Games for Tactical Training – A History of VBS2

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ABSTRACT

The paper firstly introduces the Bohemia Interactive Group, and provides a detailed history of both Bohemia Interactive and the VBS2 product. This section describes how the first computer game released by Bohemia Interactive – Operation Flashpoint – formed the basis of numerous "serious games" including DARWARS Ambush! and VBS1. The chain of events that lead to the development of VBS2 is also covered; the primary event being the ADF enterprise license purchase of 2006. The first section concludes by presenting five key enablers for the success of VBS2.

The second and final section of this paper provides a high-level technology roadmap that describes the features of past, present and future Bohemia Interactive products.

1.0   THE HISTORY OF VBS

The Bohemia Interactive (BI) Group consists of a number of privately owned software development companies based in the United States, Australia and the Czech Republic. Until the release of VBS1 in 2004, the primary focus of Bohemia Interactive was the development of computer games for entertainment. Czech-based Bohemia Interactive Studio (BIS) released Operation Flashpoint (OFP) in 2001, a landmark title that was the first to allow players to explore massive, geo-typical virtual environments. In OFP, players were free to use any means at their disposal to defeat the virtual enemy, including attacking from any direction, and using a wide range of vehicles and aircraft.

Operation Flashpoint is the basis of the military training application DARWARS Ambush! developed by US-based BBN Technologies in 2004. DARWARS Ambush! aimed to provide a flexible training environment for soldiers to learn important lessons regarding both mounted and dismounted operations in conflict zones such as Iraq and Afghanistan. DARWARS Ambush! is widely considered a great success and this positive outcome was only possible due to the flexibility and extendibility of the OFP game engine.

1.1   VBS1

The Australian branch of Bohemia Interactive, Bohemia Interactive Australia (BIA), was formed in 2001 with the mandate to develop "serious games" based on the Operation Flashpoint game engine, for use as simulation platforms outside the entertainment sector of the commercial market. BIA released VBS1 in 2004, and delivered to the United States Marine Corps (USMC) who used the product in a similar manner to the way the US Army was using DARWARS Ambush!.

VBS1 was a successful game-based 3D virtual environment tailored for "serious" usage, suited for training and education in multiple domains, despite serious limitations. VBS1 mission editing and after- action review (AAR) features were limited, it did not support real-world terrain import, and it wasn't HLA or DIS compliant.

Despite the early success of VBS1 in the USMC, it was Australian Defence Force (ADF) funding that enabled VBS to succeed as a training tool. The ADF was first exposed to the potential of VBS "serious

game" technology during the Headline Experiment in 2003, when an early version of VBS1 was used to analyse the effectiveness of various sized Infantry Section structures (the Virtual Infantry Section Experiment).

In 2005, the Australian Defence Simulation Office (ADSO) funded a range of improvements in VBS1 to make the product more suitable for mission rehearsal and training, as part of Mission Rehearsal Exercises (MRE) for deployments to Iraq. At this time, the AAR system was improved, the Instructor Interface was developed, and HLA/DIS compliance was implemented over a 12 month period of development. The majority of this development was sponsored by ADSO through a Deed of Standing Offer for the provision of Software and Software Support Services.

ADSO also contracted Bohemia Interactive to develop a VBS1-based military history training product titled 'Australians in Vietnam', designed to teach soldiers, sailors and airmen about the Battles of Long Tan and Coral. The end product was highly successful: a stand-alone computer game tailored for education.

1.2   Aircrewman Virtual Reality Simulator

In 2006, Bohemia Interactive was selected by the ADF to develop six Aircrewman Virtual Reality Simulators (AVRS), which combined VBS1 simulation technology with the latest in Virtual Reality tracking and display systems. Over a 12-month period of development, Bohemia Interactive developed and delivered a system that is arguably the most successful simulation project in ADF Army Simulation Wing history: an affordable turnkey solution for aircrewman training delivered both on time and budget.

This development is notable because it highlights the capability of Bohemia Interactive to provide turnkey simulator solutions in addition to commercial off-the-shelf (COTS) software development services.

1.3   VBS2

BIA began developing VBS2 after the ADF purchased an enterprise license of VBS1 in 2005. Building on three years of feedback regarding VBS1, VBS2 represents a powerful "serious game" platform that is now the worldwide benchmark for desktop-based simulation, particularly in the areas of tactical training and mission rehearsal.

Many requirements for VBS2 were derived from ADF experience with VBS1 during mission rehearsal exercises conducted in 2005. For example, the requirement for geo-specific terrain was paramount, but it took over six months to develop the city of As Samawah in VBS1. In contrast, it took only a few hours to generate the same terrain in the armor simulation 'Steel Beasts', because it supported VMAP (shape data) import. The need for run-time authoring became obvious due to time constraints during MREs: only a short amount of time was available for simulated training, and offline scenario editing would cost valuable minutes (bringing down the network session, modifying the scenario and restarting the network session). This need for rapid scenario modification resulted in the requirement for the VBS2 Real Time Editor (RTE). In addition, a robust AAR capability was important to allow the instructors to reinforce learning points.

VBS2 development commenced in December 2006 and was largely completed after 18 months. During development, Bohemia Interactive partnered with Calytrix Technologies to develop the VBS2 HLA/DIS gateway. In 2007, a second Czech-based development team was established to focus on improving the VBS2 Development Suite to support real-world terrain import.

In 2006, the USMC purchased an enterprise license of VBS1, with an upgrade to VBS2 upon release. Following initial delivery of VBS2 in 2007, they funded a range of enhancements that resulted in the development of the VBS2 Virtual Training Kit (VTK). Notably, the USMC did not provide any data for the VBS2 VTK development: Bohemia Interactive relied instead on publically available reference information

for all aspects, thereby enabling the full VTK functionality to be incorporated in to the standard VBS2 product for use by all civilian and military licensees of VBS2. The USMC was then provided with full access to VBS2 configuration files and unencrypted models to allow them to incorporate classified or export controlled data as required.

This flexible development model has proven very successful: it allows Bohemia Interactive to conduct independent research and development from a relatively generic requirement, and allows the customer to configure settings to suit their domain, be it military or otherwise.

The VBS2 VTK was delivered to the USMC on time and budget in June 2008, and rolled out later that year to all USMC simulation centers and on all DVTE laptops. VBS2 quickly became the simulation of choice for USMC mission rehearsal and tactical training up to the combat team level.

While the ADF and USMC have been central to the success of VBS2, enterprise licenses have also been purchased by the United Kingdom Ministry of Defence (UK MoD), the US Army and the Canadian Forces. In all cases, Bohemia Interactive has modified the VBS2 product to suit the requirements of these organizations, while still maintaining a common international baseline. VBS2 is also in daily use by NATO and many countries across Europe. Bohemia Interactive has also made improvements to suit non-military clients in the first response and mining industries.

VBS2 has become a defacto simulation standard, and a market is rapidly forming as industry begins to employ VBS2 for research and development. VBS2 includes development tools, an Application Programming Interface (API) and a scripting language in every release. The VBS2 International User Group meets bi-annually and VBS2 is a key component of upcoming joint simulation exercises.

The core of VBS2 development is coordinated by Czech-based Bohemia Interactive Simulations (BISim), consisting of approximately 90+ full time and contracted staff, the majority of whom are highly experienced software developers. Bohemia Interactive Studio (BIS), also located in the Czech Republic, maintains the core simulation engine (upon which VBS2 is based) and continues to regularly release mainstream computer game titles. Bohemia Interactive Australia (BIA), sister company of BISim, remains the primary point of sale for Bohemia Interactive's simulation products and contracts directly to numerous government agencies worldwide including the USMC. Bohemia Interactive Simulations LLC (BISim US) in Orlando, Florida is the point of sale for VBS2 licenses and development work in the United States.

Finally, a new member of the Bohemia Interactive Group has recently been established in Farnborough UK as the point of sale for VBS2 licenses and development work in the United Kingdom. Bohemia Interactive Simulations (UK) is growing quickly, aiming to provide a significant, stand-alone VBS2 development capability, and support to the UK MOD.

1.4   Real Virtuality 3

While BISim has been focusing on the VBS series, the game developer BIS has continued to improve the Real Virtuality engine for the entertainment market. Real Virtuality 3 is the result – a state-of-the-art game engine that is recognised worldwide as a leading next-generation software platform for first- person simulation. Real Virtuality 3 is the game engine behind the highly successful ArmA2, released in 2009, and also ArmA2 Operation Arrowhead. The most obvious improvement is graphical fidelity – years of effort have been applied to making the virtual environment as visually realistic as possible – but in addition to amazing graphics, the new engine has many other improvements including animation enhancements and multi-core support. Multi-core support enables the engine to be highly efficient, as simulation tasks are spread over multiple processor cores. Very efficient operation results from both AI and rendering being split up over multiple cores.

1.5   Five Keys to the Success of VBS

To conclude the history of VBS, it is worthwhile examining the reasons why VBS2 has achieved remarkable success, especially considering its origins in the game industry, and that it was entirely developed in Australia and the Czech Republic – neither of which have been known as simulation development hubs.

1. Bohemia's long-term, evolutionary development methodology has produced a robust training tool, capable of easily incorporating new middleware.

The VBS2 development methodology can be best described as evolutionary, and this is the first factor in its success. Rapid prototyping has ensured that the product has evolved and improved at great speed, with each design decision aimed at facilitating future development. In addition, all of the different parts of the simulation engine – rendering, physics, artificial intelligence (AI), animations – have been built to work together from the start, as opposed to forcing off-the-shelf middleware products to interoperate. As we have shown, it is now relatively straightforward to incorporate new middleware into VBS2 because the wider framework is already in place and working well.

2. VBS2 is developed by an agile and responsive team, with a proven track record in delivering a reliable product.

Bohemia Interactive has developed a reputation for responsiveness, and for delivering and supporting a product that has always worked. Being the underdog in the simulation industry, and operating on a much smaller budget than US-based (and often government-funded) competitors, Bohemia is very agile and able to move quickly when patches and updates are required. Therefore, the second factor in the success of VBS2, is that it 'works as advertised'.

3. Bohemia aims to establish partnerships of mutual benefit by sharing development costs and delivering back to the user community the outcomes of this development.

Bohemia Interactive aims to meet government sponsors halfway – establishing partnerships whereby new capability is part-funded by customers and part-funded internally. For example, the USMC provides Bohemia Interactive with relatively broad statements of work, and Bohemia Interactive is encouraged to come up with innovative solutions that meet both the needs of the USMC and further the product as a whole. A good example is the terrain tool Visitor 4: the USMC requirement could have been satisfied by patching an older application, but BI delivered a completely new tool that greatly exceeded the requirement and this has benefitted all VBS2 customers in whatever sector they are operating. Bohemia Interactive provides new capabilities to all members of the VBS2 International User Group at no extra cost, and this community-driven approach has enabled VBS2 to flourish.

4. VBS2 is an "Open Platform" where users are empowered to use development tools to create and modify content.

The fourth factor in the success of VBS2 is that it is an "Open Platform". Bohemia Interactive includes development tools for content creation (terrain, 3D models) and a fully functional API in every copy of VBS2. In addition, the VBS2 script language is extremely comprehensive (having evolved over a 13 year period) and enables almost any imaginable scenario to be created or any aspect of the simulation to be modified. Bohemia Interactive has scripted police chases, apartment fires, Harpoon missiles, UAV recovery mechanisms, radars, fast-roping and a multitude of other functions, and the USMC even scripted a complete call-for-fire capability with no assistance from the software developers. The success of VBS2 has proven that source code access is not required for a simulation to be successful. In fact, who better to manage the source code than the entity that developed it over a decade?

5. Game development is more art than science.

Finally, it has been acknowledged that game development is more art than science, and as such a large number of creative people from varying backgrounds have been involved in the development of VBS2. Many Bohemia Interactive employees have been sourced from the online Operation Flashpoint and Armed Assault communities. This has resulted in a unique development environment where the software developers not only truly believe in the potential of the simulation engine and the product, but have the vision, enthusiasm and dedication to make it succeed. This is certainly another key to the success of VBS2: it would have cost considerably more and taken much longer to complete the product had Bohemia Interactive staff not possessed such passion and drive. You can't buy a team like the one behind VBS2 – it must be grown.

2.0 TECHNOLOGY OVERVIEW

This section initially presents a high-level technology roadmap that extends from Bohemia Interactive's first release, Operation Flashpoint, through to the short term future.

2.1 Technology Roadmap

The following table describes the features of all major Bohemia Interactive "serious game" products since the release of Operation Flashpoint.

Product	Key Features	Key Limitations
Operation Flashpoint - 2001	• Powerful 2D mission editor • 25km x 25km terrain areas • Freely available 3D model and terrain editing tools • Highly customizable, relatively easy to modify (mod) • Large online community and freely available add-ons (downloadable content) • Powerful scripting language included	• Maximum number of networked players was between 30 – 40 • No run-time authoring capability • No after-action review capability • Proprietary network protocol, no HLA/DIS compliance • Very difficult to create geo-specific terrain • Very little official documentation • EULA prohibits training use

DARWARS Ambush! - 2004 - Based on OFP - Developed by BBN	• Many US Army entities included • Several geo-typical Iraqi and Afghan terrain areas included • Voice-over-DIS capability (BBN Talk) • Crude external AAR capability • Very good documentation	• BBN did not have source code, and therefore scope of enhancements were limited • Ambush! was basically a simple 'mod' of OFP • AAR relied on a 'hack' and was very inefficient
Virtual Battlefield System 1 - 2004 - Based on OFP	• Many USMC entities included • Several geo-specific USMC training areas included • First in-game AAR was included • Basic call-for-fire capability	• The AAR could only support recording of 8 BLUEFOR entities
Virtual Battlespace 1 - 2005 - Based on OFP	• Greatly improved AAR, supporting 3D in- game replay • VBS1 'Instructor Interface' allowed run-time authoring • Included geo-typical As Samawah and Green Zone terrains • Included ADF, NZDF, USMC and US Army content • Later versions supported HLA/DIS via a gateway • IED simulation capability	

Aircrewman Virtual Reality Simulator - 2007 - Based on VBS1, later VBS2	• Developed a new version of VBS1 with many visual enhancements to support training of helicopter aircrewman • Integrated Newton physics engine into VBS1 for realistic rope simulation and helicopter load carrying • Integrated theoretically correct RotorLib UH- 60 flight model into VBS1 • Integrated VBS with Polhemus 6DOF tracking • Most AVRS capabilities were added to VBS2 at a later stage	
Virtual Battlespace 2 - 2007 - Based on Armed Assault	• 3D and 2D mission editors • Highly capable in-game AAR • Full run-time authoring • Common user interface for mission editor, run-time authoring and AAR • Support for up to 256 networked players • Robust HLA/DIS gateway included • Supports rapid, real-world terrain generation • Streams objects and textures, allowing up to 200km x 200km terrains with up to 4 million objects	• Flat earth model • Does not support streaming terrain • 4 million object limit per terrain area

VBS2 Virtual Training Kit 1 - 2008 - Based on VBS2	• Theoretically correct thermal imaging model • In-game group, unit and weapon editing • Basic C2 functionality • Supports display of real-world topographic map on 2D map view • Destructible environment, deformable terrain • Application Scripting Interface (ASI) included (first VBS2 API)	
VBS2 Virtual Training Kit 2 - July 2009 - VBS2 v1.3 - Based on VTK1	• Includes Visitor 4, a brand new terrain import tool that understands geo-referencing, very easy to use • Includes face texture editor • CREW simulation, improved IEDs • Upgraded physics model, now supports PhysX by Nvidia • CASEVAC simulation • In-game customizable forms • UAV, UGV simulation • HLA/DIS gateway enhancements • VBS2Fusion available separately, allowing AI plug-ins such as Kynapse, AI Implant, etc	

VBS2Fires - November 2009 - US version June 2010 - Module - Requires VTK2	• An external VBS2 module • Provides highly realistic, validated, indirect call- for-fire simulation • Correct ballistics from gunline to impact • Includes terminal ballistics simulation • Seamless integration with VBS2 editors, AAR and scenarios • Supports all indirect assets (naval gunfire, self- propelled artillery, etc) • Developed to meet ADF, UK and US Call- For-Fire protocols	
VBS2 v1.4 - September 2010 - Based on VTK2	• Enhancements to support amphibious operations for USMC • Improved agility modeling • Support for limb amputation by script • Curved earth (implementation of horizon) • Render-to-texture support • Full rotation of objects in OME/RTE • Formation flying improvements • Includes VBS2Fusion 2.0 runtimes	

| VBS2 v1.50

- April 2011

- Based on VTK2 | • Terrain rendering enhancements

• Final USMC VTK2 items

• Combat realism improvements

• Import pipeline from 3D Studio Max

• Move embedded terrain objects

• Multi-optics support

• Long view distances

• Support for large objects

• Underground objects

• Editor tree improvements

• Curved earth visualisation

• Hovercraft simulation

• Full rotation of editor objects | |

VBS2 v1.60 - Jan 2012	• Support for MGRS and Lat/Long coords • Multi-channel support • Vehicle and building search • Improved amputations • Agility modelling • Improvements for higher fidelity gunnery simulation • Improved IR laser visualization • Improved boat and ship physics • Support for logistics operations using forklifts and cranes • Alternate path-planning system to allow AI to move more freely on large objects	
VBS2 v2.0 - Summer 2012	• Real Virtuality 3 (RV3) engine based • Full terrain paging • Armored enhancements • Aviation enhancements • Realistic Underwater & Scuba Diving • Realistic Parachuting & Free-fall	

2.2   VBS2 v2.0

The future of game-based training, mission rehearsal and IG Bohemia Interactive has commenced development on VBS2 v2.0, based upon the Real Virtuality 3 (RV3) game engine. The game engine behind VBS2 v2.0 is four years more advanced than VBS2's RV2, and is used as the basis for both the highly successful ArmA2 and ArmA2: Arrowhead computer games. The engine alone is much improved, with significant enhancements in graphics, efficiency (through multi-core exploitation) and AI. VBS2 v2.0 will include all VBS2 capability, plus exciting new enhancements funded largely by the US Army. VBS2 v2.0 is presently scheduled for limited release to US customers in March 2012, and wider release in the summer of 2012. The most exciting engine enhancement in VBS2 V2.0 is the implementation of paging terrain. Paging

terrain refers to loading terrain 'on-the-fly' from a data repository, such as a hard disk drive. This and other IG enhancements have been sponsored by the US Army, including:

- Larger terrain (up to 500km x 500km)

- Paging (streaming terrain)

- Increased view distance up to 40km

- Direct fire support from armored vehicles in support of an infantry maneuver

- Support for shape data overlays

- Scuba Diving

- Increased terrain detail and dynamic grid

- Fixed-frame support

- Multi-core support

- Particle effect improvements

- Micro AI

- Parallax Mapping

- Parachuting