Games – Just How Serious Are They?

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ABSTRACT

As military forces around the world begin to adopt gaming technology as an apparently cost effective and robust means for military tactical training it seems appropriate to consider how well suited they are for this task. This paper uses an evidence based approach to illustrate how American, British, Canadian and Australian forces are applying serious game (SG) technology to meet a variety of training needs. In particular, the paper uses these specific examples to address three questions: What tactical training requirements are serious games best suited to meeting? How effective and efficient are they at meeting those requirements? What are the technological limits associated with their use?

In answering these questions, the paper concludes that SGs are providing a cost-effective means to provide experience-based learning with emphasis on cognitive and increasingly affective training domains. War fighters will not develop the expert psycho-motor skills they need to effectively employ their weapon systems using game-based training. However, once the team of experts in various weapon systems is created, SG technology affords trainers the opportunity to turn them into an expert team capable of communicating well with the cognitive skills they need to effectively operate as teams. The examples demonstrate that this is true for infantry, armoured or combined arms training in open or urban terrain and holds for the very technologically demanding case of aviation training. To take full advantage of this capability, SGs need to be included as part of blended training solutions that take advantage of the strengths of the various types of training available with the SGs providing an experience-based learning alternative that has not been practically affordable since the end of the Cold War.

ABOUT THE AUTHORS

Paul Roman, CD, PhD, is an Associate Professor of Management Science and Operations Management at the Royal Military College of Canada and an Associate Professor at Queen's School of Business. After serving 20 years in the Army as a Signals Officer, Paul became a professional engineer with a successful consulting practice applying his skills in business process re-engineering to projects ranging from the development of a combat development process for the Canadian Army to enhancing the relationship between operations and maintenance at Syncrude Canada Ltd. For the past several years, he has been assisting the Army in developing and implementing a Synthetic Environment Strategy. This strategy helps to formulate policies and plans regarding the application of modelling and simulation as the primary enabling technology necessary to help the Army meet its strategic objectives. In this capacity, Paul leads the Army's Synthetic Environment Coordination Office that results in his interaction with the M&S organizations throughout the Department of National Defence and with Canada's major Allies. Paul has several publications to his credit and has chaired multiple simulation and training conferences in Singapore, the UK and Canada.

Doug Brown is the Canadian Army Synthetic Environment Repository Manager in the Directorate of Land Synthetic Environments. He graduated from the University of Western Ontario in 1981 with an HBSc in Computer Science. He then spent 15 years as a Defence Scientist in Military Operational Research holding positions with the Canadian Navy and the Canadian Army. He also had a posting as an Operational Research Scientist in the SHAPE Technical Centre in The Hague. In 1996 he moved to the then infant Joint Command and Staff Training Centre in Kingston Ontario as the principle modeling and simulation expert. He has remained there over the past 12 years. He has been responsible for the design, construction and execution of synthetic environments for hundreds of Canadian Army and Canadian Forces exercises. He has several publications to his credit.

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INTRODUCTION

Few would argue that the pedagogical advantages and impressive levels of resolution offered by the latest in video game technology make it clear that serious games (SG) have a role to play in military tactical training. Trainers close to the front lines have started adopting and adapting these tools to meet real and urgent training requirements.

In the Canadian Forces, for example, several training establishments are using their own budgets to acquire these surprisingly affordable software programs. There is no shortage of choice either as the video game industry comes to appreciate, what from their perspective might be perceived as a niche market, an opportunity to differentiate their products to meet the special needs of the military training market. Free trial licences and a willingness to accept feedback and make improvements are good business practices for these companies as they incorporate the needs of military users into products that, as a result of the increased realism, appeal to a much broader audience. One need look no further than the "Serious Games Showcase and Challenge" now in its third year at the I/ITSEC Conference to appreciate the broad scope of potential applications for military training. Furthermore, the 2007 I/ITSEC Special Event – "DoD Training – Impact of Gaming Technologies" was aimed at helping DoD determine what specific training needs could be filled with the application of game technology and gave serious games practitioners an opportunity to discuss how the industry might best meet these needs.

Urlocker and Smith (2007) chronicle the recent history of video game technology in the US Army and how it has grown to become a disruptive technology augmenting or replacing many of the less flexible and more expensive training technologies of the past. From the failed initial attempt with "Marine Doom" through the marketing success of "America's Army", the authors describe how and why video game technology has found its way into the main stream. This phenomenon is not limited to the military however, as explained by Smith (2007) who describes the five forces that are driving the adoption of game technology within multiple established industries of which the military is only one. Borrowing from the Five Forces Model popularized by Michael Porter (Porter, 1979) Smith uses an adaptation of this model to describe a traceable adoption pattern that can be easily mapped to the US Army experience with SGs (see Figure 1). It includes the niche market success (for recruiting) achieved through America's Army which provided the technology a new legitimacy or "foot in the door" that afforded innovators the opportunity to explore other options based upon an already legitimized technology. The next step in the adoption pattern, as described by Smith, is for applications to be certified for use by training authorities. A recent report on Coalition Simulation Interoperability in support of the American, British, Canadian and Australian (ABCA) armies' program highlighted that VBS 2® and OneSAF were the two simulation systems that all coalition armies were using or planning to use in the near future (Roman, et. al., 2007). This report argued for common tools as the best means to achieve simulation interoperability and proposed a SG (VBS 2®) and OneSAF as the current lead candidates for coalition simulation interoperability. The recommended practices in this report may lead to the last step in Smith's adoption pattern - mandatory standards. However, this may be several years away as the experimentation force (one of Smith's 5 forces) is likely to continue to influence the adoption pattern in the near future. Part of that experimentation is associated with determining the most effective ways to use game technology in support of military tactical training.

Pringle (2007) also supports the use of game technology in military training. He suggests that the extent to which SGs are expected to play an increasing role in training will depend on an ability to blend technologies in such a way that the training benefit is maximized. This implies a requirement to be able to measure the improvements achieved through the adoption of these technologies and a willingness to experiment with them. Unfortunately there are very few well defined or accepted standards for the specific measurement of the effectiveness of SGs and few military organizations conduct the required studies but rather seem to accept their use on faith.

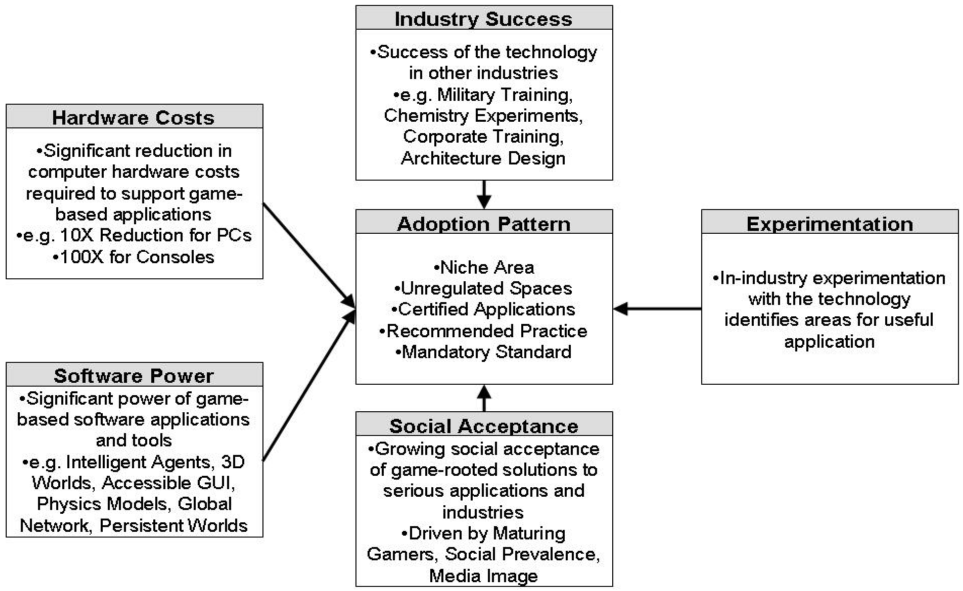

Figure 1: Five Forces behind the Adoption of Game Technologies by Diverse Industries (Smith, 2007)

One might speculate as to why this is the case, but there is considerable anecdotal evidence to suggest that commanders simply trust their intuition in terms of the effectiveness of these tools. For example, in preparation for an Afghanistan deployment, a Canadian Battle group employed the SG VBS® from Bohemia Interactive. As soon as the commander saw the value in the pilot implementation at the home station, he decided to integrate the tool into his Battle Group's high readiness training. It was by no means seen as a replacement to other training, but rather an enhancement that allowed the squads, sections and platoons to develop a cognitive understanding of the tactics techniques and procedures (TTPs) for various scenarios before executing them as part of live training. Difficult to practice scenarios such as convoy training were also greatly facilitated through the use of the game (Cote, 2007). The commander in this case clearly used his intuition to develop a blended training solution emphasizing the game for cognitive and difficult to practice skills combined with traditional live training to meet his specific needs.

The examples above illustrate that SGs are being used for some very serious purposes. There is a growing body of evidence to support the effectiveness of these tools, but there appears to be a lack of overall guidance on their strengths and current limitations.

In considering the question: "How Serious Are they?" this paper will attempt to address the following:

- What tactical training requirements are serious games best suited to meeting?
- How effective and efficient are they at meeting those requirements?
- What are the technological limits associated with their use?

WHAT TACTICAL TRAINING REQUIREMENTS ARE SERIOUS GAMES BEST SUITED TO MEETING?

The current operational tempo within the Canadian Army has forced training policy and planning organizations to become increasingly outcome oriented. While there is a great deal of interest in all of the specific tools that are available, the pressures of limited resources (most importantly, time, personnel and money) have created a very strong desire for a systems view of both requirements and the means available to achieve them. The training needs framework (TNF), was created to provide this view (Roman and Bassarab, 2007). Figure 2 displays where SGs, are being used to support Canadian Army tactical training from individual (level 1) to company (level 5).

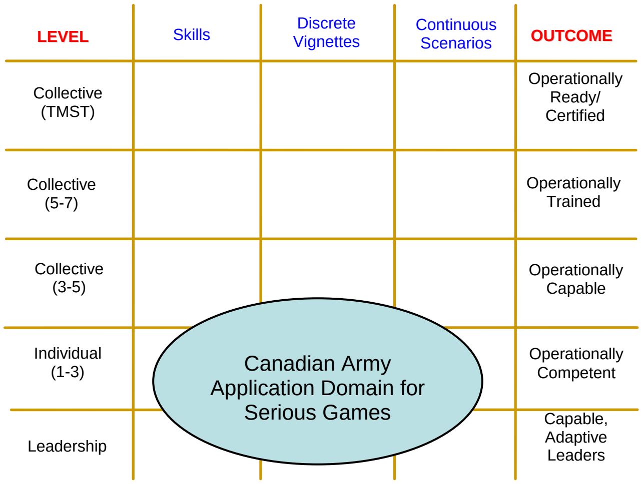

Figure 2: Application domain for SGs on the Training Needs Framework (Roman and Bassarab, 2007)

In the Canadian Army, the process of preparing forces for operational deployment is known as the "Road to High Readiness" (RHR). In many respects, the RHR is redesigned for each organization that goes through the process. It does, however, follow a relatively standard progression from individual skills to small team skills, combined arms teams and eventually full battle group tasks in the context of a brigade level operation. It does this by using the list of Battle Task Standards (Canadian equivalent of Mission Essential Task List) as the guide for the required capabilities. The culminating activity is a confirmation event conducted as live training at the Canadian Manoeuvre Training Centre (CMTC) in Wainwright, Alberta.

The RHR process uses experiential learning as its foundation. Menaker, Coleman, Collins and Murawski (2006) summarized the recent research on experiential learning as it relates to military training and advocated a structured learning cycle upon which to base the process. The authors stated that experiential learning events must:

- Engage the learner mentally.
- Emulate real-world environments. Real-world refers to the physical environment and the cognitive tasks.
- Allow the learner to experience effects of the decisions.
- Require the learner to reflect on outcomes of their actions. Build on established military practices of debriefs, lessons learned, and after action reviews.
- Revisit experiences with increasing levels of complexity to expand the learners' knowledge and skills by increasing the number of events, pace and emotional intensity.

The TNF supports this list of requirements. However, it goes further to provide a specific structure against which an appropriate learning cycle can be established. For example, the cycle builds from basic skills, such as small arms proficiency, to discrete vignettes in which the skills are practiced within various contexts. One specific example of this would be convoy operations. It then builds to continuous scenarios in which the learners receive increasing levels of cognitive loading where they must decide which actions are appropriate without knowing the overall context as would have been the case in the discrete vignette. Roman and Bassarab (2007) provide a specific example that illustrates the role of SGs as part of an overall training plan for rules of engagement training. From this example, the authors show that SGs provide an excellent fit with the requirements described above.

In addition to the Canadian Experience, British and American researchers are arriving at similar conclusions. In a series of studies funded by the UK Acquisition Research Organization, QinetiQ researchers demonstrated that training could be enhanced for dismounted infantry section and fire team TTPs. Anatolik (2005) went further to examine how much synthetic environment (SE) based training was appropriate in terms of a balance with live training. Although this study was limited to urban environments, users and trainers agreed that the video game based Dismounted Infantry Virtual Environment (DIVE), using the commercial game engine Half Life, was good for the following:

- Introducing, teaching and rehearsing new drills and TTPs.
- Showing the viewpoint of both sides, enemy and own forces.
- Representing the use and effects of current and future systems that either cannot be or are poorly represented in conventional training.
- Reviewing actions and events from all perspectives both during the event and in post game analysis.
- After Action Review (AAR). This was reported as a 'big win' and develops a feeling of inclusion in the training process for all participants.
- Developing new teams and fostering teamwork.

It was also reported that the representation of weapons and systems capabilities that cannot be represented in conventional urban training was extremely valuable. These included grenades (hand-thrown and under-slung), suppression, shooting through cover, and the effects of casualties.

Although the treatment of casualties is beyond the scope of this paper, it is notable that over the past decade, virtual reality (VR), which in this case includes game-based applications, is starting to make a significant impact on behavioural healthcare. The inaugural issue of the Journal of Cyber Therapy and Rehabilitation (JCTR) comprises seven papers that describe virtual reality applications for the treatments of psychological problems from schizophrenia to eating disorders (Weiderhold, 2008). Of particular interest from a military training standpoint is a paper written by Weiderhold & Weiderhold (2008) which is dedicated to VR applications in the treatment of post traumatic stress disorder (PTSD) and stress indoctrination training (SIT).

Australian researchers are also using VR integrated with SG technology to overcome aviation aircrewman training deficiencies. Carpenter (2008) describes an Australian Defence Force success that created the Aircrewman Virtual Reality Simulator (AVRS). This simulator provides a 360 degree field of view through a head mounted display that is stimulated by the SG VBS 2®. Carpenter explains that the AVRS project was created to address the unacceptable failure rates for aviation air crewman. The root cause was determined to be insufficient practice in appropriate scenarios and two simulation alternatives were evaluated to meet this need. They compared a high end dedicated Military Off-the-Shelf (MOTS) option, which was low risk but expensive, to a significantly higher risk development around VBS 2® that would cost considerably less. The project was approved in May, 2006 with all systems being delivered by November, 2007. Figure 3 shows the VBS 2® based AVRS instructor module in the foreground with the trainee module in the background. The trainees get a full 360 degree VR view through the headsets.

Figure 3: Aircrewman Virtual Reality Simulator (Carpenter, 2008)

Carpenter reports improved performance with a substantially improved pass rate, higher standards and increased throughput as primary benefits for which the system was created. Additional benefits include the opportunity to practice in more realistic scenarios and in all types of weather. Students who require remedial training have the opportunity to do so and, as seems to be the case when cognitive skills are improved through game-based techniques, the live training was reported to have become both safer and more effective.

EFFECTIVENESS AND EFFICIENCY OF SERIOUS GAMES

The efficiency argument for serious games is relatively easy to make based upon cost savings. This is true of simulation in general, but even more so when using commercial off-the-shelf (COTS) software compared to relatively more expensive purpose built military simulations and simulators which need to be networked together for collective training. The implicit assumption with this argument, however, is that game-based training is being used to replace live training and this does not appear to be the case. Rather, SG training is increasingly being applied as part of blended training programs or as an enhancement to live training. What the SGs may be replacing, however, is instructor lead classroom learning and as a result, may well have a cost increase associated with their adoption and use. Many students can follow a single PowerPoint presentation on how to perform room clearing TTPs, however for a squad to practice and learn the cognitive skills in the SG will require hardware and software for each trainee. The distinction between following a presentation and learning in an SG is intentional because the SG enables an experience-based approach which is more effective than instructor lead PowerPoint presentations (Menaker et al., 2006). However, it clearly will cost more than classic classroom instruction which is very efficient, but arguably not very effective for training tactical skills. One might observe that the trend to increase experience-based learning through an increase in the use of SGs for tactical training is really a return to the training paradigms of the cold-war era which had considerably more emphasis on experience-based live field training. As part of the peace dividend, resulting from the end of the Cold War, there has been a significant decrease in training budgets and, as a result, considerably less "live" experience-based training. SGs provide a cost-effective alternative.

An excellent illustration of the relationship between efficiency and effectiveness of game based training is occurring at the Canadian Combat Training Centre (CTC). CTC comprises several specific schools and is currently experimenting with multiple SGs to meet dynamic training requirements. In one trial, the Armour School recently incorporated VBS® into the Troop Warrant Officer's course. Hill (2008) provided an assessment of the cost savings (efficiency) and performance improvements (effectiveness) associated with increasing the amount of game-based training in successive serials of the Troop Warrant Officers course conducted in 2007. In the first serial of the 6 week course, the trainees received 1 day of VBS® training and 5.5 weeks of live training in the field. Figure 4 shows a partial training layout including a tank crew (Leopard) and a surveillance crew (Coyote). Figure 5 is a photograph of one of the workstations. Based on the success with VBS® during the first serial, the training staff increased the VBS® portion to 2.5 weeks for the next serial and decreased live training to 3 weeks.

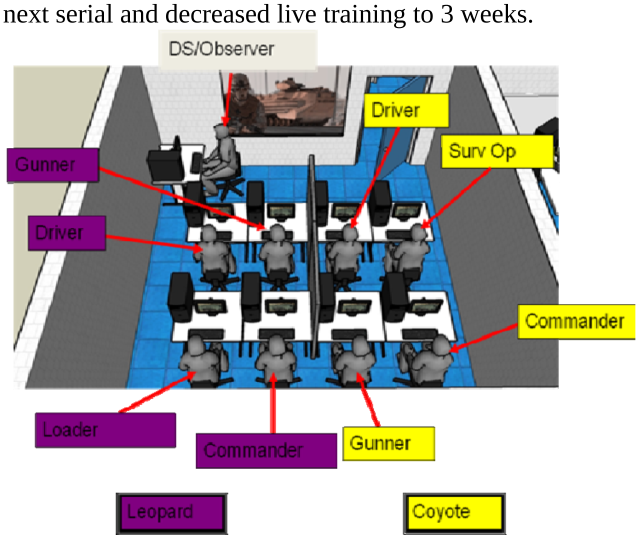

Figure 4: Partial Layout for Armoured Troop Warrant Officer Course (Hill 2008)

Figure 5: VBS 2® Workstations in the Armour School Battle Lab (Hill 2008)

The costs of the second serial were reduced by approximately 33% due to the need for less fuel, food and field pay compared to the first serial. More significant, however, was the effect on performance (effectiveness). Hill measured performance based upon student success rates as defined by the proportion of students that pass this demanding course and the number of traces (live battle runs) needed to demonstrate proficiency. Table 1 presents the results from three consecutive serials of this course. Serial 0602 had no VBS® training, and can be considered a control group. All three serials had 18 students.

	Serial 0602 (No VBS®)	Serial 0701 (1 day VBS®)	Serial 0702 (2.5 weeks VBS®)
% pass on 1st trace	0	30%	67%
% pass by ½ of traces	61%	72%	100%
% pass by end of course	72%	83%	100%

Table 1: Performance Results with Increasing Amounts of Game-Based Training (Hill 2008)

As was the case with the Australian AVRS example described earlier, the game-based training resulted in a significant improvement during the field portion of the course. Serial 0702 was reported to be the first course with a 100% success rate which was achieved in all cases with only two live traces compared to the six traces required to achieve an 83% success in the previous serial. In his presentation of these results, Hill pointed out that there were many potential confounds associated with the improvements in performance including, for example, that there were different instructors for each course. Even so, the impressive improvement in performance has resulted in CTC considering the addition of SG content in the majority of the courses they deliver.

Despite this clear success, Hill and others emphasize that the cognitive training provided by game-based simulation does not replace the need for live training. They argue that the key to effective tactical training is to develop affordable, blended training solutions, as prescribed by Pringle (2007), which take advantage of the strengths and compensates for weaknesses of all of the training modes available.

A potential strength of game-based simulation lies in the area of behavioural or affective training. Whereas cognitive training addresses the mental skills required by trainees to develop knowledge, affective training deals more with their emotional state and ability perform under stress. Although there is a growing body of evidence supporting the effectiveness of game-based training for cognitive learning, there are relatively few studies exploring the affective learning aspects of game-based desktop simulators. A recently completed three year Defence Advanced Research Projects Agency (DARPA) sponsored project employed physiological monitoring during simulation training and testing as a means to assess the degree of affective training provided by the game (Weiderhold and Weiderhold, 2006b). The overall objective of this research was to assess the effectiveness of using game-based laptop training with US armed forces personnel participating in simulation training prior to conducting live training. Specifically, the investigation examined the effectiveness of desktop training simulators to teach tactical and trauma care skills, to practice stress management and to improve performance during real-life combat situations. Nine hundred and seventy participants trained in a virtual combat scenario while their stress and arousal levels were monitored through non-invasive physiological means. A control group did not receive game-based training. All the participants were then tested in a live version of the same combat scenario to determine the effectiveness of the desktop immersive training. One subgroup of 210 United States Marine Corp (USMC) soldiers was observed during an 11-day training program. Ninety of the 210 subjects received desktop immersive training prior to live training and their performance was compared to the remaining 120 subjects who did not receive desktop training. Although the scenario in this example (proper identification and Breach techniques for a shoot house), was significantly different from the open terrain armoured traces described in Hill's presentation, the results were very similar. All personnel who had the opportunity to perform the scenarios in the game prior to the live training were assessed to be 100% accurate on all runs whereas the control group (no game-based rehearsal) was only 80% accurate 80% of the time. Furthermore, it was reported that the game-based rehearsals resulted in improved spatial awareness and the trainees completed their tasks more quickly with less need for communication as the team skills had been improved during the rehearsal. The desktop immersive trained personnel performed better at spatial awareness within the shoot house, moved more quickly entering the shoot house and required less communication than the control group, as each person was able to anticipate the other/team movements, in comparison to the control group that took an average of 6 seconds longer to perform the same tasks.

The study went into further details exploring more affective aspects for different groups of US personnel and came to the conclusion that affective and cognitive learning in desktop immersive trained groups helped them out perform in all tasks compared to those that had not received the training. Weiderhold and Weiderhold, (2008) explain this phenomenon as stress inoculation training (SIT) and argue that the benefits described above are due in part to the experience gained in the game and how that reduces the stress of performing in the live equivalent. This effect has been so pronounced, that the success demonstrated with these military examples has resulted in similar research efforts to provide SIT for medical personnel, the US Coast Guard and SWAT teams (Weiderhold and Weiderhold, 2008).

Another good practical reason to use simulation for training is if the actual equipment is 7000 miles away. In an excellent blended learning example, O'Bea and Beacham (2008) described how three types of simulation are being used to train US soldiers on route clearing operations prior to deployment in IRAQ. The motivation for this work was based upon the fact that the primary equipments used for clearing improvised explosive devices (IEDs) are being fielded directly into theatre without any systems in the US to support training. Operators do not see the actual equipment until they are deployed. To compensate for this gap, O'Bea and Beacham (2008) described how the combination of a "live" part-task trainer, a virtual reality system trainer and a game-based convoy trainer have been employed to get the Army Engineer Clearance Company ready for deployment. The part-task trainer is a hardware-based simulator with identical controls and performance characteristics to the mine clearing arm on the Buffalo that enables the operators to develop their psycho-motor skills as operators of the equipment. The Virtual Route Clearance Trainer (VRCT) is combined with classroom instruction to allow detachments to train as a team on the latest mine clearing TTPs and is reconfigurable to represent three different mine clearing systems. The training culminates with a game-based convoy scenario that employs DARWARS Ambush in which the clearance company detachments take up their role as part of a convoy allowing the full convoy team to train together in realistic scenarios that are tailored to meet specific threats expected to be encountered during operations. Figure 6 shows the DARWARS Ambush visual models of three of the clearance company's vehicles including the Buffalo with the articulated arm extended.

Figure 6: DARWARS Ambush Screenshot (US Army Photo, O'Bea and Beacham, 2008)

The mine clearing example and its use of a part-task trainer serves as a good reminder that Desktop game-based training is not well suited for the psycho-motor aspects. This is the one area in which certain negative learning aspects may come into play. To overcome this, low level mock ups and stations must be created that replicate the training that is desired and do not cause participants to achieve proficiency in an aspect of training that is not realistic. However, desktop game-based simulations can provide leaders and team members the ability to effectively practice the cognitive and decision making skills that they will need in real world situations. Knerr (2007) states that through focused, repetitive, deliberate practice with feedback based on performance, this is an ideal and effective method for training. What the examples above serve to illustrate is that this training should not replace live training, but rather SGs can make live training much more effective and efficient with soldiers meeting and even exceeding standards more quickly. The experience-based cognitive and affective learning provided by well conducted game-based training therefore, can make an overall blended approach both more effective and efficient.

WHAT ARE TECHNOLOGICAL LIMITS OF SERIOUS GAMES?

In examining the last question, two serials of a Canadian aviation exercise, Winged Warrior will be considered. Exercise Winged Warrior has traditionally been a live exercise intended to test tactical helicopter pilots in their role as aviation mission commanders during the planning end execution of complex missions. It serves as an excellent example to examine technical limits as tactical aviation is arguably the most difficult (military) case for an SG considering terrain models and graphics performance requirements. In addition to being relatively fast movers capable of covering large geographical areas, helicopters fly at low altitude demanding a high degree of visual detail. Aircraft flying fast and high can get by with a low-resolution picture draped over a low fidelity Digital Terrain Elevation Data (DTED) skin. This is not the case for aviation missions where pilots may often fly nap of the earth and would be especially limiting in exercises like Winged Warrior that include infantry units being supported by aviation. Winged Warrior also requires that the SG be federated with other simulations in order to meet a broad set of training objectives.

Typical aviation missions executed during the exercise included:

- Reconnaissance and surveillance
- Direction and control of fire
- Provision of fire support
- Combat airlift/tactical transport
- Logistical transport
- Communications support

Roman and Brown (2007) describe that the cost of the live exercise had become too great resulting in the creation of a game-based equivalent using a combination of the SG Steal Beasts® and the Joint Conflict and Tactical Simulation (JCATS) constructive simulation with the first serial occurring in 2006. Although the 2006 version of Winged Warrior was a tremendous success as the first SG application for command and staff training at the Directorate of Land Synthetic Environments, the sponsors of the 2007 version of the exercise wanted to overcome the following shortfalls from the previous year:

- Communications simulation limitations
- Lack of night operations
- No civilian personnel or vehicles
- No navigation instruments or electronic defence measures
- No door guns
- No control over weather
- No fast air
- Poor overview of entire battle-space

There was also a strong desire on the part of the Air Force to expand the scope of the exercise to include:

- Improving the in-air Command and Control representation
- Expanding the training audience to include a Helicopter Squadron's Battle Staff
- The addition of distributed simulators.

Winged Warrior 07 was executed during the period 22-31 Oct 2007 at CFB Valcartier, just outside of Quebec City. Figure 7 shows how the Area Simulation Centre, housed in a former indoor rifle range, was configured for the training.

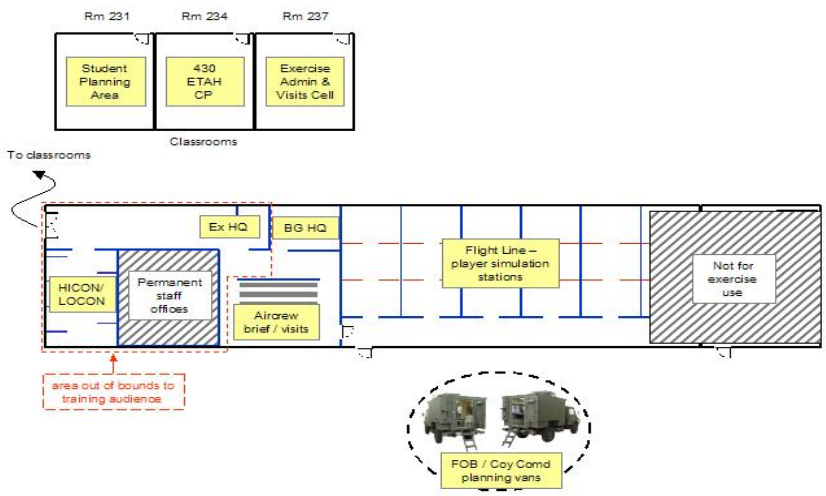

Figure 7: Exercise Winged Warrior 2007 Layout

Winged Warrior was an unclassified exercise set in simulated Afghanistan using typical aviation missions on geo-specific terrain. See Figure 8 for an out the window view for the helicopter pilot in VBS 2®. Threats were typical and varied from the very simple to the extremely complex and included both civilian and non-combatants. To overcome the shortfalls from the 2006 version of the exercise, a simulation federation was formed with IEEE 1516 (HLA) forming the basis for the link to three geographically dispersed exercise locations (Valcartier, Ottawa and Kingston). IEEE 1278 (DIS) was used to link VBS 2® with JCATS. The following simulation components formed the federation:

- VBS 2®
- JCATS
- Raptor Simulator
- ASTi® simulated Radio

VBS 2® was selected as the primary visual simulation for the exercise. The majority of objects on the simulated battlefield were generated through VBS 2® with JCATS providing a larger background air picture and the Raptor simulator providing a single virtual platform for the exercise. Given the size of the terrain and the number of objects that had to be represented, the capability of VBS 2® was considerably stretched. Indeed it was well outside the nominal bounds of what this game engine was designed to be able to handle (ground based personnel and vehicles). This was the first military exercise that employed VBS 2® for a tactical aviation primary training audience. Despite these challenges, VBS 2® performed very well, meeting most of the pre-exercise training requirements. Game engines clearly have come a very long way. The ability to process and display a very large terrain file with a high degree of detail and lots of simulation entities speaks to a maturity of this technology. What was achieved on normal computer hardware using an adapted first-person shooter game for this exercise simply could not have been achieved two years ago.

Figure 8: Pilot view in VBS 2®

The VBS 2® tool suite that supports terrain and scenario generation is due for a major upgrade in 2008. These tools were in their infancy during the lead up period to Winged Warrior. This complicated the construction of the terrain model for the exercise as this was the most complicated user created terrain model to date. Bohemia Interactive was extremely helpful in assisting in the use of these tools. Many of the observations made and lessons learned have been integrated in the new versions of these tools that will be sold as VBS 2 VTK® (Butcher, Johnson and Morrison, 2008) which will comprise both the game software, the VBS Tool Kit (VTK) to allow user modification and the software necessary to link VBS 2® with virtual or constructive simulations using HLA or DIS as appropriate.

The inclusion of a general-purpose constructive simulation proved to be a very useful component to the synthetic environment. From it, the overall air picture was easily generated and able to stimulate the secondary training audience from the helicopter squadron command post. This change from the 2006 version of the exercise was so successful that an even more advanced VBS 2® and JCATS synthetic environment was created. It is being used to support high readiness training of helicopter units potentially deploying to Afghanistan in 2008 and for future iterations of Winged Warrior.

To date, the Winged Warrior series of exercises, arguably among the most demanding scenarios for SGs, have yet to be constrained by technical limitations. Looking forward, the hardware and software will only improve. Bigger terrain tiles, more terrain objects, better visual effects and more entities will be able to be displayed and natural market forces will result in game companies continuing to compete through improved capabilities which will in turn allow the generation of richer and richer visual environments and ultimately better and better training of this type.

SUMMARY

This paper set out to address three questions regarding the use of serious game technology:

- What tactical training requirements are serious games best suited to meeting?
- How effective and efficient are they at meeting those requirements?
- What are the technical and pedagogical limits associated with there use?

Several specific examples have been provided that address the first question. It would be presumptuous, however, to assume that a list of specific requirements can be provided since the technology continues to evolve, new requirements continue to emerge and innovative researchers and trainers will continue to discover new uses over time. It is possible, however, to generalize from the examples provided to emphasize that SGs are providing a cost-effective means to provide experience-based learning with emphasis on cognitive and increasingly affective training domains. War fighters will not develop the expert psycho-motor skills they need to effectively employ their weapon systems using game-based training. However, once the team of experts in various weapon systems is created, SG technology affords trainers the opportunity to turn them into an expert team capable of communicating effectively with the cognitive skills they need to effectively operate as teams.

The body of evidence supporting the effectiveness of SG training solutions is starting to build and examples from the UK, Canada, the US and Australia have been provided. In all cases, the examples provided support the theoretical arguments that SG technology is most effective as part of a blended training solution that takes advantage of the strengths of the available training tools and processes. One consistent result is that using the SG prior to live training makes live training more effective and efficient. In the British, Canadian and USMC examples provided above, pass rates and performance conducted during live training were significantly improved when rehearsals were conducted using the SG compared to those that did not get the SG practice. In some cases, simulation may be the only training option as the trend to field the latest equipment directly into theatre results in a complete lack of training capability at the home station. Employing this equipment during collective training conducted in an SG as described above for the US Army Engineers Mine Clearance Company is arguably the only way to prepare troops to participate in combined arms teams using equipment they will not actually touch until they arrive in theatre.

In addressing the last question, the Winged Warrior experience clearly indicates that technology is not a limiting factor in terms of SG support to training exercises. Terrain database generation is improving rapidly, the games can be federated with other virtual and constructive simulations to meet a broad range of training needs and technology and market forces guarantee that the technology will continue to improve over time.

CONCLUSIONS

Serious Game technology is an effective means to meet a wide variety of tactical training requirements and is particularly well suited to developing the cognitive skills necessary to turn a team of experts into an expert team. To take advantage of this capability, SGs need to be included as part of blended training solutions that can cost-effectively meet the psycho-motor and affective training requirements as well. In stand-alone mode, the games appear to be best suited from individual up to company level, however, when used in combination with other virtual and constructive simulations may well assist in the collective training of larger groups.

Returning to the original question posed in the title of this paper: Games – just how serious are they? The answer is very serious. So serious in fact that it may not be appropriate to call them games at all. Although not described in this paper, some training establishments may have difficulty accepting games as credible training aids. We could of course call them wargames, or desktop immersive trainers, however the authors of this paper believe that it is very natural for human beings to learn through play and the use of games, albeit for some very serious purposes, is an obvious and natural fit for tactical training.

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