shooters prefer to track targets and that they hit more targets while tracking. The greater freedom of movement that tracking affords comes at the expense of added control, but it extends the time that is available to engage a target. These results suggest that soldiers should be introduced to both methods and allowed to try both. High-ability shooters are likely to be biased intially toward tracking, while low-ability shooters are likely to be biased toward trapping, biases that should result in superior performance for both groups.

To help soldiers improve their tracking and trapping skills, we worked with the Fort Benning Training Support Center to develop the Dry Fire Moving Target Engagement Trainer—DRY MOVER— (Figure 2). This inexpensive device consists of two scaled, three-dimensional targets, each situated in front of a curved shield and mounted at the end of a rod. The rod is seated on a rotating shaft that is driven by a variable speed, reversible, AC motor, which is mounted in an aluminum housing.

DRY MOVER can be configured to simulate the apparent size, speed, and exposure time of the 75-meter or 125-meter RETS moving targets. Fifteen to 30 soldiers are then arranged in a semi-circle (or circle) around the device during dry fire training. Depending on the rod's direction of rotation, these soldiers see the targets as moving from right to left (clockwise) or left to right (counterclockwise). While the device does not give the shooters any feedback on the location of their shots, with a knowledgeable instructor, it can help teach them how to fire from a partially supported position as well as how to track and trap targets.

Point of aim. Previous instruction on point of aim was overly complex. At least four different lead rules were recommended for targets moving at different speeds, angles, and ranges, making it difficult to remember the rules, much less attempt to apply them under stress. The rules also appear to have been developed on the assumption that most targets will be moving at 90 degrees relative to the direction of fire. Of course, combat targets can be expected to move at any angle, with those moving at 90 degrees being among the least threatening.

To overcome these concerns, we developed and tested a

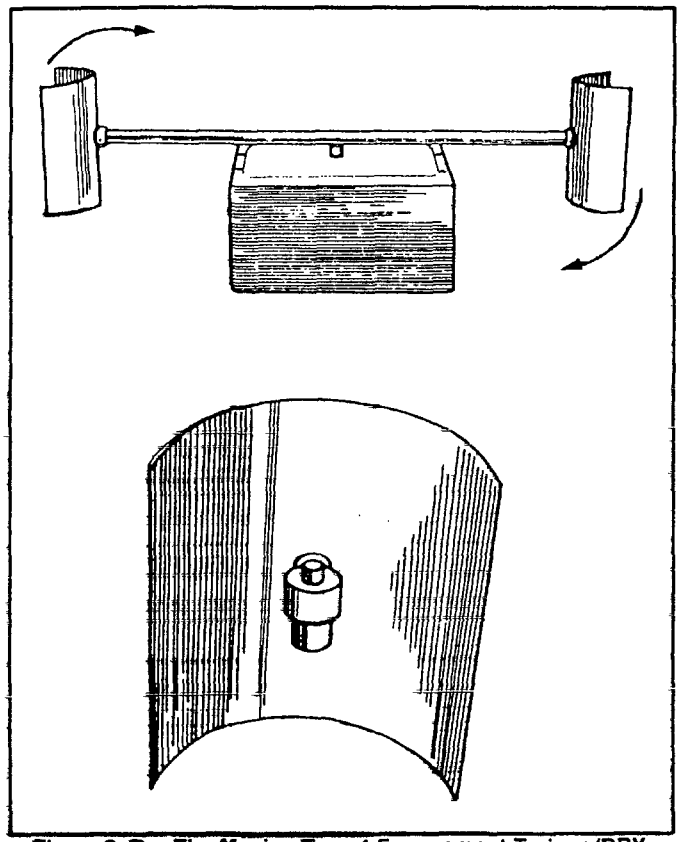

Figure 2. Dry Fire Moving Target Engagement Trainer (DRY MOVER).

single lead rule. The rule merely involves placing the trailing corner of the front sight post at the center of mass of the target (Figure 3). This causes the amount of lead to increase automatically as the range to the target increases. As illustrated in FC 23-11, the front sight post of an M16A1 rifle covers about 1.6 inches of the target at 15 meters or about 16 inches of the target at 150 meters. Since the center of the front sight post is the actual aiming point, placing the trailing corner of the front sight post on the center of mass of the target provides for a lead of about .8 inch at 15 meters, or about 8 inches at 150 meters. This single lead rule provides for hits against targets moving at a variety of speeds, angles, and ranges, and it is particularly effective against high-priority, close-in targets (targets inside 100 meters).

In the initial aiming process, speed is very important to the effective engagement of moving targets. In fact, some experts regard it as the main problem, because the more time the firer takes to react to a moving target, the less time he has to achieve a good sight picture. The single lead rule was developed to simplify and speed initial aiming. Two training aids also were developed to facilitate this process—the Aid to Improved Marksmanship (AIM) and the 25-Meter Scaled Simulated Moving Target.

AIM, like DRY MOVER, has been used for several years as part of the ARM POI. It is a self-paced, performance-based workbook designed to teach the effects of gravity and target motion on point of aim. Each AIM exercise includes two identical photographs of a scaled walking or running target seen at a range of 75, 125, or 185 meters. One of the photos appears on the left side of a page; the other photo is under a paper flap on the right side of the page.

Each exercise uses a transparent overlay to show where a shot would hit given a particular point of aim. The M16A1 sights are shown in proper alignment on the left side of the overlay; a dot appears on the right side. The soldier is told to place the sights (left side of the overlay) over the target on the left side of the page, allowing enough lead to hit the target, considering its rate and angle of movement and range. The dot on the right side of the overlay is placed under the paper flap on the right side of the page. Once the soldier has what he believes is a correct sight picture, he need only lift the paper flap to reveal his shot location (the dot).

Care was taken in the preparation of AIM to provide as much realism as possible. The M16A1 sights on the overlay were made by taking a photograph through the actual rifle sights. Additionally, the dot on the overlay was scaled to correspond in size to the four-centimeter zero circle on the 25-meter zero target. (The dot on the overlay is much smaller than four centimeters, of course, but it is scaled to appear the correct size in relation to the reduced-scale targets.) Care also was taken to ensure that the dot accurately reflected the location of each shot, given particular points of aim. This was done using trajectory and target movement data that had been confirmed through actual firings.

One person who used AIM reported that it helped him "gauge his eyeball" for M16A1 lead requirements, and the results of our testing generally agreed with this observation. Soldiers who received AIM training developed substantially more knowledge about how to lead various targets than soldiers who were given the same information about lead through lecture and demonstration.

The other training aid, the 25-meter scaled simulated moving target, has three enemy soldier silhouettes printed on it. Each silhouette appears to be moving at a different speed, angle, and range (Figure 4). A dotted silhouette, not visible from 25 meters, is offset to the front of each solid silhouette. During training, soldiers are instructed to engage each solid silhouette as if it were moving. Firers are placed under time pressure, not knowing until the last instant which silhouette—top, center, or bottom—is to be engaged on any particular trial. A tower operator controls the sequence in which silhouettes are engaged, while a spotter seated next to each firer uses a telescope or binoculars to provide feedback on shot locations. The only shots scored as hits are those within the dotted silhouettes.

Although the 25-meter scaled simulated moving target is not currently being used in ARM, it can be used in conjunction with the DRY MOVER to provide relatively low-cost moving target training. Other scaled targets also can be substituted for the simulated moving target (as discussed in FC 23-11) to support moving target training.

Trigger squeeze. As suggested in FC 23-11, the speed required to engage moving targets frequently causes a soldier to use a rapid, controlled trigger action that is more like a jerk than a squeeze. Of course, jerking the triggger can cause targets to be missed. Fortunately, though, the disruptive effects of jerking the trigger can be largely offset by placing heavy initial pressure on the trigger. In fact, our observations suggest that heavy initial pressure (about half the pressure required to fire the weapon) can reduce trigger jerk to such an

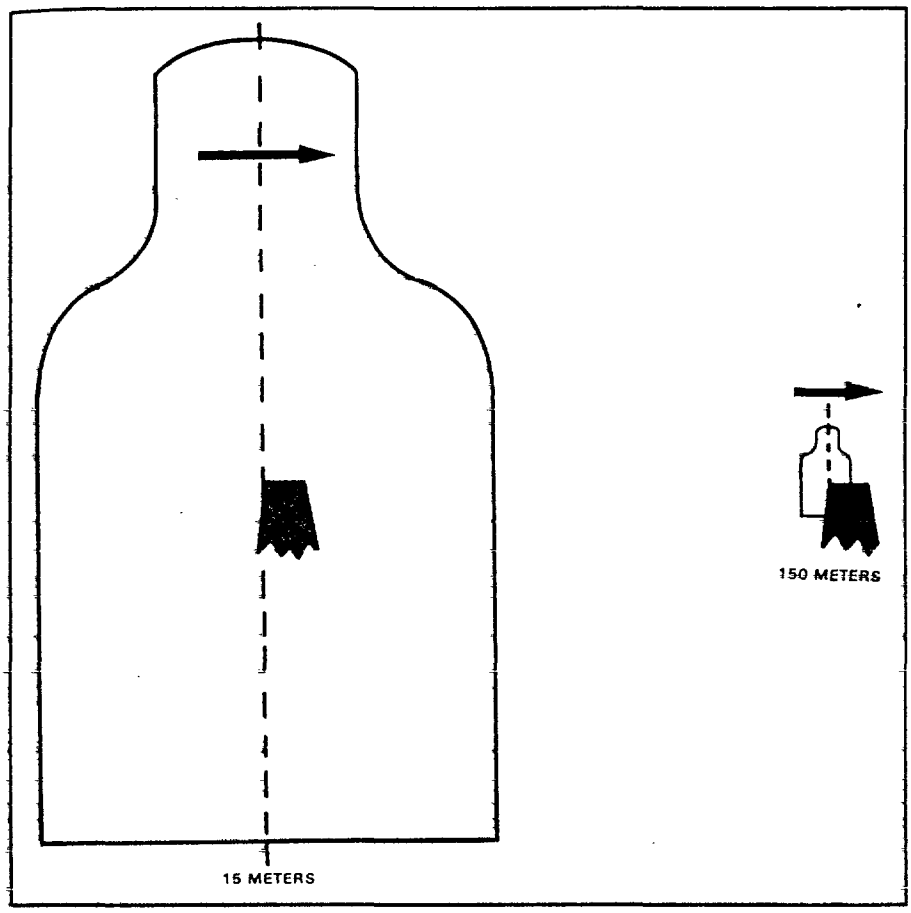

Figure 3. Single sight rule applied against scaled 15-meter and 150-meter moving targets. Arrows indicate direction of movement.

extent that it is difficult to detect any effect on the outcome of the shot. (Our observations were made on Weaponeer, a marksmanship training device that provides a video replay of the shooter's aiming point during the firing process.)

Breath control. To avoid disturbing the lay of his weapon, the firer must stop breathing while he makes a shot. For moving targets and briefly exposed stationary targets, this means he must be prepared to halt his breathing at any point during the breathing cycle, not necessarily at the moment of natural respiratory pause. The need to react quickly to the appearance of a moving target cannot be overemphasized, and breath control is essential to this process.

Faulty breath control is not easy to diagnose as a shooting problem. Like most other shooting problems, it cannot be diagnosed strictly through shot group analysis, and it is largely indistinguishable from general unsteadiness when a simulator such as Weaponeer is being used. Breathing can cause shots to be missed to the left and right as well as above and below the target; in diagnosing this shooting problem, there really is no good substitute for having a trained instructor watch a shooter during the firing process.

I am convinced that soldiers can be trained to hit moving targets in a reasonable period of time and at a reasonable cost. Working in cooperation with the Infantry School, ARI recently conducted a series of experiments examining the relative effectiveness of one- and two-day moving target POIs with and without special training devices. In addition to AIM and DRY MOVER, these devices included a Superdart Location of Miss and Hit (LOMAH) system, Weaponeer II, and the Multipurpose Arcade Combat Simulator (MACS).

LOMAH technology combines the benefits of the known distance approach to marksmanship training (precise feedback on bullet location, for example) with the benefits of pop-up targetry (target detection and realism).

LOMAH systems depend on an array of detectors that sense the sonic energy generated by a supersonic projectile passing over them. The readings from the sensors then are used to calculate the exact location of the projectile in relation to the target. This location information is instantaneously fed back to the firer by way of a video screen. (More detailed information on this system appears in "Troubleshooting Rifle Marksmanship," by Seward Smith and Art Osborne, INFANTRY, July-August 1981, pages 28-34.)

Weaponeer II is a marksmanship training device that simulates the live-fire conditions of the M16A1 rifle and closely resembles the original Weaponeer. (See "The Weaponeer and Marksmanship," Joel D. Schendel, INFANTRY, January-February 1985, pages 32-35.) Like Weaponeer, Weaponeer II includes an instructor video display showing the target, the rifle's aiming point just prior to firing, and the point of simulated bullet impact. Unlike Weaponeer, the newer device includes both stationary and moving targets.

MACS was developed (and patented) by ARI in response to a need for an inexpensive, part-task weapons trainer (Figure 5). It currently consists of an optically-enhanced light pen mounted on a demilitarized weapon, a color monitor, a Commodore 64 microcomputer, and cartridge-based software. MACS was designed so that the same general hardware could be used to support dry fire training with a variety of weapon systems, including the M16A1 rifle, M203 grenade launcher,

Figure 4. 25-meter scaled simulated moving targets.

M72A2 light antiarmor weapon, and Mark 19 40mm machinegun. The light pen is simply moved from one weapon system to another and a different cartridge is inserted in the microcomputer. (MACS targets are computer-generated images.) Most of the existing MACS software was designed to support basic, advanced, and unit rifle marksmanship training and includes programs for moving target training.

Both one-day and two-day POIs proved effective in promoting soldiers' moving target marksmanship skills. The best results were obtained for soldiers who were given a two-day POI that included the use of the single-lead rule, AIM, MACS, Weaponeer II, and LOMAH. The average soldier, after completing this POI, showed a 27 percent increase in moving target hits.

The experimental POIs were compared against the current eight-hour ARM moving target POI. Although the current POI includes many good ideas for training (such as AIM and DRY MOVER), it is not as effective as the experimental POIs. The average soldier who completed the current POI showed only a nine percent increase in moving target hits.

Neither is this POI as efficient as the experimental POIs. According to our estimates, it costs about $24.30 for a soldier to complete the POI. This figure includes the costs associated with range operation and maintenance, transportation, ammunition, and salaries. In contrast, it would cost about $35.90 per soldier to complete the experimental two-day POI. This figure includes not only these same costs but also the costs of 10 MACS systems, 10 Weaponeer II systems, and a 10-lane LOMAH system. Thus, while the two-day POI costs about 50 percent more to conduct than the current eight-hour ARM moving target POI, this increased cost translates into a 300 percent increase in performance.

Many advances have been made in moving target marksmanship training, and further advances are waiting to be made. The following are some steps that may need to be considered further.

Place greater emphasis on the engagement of high-priority moving targets. The results of some of our early experiments indicate that rifle fire may be relatively ineffective against targets beyond 100 meters that have significant lateral movement. For example, in one experiment, 91 initial entry soldiers from Fort Benning, Georgia, who had just qualified with the M16A1 rifle and who had been given information on lead, fired an intensive RETS scenario that included 44 stationary targets and 22 moving targets. The stationary targets appeared at ranges between 25 and 300 meters, the moving targets at ranges between 15 and 185 meters. All of the moving targets moved at 45 degrees relative to the firer at four (185 meters only) or eight meters per second. Overall, these soldiers averaged 27 percent hits against moving targets and 37 percent hits against stationary targets. Hits against moving targets equalled 28 percent at 75 meters, 23 percent at 125 meters, and 15 percent at 185 meters.

Even when seven shooters from the Running Target Branch, U.S. Army Marksmanship Unit (AMU), fired this scenario twice (the first time for practice), the number of hits against moving targets fell off rapidly at ranges beyond 35 meters. Only half the moving targets presented at 75 meters were hit, and this number decreased to 39 percent at 125 meters and 32 percent at 185 meters.

Emphasizing the engagement of targets inside 100 meters, moving at reduced speeds (two to six meters per second) or reduced angles (0 to 45 degrees), would serve at least three purposes: First, the soldiers would become accustomed to hitting high-priority moving targets (those that posed a significant threat) instead of targets moving at greater distances, speeds, or angles (45 to 90 degrees) (Figure 6). Reducing the targets' speed or angle of movement (lateral velocity) also would provide a better balance between high performance demands and low training resources. In effect, moving target engagement would become less of an "advanced" skill. Of course, nothing would prevent imposing increased demands on firers when time and resources allowed. Finally, having targets move at different speeds and angles would lend greater variety to training and give the soldiers more experience in engaging different types of moving targets.

Emphasizing the engagement of high-priority moving targets may serve an additional purpose as well. It may help sort out the relative importance of training soldiers to hit long-range stationary targets. With the fielding of the M16A2 rifle, more consideration has been given to the need for training soldiers

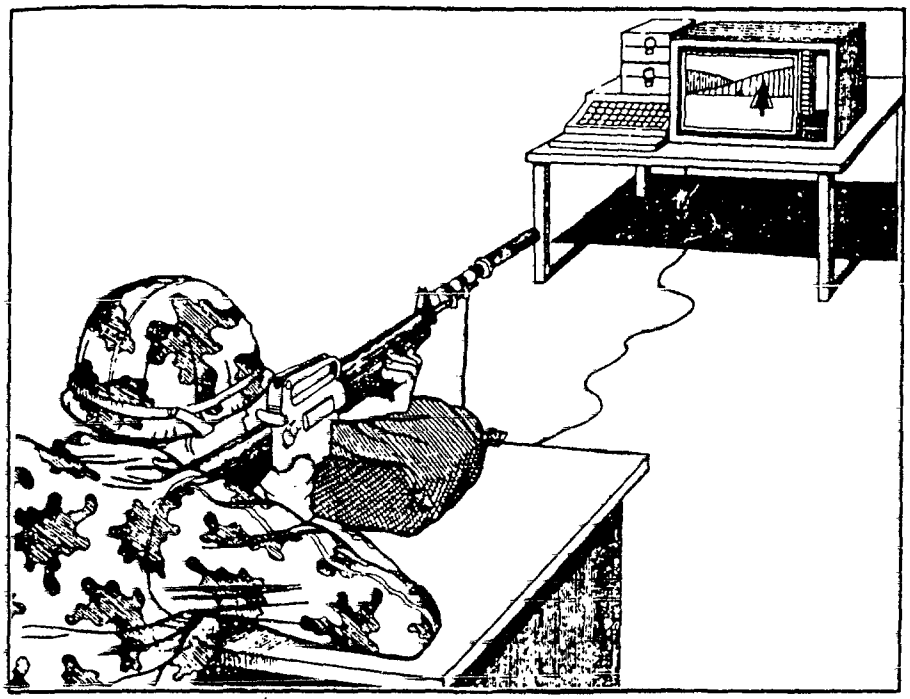

Figure 5. Multipurpose Arcade Combat Simulator (MACS) configured as an M16A1 rifle marksmanship trainer.

to hit targets at ranges greater than 300 meters. There are many practical constraints that would interfere with attempts to provide this training, not the least of which is the lack of suitable range facilities. More important, however, is deciding whether this training deserves priority over certain other types of marksmanship training, including the engagement of high-priority moving targets. Some feel it does not.

Place greater emphasis on the rapid acquisition of stationary targets. It is probably safe to assume that it costs more to conduct moving target training than to conduct stationary target training. Certainly there is no comparison between the cost of RETS moving target systems and the current stationary target systems. Given this assumption, there may be a great deal to be gained by having soldiers fire against stationary targets in preparation for shooting at moving targets.

We conducted one experiment to test the hypothesis that extending stationary target training results in better performance against moving targets. Although the data was clearly consistent with this notion, it did not lend particularly compelling support. I suspect we would have had greater success if, instead of merely having our test soldiers practice shooting at stationary targets, we had emphasized the rapid acquisition of these targets. All of our research supports the necessity for rapidly acquiring moving targets because of their limited exposure times.

Giving additional consideration to a somewhat counterintuitive notion—that some moving target training can be conducted using stationary targets—may pay benefits in terms of both reduced training costs and improved performance.

Provide more and better feedback. Feedback is probably the single most important determinant of learning. The more and the better the feedback (up to some optimal level), the faster the learning and the better the performance. Feedback is particularly important early in learning, because this is when most errors occur, and these errors can be corrected only if the learner understands where he is erring.

Providing precise shot location feedback has been a perennial problem in marksmanship training. It is difficult enough when using stationary targets. Unless special procedures (such as down-range feedback and known distance techniques) or devices (such as LOMAH) are used, firers obtain little information from target hits (when the target falls) and less information from misses (when the target does not fall). But it is worse for moving targets. Early in training, misses almost always outnumber hits, and the feedback provided by conventional methods can also be misleading. How closely a shot passed in front or in back of a target can easily be obscured by the movement of the target.

It has been suggested that tracer ammunition may be helpful in training soldiers to hit moving targets, but this hypothesis was not confirmed during recent ARI and U.S. Army Infantry Board (USAIB) testing. In any event, tracer ammunition would not be expected to compare to LOMAH technology in

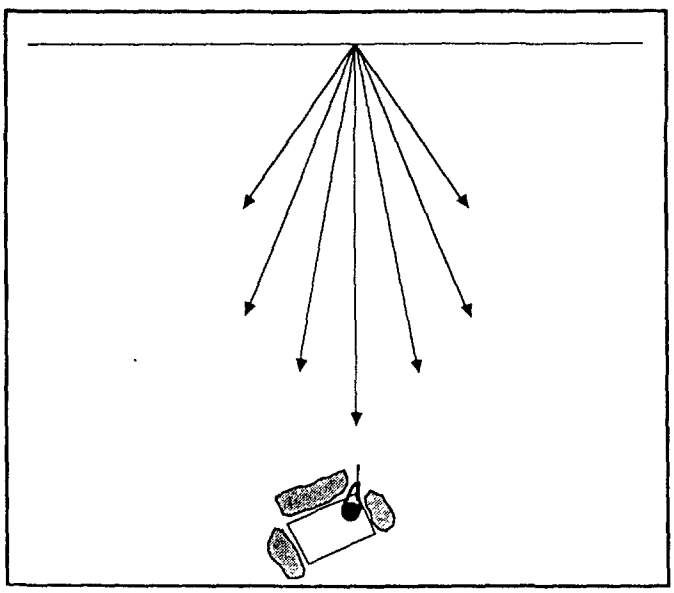

Figure 6. Moving target approaches, posing a significant threat to the firer.

terms of its training value. Using this technology, precise feedback can be provided to shooters immediately after each shot. There is no good substitute for immediate, precise feedback when it comes to getting shots on target quickly.

Improve instructor training. More and better trained instructors are needed to make sure soldiers are taught how to engage moving targets. This is particularly true for units. The observation that moving targets are more difficult to hit than stationary targets means that more soldiers will have more shooting problems than ever before. To be truly effective, instructors must be capable of diagnosing these problems and of helping solve them.

A critical concern is how to help instructors in units meet this requirement. Few soldiers who have to provide instruction can be expected to be proficient at engaging moving targets. FC 23-11 provides guidance on how to conduct moving target training, but the necessary ranges, targets, devices, and instructional materials generally are not available. A partial solution may be to develop unit training packages on moving target engagement for soldiers in Primary Leadership Development Courses (PLDC) or Basic Noncommissioned Officers Courses (BNCOC). A more complete solution may be to provide these packages to soldiers who are preparing to train on multipurpose range complexes. These ranges, which will include moving personnel targets, are planned to help units conduct threat-oriented tactical training.

Downplay the use of automatic fire against moving targets. It is frequently suggested that automatic fire is more effective than semiautomatic fire against moving targets. There is no evidence, however, to support this position. Tests conducted by USAIB and CDEC indicate that carefully aimed semiautomatic fire is more effective against moving targets than full automatic fire. A recent test conducted by ARI also showed that firing a three-round burst against a moving target is no better than engaging that target one round at a time.

Downplay the use of extended scenarios for moving target training. Since RETS targetry is programmable, it is possible to run intensive, threat-oriented scenarios that include both stationary and moving targets. Although these scenarios can be useful for evaluation purposes, they offer little in terms of marksmanship training value. Whether a soldier misses a target or hits it, he has no time to think about what he did wrong or right; he can only prepare to fire at the next one. If learning is to occur, feedback must be provided, and the learner must have some minimum amount of time to relate what he was trying to do to what actually happened.

A second problem is coaching during a scenario. How can an instructor interact effectively with a shooter? If he waits until the scenario has ended, the feedback is delayed. If he provides feedback as the shooter engages targets, he must compete with the scenario for the shooter's attention. It would appear far better to let soldiers engage moving targets one at a time, coach them, give them precise feedback, and let them think about the results of each shot.

Establish valid performance standards. One of the greatest impediments to a total solution in this area is the lack of valid performance standards for moving target engagement. Understandably, there are good reasons for not requiring all soldiers to qualify annually against moving targets, but it seems essential to require some minimum number of moving target hits for soldiers completing ARM training. (Note that this is *moving* target hits, not a cumulative total of moving plus stationary target hits.)

There are at least two reasons for this recommendation. First, performance standards give soldiers an added incentive to train hard. Second, and perhaps more important, performance standards facilitate the training development process, acting as a driver in the development and implementation of needed training improvements. As an illustration, training devices such as LOMAH, MACS, and Weaponeer II are important for marksmanship training and critical for moving target marksmanship training. In the absence of recognized moving target marksmanship standards, however, there is little justification for buying the additional devices needed to support moving target marksmanship training. Valid performance standards can be established in this area. Only in this way can we be assured that soldiers' moving target marksmanship skills are all that they can be.

Joel D. Schendel was a research psychologist with the U.S. Army Research Institute for the Behavioral and Social Sciences. He served with the Institute's Fort Benning Field Unit from 1980 to early 1987. He holds a doctorate from the University of Illinois.