The Growing Vacuum of Today's Live-Fire Ranges and their Future Requirements

by 1SG(R) Frank Belonus

Militaries and law-enforcement agencies of the world continue to adapt their training based on lessons-learned, emerging tactics, techniques and procedures, and emerging technology and capabilities. For many, live-fire is the pinnacle of training realism, validation and qualification, yet there is a growing vacuum in live-fire facilities' infrastructure and capabilities when it comes to meeting these organizations' near-future requirements.

Today's live-fire ranges have not conceptually changed much in the last 50 years. The ranges lack true flexibility and adaptability, and they are limited in the overall scope of what can be trained on them.

With that in mind, the future of live-fire ranges may be something completely different than what is seen today. Imagine projected imagery that reflects different environments:

- Targets may be realistic, three-dimensional holographic images that accurately reflect the threats of today, moving and acting like an actual foe.
- These type of targets are capable of being engaged through simulations such as lasers that are already integrated into the latest platforms and weapon systems being used, or engaged with actual munitions in live-fire.
- The targets are infused with realistic signatures and sensor-triggering capabilities for further realism.
- Targets may be maneuvered against Soldiers and may return fire.
- Unseen hit indicators cause immediate, realistic effects on targets and provide instantaneous feedback during training, and from multiple perspectives for future review.

All this done on terrain that allows freedom of maneuver with very few restrictions, allowing 360-degree engagements.

But the reality is that there is an evolutional requirement needed today to bridge the "now" and these future concepts. The current and near-future requirements are what will drive the initial evolutional change as well as the true modernization required in training and life-fire ranges until technology evolves to meet the future described.

Mindset must change

The first approach to filling the vacuum in live-fire ranges to meet future requirements is mindset. It is what allows us to see beyond the traditional to what ***could be*** and what ***will be*** required based on emerging technology, future-force capability, future threats and environments. In other words, we must start working today for what will be needed beyond tomorrow and not just focus on fulfilling today's needs at today's standards.

Parallel evolution and collaboration between customer and industry is required. This means a customer conveys a clear vision of future platforms, capabilities and training requirements, coupled with an understanding of emerging technology, industry direction and advancements. This results in an educated industry that understands future-force concepts and capabilities. It allows industry to shape its tactical employment through experience, knowledge-sharing and a shared vision.

A shared vision allows an industry to pull the latest technology from various sectors and disciplines, be it robotics, simulations, sensors, digitization, optics, communications, ballistics, metals and alloys. This is a natural part of change management and evolution for any company that strives to remain relevant through innovation, but the customer plays a key role in driving innovation in the right direction and in mitigating the industry's response time to fill needs requirements.

Research-and-development investment is required from both industry and the customer in future training and live-fire ranges if the customer wants to remain globally dominant. Technology provides the advantage, but being capable and effective in using that technology allows the customer to be dominant. Training and live-fire produces and validates that needed capability, and that will never change.

Simulations are invaluable tools that greatly enhance training, but they will never replace the need for actual live-fire. It still is crucial that Soldiers manipulate their actual equipment – be it personal equipment and weapon, or complex combined-arms fires, or everything in between.

Driving future requirements

There are many factors driving future requirements of live-fire ranges. Those factors include urbanization, an individual's flexibility and adaptability, technology, ability to implement and adapt lessons-learned, realism, better training automation and management, and enhanced training feedback.

Urbanization. According to a United Nations report, 55 percent of the world's population already lives in urban areas, and this is expected to rise to nearly 70 percent by 2050. Today the highest urban-populated regions include North America at 82 percent, Latin America and the Caribbean at 81 percent, and Europe at 74 percent. As the world's population continues to migrate toward cities, threat forces continue to mitigate advanced military capabilities and technology by forcing the fight into this complex terrain. Therefore it's crucial to understand this multi-dimensional terrain, and how to operate and survive in it is more critical than ever.

(This is not to say there is no longer a need for conventional, open-terrain capability and training because today's military forces need to be able to transition through the full spectrum of operations in various types of environments. Complex terrain such as urban and subterranean environments have become the norm for militaries, both in direct and supporting roles.)

Recent urban combat has shown that being engaged from multiple threats in windows and on rooftops at close range is common. Lessons-learned have also shown that engagements in complex terrain are fluid, with both the shooter and threat forces often moving while engaging or being engaged. Technology and capability are often diminished in this environment.

With that said, the ability to engage at extended ranges is still required in cities, though the terrain may be severely restrictive. Survivability is still increased through stand-off and accuracy superiority at range, but potential threats from a multi-dimensional domain at close range also threaten survivability in this terrain. Issues in command and control, maneuverability, communications and fires control are all further challenged in this environment.

Therefore adaptive, tailored training and live-fire ranges are needed to ensure a ready force in this world of urbanization. Unfortunately, most modern urban training and live-fire facilities lack the density and realism to prepare Soldiers for what they face worldwide today and will face in the future.

Flexibility and adaptability. Militaries and law-enforcement agencies around the world focus on developing agile and adaptive individuals who can think on their feet and make decisions rapidly. These individuals are constantly evolving forces integrated with the latest in technology and capability. They must adapt constantly to various threats, their capabilities and to ever-changing environments. Their ability to adapt is honed in training. This means training facilities and ranges must be just as adaptive and flexible to meet training requirements.

Technology. The evolution of technology continues to move forward at a blinding pace. It is allowing us to see more, shoot farther and do more with less. Unmanned systems on land, sea and air are already a reality. The near future will have manned and unmanned systems interconnected and working in unison. Advancements in conductivity will allow unique combined-arms engagements as well. Air and ground forces will become more effective and lethal. Automation and artificial intelligence will continue to evolve and make great changes in capability and in how things are done.

All these things will continue to change strategy, operations and tactics from the highest to the lowest levels. The constant is that training will inevitably require a complete overhaul to support the new way of doing things. Live-fire ranges will need to adapt to this new norm and to the integration of emerging technologies and capabilities.

Niche technology focused on equalizing the battlefield and exploiting weaknesses will continue to be a threat, and it will be unpredictable. Improvised explosive devices (IEDs) have proved effective against even the most formidable advanced militaries of the world. Drones and weaponized drones have also proved effective to some extent. Niche technology and the countermeasures implemented affect operations and tactics, changing how we

do things. Therefore, training and live-fire ranges will require rapid adaptation to address niche technology and its effects.

Evolutions in simulations and augmented/virtual reality will soon be integrated into existing and future platforms and systems. With the flip of a switch, you'll be able to enter a virtual world from within your actual tank or from any other system or platform. Laser-engagement systems will also be integrated, eliminating the time-consuming process of mounting and removing current laser-engagement systems. Training facilities and ranges need to also evolve to support this evolution in technology, and they must be able to bridge the virtual and live training worlds.

Lessons-learned. A military's ability to rapidly collect, implement and adapt to lessons-learned and best practices will greatly affect its survivability and success. At a lower level, situational training with recently learned lessons, and the exercising of new battle drills based on capability and lessons learned, makes an enormous difference.

One example of this in recent operations was the use of IEDs for shaping operations. The IED would disable or destroy a vehicle in a kill zone and block a route, which would then trigger an ambush of those in the kill zone and those blocked on the route. Battle drills were developed to counter this, but training and live-fire ranges still need to support this and other types of training requirements driven by lessons-learned.

Realism. Greater realism equates to better training and better-prepared militaries and law-enforcement agencies. Realism is the cornerstone to quality training, but it goes far beyond that. Realism exercises those things we often do not think about like "switchology," which is the ability to manipulate switches and dials without having to search for them – or even to look at them, in some cases. Realistic training conditions the mind to know what right looks like – for example, vehicle identification or even thermal-signature identification. This becomes significantly important in preventing fratricide, for instance.

Realism also becomes quite important when training to maximize the capability of the technology used. For instance, an unmanned platform with sensors will require cues to integrate its capability into training properly. Realism may include realistic movement and exposure from the threat. Realism also tests survivability drills and countermeasures properly, such as the reaction to incoming direct and indirect fires and effects like the reaction to anti-tank guided missile (ATGM) drones or lasers. Realistic training also means mitigating predictability. The threats of the world are unpredictable and capitalize on your predictability.

Better training automation and management. Automated software should be integrated with targets, cues and operators on live-fire ranges to randomly adjust scenarios by crew or shooter based on inputted engagement requirements. This will mitigate false conditioning and predictability. It will also streamline the process, allowing increased throughput.

Enhanced training feedback. Audio, visual and sensor-aided feedback greatly enhances learning and understanding. With that said, capability improvement is still needed when providing feedback and conducting after-action reviews (AARs). Evolving technology, data-collection tools and interoperability, coupled with trainers and subject-matter experts who know how to maximize these tools, will greatly enhance training feedback and the learning curve.

Live-fire range considerations

Technology is also affecting those in the live-fire-range industry as well. Evolving improvements in materials, manufacturing, capabilities, interoperability and realism continue to improve live-fire quality.

Mindset. Live-fire ranges are purpose-built. They serve a specific or limited set of purposes such as a qualification range. They are built with engagement criteria such as distance and type of target in mind. There needs to be a shift in mindset, though; we need to view them with a different perspective. They will always be needed to validate basic marksmanship, but ranges should be more adaptive and inclusive of training needs. Ranges should support live-fire rehearsals of today's battle drills – whether it be offensive armor attack in a wedge formation, react to IED-initiated ambush, incoming ATGM or sniper attack.

This will require different target configurations, range capability and maneuver space. Combat is multi-dimensional, especially in an urban environment. Live-fire over flat terrain, always at ground level and looking in

one direction with limited left and right limits does not constitute properly training and conditioning forces so they are prepared for what they may face in the future.

Variable scenario generator, management. Range-management software can be developed and tailored to a specific range to manage scenario development and range execution. This software knows all the variables in targets, ranges, safety requirements and scenario requirements. It can produce multiple scenarios based on the parameters entered, then randomly select them for each exercise.

For example, a tank crew conducting Table VIII qualification exercises has specific types of engagements they are required to exercise. The range-management system will develop several scenarios to meet these requirements based on targets available, range requirements and safety requirements. Then, as each tank crew conducts Table VIII, they will face one of these scenarios the system randomly selects. This prevents crews gaming the range and the same scenario from being used over and over. The versatility also allows greater distribution of target use, increasing target longevity.

Another benefit of the software is that it allows input to remove certain targets as they malfunction or become unusable from impact damage. Then the software adjusts to scenarios that do not use the specified targets. This reduces training down-time for maintenance.

The range-management system should be integrated with target-activating range sensors, hit indicators, timing/scoring software and other monitoring systems such as audio and video. Collectively this will provide proper feedback and validate results. This is all then integrated into an AAR suite that provides integrated, high-quality feedback. This feedback will allow input beyond traditional hit/no hit through maximizing technology, identifying reasons for poor performance as well. This facilitates automatic scoring with minimal interaction required from evaluators/scorers.

Autonomous targets. Integration of autonomous, robotic targets are still in its infancy but has great future potential. These targets provide greater range flexibility, add realism and mitigate some infrastructure needs. In turn, they decrease maneuverability restrictions, which increases their cost-effectiveness.

Autonomous targets will inevitably replicate any type of target. They will be easily integrated into existing ranges and interoperate with existing conventional targets. The autonomous targets will therefore integrate into the range-management system. They will also be facilitated into more creative live-fire training events such as a suicide car bomb or a vehicle approaching a checkpoint.

Pre-programmed routes can replicate threat and civilian movements. For example, an input command can cause different reactions such as all the civilian targets running for cover.

Inputted commands can also direct targets already engaged and “down” to either move out of play and out of the way, or to move to a designated point to be reconstituted and put back into play. They can also be used to work in tandem with traditional targets to reflect realistic actions – such as human targets dismounting from a vehicle to attack or provide cover.

Integrated simulations and live-fire capabilities. Technology is near the point where targets will soon accurately register hits from both simulated engagements and actual engagements without having to transition the range to support one form or the other of training. This will likely be accomplished through an evolution in hit sensors, all integrated into each target lifter. This advance – combined with lightweight, mobile target packages – will allow greater flexibility in training and training environments. The need for mutually supporting range, range-management system and infrastructure is inevitable as future platforms will likely have these types of simulations capabilities integrated into them.

Greater target realism. Realistic training requires realistic targets. To achieve the desired realism, potentially cost-effective three-dimensional imagery could be used on larger targets. This may also include electronic or holographic imagery when units are integrating sensors and combat multipliers such as unmanned aerial vehicles. These may be remotely projected with hit-indicating technology, allowing air and ground use, thus enhancing air/ground live-fire coordination and capability. This would also be integrated into the range-management system. Greater realism also includes proper signatures during day, night and movement. Enhanced battlefield effects also need to be improved.

For example, the “return fire” effects, when used, could be puffs of smoke to help identify targets. Small-arms night-fire ranges could have muzzle flashes. Threat-vehicle targets could better replicate return fire, and they could be networked into the vehicle-integrated simulations software to replicate effects in sight systems.

Realistic thermal signatures. Current systems simply provide “hot spots” on larger targets. However, thermal signatures should closely replicate what the target is, providing realistic training and proper conditioning. Simulated human targets should also produce proper thermal signatures that allow proper night-vision and night-optics engagements. Emerging technology also needs to address new, creative and cost-effective ways to not only achieve this but to increase duration of effectiveness after repeated impacts.

Multistage targets. Armored vehicles in defense are either in turret defilade or hull defilade. Therefore targets replicating armor vehicles in defense should reflect these two positions visually and through other cues, such as thermal signatures. Maybe the target could “pop up” in turret defilade for 30 seconds before normal target exposure to better replicate realism.

Enhanced target-lifter survivability with reduced infrastructure requirements. Emerging technology will inevitably reduce the signature and weight of target lifters, allowing reduced infrastructure requirements and portability for flexibility. Future lifters may be carrot-shaped and in a sleeve that is inserted into the ground to greatly minimize infrastructure requirements and virtually eliminate the need for target bunkers for stationary targets.

Electronics, hydraulics or the combination of the two will cause the lifters to rise out of the tube for maintenance and service purposes. Lifters are then easily moved to other tubes for range reconfiguration. Cost-effective lightweight material and increased survivability of targets will reduce the workload on lifters; this will affect their technical requirements as well.

Re-engineered methods of lifting will also impact future lifters. Enhanced wireless long-range target controlling, integrated into the range-management system with built-in hit indicators, will allow a properly networked approach. Power sources will also be impacted by advancements in rechargeable batteries and alternative power solutions and distribution.

Urban, subterranean realism

Constant and rapidly increasing urbanization globally will only increase the need for proficiency in this environment. Operations in this environment produce unique vulnerabilities and unprecedented challenges. The complexity is only amplified when adding large numbers of “civilians” and traffic to the equation. Threats may come from rooftops, windows, ground level and even from subterranean areas.

A lack of understanding of this complex environment, and a lack of proper training in this environment, was again highlighted in unnecessary losses during recent combat. Most urban training areas are woefully inadequate in depth and complexity, and they lack enough live-fire requirements for forces to properly train. Most urban-training areas are built for survivability, but they lack flexibility and realism.

With this in mind, future urban training and live-fire complexes will need to be completely redesigned with full requirements and functions in mind. This may require using buildings with subfloors and false walls that hide technology and target lifters, a large number of targets and autonomous targets replicating “civilians.” The civilian targets could transition into a threat target to fit a given scenario. Remotely controlled, interactive threat and civilian targets that can talk back would also add realism. Remote-controlled, full-sized vehicles would be needed, too.

Another important aspect of realism requires that depth, complexity and restrictiveness be included to replicate multiple types of environments such as “shoothouses” with adjustable ballistic walls to match required floor plans for live-fire rehearsals. Realism would also include survivable and/or expendable clutter such as furniture or vehicles.

The critical need for this type of realistic training environment will only grow. Therefore it needs investment. Research-and-development and related technology must be leveraged to find cost-effective, creative solutions to meet these needs.

360-degree live-fire

Combat occurs in a 360-degree environment. The greatest challenges to a 360-degree range are land requirements, safety requirements and risk. These challenges can be somewhat mitigated by the use of sub-munitions and training rounds, but they still would be virtually impossible to achieve on most modern ranges. This aspect of training should still be exercised through simulations – at a minimum, though. Those who design future ranges should consider at least multidirectional ranges and targets.

Technology and innovation will soon allow virtual range towers, eliminating their requirement on the actual range. Command, control and safety will all be done from a remote location: a range command center. Advanced day-and-night observation capability from multiple directions, range sensors, integrated battle-management systems and vehicle conductivity – both audio and visual (sight optics and turret/vehicle mounted cameras) with the range command center – will mitigate a tower's need. This range command center can be networked to multiple ranges as well.

Portable digital AAR packages linked to the range command center will allow AARs to be conducted on-site, but the range command center will have multiple complete, multi-screened suites with special integrated software to provide a detailed debriefing of any training conducted.

AARs should also include perspectives from the threat's point of view as well as the friendly point of view. Imagery and sensor feedback from drones and other combat multipliers would also be integrated into the range-management system, triggering feedback during exercises. Feedback could also be captured for AAR use and historical documentation. This will allow sensor-to-shooter tools to be integrated in live-fire.

Scenario-driven training

Ranges should be able to adapt to scenario-driven live-fire training as well. Realistic targets, threat and no-threat autonomous and remote-controlled vehicles and personnel can also support shoot/no-shoot drills on live-fire ranges. Range infrastructure and configuration should consider this type of training in the design phase.

Small-arms ranges. Militaries and law-enforcement agencies globally want to implement lessons-learned and integrate emerging technology to improve their live-fire marksmanship, training and qualification programs. Today's basic form of qualification simply evaluates one's ability to engage with a weapon at variable ranges from a fixed position, but it lacks the consideration of many other factors that the shooter will face. Greater emphasis is being given to the use of cover and concealment, magazine changes while engaging, multiple stationary and moving targets, exposure time of the shooter to the threat, weapon transition and night shooting, just to name some examples. Consideration should also be given to the environment in which Soldiers or law-enforcement personnel will operate so that training can be adapted to it.

Modern simulations systems have begun addressing some of these requirements, but our live-fire ranges and qualifications programs haven't adapted very well. The U.S. Army recently announced potential changes to its qualification requirements to include some of these factors, but changes will be required to existing live-fire ranges to properly implement. For example, ranges will need to be modified to reflect multiple environments, unpredictable moving and stationary targets, elevated targets and integration of emerging technology to provide realism and immediate feedback.

For militaries, enhanced basic-qualification ranges of the near future may not look much different than those of today, remaining focused on the fundamentals of marksmanship and the individual Soldier's ability to hit targets on varying ranges. But more qualification for those in combat arms on close-quarter battle ranges, tactical ranges and urban live-fire ranges may also be needed.

Small-arms qualification ranges. Real-time feedback on shot impact at the firing point by devices like a "location of miss and hit" electronic shot-detection and location system is outstanding, but it should also show the impact when using simulation weapons. This expands the use of the range. This will allow initial marksmanship training to be done on the range without firing actual bullets, making it more cost-effective to conduct initial or corrective marksmanship training.

Modern simulated weapons are usually actual weapons with simulation-capable modifications to them, but these weapons will likely need to be better ruggedized to withstand the elements. These simulated weapons also need to be integrated into the range-management software wirelessly to provide feedback capability from the weapon on things like sight picture and trigger pull. This feedback can be done with actual weapons as well. This feedback, along with cameras on the shooter, will allow rapid identification of fundamental flaws, needed corrections and the AAR of other factors, such as magazine changes.

Three-story building façades with windows between shooting lanes allow basic qualification of elevated targets in complex terrain. Emerging construction techniques, composites and ballistic protection will facilitate longevity and easy maintenance of such a structure. Targets can be presented from multiple windows and rooftops. A greater number of targets is required, but this allows variable scenarios and prevents shooters knowing where the targets are at each range. This also reduces range-maintenance delays and increases target life.

The integration of robotic, autonomous moving and stationary targets can also help increase targets without increasing infrastructure. Today's robotic targets can be programmed to drive a pre-programmed route or remain stationary. These are also three-dimensional and can present a realistic target regardless of the direction in which they move. Routes programmed for moving targets should travel from one form of cover to another to provide realism. These capabilities of robotic targets are also integrated into the range-management system.

Qualification ranges should not be known-distance ranges. Targets should not be exactly in 50-meter increments of range. They should vary their distances, plus or minus 10 meters, to allow an increased number of targets to be used. Qualification ranges are based on point-of-aim at various ranges, not precision adjustments based on known distance.

A couple of the qualification engagements should be fired from around a corner and behind cover such as that found in an urban area. A 45-degree, four-foot-high, three-foot-long "wall" should be placed to one side, slightly behind the normal firing position. This can be portable or fixed. The wall is at a 45-degree angle to the range to allow continued muzzle orientation downrange while using cover. Engagements from behind the wall can be from both prone and kneeling positions.

As discussed, tactical and urban live-fire ranges should also include battlefield clutter such as cars and walls. Targets could be presented from behind some of these as if the threat is using them for cover. Civilian "no-shoot" targets should also be integrated. These targets can appear in a building's window or as a robotic moving target dashing from cover to cover. Multi-target lifters can also present a non-threat target, then the same target can present as a threat target.

The range-management system described will be used for all these ranges as well, integrating many tools for command-and-control, safety and quality AARs. Tools such as monitors at the firing point and ruggedized monitors/electronic tablets will allow playback of videos taken from multiple angles, and all the other data captured by the management system would re-enforce feedback and lessons-learned on the spot. All this will also be captured and on display at the virtual tower, with artificial intelligence helping highlight individuals who need further attention and training.

Conclusion

The need for realistic live-fire training and qualification that integrates survival and combat skills with marksmanship accuracy in a variety of situations and environments has never been more important. It is crucial for Soldiers to sustain their fighting edge on today's battlefields. Emerging technology, combined with lessons-learned, allows us to adapt our live-fire ranges to ensure more lethal, survivable Soldiers/law-enforcement personnel in any environment.

The future of simulations integrated with live-fire is not far off. Rather than waiting, though, there is plenty we can do with today's technology. There will be a cost to modernizing today's live-fire ranges, but with that said, what price do you put on Soldiers'/law-enforcement officers' survivability, lethality and dominance on the battlefield of tomorrow?

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Acronym Quick-Scan

AAR – after-action review
ATGM – anti-tank guided missile
IED – improvised explosive device