# Application of Virtual Environments for Infantry Soldier Skills Training: We are Doing it Wrong

Douglas B. Maxwell(✉)

Advanced Training and Simulation Division, U.S. Army Research Laboratory, Orlando, FL, USA
douglas.maxwell3.civ@mail.mil

**Abstract.** Simulation based training (SBT) technology has been shown to be effective in a number of domains such as for pilot training and ground vehicle operator training. In the dismounted infantry soldier skills domain, the low hanging fruit for effective use of SBT is equipment operations training. However, the complexities of the operational environment are often too difficult to replicate in current virtual environments to present an accurate or effective training for the skills requiring identification of enemy activity or reacting to enemy contact. The U.S. Army Research Laboratory and the University of Central Florida have been conducting studies using large numbers of soldiers to determine how effective virtual training methods are in comparison to traditional training methods for dismounted infantry soldier skills. This paper will discuss recommendations for changes in the employment of virtual training systems that could have a meaningful impact on the performance of soldiers.

**Keywords:** Simulation based training · Leadership training · Collective training · Virtual environments · Infantry soldier skills training

## 1 Introduction

As of the writing of this paper, the U.S. Army is entering a new acquisition cycle to replace the current virtual training program of record, the Virtual Battle Spaces 3 (VBS3). The VBS3 is based on a commercial gaming engine called ARMA3 owned by Bohemia Interactive. The VBS3 is widely used within the U.S. Army for various simulation based training activities, including but not limited to infantry soldier skills training. The VBS3 is often criticized for being difficult to deploy and use, however actual usage data is difficult to acquire. The information contained in this paper is derived from field observations and data collection activities from March through December of 2015 at the 211th Florida Army National Guard Regional Training Institute's Warrior Leader Course. The purpose of the data collection activities was to determine baseline training effectiveness comparison of simulation based training methods versus traditional classroom and physical walkthrough means.

A research team composed of U.S. Army Research Laboratory (ARL) and University of Central Florida Institute for Simulation Technology (IST) personnel conducted ten data collection activities by folding into the monthly Warrior Leader Course training


S. Lackey and R. Shumaker (Eds.): VAMR 2016, LNCS 9740, pp. 424–432, 2016.
DOI: 10.1007/978-3-319-39907-2_41

cycle. Each month the team would travel to Camp Blanding, Florida and collect questionnaire and performance evaluations from the course managers. By combining the team member's observations, the questionnaire data, and the performance evaluations, certain conclusions backed by statistically relevant data could be drawn.

It is a natural reaction of the acquisition community to attempt to improve a product by replacing it with another material solution. Without understanding why the VBS3 adoption and usage was less than expected, there is a danger that the replacement system may have the same issues. In the following sections, there will be discussion of the applicability of the simulators to infantry soldier skills training, issues surrounding distributed training, understanding and leveraging the strengths of the medium.

## 2 Source Data and Field Observation

Observations in this paper derived from data collection events performed over a two year period from January 2014 to December 2015 at various Florida Army National Guard sites. The WLC managers worked closely with the ARL/UCF research team to determine how best to use it for a comparison study. This study was extremely fortunate to find an accommodating unit to allow for observation and even adopt suggested adjustments to the course.

A between-treatments experiment was designed to compare the training effectiveness of soldiers provided a virtual training method versus traditional training means. The period of instruction for this course is 20 days, with days one through 17 consisting of all soldiers provided the same classroom training with slides and instruction subject matter experts. Normally, day 18 is reserved for practical exercises and four hours is provided for simulator time. The practical exercises are provided in the form of virtual "walkthroughs" where the four major tasks are posed to the soldiers and they practice reacting to the situational stimulus. The simulation can pose situations such as indirect fire, improvised explosive device detection, land navigation to rally points, and more. The 211$^{th}$ RTI uses the U.S. Army's VBS3 product for this simulation.

The formal assessment of the squad's performance is done on days 19 and 20 using on-site situational training exercise (STX) lanes. For this experiment, and adjustment was made to the POI such that the class was separated into two groups and provided with different walkthrough training treatments. The control group was sent to a wooded areas and an instructor provided practical exercises with guided instruction (Fig. 1). This control group represents a traditional method of providing the practical instruction.

The experimental group was provided a training treatment that included simulation based training in a classroom setting and used the VBS3 suite (Fig. 2). Although the experimental design of the data collection activity treated the virtual treatment as a generic technology, the VBS3 was chosen as the target simulator and use existing training material for the course. The scenario provided within the VBS3 was created by onsite contractors and was an approximation of the STX lanes the soldiers would encounter the following day during their performance evaluations.

**Fig. 1.** Small group leader providing guided instruction


**Fig. 2.** Screenshot of virtual battle spaces 3 application in-use

The ARL/UCF research team was allowed unrestricted access to the course managers, classrooms, battle training center, practices areas, and STX lanes. The accommodations made by the 211th allowed for a deep examination of the course and the affect a simulation based training system had on the performance of infantry soldiers. The course managers were provided with periodic updates and briefed regularly on the progress of the data collection. The course managers also solicited advice from the research team on how to improve the use of the VBS3 system and played an integral role in the experimental design of the follow on study scheduled to start in the Spring of 2016.

## 3 Are Simulation Based Trainers Applicable to Infantry Soldier Skills Development?

The assumption to the question posed above is "yes". Is this assumption valid? Currently, infantry soldier tasks are not properly identified as candidates for simulation based training applications (Whitney et al. 2013). Since very little guidance is provided in the employment of the simulation based training, the ad-hoc nature of the training presents a number of challenges. Onsite simulator support (often consisting of contractors) is directed by the course managers to create scenarios aligned to the course material without much thought put into whether the tasks *should* be taught in the simulator. Applicability should be an early stage of the training design (Arthur et al. 2003), not an afterthought.

Virtual environments are not a substitute for instructor led training, rather they can be treated as proxies for the live environments. The need for guidance and feedback from instructors or intelligent tutors is still required (Vogel-Walcutt et al. 2013). Further, the guidance needs to be timely and directly applicable to the student's immediate situational awareness (Kirschner et al. 2006).

For the dismounted light infantry, three main activities they need to perform is shoot, move, and communicate (*FM 3-21.8 The Infantry Rifle Platoon and Squad* 2007). Any simulated activity, whether live or virtual, must have some value in the training to one or more of those activities. Shooting is a kinetic activity and it does not make sense to attempt to use a technology such as VBS3 to teach marksmanship, that is why the U.S. Army has other dedicated virtual trainers for that activity and physical ranges. However, the virtual environments could be leveraged to teach mission planning, or *when* to shoot.

The limitations of the technology must be identified and recognized as factors for what is trained by the simulation. The activities created to support the learning objectives inside the virtual environment must be based on validated learning theory (Landers and Callan 2012).

There is a pervasive belief that is supported by some in literature that serious games need high end graphics quality, or put another way high fidelity graphics equate to quality training and education (Chalmers and Debattista 2009). Graphics fidelity is a moving target with technological advances made continuously. Further, research into virtual environment instructional design suggests that factors such as scenario interactivity and functional alignment with the tasks to be trained have an impact on knowledge transfer as well (Hamstra et al. 2014).

## 4 Leverage Strengths of Medium

Relating the medium to dismounted infantry soldier skills, consider environments that allow for team coordination, particularly in a distributed manner. Distributed simulation based training can be performed in the barracks or at home station for pre-deployment acclimation of concepts and skills maintenance. Distributed training is key to the next generation of infantry soldier skills training, as even current technology allows for collective skills development. Since most tasks infantry soldiers are trained for are collective in nature, a simulation technology that allows for remote participation coupled with task coordination may be a more appropriate medium to use.

Time spent in the simulators will allow for the soldiers to gain tool expertise as well as provide opportunity for self-paced learning. Allowing soldiers to access the simulators from home station offers a cost effective means for training by allowing collective activities without the need for physical co-location at a battle training center (Fig. 3).

**Fig. 3.** WLC Students working through react-to-contact simulations in VBS3

Distributed training can be done safely. In the U.S. military, a significant barrier to adoption is information assurance policy. For next generation systems, decoupling data from the simulator such that the sensitive portions of the training can be performed behind a firewall, but critical issues such as tool training can be done safely on open networks using benign unclassified or generic scenarios. End-to-end encryption on modern platforms is becoming feasible on the near-term horizon. Additionally, encryption within the various content and terrain databases is also feasible and would add an extra layer of protection to the training networks. Assuming the firewalls are compromised, if the data is harvests from the databases or midstream through man-in-the-middle attacks, the data would be useless to the attacker.

A technology development lesson learned with current simulation based training environments is that information assurance and encryption cannot be treated as an afterthought. Careful design considerations and requirements specifications must be defined during the initial stages of systems engineering for new synthetic training environments. Caution is strongly urged to avoid commercial entertainment solutions or products that have no hope of accreditation due to licensing restrictions.

## 5 Common Soldier Feedback

The ARL/UCF research team was rewarded with a wealth of feedback from the soldiers during the months of data collection. Common themes began to emerge from the feedback and a few of the issues are discussed here.

In this case study, leadership training stands out as an appropriate candidate application of the technology. The soldiers reported they were comfortable with the communications mechanisms within the VBS3 and were able to communicate with each other and squad leaders effectively. The squad leaders were observed directing the fire team leaders for effective response coordination. Radio discipline and correct communication skills with the tactical operations center was positive, allowing the soldiers to adequately communicate coordinates and timing of various contact situations as well as correctly call in medical evacuation (Fig. 4) and improvised explosive device disposal requests.


**Fig. 4.** VBS3 Successful call for medical evacuation

The soldiers reported difficulty with the user interfaces. The VBS3 was described as confusing and required too much time to gain proficiency in its use. To put into context, the control group of the WLC study was able to start task training immediately upon arriving at the live training area, normally at 0800 on Day 18 of the POI. In contrast, the soldiers in the virtual training group received approximately 90 min of VBS tool training and acclimation exercises before WLC task training began after a brief break at 0945. Much less time was devoted to task training and walkthrough rehearsals than the control group. The consequence was that practical exercise time for the virtual group either reduced the number of tasks that were trained or the amount of time for each task was truncated.

The soldiers reported the locomotion interface into the virtual system was not natural given the kinds of tasks they were asked to perform and that it was difficult to discriminate between team members. Further, they had difficulty discerning direction of fire in the simulation as naturally as in a live training exercise.

Game mechanics for the entertainment industry are different than in an infantry soldier training context. For example, pulling 360 security is not entertaining, glamorous, or fun. Many of the tasks the soldiers are trained for are performed collectively and not entertaining. To relieve the tedium of some of the tasks, it is suggest that a narrative be included in the scenario. For example, if the tasks are to react to contact of some kind, then it would be beneficial to set the stage of the scenario with a back-brief to include some local politics, situational awareness of any known insurgent activity, perhaps some dossier information on major personalities in the area, etc.…

## 6 The Applicability Continuum

The findings from the observations described in this paper underline the importance of understanding which tasks are most appropriate for use with simulation based training technology. There is likely a sliding scale of applicability, a continuum, along which tasks fall. Since major factors such as performance, time, and cost are measures of the return on investment of the simulation technology, it is critical the training community understands how best to apply the new systems in the most appropriate way possible.

Figure 5 shows a graphical representation of the proposed continuum. The center of the continuum, or $< 0, 0, 0 >$, represents the current traditional (non-simulation based) training methods. We have a clear understanding through decades of live training with infantry soldiers to be able to look at historical records for baseline data. It is understood how much time (period of instruction) is takes for a given class, such as the Warrior Leader Course mentioned previously. Costs are understood for travel, lodging, instruction, and site usage. Lastly, performance expectations for the course are also understood. It is important to note that the continuum must be populated by data gathered from different tasks and genericizing assumptions that simulation based training is applicable to one task based on the data from a different task must be done with caution.

Let’s examine a hypothetical example and apply it to the continuum in Fig. 5. A particular task such “react to ambush” may yield from a sample of 20 squads that soldiers trained with a simulation on this task are able to demonstrate significant performance gains at low cost and at the same amount of time (Fig. 5). This is represented by the diamond glyph.

Over time, as more and more tasks are examined and added to this continuum, it is anticipated that certain trends my present. The “clumping” of data may indicate that certain tasks may yield common applicability characteristics that will allow future decision makers to plan for the inclusion of simulation based training in the courses. For example, if the goal of the class is to reduce as much time as possible but maintain baseline proficiency, then selecting only the tasks that lie on the negative side of the time axis will satisfy the requirement.

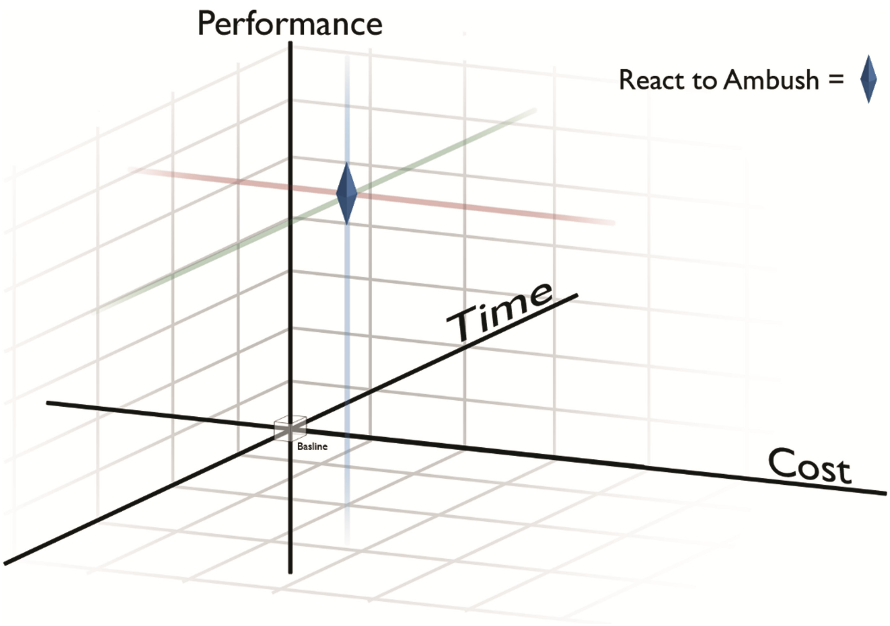


**Fig. 5.** Applicability continuum with performance, Time, and Cost axes

## 7 Conclusions

A number of key observations and lessons learned can be derived from this study. For example, a common user interface for synthetic training environment using simulation based training for infantry must be considered. If the U.S. Army is adopting a virtual environment program of record, then it makes sense to teach it in basic training. This common user interface needs to be introduced early and reinforced often throughout the soldier's career. A possible solution may be to make the user interfaces reconfigurable, recognizing that "one-size" does not fit all.

A material solution is not the entire answer. Replacing the current trainer with a new training system without changing usage behavior will likely result in similar disappointment. The Army is motivated to address gaps with material solutions, but a thorough study of the applicability of this technology to the skills required by the soldier is critical. A call for caution not to rush to a new acquisition cycle without trying modified approaches first.

Although there is room for improvement for the VBS3 application, the data suggests changes in the deployment and usage of the VBS3 could greatly increase its adoption and training effectiveness. It is hoped the acquisition community will examine the research performed in this area and adopt not just a material solution but also a change in the way the technology is used.

The U.S. Army needs to establish a firm return on investment (ROI). By formalizing methodologies for assessment (Pickup 2013) and creating rubrics based on scales rather than Boolean subject matter expert decisions will assist in the formulation of ROI. ROI starts with a new rubric, categorical data can only establish if a treatment is different but not by how much and the traditional “Go/No Go” assessment method is inadequate. It is not enough to show parity in the training treatments (traditional versus virtual), but a clear metric of goodness can answer the basic question: Are simulation based trainers worth the investment? The simulators cannot only be as effective as traditional means, they must establish themselves as superior in some way (Riecken et al. 2013), such as through cost, soldier performance, and time advantages.

**Acknowledgements.** The U. S. Army Research Laboratory and the University of Central Florida research team would like to express our profound gratitude to the dedicated men and women of the 211th without whom this work could not have been performed. We thank you for your service to our country.

## References

Arthur Jr., W., Bennett Jr., W., Edens, P.S., Bell, S.T.: Effectiveness of training in organizations: a meta-analysis of design and evaluation features. J. Appl. Psychol. **88**(2), 234–245 (2003). http://doi.org/10.1037/0021-9010.88.2.234

Chalmers, A., Debattista, K. (2009).: Level of realism for serious games. In: Proceedings of the 2009 Conference in Games and Virtual Worlds for Serious Applications, VS-GAMES 2009, pp. 225–232 (2009). http://doi.org/10.1109/VS-GAMES.2009.43

FM 3-21.8 The Infantry Rifle Platoon and Squad, vol. 8, Washington, D.C. (2007). http://armypubs.army.mil/doctrine/DR_pubs/dr_a/pdf/fm3_21x8.pdf

Hamstra, S.J., Brydges, R., Hatala, R., Zendejas, B., Cook, D.A.: Reconsidering fidelity in simulation-based training. Acad. Med. J. Assoc. Am. Med. Coll. **89**(3), 387–392 (2014). http://doi.org/10.1097/ACM.0000000000000130

Kirschner, P., Sweller, J., Clark, R.: Why minimal guidance during instruction does not work. Educ. Psychol. **41**(2), 75–86 (2006). http://doi.org/10.1207/s15326985ep4102

Landers, R.N., Callan, R.C.: Training evaluation in virtual worlds: development of a model. J. Virtual Worlds Res. **5**(3), 1–22 (2012). http://journals.tdl.org/jvwr/index.php/jvwr/article/view/6335/6300

Pickup, S. (2013).: ARMY AND MARINE Better Performance and Cost Data Needed to More Fully Assess Efforts (2013). http://www.gao.gov/assets/660/657115.pdf

Riecken, M., Powers, L.T.C.J., Janisz, C., Kierzewski, M.: The Value of Simulation in Army Training (13073), 1–16 (2013)

Vogel-Walcutt, J.J., Fiorella, L., Malone, N.: Instructional strategies framework for military training systems. Comput. Hum. Behav. **29**(4), 1490–1498 (2013). http://doi.org/10.1016/j.chb.2013.01.038

Whitney, S.J., Temby, P., Stephens, A.: Evaluating the Effectiveness of Game-Based Training: A Controlled Study with Dismounted Infantry Teams. Edinburgh (2013)