Realer Than Real: The Quest for Immersive Realism in RPA Virtual Training

Matt J. Martin, Lt Col, USAF (ret)

L3 Link Simulation and Training

Arlington, TX

Aviation simulation, including that used for military aircrew training, has typically focused on stick-and-rudder tasks. But while great strides have been made over the years in the fidelity of virtual aviation environments, enterprise training efforts have lagged in areas of environmental immersion (physical, social, cognitive, etc.). Specifically, more work is needed on aircrew interaction with command and control, supporting ground units in near-pear scenarios, and building the skills needed to maintain a high level of situational awareness in complex scenarios. This has often left practitioners in the position of having to rely on live-fly training and accumulated experience to fill in the gaps—even when that experience can only be gained during the actual employment of the weapons system with all of its associated risks.

Recent developments in Live-Virtual-Constructive (LVC) training, Distributed Mission Operations (DMO), and high-fidelity mission simulation could change that. Focusing on the USAF MQ-1/9 training enterprise as a case study, this paper outlines the promise, potential, and reality of integrated RPA training.

Since the RQ-1 Predator first took flight to support military operations in Kosovo, Iraq, and other places, the public perception of remotely-piloted aircraft (RPA) has been repeatedly quick to invoke the video game analogy. The common presumption is that the experience of piloting an aircraft from thousands of miles away must obviously create a sense of detachment such that the pilot experiences no physical, mental, or emotional connection to the aircraft or to the players on the ground. This attitude can quickly lead the layperson to the conclusion that the RPA pilot might have a cavalier approach to civilian casualties or other tragic outcomes. What's more, the video game notion may lead one to assume that training and cognitive skill is not a particular problem for RPA crews, since the aircraft must employ a high level of automation with little human input.

However the experience of practitioners—now with over two millions hours logged of combat time—has been the exact opposite. The massive expansion of military RPA capability and capacity over the past 15 years has borne out the following conclusions: that effective employment of RPA systems at the tactical level requires a high level of physical, mental, and emotional engagement on behalf of the crew; that a certain set of mental and physical skills must be well-developed for success, and that the ability to produce an immersive and complex training environment in order to reproduce the experience of operational employment has proven difficult using live-fly training and elusive in the simulator.

This paper will focus on the third conclusion of the RPA employment experience—the need for a truly immersive and effective training experience. It will begin with a review of the training approaches and practices used to date, discuss the various experiments to move the employment experience to the range and the sim, and suggest improvements to future of immersive virtual training for the military RPA enterprise.

From its inception, the RQ-1 Predator (which later took on the multi-role designation of 'MQ-1' after the addition of weapons and a combat laser), was unlike the procurement of other Department of Defense major weapons systems. Initially acquired off-the-shelf as an Advanced Concept Technology Demonstrator (ACTD), its development and refinement over time took place in the midst of operational employment. In fact the tactics needed to employ every major innovation—from the use of satellites for beyond-line-of-sight (BLOS) operations, to the use of Hellfire missiles, to the global distribution of video and data for intelligence exploitation, were developed and inculcated during combat sorties (Whittle 2014). This meant that even crews employed these tactics in the field, there was no codified set of tactics, techniques, and procedures (TTPs) that could be incorporated into a syllabus or training courseware for the expanding Initial Qualification Training (IQT) effort. In fact even though Predator combat operations began in 1995 (Whittle 2014), there was no formal system of advanced tactics development, incorporation, and standardization until 2003 (McCurley 2015).

While a dedicated IQT forum was soon established in the form of the 11th Reconnaissance Squadron schoolhouse at Indian Springs Auxiliary field, there was no figh-fidelity simulator available until the acquisition of the L3 Predator Mission Aircrew Training System in 2006 (L3 2006). Prior to the time there were part-task trainers that allowed for familiarization and "switchology," but all mission training had to be done via live-fly on the Nellis range subject to the normal challenges and attrition factors of live-fly training such as weather, aircraft maintenance, and airspace availability (Colucci 2004).

During those live-fly events in the early days of the 11 RS, integrated mission training was a rare event. The procedures for conducting multi-ship and dissimilar live training had not yet been established. There was no formal system of identifying and synchronizing training requirements between Predator crews and crews of manned aircraft. And due to ongoing operations in Iraq and Afghanistan, there were no forward air controllers or other complementary training audiences available conduct integrated training with Predator crews. It was therefore up to instructors to “role-play” these roles while simultaneously performing instructor duties (McCurley 2015).

There was one integrated training event that was a regular feature of early MQ-1 IQT—Killer scout weekend (Martin 2010). Taking advantage of the training cycle of various F-16 Air National Guard units, the instructor cadre at the 11RS were able to arrange quarterly—sometimes monthly—visits by F-16 aircraft to conduct the “Killer Scout” Strike Coordination and Reconnaissance training events in the IQT syllabus. In this aerial interdiction scenario, MQ-1 students could locate targets on the range, conduct “talk-one” to verbally guide the F-16 pilots to the targets, practice the integration and deconfliction techniques to conduct a coordinated attack, and then debrief those simulated engagements after the mission alongside the F-16 pilot who had participated. These events provided an invaluable opportunity for MQ-1 crews to work with other strike assets prior to meeting them on real-world combat missions. Figure 1 below shows an operational view of a typical MQ-1/F-16 killer scout training event.

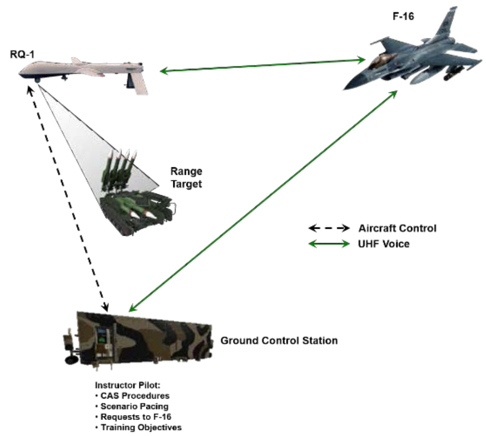

Figure 1 – Early Live-Fly "Killer Scout" Integrated Training Mission

But these types of integrated events were quite rare—as were all other types of live tactical events in MQ-1 IQT training. In fact it was not uncommon for MQ-1 crews to become qualified to fly in combat, transition to an operational squadron, began flying missions, and then be called upon to employ live ordnance from another aircraft against live targets, having never had the opportunity to perform a live weapons employment in training. In fact, due to safety rules on the range and the lack of a high-fidelity training system, many crews never even conduct the switch actuation in training (Martin 2010).

To help alleviate this lack of live integrated training opportunities, Air Combat Command hired several companies since 2008 to act as live forward air controllers, range targets, and stand-ins for live aircraft during IQT and Continuation Training Events. As contractors, these role-players bring the advantage of having no training objectives of their own. Likewise they can be dedicated to the RPA schoolhouse so that they are always available to insure all student crews have the opportunity to train with them. Since the inception of this contracted, live, role-playing capability—while there have been some limitations in capacity—every IQT crew has had the benefit of multiple tactical training events with live controllers and love-role players prior to graduating from the course. (Moore 2009)

With the advent of a high-fidelity simulator as part of the MQ-1/9 program of record—which is designed and managed to provide a certified, software concurrent, and technically realistic compliment to live-fly training—it became possible starting in 2010 to mirror this live role-playing capability in a virtual environment. The same contract forward air controllers who supported live-fly events on the range were brought into the simulator to perform those same roles for virtual training events. This brought the advantage of not only expanding student exposure to live-quality integrated training, but allowed for the transition of live-fly events into a virtual environment enabling savings in cost and efficiency by reducing attrition due to weather, aircraft maintenance, and airspace availability. It further allowed the inclusion of other operational elements in the virtual space including command and control, intelligence, and blue forces, to immerse the students in a highly-complex operational environment. Figure 2 below depicts an operational view of integrated virtual training in the PMATS simulator via role-playing.

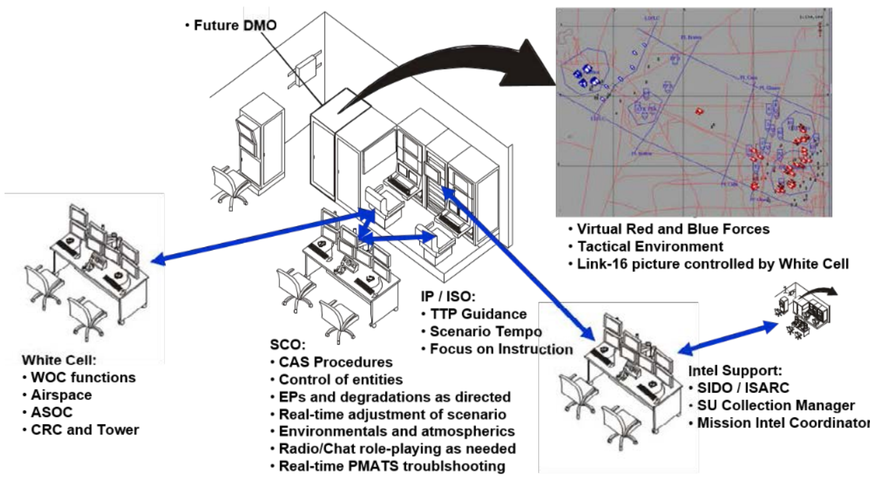

Figure 2 – The PMATS Role-Playing Set-up for RPA IQT

Beyond the intuitive, there is good data to back up the notion that virtual mission elements, and virtual scenario players, which place realistic limitations on mission execution when transposed to the real world, would lead to the development of the same cognitive skills that are importation to mission success in the real world. In fact, both the data and the experience of practitioners show that training to develop skills related to judgement, decision-making, and tactical leadership, can be trained to, and practiced in, a virtual environment with a high degree of effectiveness. Training these types of skills in simulators may be even more important than developing the physical stick-and-rudder skills that are the focus of traditional flight simulators.

For example, numerous studies of medical students have shown that scenario-based simulation training is superior to interactive problem-based training to develop critical assessment, coordinated team action, and management skills (Steadman et. al. 2006). Likewise, in civilian aviation, the Federal Aviation Administration has long recognized that scenario-based training is a far more effective way to develop judgement and decision-making skills among pilots than the old approach of focusing and physical aircraft control skills. The FAA has also accepted the concept—and helped implement it within commercial aviation—that pilots and crews can train entirely within simulators so long as they are of sufficient fidelity and complexity (FAA 2014).

The USAF has also moved more mission training into virtual environments, owing to the rising costs and restraints of live-fly training using 4th- and 5th-generation aircraft the shrinking size of the fleet, and the difficulty of reproducing sophisticated threats in a live environment. Even premier large-force training events such as Red Flag and the Weapons School integration phases, have relied more and more on virtual and constructive elements to replicate the true complexity and sophistication of high-level conflicts. This has allowed the integration of intelligence, cyber, and electronic warfare elements to make live-fly training even more complex and challenging (Bultman 2017).

What would such an approach look like for the MQ-1/9 enterprise? For starters the basic elements of software concurrency, accurate aeromodel, replication of malfunctions, weather, imagery, and weapons effects have to be of the highest possible quality. Any inaccuracy or "simism" will not just distract students from the realism of the scenario, but has the danger of teaching contrary or negative skills.

With a realistic weapons system baseline, automated and manual mission tools can be added such as command and control links, weaponeering tools, communications tools, and a datalink picture that would replicate picture used by crews during operations. Integration of these tools are essential to train not just their operation, but to train the cognitive skills of situational awareness, 3-dimenension comprehension, attention and focus management, and crew coordination.

Finally, there has to be a wealth of red, blue, green, and white forces available so that students will be immersed in a truly complex mission environment. These can be provided by live players in networked sims, automated entities, or white cell role-players. The use of live players is particularly useful since it allows student to cooperatively, plan, brief, and debrief training events in the same manner and with the same emotional potency of real-world operations.

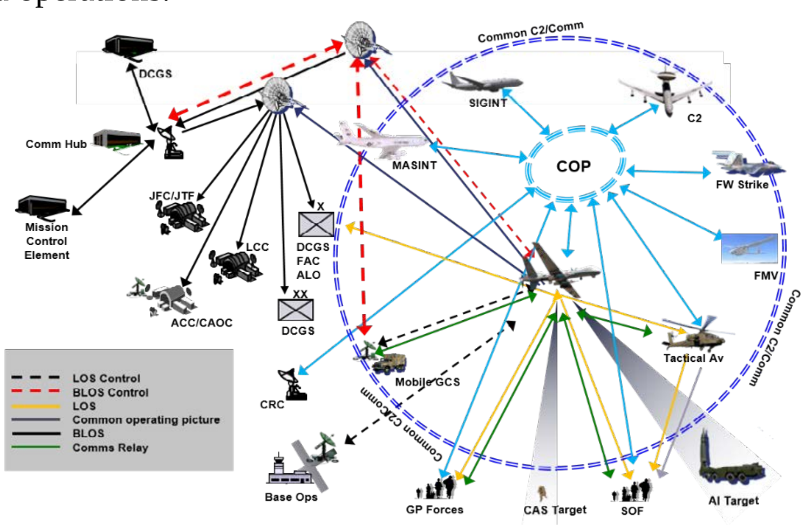

Figure 3—Total Integration for Virtual Training Events

In conclusion, highly complex mission training for RPA crews has been long in the making and is still not quite a reality. But based on the lessons of the past, both from USAF experience employing the still-growing RPA force, and from other virtual training applications, the goal can be achieved. And when virtual training is "realer than real," the RPA crew force can declare victory and focus on what really matters—the mission.

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