The Future of Marine Corps Observer Training

Augmented reality

by Frank Furman, Peter Squire, & Pete Muller

"Aviators, our Naval personnel, our armor vehicle commanders are sharpened by their frequent use of highly realistic advanced simulators. It's time now to do for our young infantry, what we have done for other domains."

–Gen James N. Mattis[1]

Any Marine who has encountered new technology, which comes with a promise of new capability or increased operational efficiency, has in many instances been underwhelmed. This cycle of promise followed by disappointment has created an atmosphere of guarded skepticism toward new technology. At its best, new technology isn't a panacea. At its worst, it's an expensive complication, a distraction from a proven method.

Consider the potential of simulation-based training. While an integral part of many warfighting communities, it is largely seen as a threat to live fire training by the combat arms community. These concerns are justifiable, but it doesn't mean that live fire training will always be better than simulation-based training. Modern simulation-based training, particularly the emerging field of augmented reality, has the potential to enhance live fire training.

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Tradeoffs: Realism versus Simulation Training

Even the most innovative Marine leader is hard pressed to manufacture fresh challenges that push his Marines with only a few tank hulks and a limited impact area on the range. Thus, the challenge of training Marines with live fire is how to prepare them for an unlimited number of scenarios in the field, while only rehearsing a fixed set during training. For example, training a tactical air control party (TACP) quickly becomes formulaic because there is a fixed set of targets, gun target lines, and geometry of surface danger zones. Live fire limits the training realism by operating within these constraints.

While live fire training feels realistic, all training is still a simulation. Until tank hulks and pop-up targets think, eat, sleep, and shoot back, they remain a simulated enemy. Shooting real rounds at them doesn't make them real. Range 400 at Twentynine Palms is a simulated attack. We accept the flaws of simulations to permit both the progression of training and the physical health of our Marines. Balancing which flaws we accept against limited resources has occupied the thoughts of military leaders since the dawn of warfare.

Realizing the limitations, how can the Marine Corps as a Service take training to the next level? Imagine a system that allows simulating targets and effects anywhere in the training area—even in close proximity to structures or friendly forces. Imagine controlling aircraft that can approach from multiple angles and directions instead

of preapproved initial points. As you look out from your observation post, the image of an enemy vehicle is projected onto your glasses, appearing in the valley ahead. As your head moves, the image moves accordingly, appearing to be stationary in the valley. After you call in a nine-line brief or a call for fire, you look up to check to see if the aircraft, projected onto your lens, is on the correct final attack heading. You watch as the artillery rounds drop their mark by the tank. As you shift to your Vector 21, which is wired to project the magnified landscape and tank in front of you, you see the laser guided bomb miss the target by 300 meters. You can immediately transmit the correction to a simulated Dash 2 aircraft and watch, through your Vector 21, the next bomb drop to reduce the tank to a smoking hulk. This system is not for deployment in a lab or in front of a screen but from any observation post or training area you choose. Dust will clog nostrils; body armor will still chafe shoulders. Real weather, real equipment, and real terrain are all part of the package.

The Office of Naval Research (ONR) has been pursuing the science and technology (S&T) to make this system a reality for over a decade. Working with Training and Education Command (TECOM) and Marine Corps Systems Command Program Manager for Training Systems (PM TRASYS), ONR as part of a Future Naval Capability initiative is developing an augmented reality system that will transition to the force and fleet. This system, called Augmented Immersive Team Trainer (AITT), is being developed to enhance force-on-force and force-on-target training of call for fire and close air support by using augmented reality to show battlefield effects. The system will integrate with and augment the Instrumented-Tactical Engagement Simulation System (I-TESS II) inserting/projecting virtual aircraft, vehicles, role players, and indirect fire effects onto actual terrain.

Four virtual tanks as seen by a trainee. *(Photo by Richard Schaffer.)*

Augmented Reality Works

The idea of advanced simulation training isn't new. The first flight simulator was built in 1929,[2] and in 1961, Philco developed the Headsight, the world's first heads-up display.[3] For several decades, American pilots and ship helmsmen have used simulators to train in their craft. Simulators are used wherever acquisition of the desired skill is dangerous, costly, or both. Ground combat definitely falls into these categories. While the movement of large bodies such as planes and ships in a constant continuum of air or water is easier for computers to model, the challenge of a human interacting with a simulated environment is getting closer to being solved.

The Infantry Immersion Trainer (IIT) introduces infantrymen to the sights, smells, and sounds of combat using a simple type of augmented reality. The big question is whether the training is as effective as live fire training. Much of the concern is due to the specter of negative training, where performing an action incorrectly in training to account for an unrealistic scenario leads to performing that action incorrectly in a real situation. Recent research indicates that the key to effective simulation-based training is the participation of expert mentors for facilitation.[4] Accustomed to working with the Coyotes of Tactical Training Evaluation Control Group or the Red Hats of Mountain Warfare Training Center, Bridgeport, CA; this should come as no surprise to Marines. The fact is that augmented reality training works—provided it is correctly and expertly implemented. Live fire training is no different.

Cost

There are significant challenges and technical hurdles ahead, but the ongoing development of the AITT has already demonstrated startling capability. Although the AITT program is not focused on JTACs (joint terminal attack controller), let's use it as a case for a quick analysis. As stated in *NAVMC 3500.42B* (*Tactical Air Control Party Training and Readiness Manual*, Department of the Navy, [Washington, DC: 1 May 2014]) a JTAC requires six controls w/in a six-month period two of which may be in the simulator—only certain controls can be performed in the simulator though. Let's say a battalion wants to plan a training exercise for 10 JTACs to maintain their certification. That's 40 controls. As a planning factor, Expeditionary Warfare Training Group shoots for two nine-lines completed for every one-half hour of on-station time. Now, say a section of Harriers takes off from Marine Corps Air Station Yuma to support a shoot in Twentynine Palms. After 25 minutes of transit and check-in, you get about 15 minutes of on-station time, followed by a 25 minute flight back, or about 15 minutes of on-station time for each flight hour. The lowest open source estimate we found was $11,134.00 per flight hour.[5]

Just a back of the envelope calculation, not including the common addition of supporting elements like external fuel tanks and aerial refueling tankers. In addition, we haven't factored in that

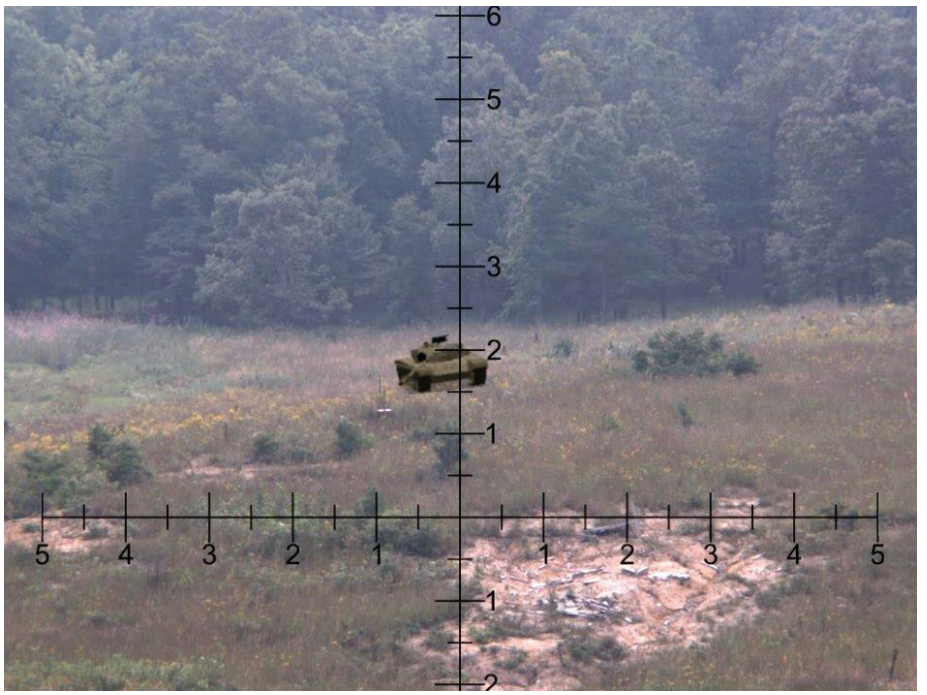
$$\frac{40\text{ controls}}{\text{Bn sustainment}} \times \frac{30\text{m O/S time}}{2\text{ controls}} \times \frac{1\text{ flight hr}}{15\text{m O/S time}} \times \frac{\$11{,}134}{\text{flight hr}} \times 2\text{ aircraft} \cong \$900\text{ K}$$

supporting artillery battery taking 10 HMMWVs and 18 MTVRs (medium tactical vehicle replacements) to the field, along with 100 Marines. Finally, the cost of each joint direct attack munitions ($25,000.00), the thousands of man-hours, or the fully burdened cost of fuel also need to be added in as comparison factors. One might respond by saying that those artillerymen, mortarmen, and pilots supporting the exercise are getting their required training as well, but that argument simply doesn't stand up to scrutiny. Wouldn't the training of those artillerymen, mortarmen, and pilots be better accomplished by supporting more complex combined arms training? Wouldn't the limited amounts of ordnance and fuel be better used then?

As the Marine Corps balances priorities and resources, it is time to consider balancing live fire training with more cost-effective methods. The aviation community doesn't use simulators simply for safety purposes; the community has been driven to simulator use by the high cost of flight operations. Simulation training has proven the only way to get the training we want with the resources we have. Infantrymen may soon find themselves in a similar position.

The Counterargument

"Train as you fight." This simple sentence is drilled into every Marine's head, and it applies to everything—from how you run a company attack to how a Marine laces his boots. We fight with live ordnance, we train with live ordnance, and no training system can recreate the concussion of high explosives more accurately than the use of live systems. Furthermore, Marines fundamentally treat live fire training differently. An unloaded rifle is no more dangerous than your grandfather's cane, but loading live rounds turns it into a killing machine, capable of taking out the enemy 500 meters away or your buddy right in front of you. Weapon discipline improves. Pupils dilate as mental preparedness for training with dangerous conditions set in. Our 0311s are largely 19- to 25-year-olds, raised on *Call of Duty* and other video games. Range 400, in Twentynine Palms, may be a simulated attack environment, but live rounds get these young Marines into that simulation more effectively. Ask any pilot and he will tell you that carrying live ordnance affects his entire approach to the day. There is something visceral about the report of an M4 by your ear or the compression of your rib-cage when an artillery round lands just a bit closer than expected. Regardless of cost, converting chemical energy to heat and pressure quickly and violently lends gravity to a serious undertaking.



Another view through the AITT. *(Photo by Richard Schaffer.)*

Conclusion

The entire training community is devoted to getting the best possible training for our Marines. The goal will be to do more with less, and where that optimization point lies will be up for debate for as long as there are Marines and as long as there are competitions for resources. What our Marines deserve, however, is a frank and honest discussion on the role augmented reality simulations *can* and *will* play in the not so distant future. This discussion requires evaluating the efficacy of augmented reality systems and determining under what conditions and at what levels the training can be as beneficial as live fire training. The opening salvo for augmented reality in training systems is to augment the real environment with virtual battlefield effects for force-on-force and force-on-target training. Future uses require extensive feedback from operational units, and rigorous analysis of the economics, with accurate accounting of time, labor, and resources. Lower costs can be achieved by eliminating the redundancy borne of fixed targets and impact areas. Live ordnance can be reserved for true combined arms training to maximize its benefits. Marine Corps leadership will soon be faced with a tough choice—not between augmented reality training and live fire training but between augmented reality training and less training. We need to ensure that we're ready to make that choice when the time comes.

Notes

1. Gen James N. Mattis, "Future Immersive Training Environment," United States Joint Forces Command video, (Suffolk, VA: 17 July 2010).

2. Ray L. Page, "Brief History of Flight Simulation," R.L. Page and Associates, SimTechT 2000 Proceedings, (Sydney: The SimtechT 2000 Organizing and Technical Committee, 2000), accessed at http://citeseerx.ist.psu.edu.

An instructor employing Vector. *(Photo by Richard Schaffer.)*

3. Kiyoshi Kiyokawa, "An Introduction to Head Mounted Displays for Augmented Reality," in M. Haller, M. Billinghurst, B. H. Thomas, Eds, *Emerging Technologies of Augmented Reality Interfaces and Design*, (Hershey: Idea Group, 2007), 43–63.

4. Syed Haque and Shandkar Srinivasan, "A Meta-Analysis of the Training Effectiveness of Virtual Reality Surgical Simulators," *IEEE Transactions On Information Technology In Biomedicine*, (January 2006), 10:51.

5. Department of Defense, *Department of Defense Fiscal Year 2012 (FY 12) Budget Estimates, Air Force Justification Book Procurement of Ammunition*, (Washington, DC: February 2011), accessed at http://www.saffm.hq.af.mil.