SMALL ARMS TARGETS AND TARGET SCORING

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INTRODUCTION

The major emphasis in the development of scoring systems by the military sciences is in the missile field where air-to-air miss distance indications are required. Very little attention has been given to the scoring of small arms projectiles. Yet, innovations in firing range training, targets and scoring methods for small arms have been of major concern to the Naval Training Device Center. Much effort has been expended in the development of more sophisticated systems.

The training received by the individual soldier is critical, and is the backbone of any military situation. The confidence a soldier has in himself makes a confident army; his ability to handle his weapon makes him a fighting man. Confidence and skill are obtained in the target training he undergoes on the firing range. Like a craftsman who learns to handle his tools by working with them, the trainee should not merely hold and synthetically fire his weapon, but actually fire it on a range against a good target.

It is the military training agencies' duty to furnish the trainee with the equipment and training he needs to win in any situation, yet he has not received optimum training. We have not produced the ideal small arms scoring system. The techniques we have produced have been only partially successful.

In order to produce this ideal target and target scoring system for small arms, much more effort must be expended to furnish an indestructible nonmaterial target; a scoring system with the ability to register the exact location of a projectile whether it hits or misses the target; a scoring system having no solid material in the projectile path; a scoring system of low cost, and a scoring system which eliminates the requirement for specialized maintenance and scoring personnel.

The Naval Training Device Center maintains a small arms research group and necessary firing range equipment in the Visual Simulation Laboratory where development and testing of new devices leading to ideal targets and target scoring systems are conducted.

DISCUSSION

The approach to target scoring systems has taken many avenues. In 1909, an electrical method was developed in Hungary. The system consisted of two plates, the back plate being made of stout sheet iron and the front plate, being made of flexible shot-proof material. These target plates were interlaced with wire. When a projectile hit the target it completed the circuit near the projectile by forcing the wire against the back plate; however, the formidable problem of ricochets was not considered.

Light scoring systems have shown good possibilities. LASERS can be used for scoring; however, their cost, maintenance and danger keep them out of small arms scoring at the present time. An approach that has been used successfully utilizes ultraviolet light at a frequency of 253.7 millimicrons. As the projectile passes through the illuminated area, a certain amount of light is reflected back to the sensor. The quantity of the reflected light depends on the reflectivity of the projectile surface and the amount of light that is collected by the image lens.

The selection of a light source sufficiently removed from the spectrum of the sun is essential and a filter is required to cut out the rays of the sun from the receiver. The spectrum output of the sun effectively starts at 300 millimicrons. In an attempt to bypass the sun's interference, a U-V optical filter covering the photomultiplier tube permits only light of 253.7 millimicrons to pass. A mask is inserted between the filter and the photomultiplier tube having a small slit and a larger slit perpendicular to the path of the projectile. This permits coding of the projectile location by giving one pulse on the edge and two pulses if light is reflected through the center. These masks could be designed in a more complex manner, thereby designating the position of the projectile with greater accuracy. Work in this area has been conducted by Nuclear Research Associates under contract to the Naval Training Device Center.

Television systems are straight forward. The television camera can be placed near the target and the results displayed on a remote monitor. Another feasible television approach utilizes the high scan rate of the TV camera to detect any change in the viewed target. Systems of this type are used for intrusion devices. Television as a scoring method is still expensive and maintenance in the field is a problem.

Scoring by acoustical means is a much used method especially in air-to-air and air-to-ground gunnery. Many systems have been designed for small arms. Sensors used have been anything from a phonograph cartridge, including the needle, to vibrating rods; microphones used range in cost from one dollar to many hundreds. This broad range is permissible as nearly any acoustic frequency band can be used. The most useful information is obtained by using the sonic boom set up by a projectile with a velocity greater than 1080 feet per second. Most small arms projectiles travel at least this fast at a range of 300 yards. The bow wave falls off the projectile at 90 degrees for Mach 1, about 30 degrees for Mach 2, and about 20 degrees for Mach 3. The spread of the wavefront takes place at the speed of sound and at right angles to the frontal surface of the bow wave layer. The amplitude of the wave depends on the projectile shape, speed, atmospheric pressure and distance. There is an inherent ten per cent error in mill distance and boundary zones. This is, in most part, due to the individual differences in rounds. However, by knowing the projectile and expected speed, the error can be greatly reduced. An acoustic system developed by Del Mar is utilized in Device 3H18A, B and C used at Pinecastle, Florida, and Fallon, Nevada.

The Doppler radar is an effective technique which has been used for air-to-air and air-to-ground gunnery. A system developed by Sanders Associates is now being evaluated at Eglin Air Force Base, Florida. The radar sensors are positioned near the nulls of the radar antenna pattern. The scoring is done at an operational frequency of 9.4 GHz. The magnatron four watt output is gated at a rate of 4 MHz to form ten nanosecond pulses. These pulses go out, reflect off the projectile, and return to the transmitter before the next pulse is sent out. A parabolic reflector one foot in diameter sends out a five degree beam. By monitoring the Doppler shift, projectile velocity can be measured and effectively eliminate ricochet. Fifteen thousand rounds per minute can be scored in this manner.

These and other less successful systems have been tried. All have fallen short of the true ideal target scoring system. The major problem encountered in the developement of small arms scoring devices is producing a low cost system that will score the exact location of the projectile from a remote position so that the projectile will not hit the sensors.

In conjunction with the problem of sensors is the problem of constructing a target. A requirement still exists for an indestructible target. Tests have been conducted using a water spout with an image projected on it; however, operating with water spouts is messy. What is needed is a ghost image in space. So far, the closest we have come to an indestructible target is a polyethylene target that has been developed and tested under the control of the Naval Training Device Center. This target can take 2,000 to 3,000 rounds and is reasonable in price. A quarter of a million of these targets are in the production stage at this time. In the manufacture of targets, different companies will produce targets with different responses even though the same specifications are used. Small differences in the hardness of the target make a significant effect in transferring the energy from the bullet to the target. The energy absorption characteristics of the targets are noticeable when a BB gun gets 100% response from the target while an M-16 rifle gets only 82%. The BB, not penetrating the target transfers nearly 100% of its energy down the target into the sensors while the M-16 passes through the target without losing much energy.

The Naval Training Device Center is developing a new small arms projectile device which may establish new requirements for target and target scoring systems. This device is a safe bullet - the M-16 training pellet. This may provide greater flexibility in the training of combat troops. Presently it has a range of 200 feet with a mean radius accuracy of 7 inches, and will actuate the pop-up mechanism with every hit. Eventually, it would permit the trainees to go into the training field and fire at a moving target - another trainee who is firing back. Along with the development of a light weight, slow speed bullet, a certain amount of body shielding must be provided for the vulnerable parts of the body. If noncasualty projectiles can be developed to act in the same manner as the steel projectiles, new and unique targets and scoring systems may be forthcoming.

CONCLUSION

Many areas have been investigated to produce an economic small arms scoring system. Nearly every field of science has been applied without complete success. It is within the state of the art to produce a successful economic, ideal scoring system. This could be done within a year. It is left for some group to take on the problem and do it.

THE OCULOMETER: A NEW INSTRUMENT FOR MEASUREMENT AND CONTROL

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INTRODUCTION

In the normal act of vision, the eyeball is pointed very accurately and rapidly at the target detail being scanned (typical accuracy 0.1 degree, typical speed 0.2 second). Target acquisition, tracking, designation, etc., could, in many cases, be performed, therefore, much better by eye than by hand - if a practical eye direction measuring device were available. The eye pointing action that would be utilized is not an "extra task" that the operator must consciously perform but is performed naturally, in normal vision, without any conscious effect involved.