From the Boresight Line: Correlating Proficiency and Lethality in the Stryker Brigade Combat Team

by SFC Zack D. Eckert

Soldiers who have spent time in a Stryker brigade combat team (SBCT) after previously serving in an armored brigade combat team (ABCT) will often find themselves in a strange environment when the topic of gunnery and live-fire comes up. For instance, the drastic distinction between the definitions of "crew" is a prime example.

Tank crewmembers are often situated on a given tank for extended periods of time. The tank commander, once a young sergeant, now commands the tank using the same driver and loader, both of whom have also been promoted in rank and position. The lieutenant, leading the tank platoon, is the person most likely to transition out of the platoon.

Conversely, the SBCT often relies on one Soldier to serve as both the vehicle commander and the gunner. The proficiency of the crew is sufficient only to qualify once and then serve as the supporting asset for tactical operations. Since this crewmember is slated against dismounted positions, it is vital for career progression for him/her to be rotated from the gunner position to gain critical leadership time on the ground as a team or squad leader.

This turnover often has a significant impact on the SBCT. Specifically speaking, platform proficiency remains at the lowest level of requirements inside the infantry battalions due to the lack of visibility, quality assurance and emphasis on platform lethality. This discussion intends to help remedy this problem by informing SBCT leaders about recommended methods to develop quality gunners for their formations.

Variables

The following analysis comes from the information gleaned by scouring evaluation packages for live-fire events conducted from 2017 to 2019.[1] While not an empirical study, the information provides enough anecdotal evidence to support the thrust of this article. All variables listed here are pertinent factors in a crewmember's ability to effectively engage targets from the firing platform.

The inclusive list is an essential part of determining the maximum engagement limit of each platform and each echelon when aggregate data is applied.

Probability of hit

Probability of hit (Ph) is a key factor in crew gunnery. Ph is factored by the number of rounds fired against a target in relation to the number of rounds striking the given target.[2] For this assessment, two factors take precedence: range-to-target and firing-vehicle posture.

As the range to a target increases, the muzzle velocity drops and dispersion increases, thereby reducing the likelihood for a round to fly true. Determining the appropriate range-to-target is an essential factor for target acquisition, especially for non-stabilized weapon systems. Also, firing on the move decreases a weapon's accuracy.

Given these factors, the most effective shot would be a short-range static engagement from a defensive position. Also, effective target acquisition and ammunition selection positively influence a gunner's effectiveness. To increase effective target acquisition, gunners should follow three basic rules:

- **End gunner lay in elevation.** Once the left and right limits have been established, releasing the handles either manually or electronically will cause the bore to settle at the last second. To reduce this possibility, a gunner ends with an upward adjustment to ensure the reticle and bore stay on the intended mark.
- **Aim center visible mass.** To guarantee a target is hit based on exposure, avoid guesswork. What is presented and visible is the target to aim for.

- **Remember sight picture and trigger squeeze.** A weapon is only as effective as the operator, so setting this final condition ensures that when the weapon cycles through and functions, all potential loss of accuracy has been mitigated.

Finally, improper ammunition selection can dramatically affect the ballistic firing solution for an intended target, causing the round to hit wildly off-target. For example, on a dual-feed weapon such as the M242 25mm Bushmaster, the last round on the face of the bolt is projected to follow the current ballistic solution and cannot be discarded easily. This creates a requirement during Bradley gunnery to allow the firing of a “dump round” when transitioning from anti-phosphorus to high-explosive (HE) munitions. For the tank, incorrectly indexing the round results in sabots going extremely high of the target, whereas an HE anti-tank fired with sabot indexed results in the round falling well short of the target.

In either case, “switchology” is a fundamental task for gunners and important in effective crew communication during a firing engagement.

Figure 1. A Stryker Mobile Gun System engages an armored target. (*U.S. Army photo by SFC Ben Johnson)*

Probability of detection

With the advancement of sensor technology, the likelihood of detecting active targets has become increasingly more lucrative. Target detection remains a significant factor in the engagement process, as it reduces the exposure of the firing vehicle prior to issuing a fire command and engaging. Common detection systems include the Forward-Looking Infrared, PAS-13 thermal sight and the Long-Range Advanced Scout Surveillance System. These systems are designed to detect thermal signatures with a common performance measure rating out to no less than 2,500 meters.

That being said, utilization rates and practice indicate that sensors are not being implemented into training programs to increase the outcome of detection. Commanders should ensure that gunners understand appropriate scanning techniques using the associated detection sensor and that they can rapidly distinguish battlefield debris from targets in addition to recognizing the presence of camouflage, concealment and decoys (CCD). Environmental hazards such as rain, snow, dust and smoke further complicate target detection. Gunners must be exposed to these elements during training to increase their comfort in challenging target-detection environments, with the goal being to maximize their proficiency.

Common training methods for this include acquisition drills and counter-CCD. Acquisition drills ensure that for each engagement and for each position, the gunner has determined his ability to “see” targets, traversing from the left range limit and transitioning from wide field of view (WFoV) to narrow field of view. If equipped with a laser range finder (LRF), the gunner should be able to lase a target and obtain an accurate return. Once complete, the gunner returns to WFoV, rapidly traversing the sector to the right range limit and repeating the procedure.

Counter-CCD is an element that can be taught in a classroom environment and given practical experience in a simulator. Gunners should be aware of how to determine which irregularities in their field of view may act as indicators of a target attempting deception and camouflage.

Finally, the detection system should be maintained regularly to ensure it meets the expected technical specifications by performing drift null, boresight or alignment. However, since each of these systems will still be subject to shock, gravity and static buildup over time, firers should be prepared to conduct a sensor reset as frequently as the tactical situation permits.

Reliability of targeting system

Fire-control systems (FCSs) vary by platform, but all follow an inherent series of principles in which to compute ballistic solutions and increase the probability of a first-round hit. Some sensor systems determine whether or not the gun trunnion is perfectly level with the horizon (cant), thereby removing one source of gunner error. The vehicle's ability to compute movement through the use of an inertial navigation unit will update ballistic solutions to add or remove drift.

Vehicles with a height-management system can make adjustments to provide a greater field of view or reduce exposure. With the implementation of an integrated LRF, the vehicle then uses the computer inside the FCS to factor the following: vehicle status, range to target and weapon/ammunition inputs. It computes these factors to make corrections to the reticle and bore, applying adjustments as necessary to conduct the engagement.

While the platform and weapons may vary, these three factors remain the same. Training conducted to enhance targeting effectiveness relies on the use of training aids, devices, simulators and simulations (TADSS) to gain a technical appreciation for the related systems. Crewmembers familiar with the targeting process are more likely to avoid incorrect inputs.

Also, while systems are designed to communicate with each other, not all circumstances will grant the ability to use a fully functional FCS. In those events, crewmembers must be trained and proficient in degraded operations. For example, a targeting system with an ineffective LRF can still be used with the manual input of an accurate range to target, but only if the crewmember has been trained to determine range accurately.

Reliability of weapon

Not all weapon systems are created equal. Also, not all platforms are equally functional. Therefore it is important for commanders to conduct an analysis of the equipment provided to determine whether the gunner or the equipment is the problem.

For example, two brand-new M2A1 .50-caliber machineguns are assigned to a section with unstabilized MK-93 mounts. Both mounts have a traverse and elevation mechanism assigned, and both gunners have engaged the same target from identical platforms. Gunner 1 has placed 75 percent of his rounds within a 12-inch circle at 500 meters. Gunner 2 has only placed 30 percent in the same area.

What caused such a dramatic drop in performance? While the fastest answer is usually that Gunner 2 is simply not as good as Gunner 1, it was determined that his mount had been in circulation for 10 years, while Gunner 1 was using a brand-new gun mount.

Two key elements play into the dependability of the mount and weapon system: circular error probable (CEP) and dispersion radius. When determining CEP, a control should be established with assigned equipment to determine the level of accuracy, regardless of the gunner. CEP is a measure of the weapon system's precision, so determining these results does require the use of controlled execution. As a crewmember assigned to a specific platform and associated equipment, each gunner implements the same conditions and records the results.

Fifty percent of the rounds falling within the expected tolerance for the weapon system for a given range (in this scenario, 500 meters) create the mean point of impact.[3] For 100 rounds, the remaining 50 rounds become the average impact point.

Determining the effectiveness of the weapon system – the weapon paired with the mount and platform – relies on the individual platform in comparison to the rest of the commander's fleet.

Secondly, dispersion determines the ability to consistently place rounds in the same place, shot after shot. When planning this control, the first step is to determine an appropriate target. For the baseline experiment, a target placed at 500 meters from the gun target line will produce the desired result. For stabilized firing platforms, the expected dispersion is two degrees left or right of the mean point of impact, or center of the target, based on single-shot or automatic modes of fire.

For unstabilized platforms, the intended dispersion angle is five degrees. Using the same control principles as before, each platform uses its organic equipment to validate the information and records it for consolidation. Since the dispersion area accounts for multiple variables – human error, gun or cannon tube wear, propellant temperature and type of munition fired – the emphasis lies on replicating the exact conditions for all tests.

Finally, the reliability of a platform with an FCS requires the implementation of a muzzle reference system update that accounts for excessive firing and gun tube droop. While a smaller-caliber weapon may not be subject to gravity, it will require a change of barrel or reticle reset to retain accuracy.

Probability of a kill given a hit

To determine a platform's true lethality, synthesize the previously mentioned factors through the application of a formula that amalgamates all probabilities into a singular result. For this, determine that the ammunition selected is appropriate to meet a kill standard for a given threat. Then convert the data from percentage to decimal, then back to percentage for the result.

The probability a of kill (Pk) equals probability of hit (Ph) times probability of detection (Pd) times reliability of targeting system (Rsys) times reliability of weapon (Rw), or Pk = Ph x Pd x Rsys x Rw. For example, if a missile operates properly 90 percent of the time (assuming a good shot), the targeting system operates properly 85 percent of the time and enemy targets are detected at 50 percent, then our Pk estimation is Pk = 0.9 x 0.5 x 0.85 x 0.90 = 0.344 = 34 percent Pk.

Application

Commanders tend to assume each firing platform is equal. While this prediction satisfies the engagement criteria for a templated, untrained adversary, the results from execution lean toward the inability of the crews to operate at the expected threshold, thereby affecting the results. When an analysis of all factors are applied, units can better determine the strengths and weaknesses of platform firers at echelon and cross-organize their assets to achieve realistic effects. If the unit performs better under ideal weather and time conditions, give the crews a more offensive-oriented threat package to elevate training. If crews cannot qualify the minimum standard, they should be allocated with a supporting platform (wingman) to ensure the objectives have been met on the battlefield.

Table 1 gives an example of the information.[4]

BMP No.	Weapon system	Gunnery Table VI score (Ph)	Detection average (Pd)	Rws target system operational (Rsys)	Reliability of weapon (Rw)	Pk
B11	M2A1	825 (.83)	.87	.85	1	61%
B12	M2A1	850 (.85)	.9	.85	1	65%
B13	MK19	765 (.77)	.7	.85	.65	30%
B14	MK19	798 (.80)	.7	.85	.85	40%
B15	M2A1	925 (.93)	.9	.85	.9	64%
B16	M2A1	816 (.82)	.8	.85	.9	50%
A SEC AVG		820 (.82)	.76	.85	.88	47%
B SEC AVG		830 (.83)	.6	.85	.88	37%
PLT AVG		825 (.83)	.68	.85	.88	42%

Table 1.

The scenario depicted includes the execution of three degraded tasks of the 10 steps conducted during Table VI. More information can be collected from the evaluation and consolidation of the qualification packets: Pk for offensive or defensive engagements only, Pk for day or night engagements only and average Pk based on range to target and target posture.

Training development, management

Key elements play a part in the ability to gauge proficiency on this level. Commander involvement is a must to ensure the controlled tests are conducted to a standard that collects appropriate data prior to the execution of gunnery. If issues can be addressed, the information collected at qualification Table VI will prove an accurate assessment of proficiency.

Also, the implementation of quality-assurance practices enhance the program's feasibility and maximizes resources, both TADSS and live-fire ammunition. The team used for this should be qualified to operate as both vehicle-crew evaluators and range safety officer for events, increasing the exposure and ensuring that expectations are met.

Moving beyond the Tier 3 crew strategy, more evaluators should be integrated into the process for data collection and integration. The battalion-level staff should seek the guidance of the master gunner to facilitate the preparation of live-fire events as well as using their knowledge to inform crew members of the requirements. Crew members assigned to a firing platform should be stabilized to validate their performance on the platform, providing commanders a baseline for increasing proficiency through repetition. Finally, sergeants' time training conducted at the company level should be aligned with weapons proficiency for the crew members to reinforce the practical application of gunnery skills.

Conclusion

When the SBCT brings its guns to the fight, crew members should remain actively employed to support the operation from their platform. If commanders can reinforce the need for direct-fire support, the result is more lethal support-by-fire elements from positions of relative advantage. Crew members who have been trained to deploy, fight and win from their firing platform bring the ability to retain the initiative against a near-peer threat and maintain the support needs of the dismounted infantry. What the SBCT lacks in firepower, it compensates for in manpower, and as the Army continues to develop new platforms to increase the effectiveness of these platforms, crew mentality needs to develop into a culture of "fighting from the hatch" to preserve the freedom to maneuver against an ever-evolving threat.

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Notes

[1] III Corps lethality report on the state of the ABCT direct-fire weapon systems (M1 Abrams and M2 Bradley family of vehicles), Sept. 20, 2019.

[2] Donald E. Carlucci and Sydney S. Davidson, ***Ballistics Theory and Design of Guns and Ammunition***, Boca Raton, FL, London and New York: CRC Press, Taylor and Francis Group, 2007.

[3] William Hackborn, "The Science of Ballistics: Mathematics Serving the Dark Side," Canadian Society for the History and Philosophy of Mathematics, 2006 annual meeting, York University, Toronto, Canada; https://www.researchgate.net/publication/319459791.

[4] Technical Report 2013-56, ***Probability of Hit and Kill Simulation User/Analyst Manual***, Army Materiel Systems Analysis Activity, September 2013; https://www.dac.ccdc.army.mil/TopMS.html.

Acronym Quick-Scan

ABCT – armored brigade combat team
CCD – camouflage, concealment and decoys
CEP – circular error probable
FCS – fire-control system
HE – high explosive
LRF – laser range finder
Pd – probability of detection
Ph – probability of hit
Pk – probability a of kill
Pkh – Probability of a kill given a hit
Rsys – reliability of targeting system
Rw – reliability of weapon
SBCT – Stryker brigade combat team
TADSS – training aids, devices, simulators and simulations
TVI – crew Table VI, qualification
WFoV – wide field of view