

1.1 Emergent Capabilities Converging into M&S 2.0

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Abstract. The continued operational environment complexity faced by the Department of Defense, despite a restricted resource environment, is a mandate for greater adaptability and availability in joint training. To address these constraints, this paper proposes a model for the potential integration of adaptability training, virtual world capabilities and immersive training into the wider Joint Live Virtual and Constructive (JLVC) Federation, supported by human social cultural and behavior modeling, and measurement and assessment. By fusing those capabilities and modeling and simulation enhancements into the JLVC federation, it will create a force who is more apt to arrive at and implement correct decisions, and more able to appropriately seize initiative in the field. The model would allow for the testing and training of capabilities and TTPs that cannot be reasonably explored to their logical conclusions in a 'live' environment, as well as enhance training fidelity for all echelons and tasks.

1. INTRODUCTION

The future that our warfighters face will be complex in terms of both the geographical and human terrain [13]. This is a mandate for greater adaptability at lower tactical echelons to achieve operational objectives more efficiently. To prepare our warfighters to operate in this environment, greater access to embedded cultural and language training, engagement rehearsal capabilities, and realistic immersive environments are required.

This can be accomplished through the convergence of the fields of human and organizational adaptability; a persistent globally accessible virtual world; and, specifically, realistic virtual training environments that stress the warfighter on a physical and mental level. Combined, these integrated focus areas will make the training experience more holistically valid and representative of actual combat conditions. The resulting model of converging ideals will be supported by the implementation of independent assessment, including extensive measurement, best training practices from across the continuum, and cognitive learning theories.

1.2 Operational Problem

"In order to sustain operational and training superiority, the DoD must be able to effectively and efficiently prepare future

training audiences with limited fiscal, time, material, and personnel resources" [5, pg.3]. To accomplish this, the department must undertake a focused effort on creating and measuring adaptive human performance and learning methodologies for combat and combat support forces and apply it to training.

Over the last three decades, the academic and scientific communities have made great improvements in learning techniques and human performance – particularly advancements in learning under stress [1].

Through integrating state of the art human performance learning processes, stress inoculation techniques and procedures into the current modeling, simulation and training continuum, we can expect:

- Improved individual and team performance.
- Improved situational understanding, resulting in better decision making.
- Improved coping skills with the stress of combat.
- Capture, measurement, and assessment of training effectiveness.
- More confidence and ability to adapt correctly to a changing situation.
- A mechanism to inculcate best practices from experts to newer warfighters.

- A bias for positive action that translates into an overall increase in subordinate initiative.

1.3 Current and Future Operating Environment

To frame the operational problem, it is necessary to examine the expected operating environment. The August 2010 Commander International Security Assistance Force (COMISAF) Counterinsurgency Guidance succinctly frames the challenges of the future operating environment in its overall theme as “Learn and adapt” (pg. 1). It calls for our warfighters to exercise initiative and for leaders to empower their subordinates down to the lowest tactical echelon possible. The COMISAF Guidance also places importance on cultural understanding, thinking from the perspective of our international partners and our adversaries [2]. As brought up in the 2010 Quadrennial Defense Report, prevailing against our current adaptive adversaries requires a dynamic toolset of capabilities which not only focuses on military competence but also intelligence, diplomacy, and law enforcement activities [4].

Learning and adapting is not just a need in the current operating environment but a requirement to survive and prevail. In its current state, learning and adapting occurs as happenstance, not a systemic activity. The requirement for a dynamic, adaptive force will only increase in the future. The Joint Operating Environment (JOE) 2010 laid out constants and expected trends the Department of Defense will face for the next 15 years. The JOE’s constants weigh on the need for adaptability in our forces: there is the nature of war itself, filled with unexpected frictions; the nature of change, drastic as it can be; disruptions in the world and the battlefield, whether they are brought on by human error, natural disaster, or inflicted purposefully; and the flaws in maintaining grand strategies, despite the

challenge of disruptions and the nature of change [13].

One predicted change that will increase the challenge for the joint forces is the worldwide shift in urban density. The trends of continued resource scarcity, interdependent development, heightened technological evolution, and greater ease of pandemic spread interact with the shift of urban density, and will influence the ability of our joint forces to pursue missions. It is expected that by the 30s, five billion of the world’s total eight billion in population will reside in cities; two billion of those will be in the Middle East, Africa and Asia. The JOE 2010 goes on to state, “With so much of the world’s population crammed into dense urban areas and their immediate surroundings, future Joint Force commanders will be unable to evade operations in urban terrain” [13, pg. 57].

Historically, urban terrain requires more ground troops than any other type of terrain, while producing higher casualty rates for ground forces [7]. To maintain presence in a city, forces will have to act in concert with international partners and the host nation, which adds additional requirements for warfighters to maintain greater cultural understanding and refined communication skills [3]. The joint forces additionally will need a greater ability to understand second and third order effects. These skill sets need to be trained and honed in addition to standard warfighting tasks, and be provided from the same constrained pool of available time and resources.

The Capstone Concept for Joint Operations (2009) stresses that for the future, we must be prepared to “institute mechanisms to prepare general-purpose forces quickly for mission changes,” “develop innovative and adaptive leaders down to the lowest levels,” and “drive synergy to the lowest echelon at which it can be managed effectively” (pg. 21-28). This reinforces the distributed nature expected of future operations, where tactical troops will face strategic

compression, the compression of decision-making responsibilities down to the lowest level; and all echelons will be faced with the need to maintain a force that is organizationally flexible, able to respond quickly to chaotic changes in the operating environment. Training and technology can facilitate this shift towards quick forming teams of soldiers, multinationals and non-governmental agencies, as well as aid those units who are required to quickly transition from a combat mission to security or stability missions [3].

1.4 Mandate

The Strategic Plan for the Next Generation of Training for the Department of Defense states that it expects a revolution in training which “will be driven by the dual engines of powerful new training technologies and adaptive pedagogy that will fundamentally change how DoD Components train day-to-day at home station” (pg. 2) This will occur concurrently with the previously mentioned limited resources and encroachment on training grounds [5]. The solution is to augment live training with other capabilities. Immersive training permits for the realistic replication of any operating environment yet cannot exist in a vacuum of stand-alone developments. The ability of immersive training to cope with the inevitable constraints to resources is recognized by *The Strategic Plan for the Next Generation of Training*, which explicitly articulates the need for an immersive training environment that trains to a range of objectives with a focus that includes training in cognition, intuition, innovation and adaptive thinking. All of this needs to be accomplished while remaining technologically intuitive and agile.

2. EMERGENT CAPABILITIES

Emergent capabilities are technology and training enablers that can support improved warfighter training when linked with developments within the fields of human and organizational adaptability, virtual worlds, and immersive training, and areas yet to be developed.

2.1 Essential Elements

2.1.1 Virtual Worlds and Immersive Training

The immersive training and virtual worlds capabilities must overlap in terms of providing structured training and persistent terrain and human models. It would supply a common space, a persistent world built to simulate in large portion the real world, available 24/7 for home station and collective training for disaggregated entities. Virtual worlds additionally allow for the testing and training of capabilities and tactics, techniques and procedures that cannot be fully explored to their logical conclusions in a ‘live’ environment. Immersive training, whether it is performed with a man worn system, in military operations in an urban terrain facility, or with augmented reality technologies, should link into the same virtual world capability. This interconnectedness will assist in providing the necessary complex, sensory-realistic environment which stimulates cognition, intuition, innovation and adaptive thinking, while honing complex decision making skills [5]. Such an environment would be used to bring together disparate groups and expertise separated by logistically challenging conditions.

2.1.2 Human Factors

By placing emphasis on enhancing the cognitive performance of the human utilizing the system, technological capabilities can produce a greater increase in training that transfers accurately to the operational environment. There is a large body of literature on the potential of raising the expertise level of trainees through training focused on enhancing decision making [12], as well as building resiliency through training [1]. Transferring such effective experiential learning is reliant on more than psychological factors; however, because of the importance of model end state rather than visual enjoyment, effective training can be transferred through low-end technology means. The importance is the functional fidelity of experience which re-creates the

opportunity to mimic expert-level mental models [11].

The scenarios provided in a virtual environment must test trainees' assumptions not only about the actions they are immediately taking but also their deeper assumption sets and the second and third order effects of their actions [8].

2.1.3 World Class Trainers

Without a pool of skilled trainers to support the training in immersive and virtual worlds, the possibility of negative training is high. Branching scenarios need to be created or offered as a scaffold for leaders to build their own training scenarios. Leveraging best practices pulled from industry and academia, skilled trainers would be educated in the most effective and efficient methodologies to heighten transfer of experiential learning to their trainees.

In the future, after action review capabilities within an ad-hoc virtual world training session could be facilitated by a digital tutor system which is aware of prior trainee live and virtual performance through use of a persistent avatar card. This system would further support on the ground trainers by providing information on the progress attained and results of these ad-hoc sessions. It also has the potential to provide support for creating appropriate learning within scenarios based on units' experiences downrange.

2.1.4 Measurement and Assessment

Fully leveraging emergent capabilities includes measured performance and a better understanding of how we learn under stress as well as the heightened transfer of training that would be provided by an advanced training methodology. As we create, support and integrate technologies, solid metrics allow for true evaluation of the return on investment, as well as key areas for improvement as we develop the next system. Examples of measurements which will bring us towards the desired end state of institutionalizing adaptive virtual training

are: performance under stress, mission essential task performance, decision making performance, assessments of training practices, technologies, and trainer performance.

2.2 Building on Current Developments

The first steps towards integrating emergent capabilities into modeling and simulation of the future have already begun, as represented by the Joint Training and Exercise Network (JTEN) 2.0, and ongoing development expanding the JLVC Federation. These developments are bolstered by the US Army's Maneuver Center of Excellence's focus on bringing interconnectivity to the dismounted unit, while providing them a persistent, accurate virtual avatar for insertion into immersive and virtual training worlds [9]. The unification of systems that link live, virtual and constructive training with these more human-centric enablers will be key supporting capabilities in taking the first steps towards addressing the operational problem.

2.2.1 JLVC Federation

The JLVC Federation allows for the seamless integration of constructive and virtual entities into live training exercises, filling gaps in resources and spreading the training's reach to units who would otherwise be unable to participate. The functional fidelity provided by the JLVC Federation during training events is key, as many players were unable to tell that the air assets or nearby units with which they were coordinating were actually simulated by a computer located thousands of miles away [6]. This capability demonstrates the potential of uniting virtual worlds and immersive training.

2.2.2 JTEN

The backbone to this system is the JTEN, which is transitioning to an upgraded architecture with capacity to provide better speed, connectivity, and responsive interactions [10]. Most recently, the network was extended in a demonstration capacity

to provide support for tactical networks in the field that are operating out of the reach of the wire networks and support which accompanies most JTEN executions [6].

Supporting a persistent integrated immersive training capability available to all warfighters is crucial to achieve the vision of fully integrated training not only among the joint forces, but coalition as well [14].

3. CONCEPT FOR MODEL IMPLEMENTATION

These developments will not occur overnight, but rather progress incrementally. The Department of Defense can support these increments by focusing on creating an overall leap-ahead advancement in the technology. Technology in this case is defined in both materiel and non-materiel terms. This will be an iterative process to reach the end state, pushing the boundaries of available technologies and research with every iteration. Each stage would have a solid task statement and aggressive completion deadlines to speed delivery to the warfighters.

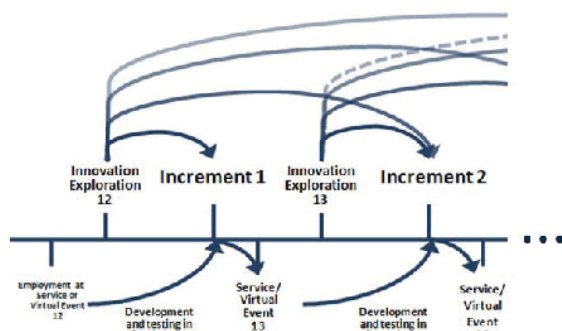


Figure 1. Developing Innovation.

While the terms increment and leap-ahead seem contradictory when placed side by side, they are actually mutually supportive in action (See Fig. 1). Each series of innovation exploration leads to the discovery of training and technologies that are then rolled into development increments at the appropriate time according to the Technology Readiness Level and cost. To accomplish some of the technologies which will bring us closer to the desired end state,

it will require longer periods of investment with industry, labs and academia. However, there are technologies available today or in the near term that need only to be integrated through incentivization to achieve the level of functionality needed. The incremental integration of these technologies into exercises and events will help industry and academia refine the utility of their demonstrated capabilities.

Key to accomplishing the model is identifying which parts of the growth process can be implemented in the short term, and which portions need to be worked and supported for inclusion into a later year's increment of development as part of the overall investment plan. Immature technologies and concepts are encouraged towards further development, while mature technologies and concepts are assessed and integrated quickly to maintain speedy delivery of capabilities to our forces. This approach will inform the technology associated with immersive training and virtual worlds, and spur development, research and integration of concepts.

3.1 Setting Conditions for Innovation

3.1.1 Innovation Exploration

Exploring innovation can be performed at existent major industry, entertainment and academic events, in collusion with partner organizations' exploratory events, or specifically tailored events hosted live or virtually. Products, capabilities and theories shared at these events are then analyzed for their current development level and applicability to future desired capability criteria.

In addition to directed exploratory events in real and virtual worlds, we would need to provide for targeted academic working groups and conferences, to allow for the further development of ideas and theories across disparate fields of study.

3.1.2 Technology Criteria

To qualify for movement from the technology exploration event to a development increment, technologies and training will need to demonstrate that they contribute substantially towards filling an identified gap.

3.1.3 Battle Labs

The creation of dedicated field and home-station based labs has aided previous fast-paced training and technology developments. Creation of a true battle lab for each service at a training site of their choosing would create further interoperability among the Services, industry, entertainment and academia while maintaining direct focus on the intended training audience.

This would allow for products from previous initiatives to be further refined and tested, and would allow immature innovations a location to refine their concepts. It would aid in initial scenario development, training and technology testing by leveraging actual service members.

4. CONCLUSIONS

In the complex environments we will continue to face, there is critical importance to being able to increase training capabilities offered to the warfighter, while improving their critical thinking and decision making. The Quadrennial Defense Report stated that one forward focus area is joint force holistic health. Citing programs such as the Comprehensive Soldier Fitness program, the Quadrennial Defense Report called out the importance of physical, psychological, spiritual and social health [4]. The ability to effectively make decisions (based on one's situational awareness, critical thinking, resilience, duress/stress, meta-cognition, sense making, and cue/pattern recognition) is part of joint force holistic psychological health. That skill set has a high degree of utility in the ongoing nature of strategic compression, which has increased the necessity for subordinates to appropriately seize initiative with an eye to second and third order effects. It requires

enhanced ability to receive and deliver precise information. To understand the implications of their actions, warfighters need to be able to leverage an adversarial point of view.

In the near future, adaptability, immersive training and virtual worlds will converge, touching not only enhancements in training and education, but also readiness across the force. Members of a high performance unit on patrol through a village will have the ability to articulate their understanding of changes in the local pattern of life, react to the dangerous situation before it becomes fatal, and act from a position of strength to manipulate their circumstances.

Because the team leader will wear a small, high resolution camera utilized to relay a live feed to higher headquarters, top trainers are able to capture that patrol and translate it into a scenario for the cross Department of Defense immersive training scenario pool. This allows for pre-deployment units to train in a high fidelity version of that original patrol, which accurately replicates the hair standing up on the back of the neck feeling experienced by the original patrol.

Since the event is loaded into the scenario pool, it is accessible for trainers, academics and the original team members. This access would allow for the creation of deeper lessons learned, manipulation of the scenario in a test bed environment, or allow team members to re-experience a physician-guided portion of the scenario as part of a post-traumatic stress disorder mitigation strategy.

By creatively leveraging such an intertwined capability, we create a force that is better able to cope with stress, more apt to arrive at and implement correct decisions, and more able to appropriately seize initiative in the field.

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6. ACKNOWLEDGMENT

This work was supported in part by the US Joint Forces Command (**Contract # N65236-09-D-3809**). The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the USJFCOM or the US Government. The US Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon.