Virtual Dismounted Infantry Training: Requiem for a Dream

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ABSTRACT

A fire team breaches a two story building, quickly suffering casualties; an infantry platoon comes under mortar fire while conducting a cordon and search supported by an RQ-7 Shadow and AC-130; a squad leader participates in a key leader engagement for the first time to disastrous outcomes. In all cases, the leader steps out of a virtual training environment and into a classroom where he guides his team through an after action review (AAR) that allows him to rewind, review, and truly understand the capabilities, and limitations, of his team and himself.

The above scenario is still the ideal: a persistent, demanding training environment accessible from home station that provides joint and coalition context. While this ideal has not yet been achieved, it is within reach. Major strides were made toward this ideal for dismounted infantry units with the inception of the Army's Dismounted Soldier Training System (DSTS) in 2012. However, the DSTS system suffered from a mismatch between trainee expectations and system capabilities. In response to the limitations of the system, the Army subsequently decided to downsize its DSTS inventory and transfer most of the remaining systems out of the active force. This paper focuses on gains in capability, usability and training transfer experienced with DSTS since 2011, analyzing feedback from multiple Services and nations across six mission types and multiple use cases. It provides an overview of four years of training transfer, systems feedback, and interoperability gains data spanning five experiments and over 200 participants, and the usability challenges which were recorded at every stage of the capability development. It offers recommended areas for future improvements, pitfalls to avoid, and describes future capabilities that could meet soldier expectations about training.

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INTRODUCTION

A fire team breaches a two story building, quickly suffering casualties; an infantry platoon comes under mortar fire while conducting a cordon and search supported by an RQ-7 Shadow and AC-130; a squad leader participates in a key leader engagement for the first time to disastrous outcomes; a company maneuvers into a village in a carefully coordinated security task that culminates in soldiers participating in a successful Shura. In all cases, after allowing consequences to set in, and the mission to come to a conclusion, the leader steps out of a virtual training environment. He can then move into a classroom, where he guides his team through an after action review (AAR) that allows him to rewind, review, and truly understand the capabilities, and limitations, of his team and himself.

The above scenario is still the ideal: a persistent, demanding training environment accessible from home station that provides joint and coalition context. The training environment that allows for high risk tasks to be trained to safely, with detailed feedback drawn from performance data making it possible to increase training outcomes for the participants. While this ideal has not yet been achieved, it is still within reach. Major strides were made toward this ideal for dismounted infantry units with the inception of the Army's Dismounted Soldier Training System (DSTS) in 2012. But like many fielded systems, the DSTS system suffered from a mismatch between trainee expectations and system capabilities. Commercially available games and systems that encouraged team-play and challenging situations quickly surpassed the capabilities required of DSTS when it was first designed; and users still expected to interact with a system that represented fairly modern technological capabilities.

In response to the limitations of the system, the Army subsequently decided to downsize its DSTS inventory and transfer most of the remaining systems out of the active force. This paper focuses on gains in capability, usability and training transfer experienced with DSTS since 2011, analyzing feedback from multiple Services and nations across six mission types and multiple use cases. It provides an overview of five years of systems feedback, interoperability gains data spanning five experiments and over 200 participants, and the usability challenges which were recorded at every stage of the capability development. It offers recommended areas for future improvements, pitfalls to avoid, and describes future capabilities that could meet soldier expectations about training.

DISMOUNTED TRAINING: PAST, PRESENT, FUTURE

No capability for training exists in a vacuum. DSTS had its roots in the Irregular Warfare training requirements which came to the forefront again with operations in Iraq and Afghanistan (US Department of Defense, 2010), and military training capabilities and concepts focused on developing in-extremis performance enhancers going back decades (Kolditz, 2006).

Past

As the forerunner of today's dismounted infantry virtual training systems, the Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) was a US Joint Forces Command (USJFCOM) effort to demonstrate the value and potential of immersive training systems for dismounted infantry units. Chartered in 2008, FITE JCTD was not the first attempt to demonstrate virtual training for dismounted infantry, but it was probably the most ambitious. The first attempts were inspired by commercial-based capabilities like Marine Doom (Riddell, 1997). Many of them started from similar soldier-designed concepts, which were a clear expression of the desire for this capability as posed by the generation of warfighters who came of age during more than a decade of war. The purpose of FITE was to address those demand signals, as well as the following joint operational problem:

> *Military trainers have insufficient enablers to train close-combat tasks in a realistic, fully immersive training environment that creates and reinforces complex (tactical and human dimension) decision-making skills.* -- US Joint Forces Command, 2009.

This broad problem space included insufficient enablers to provide an immersive environment with adequate decision-making stimuli; lack of an affordable home station training capability that can be modified based on current attributes of the joint operational environment; and a lack of high-fidelity virtual entities to realistically replicate human interactions. The FITE JCTD envisioned an end state in 2010 where these problems were understood to the extent that programmatic decisions could be made that would deliver solutions to meet this critical need. The capabilities projected for FY10 included:

1. Replicating elements and conditions of the battlefield across the full spectrum of operations in order to improve situational awareness, cognitive skills and higher decision making.
2. Allowing team members to exercise close combat tasks in a realistic, fully immersive training environment that reinforces ethical and legal decision making against an asymmetric enemy employing IEDs, criminal networks and insurgency tactics.
3. Providing culturally-realistic, dynamic, synthetic entities that allow realistic interaction within the operational environment, to include friendly units, hostile forces and civilians.
4. Supporting repeatable and rapidly reconfigurable scenarios and training systems or ranges.
5. Providing realistic threat cues, indicators and features to enhance situational awareness in order to improve predictive capability to identify enemy threats.
6. Supporting trainees' ability to request, control, and coordinate supporting arms and Intelligence, Surveillance, and Reconnaissance (ISR) resources within the training scenario.
7. The ability to record and playback each entity's movements, orientation, and communications to provide in-depth AAR.

The FITE JCTD was divided into two phases or "spirals" that addressed immersive individually-worn virtual reality solutions and fixed-facility mixed reality/individually-worn augmented reality solutions, respectively. The Spiral 1 technology solution was an individually-worn virtual reality system of current and evolving commercial/government off-the-shelf technologies, and capabilities designed to create an immersive environment for realistic squad training and mission rehearsal. While the FITE JCTD did not advocate any specific vendor solution, its hardware component consisted of a wearable virtual system, with additional haptic devices and olfactory generators, and the Virtual Battle Space (VBS) 2™ software which generated the simulated environment. The system configuration decided on is depicted in Figure 1 below.

Figure 1. US Marines from the 2nd Battalion, 8th Marine Regiment, battle a virtual enemy using the FITE JCTD capability at Camp Lejeune, N.C. (US Navy photo by John F. Williams/Released)

The USJFCOM Limited Joint Operational Utility Assessment report (2010) concluded that the FITE JCTD demonstrated immediate operational training utility within the scope of the JCTD project. This meant that, in the demonstration, each of the seven far reaching capabilities outlined had reached an acceptable level of performance.

Present

Informed by some of the results of the FITE JCTD, the US Army fielded DSTS as a new program of record starting in 2012 **(**USAEC, et al, 2013**)**. DSTS, which was fielded to a number of Army posts and installations, represented a significant first step into the potential for the routine use of virtual training for dismounted infantry units. However, the far-reaching goals set for the FITE JCTD to be achieved by 2010 were matched with challenges that any concept of a dismounted infantry virtual trainer is still working to overcome: maturity and stability of virtual technologies, validation of the content, how to avoid negative training, and the struggle to define the tasks best addressed by the system.

While the FITE JCTD was successful in demonstrating a concept for effective dismounted soldier training, the transition from demonstration to fielded capability was rocky. The capability/requirements document that was bid against had less capabilities than the system demonstrated in the FITE JCTD did. There was a challenge in contracting the capability demonstrated in FITE to a fielded system. During FITE, the soldiers were supported by a cast of high level technicians, VBS2 operators and white cell actors whose level of experience could not be feasibly duplicated in an operationally fielded system.

Not surprisingly, the DSTS post-fielding training effectiveness assessments, led by the Army (USAEC, et al, 2013) and also outlined in Bink et al, 2014, highlighted these areas as needing improvement. In a recent industry publication, the US Marine Corps' modernization of their live training sites was highlighted, and tied to the ability to create virtual prototypes much more quickly in game-based solutions such as VBS2 and Deployable Virtual Training Environment (DVTE) (Weirauch, 2015). Because of the recognized utility of having rapidly configurable environments, the Services have continued to move forward on dismounted soldier training, and the simulation systems that drive it, attempting to address the shortfalls they experienced in-stride. While delivering a virtual environment to live dismounted infantry units is a challenging technical problem, the deficiencies which will be further described below are not new problems, and have been experienced in earlier attempts to serve the same audiences (Dean et al, 2004).

DSTS IN THE BOLD QUEST OPERATIONAL DEMONSTRATION

The US Joint Staff sponsored Coalition Capability Demonstration and Assessment series, more commonly known as Bold Quest (BQ), is a collaborative joint and multinational enterprise in which Nations, Services and Programs pool their resources in a recurring cycle of capability development, demonstration and analysis. The overarching aim is to improve interoperability and information sharing across a range of coalition warfighting capabilities. In general, initiatives brought to BQ by the sponsoring participants focus on improving interoperability in the kinetic fires kill chain at all levels, from Joint Forward Observer (JFO)/Joint Terminal Attack Controller (JTAC) to a Combined Joint Task Force Headquarters.

In addition to live events and actions, since 2011, BQ has included a mix of live and virtual (L/V) capability demonstrations that play a growing role in the Joint Staff J6's recurring BQ series of events. These capabilities consist primarily of live and virtual simulation environments applied to the development and sustainment of joint fires interoperability. The focus of this effort is on the individuals, crews and small teams of warfighters who operate in a complex joint and coalition environment. Accordingly, much of the current L/V effort is focused on demonstrating, integrating and assessing methods and tools to improve the collective performance of small teams conducting joint close air support in coalition operations – JTACs, JFOs, fixed- and rotary-wing aircrew, Unmanned Aerial System (UAS) aircrew and sensor operators, and small infantry unit leaders, using dismounted and game-based systems. Between BQ 2011 and 2015, BQ has repeatedly included participation of a version of the DSTS system, as it was seen as an effective situational awareness and performance enhancement tool for small units – though not an optimized solution. It also provided a way to link soldiers in simulation to fires-related training capabilities which they seldom have access to prior to deployment, such as the virtual AC-130 and AH-64D trainers.

Event Methodology

The methodology varied from event to event, based on the requirements of the participating forces and other, operationally focused decisions. The mix of training capabilities and sequence of training participants in L/V demonstrations since 2011 is shown in Figure 2. The in-depth explanations are provided in other papers, but the soldiers' use of the DSTS systems were rooted in live and virtual mission performance, and usually preceded by relevant classroom-based training events.

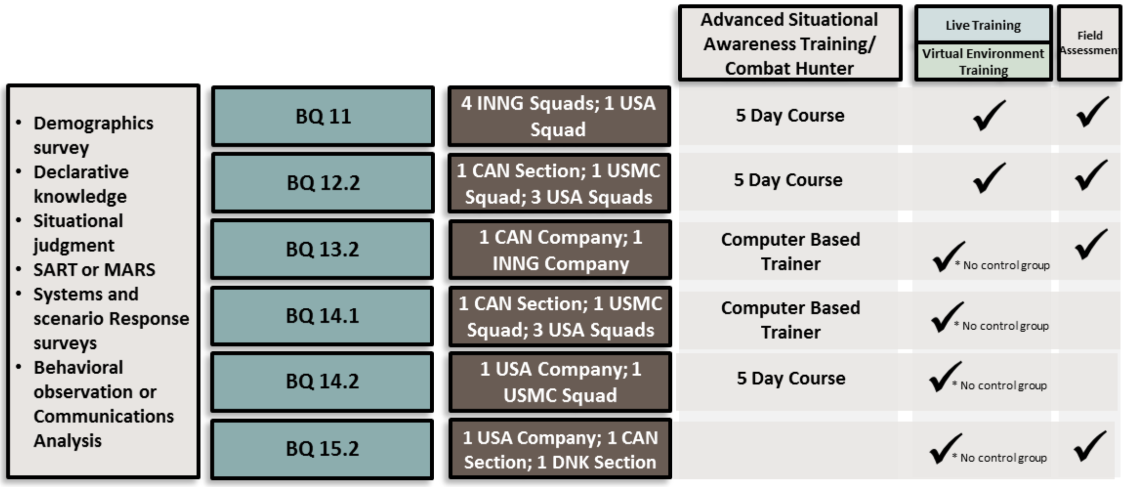

Figure 2. BQ Participant Training.

BQ11 focused on providing the US Army's Combat Hunter analogue, Advanced Situational Awareness Training (ASAT), to a range of participants in conjunction with mission rehearsals in the former FITE JCTD individually-worn virtual reality trainer. BQ12.2 / Army Expeditionary Warrior Experiment (AEWE) focused on employment of multiple virtual environment capabilities, including the pre-block 1 fielding of the Army's program of record, DSTS (Reitz, Richards, 2013). BQ13.2 provided a comprehensive process of VBS2 and DSTS facilitated mission rehearsals, with distributed support from high fidelity U.S. Special Operations Command's Joint Training Support Center (JTSC) AC-130 and the Army's UH-60 simulators, which culminated daily in rotating, live force-on-force mission scenarios executed at the Muscatatuck Urban Training Center (MUTC). Because of the multinational and cross-Service nature of BQ, Canadian forces, National Guard, and USMC regularly participated in these events, leveraging US Army training systems. While BQ14.1 was a risk-mitigation focused event, there were many opportunities to provide participants with non-sequenced exposure to training opportunities, with concurrent elicitation of feedback. BQ14.2 had three phases of activity, many of which overlapped during the month-long data collection window. One infantry platoon participated in Combat Hunter training and follow-on integrated virtual scenarios with virtual joint fires platforms (AH-64D and AC-130 virtual trainers); while 1st Armored Division (1AD)'s forces were participating in the Network Integration Evaluation (NIE), and one 1-151 Indiana National Guard platoon participated in the same virtual scenarios, operating on the same virtual terrain and networked in from Camp Atterbury, IN. BQ15.2 focused on a Canadian infantry section at the Canadian Army Simulation Centre in Kingston, Ontario, Canada conducting distributed virtual missions with US, Canadian and Danish squads at Fort Bliss, TX; virtual UH-60 Blackhawk helicopters and a US infantry squad located at Camp Atterbury, IN; and the JTSC AC-130 simulator at Hurlbert Field, FL.

Table 1. BQ Participant Demographics

	Age	Deployed
BQ 11 (n=78)	26.70	72%
BQ 12.2 (n= 55)	25.65	46%
BQ 13.2 (n=112)	27.20	71%
BQ 14.1 (n= 23)	24.82	62%
BQ 14.2 (n= 23)	23.63	63%
BQ 15.2 (n= 80)	23.60	64%

Collection Methodology

Across the five years, multiple assessment apparatus were used, including tests of declarative knowledge associated with the ASAT/Combat Hunter courses, situational awareness collection tools like Mission Awareness Rating Scale (MARS) (Matthews, Beal, & Pleban, 2002) and situation awareness rating technique (SART) (Taylor, 1990), and systems feedback tools. The participating forces were solicited after each mission for feedback on the device's perceived utility, as well as specific questions related to the mission they just performed. Throughout the BQ L/V activities, participant demographics were collected and tested as a potential factor on performance, self-assessments, and system assessments (Table 1).

RESULTS

The free-test results provided are an analysis of responses using the Descriptive Coding method, with associated sub-codes (Saldaña, 2012). When using the descriptive coding method, researchers assign a word or phrase that summarizes the data being reviewed. In this instance, each free-text response provided by participants in their surveys were coded, whether that response was prompted by the question or offered freely by the participant. The primary topic codes were: (1) Technical Feedback, (2) Training Utility, and (3) Recommendations for employment. Sub-codes were based on types of participant responses. The distribution of topic codes across years are shown in Table 2, and the results of the qualitative coding are summarized at a high level in Table 3.

Table 2. Feedback Topics by Year

	2013	2012	2014.1	2014.2	2015.2
Technical Feedback	31.91%	35.45%	56.32%	33.33%	12.50%
Training Utility	56.74%	57.46%	36.78%	44.44%	75.00%
Recommendations for Employment	11.35%	7.09%	6.90%	22.22%	12.50%

Table 3. Most frequent topics offered by soldiers after using the system

Topic Category: Technical Feedback (n=243)	**Percent of comments**
• Glitches halting training	23.05%
• Visuals insufficient for battlefield cues (field of view)	16.46%
• Quality of audio did not provide for needed battlefield cues (Directionality of audio & challenges of single net communications)	13.99%
• Lack of Realism (In terrain and weapons)	11.52%
• Suffered difficulty with controls, and had no recommendations for changes	10.70%
Topic Category: Training Utility (n=357)	**Percent of comments**
• Positive impact of the system (AAR capabilities)	25.77%
• Negative training impact due to poor communications and system not using muscle memory	22.41%
• Potential for Small Team training	14.85%
• Would not use system	12.32%
Topic Category: Recommendations for employment (n=54)	**Percent of comments**
• Suffered difficulties with controls, and had recommendations for changes	44.44%
• Wanted a larger range of scenarios to improve use of system	16.67%
• Found the pattern of life and terrain insufficient for battlefield cues	14.81%
• Improve system training	11.11%
** Note: Items shown above are only those representing more than 10% of the comments made in each category.*	

A repeated measures ANOVA (Analysis of Variance) was performed on the data, across dates when feedback was provided, nations the comments came from, leadership status, mission type, and system used. None of these were statistically significant impacts on the types of feedback provided, which remained relatively consistent across five years of data collection.

Focusing on the top areas commented on in each topic category, participants, regardless of which year they participated in, experienced glitches in the system that completely halted their training; suffered difficulties with the controls; and yet despite that, there was a persistence of participants attempting to provide feedback on the potential for the positive impact of the system's AAR capabilities. It is important to note that much of the feedback marked as 'Recommendations for Employment' were still addressing critical faults in the system, but in a positive manner. As an example, the phrases used in recommendations for employment provided for constructive suggestions, such as 'If these changes are made to the movement system, this would be usable'; a parallel item in the technical feedback topic would be one which focused on the inability of the user to navigate effectively in the world due to sensor issues; a parallel item in the training utility topic would be one which spoke of the negative impact of not moving in the system and having to use a joystick instead. While these comments were mostly provided spontaneously, an overwhelming amount of them were still looking at the potential of the system if items as noted above were improved.

Participant Systems Feedback

The last comparable apparatus across multiple uses of DSTS years was systems feedback. The feedback provided by trainees on DSTS suitability (Table), and perceived impact on decision making (Table) showed some key areas of difference in system perception as the years progressed. A one-way between subjects ANOVA was conducted to compare trainees' reaction to DSTS in BQ12.2, BQ13.2, BQ14.1, and BQ14.2. There were significant effects between groups for the following questions, with the BQ14.2 virtual participants at both MUTC and Ft. Bliss rating the following questions higher to a statistically significant degree:

- "Does using this Simulator provide you an opportunity to practice making sound tactical decisions?" (F(3.74)=4.143, p=.020)
- "Does training with this Simulator improve your ability to make more rapid tactical decisions?" (F(3,74)=3.459, p=.037)
- "Does training with this Simulator have a valuable impact on your decision making skills?" (F(3,74)=3.783, p=.027)
- "To what extent does this Simulator teach you something new about decision making that is not now or not easily covered in normal classroom or field training?" (F(3,79)=7.038, p=.002)
- "To what extent will training with this Simulator allow you to practice the types of decisions you must make as a small unit leader?" (F(2,74)=3.358, p=.041)
- "Would training with this Simulator be a valuable learning experience?" (F (3,69)=6.261, p=.003)
- "Were the visual cues distinct enough to replicate patterns of life?" (F (3,69)=4.640, p=.013)
- "Were the audio cues distinct enough to identify the location of enemy forces?" (F (3,75)=5.694, p=.005)
- "Was the opposing force ratio sufficient enough to evaluate the unit?" (F (3,75)=3.350, p=.041)

BQ14.2 virtual participants consistently rated their experiences with the system higher than all other BQ participating years, which could be attributed to an extremely seasoned cadre of trainer leading the system. Additionally, BQ14.2 participants experienced effective integration with joint air enablers in their environment, creating a richer, more realistic training environment than was experienced in previous years.

Table 4. Participant reactions on critical thinking in relation to DSTS. (None = 1; Some/Somewhat = 2; Good = 3 ; Very = 4)

	BQ12-2 (N≈55)	**BQ13-2 (N ≈ 35)**	**BQ14.1 (N≈23)**	**BQ14.2 (N≈19)**
Does using this Simulator provide you an opportunity to practice making sound tactical decisions?	1.85	2.29	2.04	2.79
Does training with this Simulator improve your ability to make more rapid tactical decisions?	2.03	2.83	2.70	3.16
Does training with this Simulator make you confident in your ability to make tactical decisions?	2.03	2.37	2.09	2.79
How challenging is the overall experience provided by training with this Simulator?	2.18	2.49	2.3	2.58
Does training with this Simulator have a valuable impact on your decision making skills?	2.33	2.29	2.04	2.68
Does training with this Simulator help you focus on critical factors that influence tactical decisions?	2.48	2.35	2.00	2.63
To what extent does this Simulator teach you something new about decision making that is not now or not easily covered in normal classroom or field training?	2.53	2.12	1.61	2.37

To what extent will training with this Simulator help you make sound tactical decisions?	2.68	2.3	2.05	2.58
To what extent will training with this Simulator allow you to practice the types of decisions you must make as a small unit leader?	2.93	2.25	2.09	2.68
Would training with this Simulator be a valuable learning experience?	3.08	2.34	2.09	3.06

Table 5. Participant reactions on DSTS, where. 1=Not at all Adequate; 2= Generally NOT adequate; 3= Neither adequate nor inadequate; 4= Generally Adequate; 5= Very Adequate

	BQ12-2 (N≈55)	**BQ13-2 (N ≈ 35)**	**BQ14.1 (N≈23)**	**BQ14.2 (N≈19)**
Was the length (time) of the scenario adequate for the training exercise?	1.7	3.55	3.59	3.83
Was the scenario realistic enough for you to feel immersed in the exercise?	2	3.42		3.67
Was the scenario complex enough to challenge you?	1.69	3.33	3.48	3.7
Were the terrain, landscape, and buildings realistic enough not to cause a distraction to training?	1.8	3.27		3.56
Were the audio cues distinct enough to replicate patterns of life?	1.5	3.64	3.29	3.94
Were the visual cues distinct enough to replicate patterns of life?	1.58	3.22	3.1	4
Were the visual clues distinct enough to discriminate non-combatants?	1.5	3.42		3.89
Were the visual clues distinct enough to identify key individuals?	1.58	3.56		4.00
Were the audio cues distinct enough to identify the location of enemy forces?	1.65	3.47	2.9	3.94
Were the visual cues distinct enough to identify the location of enemy forces?	1.8	3.53	3.43	4.06
Was the opposing force ratio sufficient enough to evaluate the unit?	1.68	3.59	3.29	4.06

The improvement of the realism of the systems to support the types of scenarios soldiers expect and consider adequate to train with, as well as the improvement in support to decision making has been steady since the first data collections in BQ12.2. This indicates that in the future, most soldiers might find it adequate for their training needs, if development continues.

As can be seen in both data sets, participants were positive about the idea and general execution of the idea, and they were negative about what were essentially the tools to implement it. While the trainees seldom felt that the system had impacted their critical thinking, they also generally agreed that it would be a valuable learning experience to share with other soldiers; this is despite their direct feedback on the technical experience which, across all areas, evened out to a statement that the capabilities of the system remained around 'Neither adequate nor inadequate' across multiple years of system improvements.

RECOMMENDATIONS

To attain the virtual small unit training capabilities advocated by the FITE JCTD, there is still much work to be done. Based on the trainee feedback and learning exhibited above – which does show a steady improvement and the ability to use the capability to train not just skills and techniques, but to reinforce knowledge – we propose the following recommendations to continue growing these capabilities:

1. **Explore novel techniques to reach required capabilities.** Integrating and assessing promising new technologies, such as Augmented Reality (AR), have been key functions of recent BQ L/V environment events. Based on data collected over BQ14.1 and BQ14.2, virtual reality alone may not provide the range of realism and engagement required. AR, as a promising new area of mixed reality, is a potential means to close significant gaps in Live, Virtual and Constructive (LVC) interoperability by "melting the boundaries between the live, virtual and constructive domains" (Dean et al, 2004). Representing many of the best aspects of live

and virtual training, AR allows units to train at a live range in actual weather with real equipment, yet still enjoy the many advantages of virtual training – no need for costly live aircraft sorties, weapons or OPFOR.

2. **Engage in learning.** Standing up a piece of technology and expecting learning to occur because users are interacting with it is a dubious assumption at best. It is broadly understood that communication and awareness can be trained in virtual environments, and that for particular tasks, the constant repetition to create mental muscle memory is best performed in an easily re-set training environment. Nonetheless, providing participants a challenging, realistic military environment often creates issues when attempting to break the training process down into smaller blocks of causation. Over the past five years of software and concept development and improvement, the understanding of how best to use these technologies has improved, though not to a level of understanding specifically what tasks, conditions and standards are best met in virtual rather than live training. That research is to come.

3. **Utilize open source model and terrain concepts.** Warfighters are prized for their ingenuity; every practitioner has a story of the unit who trained themselves very effectively before a mission with ketchup packets, a squared off space of dirt, and string. But training systems are treated as things to be administered, and soldiers are often put through a regimented series of scenarios and environments which they believe they could create better, if they were given time and tools to. Encouraging soldiers to build their own environments and models would give rise to exchangeable terrain and model improvements, and engage pride in ownership within the unit.

4. **Apply international technical standards and joint interoperability tools to rapidly compose and integrate LVC environments.** Training a dismounted squad to operate in today's operational environment involves much more than the squad operating in isolation. Realistic interactions are required with team members, higher headquarters, and adjacent units, supporting arms, civilians and OPFOR; however, creating an integrated LVC environment across Nations, Services and Programs is still a challenge. With multiple flavors and versions of standards to choose from (e.g., High Level Architecture (HLA), Distributed Interactive Simulation (DIS)), interoperability is almost never "plug and play." Building the interoperability required to enable rapid generation of joint and coalition training environments that represent the world soldiers face when deployed requires vast improvements in the application of technical standards and interoperability tools.

5. **Establish distributed networks that support LVC data exchange.** During 2015 Joint Staff J6 extended the L/V environment via distributed networks to partner nation simulator sites, including the Canadian Army Simulation Center in Kingston, Ontario and the French Air Force Air-Ground Operations School at Nancy-Ochey Air Base. This work has required significant effort and extensive staff-work to meet the many requirements to establishing distributed network connectivity. To be able to rapidly generate distributed virtual environments, the distributed network must include other nation sites at whatever security level is required. Although not a fix to these problems, standing up an episodic Mission Partner Environment (MPE), as is being done to support BQ16.2, may be a model for establishing distributed connectivity for joint and coalition LVC interoperability as well.

6. **Capability developers must increase participation with real End Users prior to acquisition.** The spiral development of a capability should ideally include multiple points for the end user community to engage with it. Ignoring feedback from that community, or mistaking their neutral reaction for a positive reaction could lead to costly systems simply being left in storage boxes. Engaging with the end users in a structured manner during the development process is key to building systems that will see continued use.

By following the above outlined recommendations, a capability developer will not only be able to provide a product which meets the letter of a capability document, but also the spirit that all of these documents and their source material are based on – an attempt to improve warfighter capability faster, with greater fidelity, than can be done in a field training event.

CONCLUSIONS

The speed of technology developments will always outstrip the speed of the acquisition process; barring a total revision of the process to build stable, reliable and field-able programs of record, that is a fact. But that fact can be mitigated by using flexible software, novel part task training techniques, networked capabilities and better leveraging the best of current research.

Several areas show promise for taking current dismounted squad training (as well as JTAC and JFO training) and turning it into a truly distributed and integrated environment. AR and other forms of mixed reality show potential to support creation of truly joint and coalition LVC architectures, across Services and nations, so we may see the somewhat tired adage "train as you fight" actually happen.

The ubiquity of a robust virtual environment doesn't have to stop with training. As the US and other nations' defense departments face a continued reduction in availability of live aircraft and range resources, it becomes feasible to explore pre-fielding and demonstration capabilities in a mixed live and virtual environment, to help the discovery of interoperability issues – whether in doctrine, TTP, or the data exchange level can be discovered and addressed prior to use in combat.

Virtual training can ideally provide a broad range of demanding, theater-specific experiences for young soldiers well ahead of their deployment. AAR capabilities will allow a squad leader to understand the capabilities of each member of the unit and help guide further training; other resources that a squad would need to interact with (supporting fires, adjacent units, etc.) can be made available through simulation during training, allowing the squad to hone their TTPs in a mission-specific context that they might encounter downrange. Realistic dismounted training can be enhanced by other joint enablers and systems, creating a realistic training environment to prepare soldiers the same way we prepare fighter pilots – providing them endless repetitions and challenges, including putting them in *in extremis* situations not possible during live training, to improve decision making under stress. This future lies not just with an optimal system which contains everything, but in modularity, and offering distributed simulations, and leveraging augmented reality.

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