

# **NRAC Report: Immersive Simulation for Marine Corps Small Unit Training**

## **Executive Summary**

### *Background*

The challenges and risks to US ground forces in the contemporary operational environment (COE), particularly with respect to Irregular Warfare, are well known. Since the end of World War II, there has been a disproportionate burden in casualties born by the Infantry relative to other branches of the US military. It is believed that virtual simulation, with proven effectiveness in training Airmen and Sailors, can improve the safety and effectiveness of Marines and Soldiers by aiding them in developing complex and intuitive decision skills under conditions of stress. Additionally, the phenomenon of “strategic compression”, pushing responsibility for decisions with far-reaching consequences to the lowest echelons of military organizations, requires the means of developing effective cognitive decision-making capabilities for US ground forces small unit leaders.

With the objective of studying concepts of immersive training simulation for Marine Corps Small Units, a Naval Research Advisory Committee (NRAC) study was commissioned, whose Terms of Reference included six principal areas of concentration: (1) the decomposition of the small unit immersive simulation training problem, (2) Identifying the desired effects of this training, (3) examining the metrics necessary to gauge training effectiveness, (4) reviewing current and developing virtual training methods, (5) evaluating current science and technology (S&T) initiatives and (6) recommending technology solutions, investments and developments.

NRAC leadership composed a panel of NRAC members including representatives with industry, medical, military, academic and acquisition backgrounds including retired USMC General Officers and Naval Flag Officers. The study engaged stakeholders and participants in Government, academia and industry.

### *Findings*

At the outset, the panel found that there is no broad consensus on the meaning of *immersion*, with some in the “presence” research community favoring a set of objective criteria (spanning the number of senses addressed and the fidelity of sensory impressions) and others favoring a definition relying on a subjective impression of engagement and suspension of disbelief. The panel favored the later definition in its deliberations.

The panel adopted a learning hierarchy framework for training USMC small units spanning (a) declarative knowledge of facts, (b) consolidation and acquisition of procedural knowledge and (c) higher order skills and team organization. Against this, the panel considered a range of virtual simulation alternatives.

Virtual reality, in which the user experiences a synthetic environment exclusively, typically involves a desktop, large-format or head-mounted display (HMD) interface for increasing levels of immersion. Mixed reality includes augmented virtuality, in which the user experiences a synthetic environment with selected real-world components that appear in scene graph masks (i.e. holes in the scene image), typically with a see-through optical HMD. In augmented reality, the user’s primary experience is of the real world with synthetic objects occluding the real-world, typically with a see-through optical HMD interface.

This range of virtual simulation alternatives suggests a potential fit with the hierarchy of training challenges. Thus an augmented reality capability, with the ability to move freely in a physical, three-dimensional space, might be a good fit for learning higher order skills and organization while desktop virtual reality might be suited to learning declarative knowledge of facts. Whatever the level of training, however, the inherent non-sequential nature of simulation training more naturally supports the development of higher-order cognitive capabilities than linear task and part-task training.

There is, perforce, an issue of the maturity of the enabling technologies for some of these virtual training approaches. Augmented reality, for example, relies on accurate position-location information (PLI) along with practical, see-through optical HMD’s. The panel determined that

PLI, at a scale in footprint and number of participants required for USMC small unit training, was not yet available. Similarly, lightweight, inexpensive see-through optical HMD's will require additional S&T investment.

For current and upcoming virtual training solutions, there is the additional challenge of a general lack of metrics for determining the effectiveness of alternatives. This has contributed, the panel believes, to a lack of consensus of the value of simulation training for USMC small units. Notwithstanding the current availability of several virtual simulation tools, there is no actual guidance on their employment in the USMC Infantry Training and Readiness (T&R) manual. Without metrics, it is difficult to provide guidance about the value of virtual systems as an alternative to, for example, live training exercises. Moreover, the Mission Essential Tasks (MET's) in the T&R manual do not include the cognitive aspects of irregular warfare. Thus there are currently no tasks against which to consider virtual training tools that might, for example, build meta-cognition skills.

The panel found potential for addressing the absence of metrics for virtual simulation products in a study conducted by Canadian researcher, Dr. Paul Roman of the Royal Military College of Canada. In a study published in December 2008, Dr. Roman found that the cognitive decision-making skills of Canadian tank commander students increased dramatically with a portion of the conventional classroom curriculum was re-directed to virtual simulation exercises.

His metrics, however, derived exclusively from the subjective assessment of trained, experienced evaluators. The dependent variable in this experiment was the pass/fail outcome for the students in the course. The experimental group in the Roman protocol passed the course earlier and in greater numbers than the control group.

Until other, possibly computationally-based, automated approaches may be found; the panel believes that the systematic application of assessment by trained evaluators considering the outcome of training events will provide the hard data necessary for evaluating training alternatives.

Notwithstanding the limitations of available technological components and metrics, the USMC has seized the initiative, building an Infantry simulator at Camp Pendleton, the Infantry Immersive Trainer (IIT). With limitations in throughput and availability, the IIT is intended to inform a planned Program of Record, the Squad Immersive Training Environment (SITE). According to users, much good has already come of this pioneer effort. The panel noted some immediate enhancements (e.g. sound design/reinforcement) that could add to the immersive qualities of the IIT.

In future implementations, the requirements of IIT-type facilities could benefit from cognitive task decomposition: teasing apart the desired training end-states from immersive simulation training events. This would enable trainers to maximize the effect of time spent in IIT-type facilities and modulate the training that the facilities would be required to provide.

### *Recommendations*

For immediate action, the panel recommends (a) the implementation of systematic, subjective assessment methods to evaluate simulation alternatives, (b) the development of cognitive, irregular warfare-related MET's, (c) various enhancements to the IIT along with (d) cognitive task decomposition to support an "end-to-end" training solution.

With an eye to the future, the panel considered the current USMC S&T investment ("Code 30" in the Office of Naval Research Budget) in addition to the broader Department of Defense technology investment. The panel found that the current portfolio is under-resourced in terms of supporting the technology components required for practical augmented reality, the likely next step in immersive small unit virtual simulation training. The panel also determined that the SITE program needs an integration laboratory (most likely at Camp Pendleton's IIT) to validate the development of technology components as they become available and the ways these tools will be used in the SITE program.

With this approach, the panel believes Marines, in the future, will face their first combat in a simulator: not on the battlefield. The panel believes further this will make a great difference in avoiding casualties and saving lives.