

Proficient Soldier to Skilled Gamer: Training for COTS Success

Peter Morrison[¥]; Michael Barlow[¥]; Glen Bethel[±]; Scott Clothier[±]

(¥) *Virtual Environments & Simulation Laboratory (VESL), School of ITEE, UNSW@ADFA*
{p.morrison,spike}@adfa.edu.au

(±) *Land Warfare Simulation Centre, Army Simulation Wing, Australian Army*
{glen.bethel ,scott.clothier}@defence.gov.au

Abstract. A number of military organisations have begun to adopt COTS computer games as potential tools for military training, experimentation and decision support. One of the significant challenges faced in implementing a COTS computer game for a military purpose is that of participant training. It is necessary to ensure that military participants acquire sufficient proficiency with the tool that training or experimental outcomes are not impacted by participant's skill with the game but rather are a reflection of the underlying task itself. The paper describes two experiments involving the use of a COTS 1st Person Simulator known as Virtual Battlefield Systems 1 (VBS1). The first experiment measured participant performance in the simulation across the length of the experiment - 1 week - in order to measure proficiency change in different spheres of skill as a function of time. It appears that participants quickly learnt procedural tasks (such as moving an avatar and firing weapons) but higher-level cognitive skills (such as teamwork) required more practice to develop. The results (when linked to theoretical models of human skill acquisition) support a bottom-up model of initial proficiency broadening to declarative generality. The second experiment aimed to quantify the utility of the simulator for section to combat team level combined arms training activities through subjective measures. The results support the use of VBS1 as a training tool within the Australian Army, providing a number of minor modifications are implemented. The paper concludes with recommendations about training military personnel to use COTS simulations and the employment of VBS1 within Defence.

1. INTRODUCTION

The potential of COTS computer games has been identified in the literature [2],[5],[7] proving in a number of cases to be low-cost (and therefore low-risk) training alternatives. COTS simulation now provides a useful supplement to conventional live training in Defence. This paper concerns a particular genre of COTS game known as the 1st Person Shooter (1PS), in which a human participant controls a single 'entity' in the simulated environment from the first person perspective. 1PS usually possess a high level of fidelity (when compared to larger, distributed simulations) and aim to *immerse* a participant in the virtual world. The COTS simulator used for the experimentation described by this paper is *Virtual Battlefield Systems 1* (VBS1), a 1PS that is marketed as a tactical training tool for military organisations [12]. Previous research has shown VBS1 to have potential for military usage [4],[9] and this study aims to build upon that literature. This paper also makes reference to research into human skill acquisition, specifically that concerning differences between procedural and declarative knowledge [1],[10], in order to provide a framework describing how user proficiency at operating the 1PS changed over time.

This article has the following structure. The paper will initially discuss an activity in which VBS1 was trialed as a potential training tool for the Australian Army. The paper will then focus on two experiments that were conducted over the course of the trial, these being (1) a practical and theoretical evaluation of the acquisition of proficiency of participants within the 1PS; and (2) an evaluation of the simulator as a training tool for section (troop) to platoon (squadron)

level combined arms operations. The paper concludes with a number of recommendations regarding the implementation of a COTS game for the purpose of military training and possible future work on the subject.

2. THE VICE TRIAL

VBS1, a modification of the popular computer game *Operation Flashpoint* (OFP), is marketed as a tactical-level training tool for military (or similar) organisations. The simulator is a low-cost product designed to be run on a number of networked desktop computers in a benign environment. Participants carry out a wide range of actions within VBS1 (movement, firing, driving vehicles) in order to accomplish scenario-specific tasks (scenarios can be created using an in-built scenario editor shipped with the product). VBS1 provides a number of vehicles that can be driven and flown by trainees (from the 1st person perspective) allowing for combined arms operations within the simulator involving infantry being supported by armoured vehicles and aircraft, all controlled by human participants.

In order to determine the potential utility of the simulator to the Australian Army, the Army Simulation Wing (ASW) conducted a week-long trial with VBS1 in November 04 at the Tactical Training Simulation Site (TTSS) in Darwin, Australia. VBS1 forms the core of the Virtual Immersive Combat Environment (VICE), a training solution being developed for Army by ASW. The activity was therefore named the 'VICE trial' and aimed to demonstrate the utility of VBS1 as a simulation tool for section to combat team combined

training activities. In addition, the VICE trial aimed to source feedback on the viability of VBS1 and similar products for use in training, gather information to customise VBS1 for the Australian Army and validate the training process used for the trial.

2.1 Trial participants

Participants (numbering 60 in total) were drawn from a range of infantry, artillery, armoured and aviation units stationed around Darwin. Participants were not specially prepared for the activity and (for most) the VICE trial would be their first experience with VBS1. Table 1 details participant level of experience with computers and computer games at the start of the trial.

Table 1: Previous computer and computer game usage by VICE trial participants (the sample size is 53).

Question	Yes (%)	No (%)
Own a home computer	58.5	41.5
Own a game console	54.7	45.3
> 10 hrs playing a 1PS	45.3	54.7
Played OFP or VBS1	20.8	79.2
Finished a 1PS	49.1	50.9

As shown, roughly half of the participants owned a computer or game console at home and had played 1PS-style computer games before. This is an interesting result as a high proportion of soldiers are familiar with computer-based products and computer games in general. 33 of the 53 participants spent time playing computer games each week. The average time spent playing computer games per week was 5.8, with a standard deviation of 7.8. Only a relatively small percentage had played OFP or VBS1 previously, however 4 participants considered themselves 'very experienced' with OFP, having previously played the game for over 40 hours.

2.2 Observer/Trainers

Previous experimentation with VBS1 has shown the importance of monitoring participants throughout an activity to ensure realistic soldierly behaviour. A problem during previous experiments has been 'super soldier syndrome', whereby a single soldier performs in the virtual environment (VE) to a standard that is out of proportion to a soldier's performance in real life [3]. Each directing staff member monitored groups of 10 – 20 participants throughout the trial. In addition an 'observer room' was set aside so directing staff could remotely monitor the actions of participants. The Observer interface within VBS1 allows directing staff to 'look over the shoulder' of simulated entities as they move and interact in the simulated environment.

2.3 Network Gaming for Defence

The TTSS facility contains a large number of desktop PCs segregated into different rooms. The participants were separated into infantry, aviation, headquarters, and armoured elements. Communication between the various elements was via radio (as opposed to voice over IP, which was not used due to bandwidth

limitations), as well as for communication between sub-elements such as infantry sections and individual vehicles and aircraft.

The infantry element was composed of three mechanised sections and a mechanised HQ. Virtual infantry units were controlled by keyboard and mouse and the drivers of the armoured personnel carriers used racing-game style steering wheels. Each of the two simulated helicopter gunships were occupied by a pilot and gunner, the pilots using standard joysticks as the main method of flying the aircraft. The armoured vehicles were controlled by steering wheels (for the driver) and keyboard and mouse for the commander and gunner. The main headquarters consisted of a number of drivers, the Officer Commanding and a Forward Observer (FO) team all of which used keyboard and mouse to interact with the VE.

During a scenario all computers (65 in total including OPFOR and observer machines) would be networked to a designated server, which coordinated each scenario and recorded data throughout the trial. The overall exercise controller managed the server to start and stop scenarios as appropriate, and was located in an upstairs room that overlooked the various segregated areas below.

One of the main aims of the VICE trial was to determine if the VBS1 training tool is able to simulate combat team operations. Scenarios were developed with various combinations of BLUEFOR, such as infantry supported by armour, infantry supported by aviation and armour supported by aviation. The FO party supported all three elements across various scenarios (artillery support was made available by the VBS1 Artillery Module that adds a range of indirect fire support assets to VBS1). OPFOR were human-controlled by 2 – 3 directing staff located in the server room. Combat team maneuvers were conducted across a 25km x 25km terrain area, and included attack/defence and advance/quick attack scenarios.

3. SOLDIER TO GAMER – ACQUIRING PROFICIENCY IN A 1PS

Prior to commencing combat team operations, a range of training scenarios were conducted to bring all participants up to the required proficiency level. Subjective data was collected during the trial to assess the effectiveness of the training regime and allow an examination of participant proficiency as a function of time. The paper will go on to examine the training scenarios conducted and the capacity of the participants to acquire competency at operating within the VE.

3.1 Training for simulated operations

A thorough training and familiarisation phase for participants using a 1PS is vital in obtaining solid results in which confidence can be placed. Simulated conflict in a training tool aims to replicate the real-life experience – the high paced, stressful nature of such an

environment requires that all participants are competent at controlling an entity in the simulator. As shown in table 1 (above), participants had varying experience at playing computer games, and very few had experience at OFP, the game that VBS1 is based upon. Initially there was a very uneven playing field and therefore time needed to be invested in training prior to the commencement of the trial itself.

Two days were allocated to training the soldiers to use the simulation up to a standard whereby they could begin to operate at combat team level. A number of training scenarios were developed to facilitate the training process. Initially all participants undertook four training scenarios. An introductory scenario taught movement in the VE, entering vehicles and firing basic weapons. A navigation scenario taught how to navigate using the VBS1 map and compass, both on foot and in a vehicle. A problem solving scenario required the participant to accomplish a number of tasks in VBS1, including using advanced weapons (such as an anti-armour weapon) and conducting reconnaissance. Finally a Test of Objectives scenario was conducted that required participants to accomplish a series of moving and shooting tasks to confirm their competency at using the simulation.

Once these initial training missions were complete corp-specific training scenarios were conducted. These included infantry section command, tank and APC driver/gunner/commander and helicopter pilot/gunner training. The final phase of training involved a number of multi-participant scenarios of increasing scope and difficulty; infantry section (or armoured troop), infantry platoon (or armoured squadron), mechanised infantry platoon, and finally combat team (infantry plus aviation or armour). The success of this training regime was measured through observation of the participants over the course of the trial, and also a questionnaire completed by each at the end of the activity.

3.2 Proficiency in a IPS

Initially two days had been allocated for simulation familiarisation and training, an estimate based upon previous experiments using VBS1. A full day of training was allocated for the Virtual Infantry Section Experiment (VISE) in 2003 [4], which involved around 30 participants conducting section-level operations. The time allocated for training during the VICE trial was doubled due to the relative complexity of scenarios and the number of participants. Unlike VISE, comprehensive in-game training missions were developed for the VICE activity and this greatly reduced the overall time required for training (even though, when compared to VISE, there were approximately twice as many participants spread over double the number of rooms).

Following initial briefing participants were given approximately four hours to complete the single-participant training missions. The time taken to

complete these missions varied greatly and directing staff were available to assist if required. The overall aim of the initial training phase was to raise the level of proficiency at using the keyboard and mouse so that participants could control an entity in a realistic manner – as a natural extension of a soldier’s existing war fighting skills. The ‘pass marks’ for the Test of Objectives scenario were set by an expert at the start of the trial, and participants were to achieve the required standard prior to advancing to multi-participant (networked) training.

The value of the training regime was measured via a questionnaire completed by the participants at the end of the trial. Participants were questioned as to how long they took to achieve competency and mastery at a range of skill sets, including movement, weapons, navigation, physics, team work, problem solving and situational awareness. The time scales provided were ‘already had’ (A), ‘a few minutes’ (M), ‘an hour or two’ (H), ‘a few hours’ (HS), ‘a day or two’ (D), and ‘not yet’ (NY). Figure 1 illustrates how long (on average) participants took to attain competency and mastery at movement, weapons, team work and finally an aggregate of all skill sets. Figure 1 does not show physics, problem solving, situational awareness or navigation as these skill sets had a similar distribution to movement and weapons.

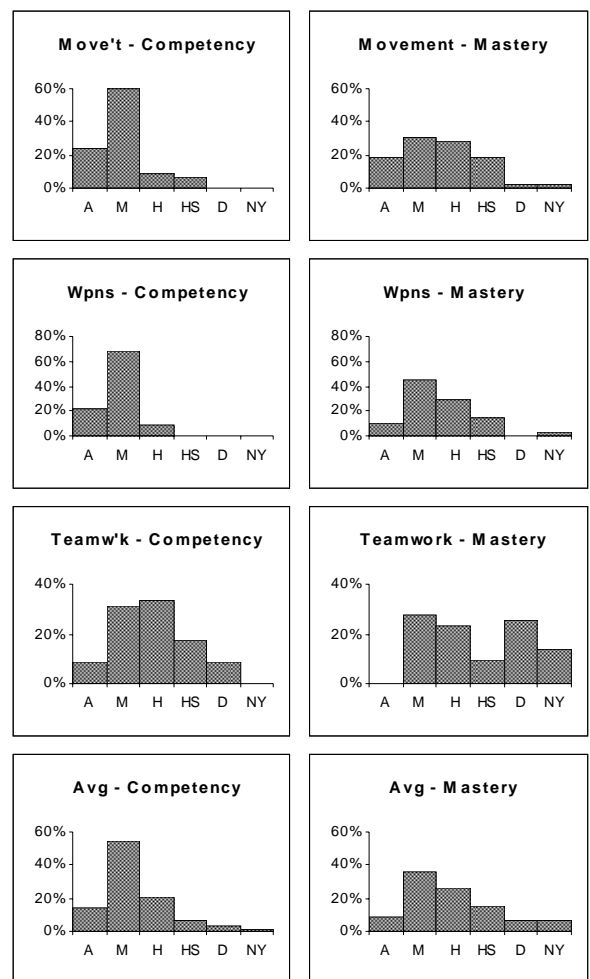


Figure 1: How long participants took to become competent and masterful at a range of skills in VBS1.

The final two graphs show an aggregate of all skill sets.

Of note is the increased amount of time participants required in order to achieve competency and mastery at teamwork as opposed to individual skills such as movement and operating weapons. Operating as a team is a key requirement for the practice of combat team tactics, and 25% of participants required a day or two to become masterful at this aspect of VBS1 (and 20% did not achieve mastery after a full week of practice). This figure suggests that whilst the VICE training scenarios were very good at teaching single-participant skills, additional time is required in order to properly train participants to work with others in the VE. Figure 2 compares the amount of time required to attain competency and mastery between differing participant roles: infantry, armoured and aviation.

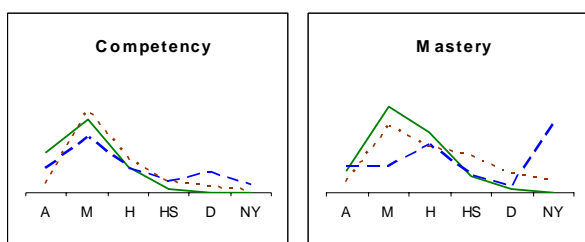


Figure 2: Graphs comparing the time required to attain competency and mastery at an aggregate of all skill sets between infantry (unbroken line), armoured (dashed line) and aviation (dotted line) personnel.

Whilst all participants took a similar amount of time to become competent at an aggregate of all skill sets, armoured and aviation personnel required more time to become masterful. Controlling a vehicle adds additional complexity to operating in the VE, especially as navigation is more difficult (a vehicle generally moves faster than a soldier on foot) and situational awareness can be limited (when locked inside a tank, for example). The helicopter crews found it very difficult to become masterful at operating in VBS1 (some respondents had not mastered the skills required after a week of practice) because a) no moving map (as is used in real life) was provided by the simulation and b) visibility was limited to a kilometer due to simulation limitations.

3.3 Applying theoretical models of skill acquisition

The paper has presented the training scenarios and proficiency results of the VICE trial, but how do the outcomes link to models of human skill acquisition? This is important as a theoretical understanding of how individuals learn in VBS1 will assist in planning future exercises involving simulators derived from the IPS genre. Cognitive skill acquisition refers to learning to solve problems in intellectually oriented tasks, however skills may vary in complexity and degree of cognitive involvement [10]. Learning to operate VBS1 involves 'low-level' cognitive skills such as simple motor movements, whilst conducting operations in the VE might require problem solving ability that would be considered more of a high-level intellectual skill.

The literature provides two broad models of skill learning. The top-down approach states that learners acquire declarative knowledge (facts and information about a skill [1] – how to do something) and then convert this knowledge into a procedural form that in turn leads to skilled performance [10]. Anderson (1982) states that “the conversion occurs over time as instruction rules are turned into production rules and then refined through practice” [1]. However, research has since shown that there may exist a dissociation between explicit knowledge and skilled performance [10], leading to the bottom-up approach in which procedural (implicit) knowledge is developed prior to explicit knowledge. However, the literature also suggests that both types of learning are engaged in most situations, with varying contributions from each [11].

Based upon expert observation, the bottom-up model best describes participant learning during the VICE trial. Initially, participants have no knowledge of the simulator and therefore do not have a declarative understanding (depending on previous experience with IPS games). The objective of the VBS1 training is to instill experiential cognition – whereby one reacts to events efficiently and effortlessly, as opposed to reflective cognition that relies on comparison and contrast of thought and decision making [6]. The training regime instituted for the VICE trial immediately concentrated on procedural skills sets; participants were not given any introduction to the system prior to initial immersion in the introductory scenario. The importance of immersion and ‘sense of presence’ is also described in the literature – as stated by Mantovani et al (2003) “first-person experience, activity and interactivity, together with narrative dimension represent important dimensions to learning” [8].

Participants were required to practice their procedural skills until the Test of Objectives scenario could be accomplished – at which point training entered in multi-participant arena wherein high-level declarative knowledge become important – participants were forced to ask questions such as ‘where am I?’, ‘how do I perform as part of my Section to take this hill?’ and ‘what is my commander’s intent?’. Based upon the results of the VICE trial, facilitating a bottom-up model of initial procedural proficiency broadening to declarative generality through on-line training scenarios (of increasing difficulty) reduced the overall amount of time required for training.

4. IPS: GAMES OR POTENTIAL TRAINING TOOLS?

As previously mentioned the purpose of the VICE trial was to assess the utility of the VICE training solution as a simulation tool for section to combat team level combined arms training activities. The evaluation was facilitated by a naturalistic evaluation process – participants completed a number of questionnaires at the end of the exercise, and were encouraged to make comments on any aspect of the training or the

simulation. This research aimed to build upon previous research conducted by Barlow et al (2002) wherein a preliminary study of the potential of a COTS game (OFP) to Defence was conducted [5]. During the VICE trial data was collected on both training outcomes and simulation performance. Findings from the data collection were categorised so that the simulation's performance could be assessed against specified criteria, which were based on the training outcomes that ASW (in consultation with unit commanders) considered the highest priorities for the potential use of VBS1.

Areas covered by the questionnaires included warfighting, command and control, standard operating procedures and training potential. Responses ranged from unsatisfactory through to excellent, and included a N/A (not applicable) selection (to be selected by those participants who either did not use VBS1 for that specific function or did not comment).

4.1 Warfighting

Warfighting encompasses tactics, team building and situational awareness in the simulation. Participants were questioned as to how well they believe VBS1 facilitates warfighting aspects (figure 3).

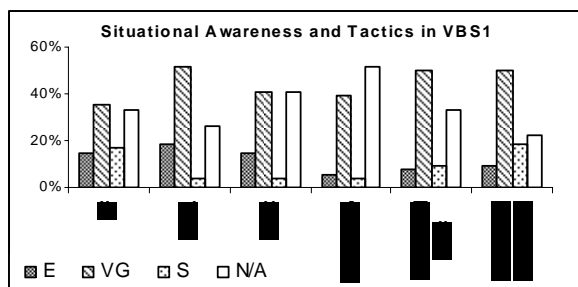


Figure 3: Percentage responses to questions pertaining to how well VBS1 facilitates situational awareness and tactics across a range of combat arms (E – excellent, VG – very good, S – satisfactory). There were no ‘unsatisfactory’ responses and therefore this result is not graphed.

The majority of respondents perceived VBS1 to be an effective tool for the practice of small team tactics up to the combat team level. Comments from participants reflected a greater concern with the simulation's ability to provide situational awareness, as respondents found it difficult to visually identify entities in the VE and relate the 2D map to the 1st person view of the terrain. Overall the simulation was seen to be able to replicate a convincing combat environment for participants, and provide an effective warfighting simulation. Commanders were, on average, slightly less convinced of the simulations effectiveness than the majority.

4.2 Command and Control (C2)

Participants were questioned on how well they believed the simulation would assist in teaching the fundamentals of C2 during combat missions. This includes how well the VICE solution allows for an

understanding of units under command, facilitates the Mission Analysis process, illustrates the importance of clear, concise orders, facilitates the learning and practice of Mission Planning, and facilitates the learning and practice of synchronising combat assets. Most respondents thought that the tool would perform very well across all these areas, however comments from personnel in leadership positions highlighted a number of deficiencies. The capabilities of units were seen as unrealistic (for example the simulator does not possess an overly realistic fatigue model) and the lack of communication functions within the simulation was identified as a concern. One higher-ranked participant noted however that “the greatest outcome of this tool [is] making leaders work for control and illustrates [the] area[s] that they are lacking very well”.

4.3 Mission Rehearsal and Standard Operating Procedures (SOP)

The HQ group noted that the simulation would be a valuable tool for mission rehearsal – comments included “By far the best simulation system I have seen in Australia. Allows you to conduct recon, rehearsals, plan, implement and fight a battle...” and “Very good for recce and also conducting rehearsals”. Participants were also questioned on how well they believed VBS1 would assist commanders in learning command procedures. 42.9% of respondents believed that VBS1 would perform to an excellent standard in this role. Commanders commented that the After Action Review (AAR) function could assist in the development of procedures, as the tool allows an action or maneuver to be critiqued once completed.

4.4 Training Potential

Participants were questioned on how well they believed the simulation could facilitate the learning and practice of tactical concepts and procedures at a combat arms school. The majority of respondents indicated that VBS1 would perform to an excellent standard at this role. On average respondents thought that the tool would perform slightly better for Junior NCOs than for the higher ranks. Commanders generally supported the concept of using the simulation in training organisations and espoused the value of the AAR that would allow trainees to ‘learn from their mistakes’.

4.5 Simulation Limitations

Whilst the aforementioned comments indicate acceptance of VBS1 as a training tool there were a number of simulation limitations that became apparent over the course of the VICE trial. VBS1 is primarily an infantry combat simulation and as such does not provide an accurate (or realistic) simulation of armoured or airbourne weapon platforms. Whilst tank, light armoured vehicle and helicopter crews could still perform in a *similar* fashion to real life there were a number of negative comments regarding fidelity. For example, tank gunners and commanders could not perform as they would in a real vehicle – the

commander was unable to direct the turret and the gunner could not lose a target (a point-and-shoot system has been implemented instead). It was noted that crews modified their procedures to compensate for such deficiencies, which may have possible negative training implications in the long term.

The limitations of VBS1 identified during the VICE trial include unrealistic aircraft performance and behaviour, tank weapon platform characteristics are not modeled on actual systems, visibility is limited to around a kilometer and situational awareness is hampered by the very narrow field of view, equipment load lists are inflexible in that they can not be altered by a section commander at the start of a mission and identification of individual ground troops is difficult due to generic soldier models.

5. DISCUSSION

VBS1 has proved to be a versatile COTS product suitable for use as a military training tool, as a majority of the VICE trial participants indicated their belief that that VBS1 would perform to an excellent or very good standard at facilitating the achievement of unit training objectives. Given that VBS1 costs only a fraction of a purpose-built simulator the success of this game-turned-military tool illustrates the indisputable potential of COTS games to Defence.

Research into the rate at which military participants have become proficient at using VBS1 has shown that almost 80% of new users will acquire competency at individual skills within a few hours (providing comprehensive in-game training scenarios are provided). Higher-level skills such as team work and situational awareness take longer for trainees to acquire (from a few days to a week to master). The fact that many participants owned their own computer and/or game console, and have played 1PS computer games before, shortened the length of time required to train the soldiers to become proficient operators in VBS1.

The VICE trial is the initial step in introducing VBS1 to Defence, and whilst it is not a purely 'out-of-the-box' COTS solution (an amount of modification has been conducted [9]) the simulation was readily accepted by participants. Through research and experimentation into a) acquisition of proficiency in VBS1 and b) implementing VBS1 as a training tool for combat team level combined arms training activities, recommendations with regards to employing COTS games for military applications are as follows:

- In-game training scenarios should be developed for any virtual exercise involving VBS1. Teamwork and situational awareness take longer to acquire than procedural skills such as controlling the actions of individual entities.
- Separate, comprehensive training scenarios should be developed for vehicle crews, and care should be taken to ensure negative training does not occur due to flaws in the simulation.

- It is recommended that improvements to VBS1 to overcome identified simulation limitations be investigated, prioritised and acted upon by the developers of the product.

6. FUTURE WORK

To further explore the process of learning in VBS1, an objective trial (involving the collection of data relating to participant performance) could be conducted, and the results contrasted with the subjective study described by this paper. In addition, training transfer from the simulation to the exercise area should be examined: does training in a simulated environment prior to an exercise (or operation) provide a quantifiable benefit to our soldiers?

REFERENCES

1. Anderson J.R. (1982) "Acquisition of cognitive skill", *Psychological Review*, Vol. 89, pp. 369-406.
2. Appleget J. & Illingworth J. (2001) "Land Warrior Training Initiative", *Proceedings of SimTecT 2001*, Canberra May 2001.
3. Barlow M. & Morrison P. (2005) "Challenging the Super Soldier Syndrome in 1st Person Simulations", in *proceedings*.
4. Barlow M.; Morrison P. & Dickie A. (2004) "Constructing the Virtual Section", *Proceedings of SimTecT 2004*, Canberra May 2004.
5. Barlow M.; Morrison P. & Easton A. (2002) "1st Person Tactical Shooters: COTS Games with Military Training Potential", *Proceedings of SimTect2002*, Melbourne, May 2002.
6. Jones M.G., (1998) "Creating engagement in computer-based learning environments", *ITForum*, invited paper posted 7 December 1998. <http://itech1.coe.uga.edu/itforum/paper30/paper30.html>
7. Macedonia, M. (2002), "Games Soldiers Play", *IEEE Spectrum OnLine*, 28 Feb 2002. <http://www.spectrum.ieee.org/WEBONLY/publicfeature/mar02/mili.html>
8. Mantovani F. & Castelnuovo G. (2003) "Sense of Presence in Virtual Training: Enhancing Skills Acquisition and Transfer of Knowledge through Learning Experience in Virtual Environments", *Being There: Concepts effects and measurement of user presence in synthetic environments*, Ios Press, 2003, Amsterdam.
9. Morrison P. & Barlow M. (2004) "Child's Play? Coercing a COTS Game into a Military Experimentation Tool", *Proceedings of SimTecT 2004*, Canberra May 2004.
10. Sun R.; Merrill E. & Peterson T. (1999) "From Implicit Skills to Explicit Knowledge: A Bottom-Up Model of Skill Learning", *Cognitive Science*, Vol.25, No.2, pp.203-244. 2001.
11. Sun R. & Zhang X. (2002) "Top-down versus bottom-up learning in skill acquisition", *Proceedings of the 24th Annual Conference of the Cognitive*

Science Society, Fairfax, VA. Lawrence Erlbaum Associates, Mahwah, NJ. 2002.

12. Virtual Battlefield Systems Homepage.
<http://www.vbsresources.com>