Using Commercial Technologies to Deliver Defence Simulations

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ABSTRACT

Modelling and Simulation for training, analysis and mission planning are not new concepts. With increases in the cost of equipment and live training there is a need to look at how commercial technologies can support the needs of the defence community. This paper examines the history of games technologies, some of the technologies that already exist and how they are used today.

1.0 INTRODUCTION

The use of Modelling and Simulation (M&S) for training, analysis and mission planning are not new concepts. Combat models and simulations have been around for hundreds of years although predominantly through the use of manual wargames. Evidence of early Modelling and simulations are clearly seen in the writings of Sun Tzu, Vegetius and Machiavelli [1], [2].

Traditionally M&S applications have been bespoke systems designed for one specific purpose i.e. an aircraft flight simulator for training, and a weapon engagement model for weapon performance assessment. They normally use bespoke hardware and software and are normally designed, tested and supported for one purpose and one purpose only. They require individual support contracts with the original equipment manufacturer and are generally expensive to upgrade with new capabilities. Therefore the Research & Development costs of such simulations are passed onto the organization purchasing the original equipment.

Commercial Off The Shelf (COTS) Games Technologies and Serious Games on the other hand provide a means by which most of the development costs are recovered from commercial sales and the market forces which drive commercial games development provide the impetus for continuing product development that can be of benefit to the Military and other Serious Games uses.

2.0 AIM

The aim of this lecture is to discuss the concepts and issues surrounding the use of COTS Games Technologies within defence. It will describe the history of COTS Games Technologies and Serious Games. Identify why defence should be interested in this area, describe some of the elements of technology that go into today's computer games and Serious Games specifically. Finally it will look at the employment of Serious Games / COTS Games Technology and the reasons why they are relevant to today's defence simulation needs.

3.0 HISTORY OF GAMES TECHNOLOGY

Large scale commercial development of computer based gaming and simulation began in the 1970s. Advances in technology reduced the size of computers from machines that filled a whole room, to those the

size of arcade machines still in use today. It was these arcade sized machines that were available in large numbers to the public. By 1975 small home machines were becoming available in the USA.

In 1980 the game "Battlezone" became the first game to use a 3 Dimensional Game world. Stone [3] suggests this was the first application of games technology in Serious Gaming, when in 1981 the US army asked Atari to transform the game into a military training device. The revised product was called "Bradley Trainer" or "Army Battlezone" and supported Bradley Military vehicle training. It was however limited to just vehicles with no depiction of humans.

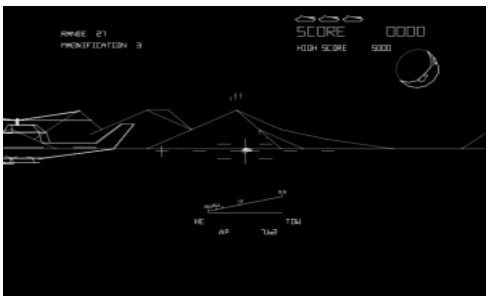


Image Atari Inc

Figure 1: Army Battlezone

During the early 1980s it was military and aviation applications that were the driving force in computer technology improvements both in Hardware and Software terms. Although in the late 1980's the military simulation market and the commercial games market diverged. From a military perspective, work began to concentrate on the use of "Virtual Reality" systems which drove advances in computer graphics. The development of these systems was hampered however by unreliable and un-wearable (usually heavy and cumbersome) head mounted display devices, limited software products and expensive maintenance costs. By the mid-1990s it was the rapid growth in the video games market that was, and still is driving graphics and gaming technology today.

In 1996 the United Sates Marine Corps (USMC) developed Marine Doom, a modified version of id software's Doom II. Sgt Daniel Snyder one of the development team is quoted with saying:

"This is the first of what we hope will be many efforts to provide an inexpensive fire team simulation to the fire- team."

Marine Doom allowed four man fire teams to practice concepts such as mutual fire team support, use of cover and concealment and effective communications. The major modification from Doom was to the weapons and avatars. This was only possible because id Software had released Doom II as shareware[4].

Figure 2: Marine Doom

4.0 CURRENT GAMES MARKET

In 2007 the worldwide games market was valued at $37.7bn (Sustainable Industries, 2007), by 2010 the UK market alone was valued at £4.65Bn and back in 2008 Price Waterhouse Cooper expected the worldwide market to grow to $86.8Bn by 2014. The global recession has slowed everything down but growth is still occurring. Forbes currently reports it expects the market to grow to $82bn by 2017. While global defence budgets are much bigger than this, the spend on simulation within those budgets, is likely to be significantly smaller.

With figures that exceed defence spending for most NATO countries, there is significant defence interest in Games Technologies. One of the most popular games of all time Call of Duty was first released in 2003. It has had 10 different versions released in that time, and represents a significant investment in development by Activision.

Call of Duty 4: Modern Warfare is still one of the most frequently played online games. As of Sept 13 it was still #2 in the First Person Shooter Genre according to www.xfire.com with some 40,000 players a day spending 70,000hrs playing online.

An earlier version Call of Duty 2 is #3 with approx. 20,000 people spending a total of 17 500hrs a day playing it. That is almost 2 man years per day spent on one game. At its height Call of Duty 4: Modern Warfare was clocking up ~16.5 man year per day online game play. But this type of following doesn't come cheap.

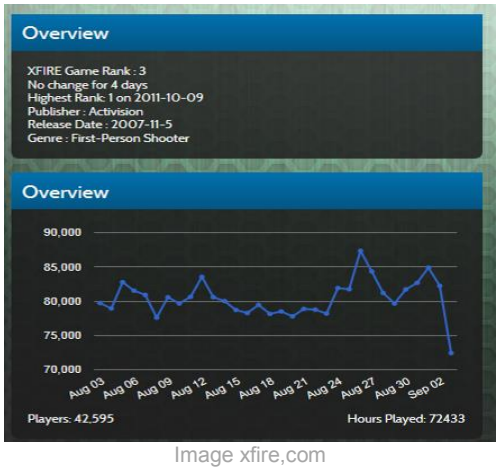


Image xfire,com

Figure 3 X-Fire Statistics for Call of Duty 4: Modern Warfare

4.1 Game Development Costs.

Call of Duty: Modern Warfare 2 was released by Activision on the 11th November 2009. It is reported to have taken 100 developers 2 years at a cost of $20M to develop. Another $20-$30M was spent paying royalties to 3rd party tool/library providers, and conservative estimates suggest another $60-80M (based on 13% of estimated sales) was spent on marketing. So a Rough Order of Magnitude cost for the development of a top selling commercial game in 2009 would be roughly $100-130M. It is reported to have sold approximately 24M across copies worldwide up to Oct 2013 [5] according to the Video Games Chartz

Across the family of Call of Duty games sales have reached in excess of 126M at approximately $30 a game equates to sales of $3.78Bn across PC, PS3, XBox360, Wii. Call of Duty Black Ops reached $1Bn in sales in the first six weeks of release.

Grand Theft Auto V by Rockstar Games sold 24M copies in its first four weeks of release (September 2013). It has reportedly taken over 1000 developers 5 years [6] to develop with estimates of development and marketing costs between US$137-265 million. Making it more expensive that some Hollywood blockbuster films [7].

5.0 DEFENCE INTEREST IN GAMES TECHNOLOGY

Defence cannot compete with these sorts of figures and development times. In fact until very recently most militaries were still paying defence contractors to build bespoke simulators using bespoke graphics and physics engines and hardware that took years to develop and were already behind commercial capability once delivered.

Therefore with such a large investment by the games companies it makes sense that Defence will look to leverage this. But why? Commercial Games technology is widely accepted as having:

- Engaging applications with visually appealing interfaces to the user, story/characters with believable worlds, intuitive control systems.
- Immersive graphics, physics, audio and easy to network.
- Support for a wide range of COTS hardware – any gaming device (PC, Mobile, and Console) that supports the "minimum specification" upwards. (Write Once, compile multiple times, for example Far Cry using the original CryEngine gives hardware/platform optimised performance for minimal extra development)

Image Crytek

Figure 4 COTS Multi Platform Development

- Market forces drive customisation; mission building and modification through Software Development Kits (SDK) / 3rd party add-ons (these also extend the shelf-life of a game).
- Business model - distribution of development costs over large consumer base, frequent technology refresh cycles; cost effective to run.

With a reduction on defence spending across most countries every element of the defence organisation needs to make best use of its resources. So these games technologies may meet the defence requirement for simple, available procedural, judgmental and Part Task trainers that can be delivered quickly to the user, and provide a training or analysis capability in a standalone or networked environment.

6.0 SERIOUS GAMES – THE THEORY

A serious game is considered to be an application which uses games technologies (usually COTS) to support activities other than entertainment. Such as analysis, training, education, visualisation, etc. Serious Games involve structured learning activities using the element of play for experiential learning, or learn by discovery. Zyda's [8] graphical representation of the potential applications of serious games, supports this broad definition

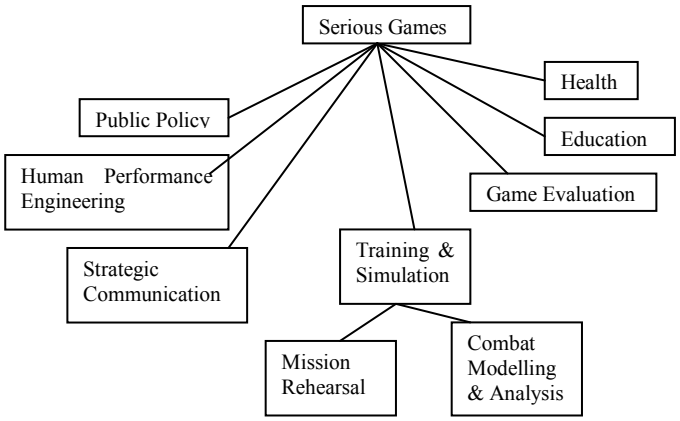


Figure 5 Potential Application Areas of Serious Games

But in Defence there is a need for:

- Validation and prevention of negative learning.
- Incorporation of simulation interoperability standards.
- Avoiding technology for technology's sake.

6.1 Serious Games Components and Game Engine Examples

All of the examples described in the early parts of this document have a number of common components. In any commercial game these core components are:

- The Engine. Core Software used to drive the game. It incorporates functions such as:
  - Graphics (visual rendering of the seen)
  - Physics (dynamics of vehicles)
  - Audio
  - Artificial Intelligence (Behaviour, reactions, path planning)
  - Networking
  - After Action Review
- Modding ('Modifying') Tools & Software Development Kits (SDK)

From a defence perspective this can be locally developed or based on a commercially available engine, examples of which will be given later but include Delta3D, Havok, Unity, and CryEngine amongst the many. Using a commercial Engine may require licencing and/or royalties. Many games companies will use an already commercially available engine to develop their application others may create their own.

The Modding Tools & Software Development Kits (SDK) allow the user to create and modify content. This includes tools for 3D Modelling, Terrain, Scripting, building/editing scenarios.

Some companies will also provide and externally facing Application Programming Interface (API). This allows the user to use software from another application for example a better vehicle physics model, a more accurate weapons model, better Artificial Intelligence (AI).

6.1.1 Delta3D Game Engine

Delta3D is an example of an open source game engine, originally designed by the US DOD. A well-supported and fully-funded open source project, Delta3D is a full-function game engine appropriate for a wide variety of modelling & simulation applications. Delta3D is unique because it offers features specifically suited to the Modelling and Simulation and DoD communities such as High Level Architecture (HLA), After Action Review (AAR), large scale terrain support, and SCORM Learning Management System (LMS) integration [9].

Delta3D is released under the GNU Lesser General Public License (LGPL). The underlying modules may have their own licensing, but are at the minimum, considered Open Source and are freely distributable. Delta3D's modular design integrates other well-known Open Source projects such as:

- Open Scene Graph(OSG) a 3D graphics toolkit.
- Open Dynamics Engine (ODE) a library for simulating rigid bodies.
- Character Animation Library (CAL3D). Skeletal based 3d character animation library.
- OpenAL, integrating them in an easy-to-use API.

It has been used to create numerous games based applications including:

- HuntIR. A single player classroom level IR target identification game.
- DCOS FireFighter, USN Ship Borne Fire Fighter Training.
- SIMEXAM Spanish based basic automobile simulator for driving schools.

Images: Camber[10[, Simpace[11], DCOS Fire Fighter[12]

Figure 6 Delta3D Example Applications

6.1.2 Havok™ Game Engine

Havok is best known as being a physics engine for the Commercial Gaming market, but it is now a Toolkit designed for Integrators to develop simulations. It products have been used in commercial titles including HALO4 and Call of Duty ®: Black Ops2. In the defence arena it's been used by integrators such as Lockheed Martin, Rhienmetall Defence and KNOGSBERG. The toolkit includes:

- **Vision Engine**: SDK includes content libraries, multichannel frameworks, sensor physics.
- **Havok Physics:** SDK to develop realistic vehicle / human physics.
- **Havok Destruction:** SDK to develop realistic break points, damage and destruction to buildings, vehicles and objects.

- **Havok Animation & Cloth:** SDK for Avatar and Object Animation including foliage, cloth, hard etc.
- **Havok Script & AI**: SDK using LUA programming language.

Images: Havok Simulation

Figure 7 Havok Vision Engine and SDK Products

Nothing comes for free and like any other software the use of COTS technology will cost something. With a commercially available engine (Havok or CryEngine) you may have to pay developers fee to use the engine, then pay royalties on every sale or deployment of your product.

If you use an Open Source Engine (Delta3D) you might not be able to charge for your product depending on the original licensing conditions.

But even if someone else uses an engine and develops the game for you (e.g. Virtual Battlespace 2 (VBS2)) you will still have to buy a license to use it. These can range from single seat licences up to an enterprise license that, for a set fee, allows and organisation to use as many copies as it likes. You will also need to consider support in the form of training for users, operators and developers, bug fixing and products improvements and updates.

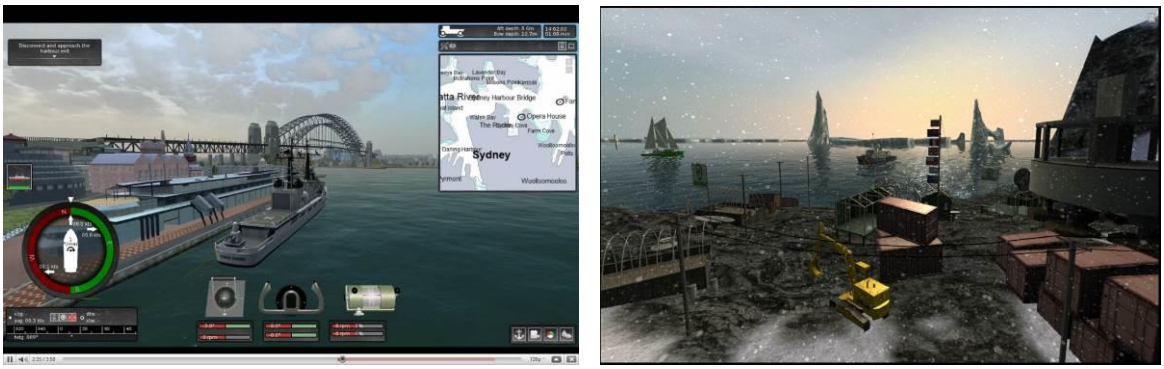
7.0 COMMERCIAL GAMES TECHNOLOGY EXAMPLES

It is generally a completed product that interests the military customer, as most Defence Departments do not have the skillset required to take a game engine and produce a product. This section will now look at some of the Commercial Games Technologies and the equipment needed to support those applications that is available today.

7.1 Maritime Environment Commercial Games Technology

7.1.1 Ship Simulation Extremes and NAUTIS

Ship Simulation Extremes [13] is part of a series of games developed by VSTEP in Holland. The game includes many famous harbours and locations from around the world. It provides a wide range of vessels to captain, including hovercraft, Coast Guard interceptors, large tankers, tugboats, luxury cruise liners, fast inflatable boats. Out of the box it has an online multiplayer mode and includes a mission editor.



Images: VSTEP

Figure 8 Ship Simulator Extremes

Ship Simulation Extremes was considered by the Royal Navy as a desktop trainer for Basic Navigation Skills. It was discounted at the time because:

- The commercial game was not designed to interact with other simulations.
- It has no organic After Action Review capability allowing you to move between view points, but you can create videos.
- Scenario and model creation (dynamics) were deemed to be very difficult.
- Cannot cluster screens or PCs together this needs the more expensive "Pro" application NAUTIS.

VTSEP do develop applications for the Serious Games Market, the maritime version of Ship Simulator Extreme is NAUTIS a DNV certified product used extensively in the commercial maritime training environment. But it isn't just the Game Engine that makes NAUTIS, it the hardware deployed with its desktop and mission simulators that give it the civilian accreditation. NAUTIS is designed with interoperability and instructor customisation in mind. At the time of writing the author was unable to find any commercially available boat controllers.

Images: VSTEP [14]

Figure 9 NAUTIS simulation products

7.1.2 Dangerous Waters

Developed by Sonalysts Combat Simulations (SCS) in 2004 using the SCS Simulation Engine the game allows you to conduct Anti-Surface and Submarine warfare. It gives the user control of Ships, Aircraft and Submarines. It supports up to 30 users in multiplayer mode and out of the box provides the capability to create custom mission and campaigns. It has been used by the US, Canadian and German Navies for training.

Images: SCS [14]

Figure 10 Sonalysts Combat Simulations; Dangerous Waters

The Royal Navy investigated its use in a Capability Concept Demonstrator looking at collaborative crew training for Pilots, Observers and Sonar Operators. It was not taken further because the Royal Navy didn't believe it had the skills required in house to generate scenarios and training material.

The German Navy bought the non-commercial version which gave them a database editor, 3D model import, Terrain and Image Overlays, HLA interface and Bathymetric Overlays. It was initially procured to support a Ship Borne Helicopter Requirement. Its usage has been expanded to included using as a Simulated Bridge, part of an P3C Maritime Patrol Aircraft Simulator and 3D Scenario Display [15].

In the last few months the US Defence Advanced Research Agency (DARPA) has used Dangerous Waters to crowd source ideas for it Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV) [16].

Images: DARPA

Figure 11 DARPA ACTUV

7.1.3 Command: Modern Air Naval Operations

Released in September 2013, Command: Modern Air Naval Operations is a game developed by Warfare Sims that allows the user to control Surface, Sub Surface, Air and Space entities in large scale warfare. It comes with its own scenario editor and lots on online tutorials. The author has not had time to test the software but the website claims[17]:

- Powerful, intuitive 3D-globe (Google Earth-style) user interface with multiple map layers
- Aircraft, surface ships, submarines, land units, strategic & space forces are at your disposal

- Extensive, detailed simulation databases, modelling faithfully, the capabilities & limitations of each asset
- Plenty of scenarios covering multiple historic and hypothetical conflicts, plus an integrated scenario editor
- Tremendous flexibility of scale: From counter-piracy skirmishes to strategic nuclear war
- Detailed modelling of air (including near-space) and naval operations, both surface and underwater, supported by high-quality physics, sensor/EW, terrain and weather, weapon and damage models
- Good modelling of land-based forces (relevant to air/naval/space operations)
- Mine and mine-countermeasure operations
- Nuclear operations (possibly other special-weapon categories)
- Recorder & replay ability

If this is the case then the game does have the possibility of providing defence organisations the ability to look at naval history.

7.2 Air Environment Commercial Games Technology

Flight simulators first arrived openly on the market in the 80's with Flight Simulator. Microsoft's first full flight simulator Flight Simulator 1.0 was released in 1982. It wasn't until version 4 in 1989 that gave the user the opportunity to modify and build their own aircraft and create custom scenery. It was another 10 years or so before Microsoft released a version with Air Traffic Control and Artificial Intelligence enabling users to fly alongside computer controlled aircraft.

In 2009 Microsoft sold the intellectual property rights and source code for the commercial version of Flight Simulator 10 (FSX) – Microsoft ESP (Originally "Enterprise Simulation Platform") to Lockheed Martin. The product was renamed Prepar3D (apparently pronounced "Prepared").

Flight simulators by their nature have always been very graphically and processor intensive due to the ability to relatively quickly change direction and speed and more complex physics than land based systems.

It's not just Microsoft who developed flight simulators, many other games companies developed including Ubisoft's Lock On: Modern Air Combat that came out in 2003. It also included AI controlled planes and the ability to do carrier landings and Air to Air refuelling. It also came with a mission editor.

Images: Microsoft, Ubisoft, Laminar Research

Figure 12 Progression of Flight Simulation over last 30 years

7.2.1 X-Plane 10

X-Plane, developed by US company Laminar research is another flight simulator, but this one is based principally on physics. With the appropriate hardware and professional version of the software it can be used to log hours towards private and commercial pilots licences approved by the Federal Aviation Authority. X-Plane for Professional-Use [18] is the world's foremost general-purpose flight simulator. It allows you to build a professional-grade flight simulator using a standard Mac, Windows, or Linux computer. Designed for professional-use and FAA-certified simulators, the Pro-Use USB Key will:

- Run frame-rate and joystick checks on start-up, as is needed for FAA certification.
- Allow you to select cylindrical and spherical projection, as needed for some big simulators.
- Allow you to interface with real versions of the numerous Garmin GPS units.

The standard option provide for single and multiplayer use, large terrains and active weather and Air Traffic Control. On the down side in order to use X-Plane to interoperate with other military applications you need to purchase a separate DIS / HLA interface (one available from Calytrix[1] but it currently only supports X-Plane 10). You do need external software to develop terrains and 3D models, and a very limited Combat Functionality.

7.2.2 Flex-Air

SA Simulation in Australia has used X-Plane to form the basis of a new COTS available military flight simulation tool called Flex-Air. Flex-Air provides tools to develop customised pilot displays and instrumentation. Its SDK allows creation of Cockpits, Display Instrumentation, Weapons, Radar, Sensors and performance parameters. It also provides a native DIS and HLA interface for connecting with other simulation capabilities, and a scripting interface to attribute actions and behaviours to entities. 3D modelling and terrain generation still has to be done via external software and in order to get any Artificial Intelligence for ground units you will need to use another capability.

Image: SASimulations[19]

Figure 13 Flex Air Cockpit Configurations

7.2.3 Air Environment COTS Hardware.

In order to make a flight simulator using COTS technology not only do you need the software you also need some hardware. Depending on the physical fidelity and processing power required this can range from a simple laptop with a joystick to multi-pcs with high specification COTS hardware. It should be noted that at the highest levels the line between COTS and bespoke becomes blurry spending anything from single thousands to hundreds or even millions as shown in figure 14. The costs included in this figure are purely indicative.

In the simplest system shown, the capability is provided by a single laptop, and joystick using a single simulation application. At the top end of the figure the systems shown comprise high end multi pc configurations with top spec memory and graphics cards and utilise multiple pieces of software. In this instance the COTS software is used to build and interact with bespoke cockpit displays, high fidelity aerodynamics libraries and communications software allowing the user communicate using intercom and

[1] Calytrix LVC Game is a bidirectional middleware gateway that connects serious games and other third party applications to DIS/HLA and C2 military systems.

radios systems similar to that in the real aircraft. In selecting the most appropriate type of fidelity and cost it is important to understand what is it that you are trying to do, and what is important.

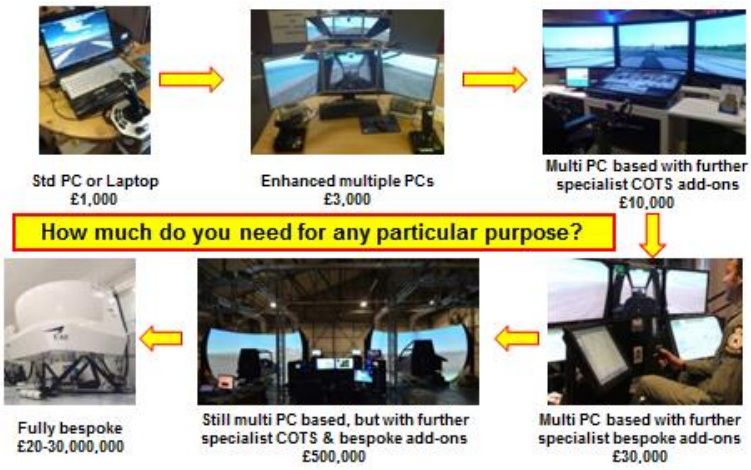


Figure 14 COTS Air Levels of Fidelity and Cost

7.2.4 Examples of COTS Use in Air Environment

In the last 12 months the UK MoD sponsored a Capability Concept Demonstrator (CCD) to investigate the suitability of COTS gaming technology to deliver an effective simulated training capability in the Attack Helicopter role. It built a targeted fidelity prototype AH mission training device that sought to maximise the use of Off the Shelf Components.

Images: UK MoD

Figure 15 UK MOD Attack Helicopter CCD

The CCD concluded that by implementing gaming technologies with a modular open architecture the project demonstrated a credible, viable and cost effective way to deliver a number of elements of aviation training [20]

The CCD used common COTS software to develop both the simulator Multi-Function Displays and a training application that allowed the users to work through targeted training scenarios such as emergency procedures.

Figure 16 AH CCD IOS Training App

It is not only the UK looking at this the European Defence Agency had already deployed helicopter simulators using Games Technology to deliver the European Helicopter Tactics Instructors Course (EHTIC) to NATO helicopter crews at RAF Linton-on-Ouse. The simulator uses VBS2 Software and COTS hardware to deliver tactics training to both front and rear crews.

Images: Cursive Simulation [21]

Figure 17 EDA Helicopter Tactics Trainer

So could this approach be applied to the fast air domain? The author proposes that with current COTS games and other simulation technology it is possible to create a fast air simulator using an open and modular architecture as shown in Figure 18 by linking this with COTS hardware.

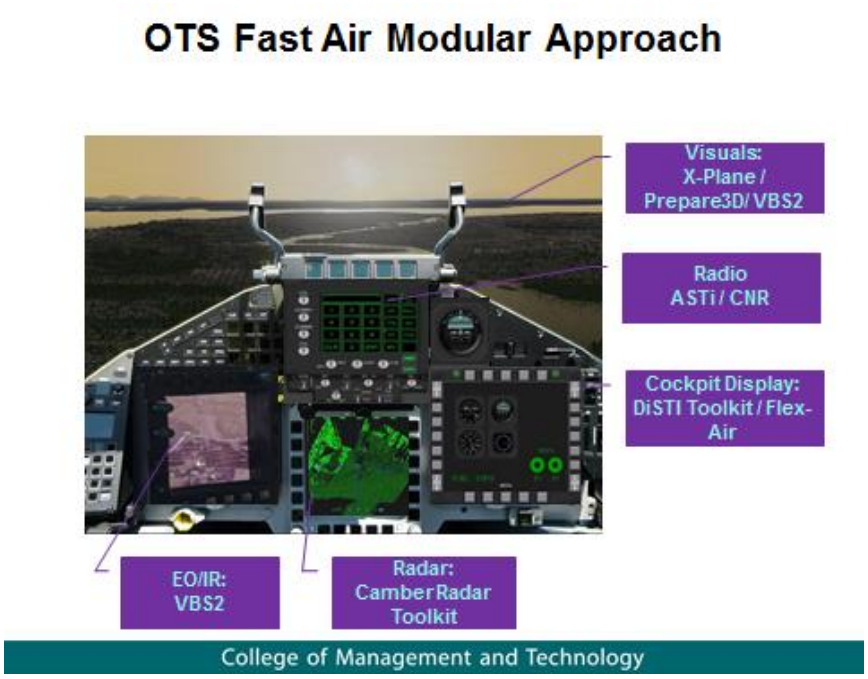


Figure 18 OTS Fast Air Module Approach

7.3 Land Environment Commercial Games Technology

While VBS2 has become the "de facto" standard for COTS/desktop PC training simulations for the military, there are other games base technologies out there.

7.3.1 Americas Army

A US Army product developed using the Unreal Engine and releases in 2002. Americas Army (AA) was developed as a global public relations initiative and recruitment tool, with reports suggesting up to 28% of people have clicked through to the US Army Careers Website. AA was developed in house and is estimated to have cost $33m since creation. It has over 13m registered account holders and its latest version is currently ranked 161 in the *xfire* game chart as of 31st October 2013.

Originally you could only progress thorough the game by completing boot camp training, including obstacle courses and marksmanship training. Although in the latest releases the users can go straight in mission scenarios.

AA allows for single player training (figure 19) and multiplayer squad missions, and provides a head to head mode, that has both sides seeing themselves as American Soldiers and the other team as opposing forces. The user is bound my strict US Army Rules of Engagement and you can never intentionally kill and American solider or play on the enemy side.

It has been deployed as a training tool at Fort Benning for trainees prior to them going proceeding to live firing ranges and at West Point Military Academy for land navigation training.

Figure 19 Americas Army

Again using a product like this out of the box presents opportunities and challenges when deploying in a professional environment. On the positive side it is very good for getting students familiar with traditional gaming controls, Rule of Engagement, and Small Unit tactics, and it is being actively developed. The challenges presented include for those using it outside of the US that it is limited to US Army Equipment can only play as a US Army Solider and is limited to a maximum 12 v 12 scenario. As far as the author is aware you cannot develop your own scenarios, terrains or models

7.3.2 Steel Beasts

Steel Beasts (Pro) developed by German company eSim Games has been used with great success by other nations for training (USA, Spanish, Swedish, etc). First developed in 1995 with an emphasis on Armoured Fighting Vehicles Fire Control Systems, the Pro edition is the one used by defence organisations.

Steel Beasts Pro can support human in the loop and constructive scenarios up to Battalion Level interactions. It specialises in the ballistics calculations to provide an Accurate Gunnery Trainer that can be integrated with real or commercially available replica vehicle controls [22] [23]

In order to interoperate with other simulations the user needs to purchase separate Calytrix LVC Game plug-in licences. and allows Steel Beasts Pro to be DIS/HLA Compliant. Terrain and 3D Model changes can be done but require the purchase of Terrain and 3D modelling applications. The Professional edition has AAR modes the ability to create new maps and built in Joint Fires Effects.

Images: eSim

Figure 20 eSim Games Steel Beasts Pro

7.4 Growth Smartphones and Tablets

The mobile market has been a significant game changer for many Game Engineer, PC and console games developer. Now nearly every game engine will enable you to develop applications for mobile devices. With such a proliferation of devices, it would be remiss of defence departments to ignore their potential. The United Kingdom has done several different studies on what it terms Hand Held Devices, in fact the British Army now has its own Application (App) Store on the UK MOD Defence Gateway and has developed Applications that include:

- Cultural Awareness
- Combat Estimate
- Badges of Rank

The UK isn't the only country to take advantage of this technology the United States Military has numerous apps from vehicle recognition, fitness test to the US Army Creed. Although that doesn't mean you have to develop your own applications. There are many commercially available apps that might have military applicability these include:

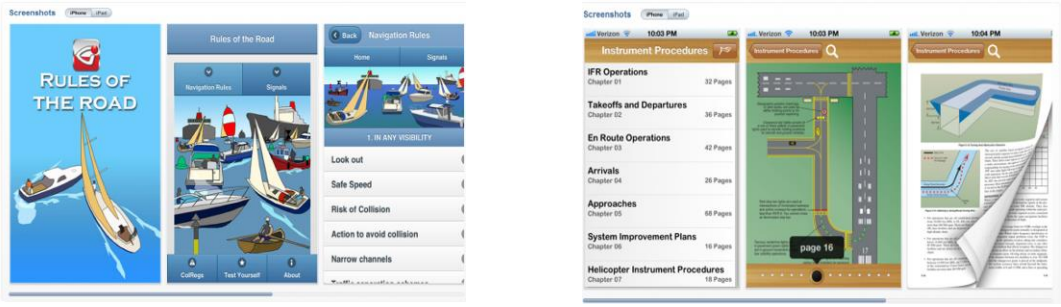


Figure 21 Maritime Rules of the Road and FAA Instrument Flying Applications

The US Army TRADOC has deployed multi-user apps for training Patriot Missile Battery Procedures. If you look on any of the available APP Stores you can even find a US Army one for Medevac procedures and conducting After Action Reviews. In fact the US Army now has a Mobile Best Practices Document [24].

8.0 OTHER USES OF COTS TECHNOLOGIES

The use of commercial technologies is not just about delivering training simulations. As shown by figure 5. But here are some other ways of using the technology:

- As training simulator (single, many)
- As visualisation tool (laydowns)
- As a live simulation viewing tool
- As a demonstration / instruction tool
- For preparation of Training Materials (eg. easily generate 3D pictures and movie files)

There are other ways to employ the technology and not just in the training domain. But looking at training first why can't some of these technologies be used to produce training materials like PowerPoint slides and videos, and then used to give practical demonstration of the subject being delivered. Figure 19 shows a simple example of using VBS2 to demonstrate the concept of Hull Up, Hull Down and Turret Down we teaching basic concealment techniques. Then using the camera option or even a commercial screen grabber like FRAPS, the instructor can create a fly through video to show the students. This mission can then be used for students to understand the opportunities and challenges posed by each method of concealment to the vehicle crew and potential aggressors.

The US DOD Training Brain Operations Centre uses commercial technologies (namely VBS2) to generate training videos on lessons learnt from in theatre incidents, a number of which can be found on its YOUTUBE channel [25]

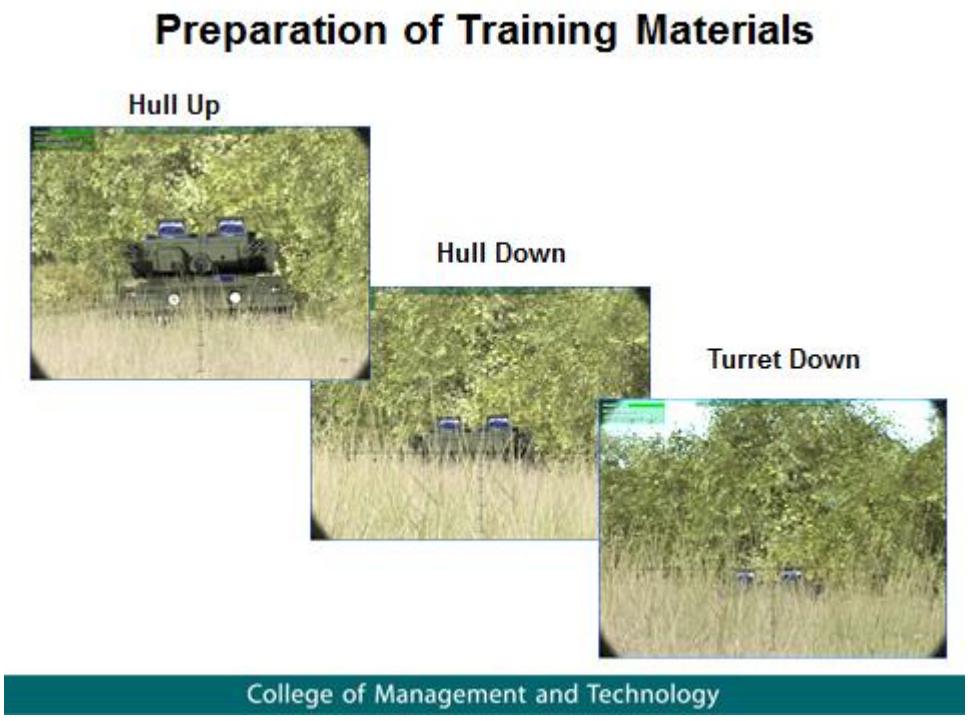


Figure 22 Using VBS2 to generate Training Materials

The Modelling and Simulation Group at the Defence Academy of the United Kingdom use commercial and governmental technologies to educate and teach student in Simulation and with simulation.

In Simulation the focus is on the detail of the processes, technologies and issues that come with procuring, operating and support the use of simulation (including commercial technologies).

With simulation is about using simulation to support the teaching of fundamental subjects in the defence domain, such a Survivability, C4ISR, Experimentation and Analysis.

Examples of some non-traditional COTS technologies used at the Defence Academy are discussed below.

8.1 Commercial Technologies – Teaching with Simulation

Commercial games technologies are now becoming common place in everyday military training, but they can be used for experimentation and analysis at many levels of the Operational Research spectrum. One use of it is on the Defence Academies Trials Managers Course were personnel are required to conduct a small trial to consolidate the academic teaching.

Here VBS2, Lasershot and COTS games controller products are used to facilitate two trials. The first looking at the deployment of Remote Weapons Stations for base protection, the second to look at the effects of Body Armour and Helmet design on dismounted weapon accuracy as shown in figures 23 and 24 In both of these trials the games technology supports the event and allows analysis of results.

Figure 23 shows the students using a BB version of the SA-80 modified with a laser attached to the trigger and a Lasershot M4. The in game statistics give the students the opportunity to do real mathematical analysis about the impact of various degrees of personnel protection on the weapon accuracy.

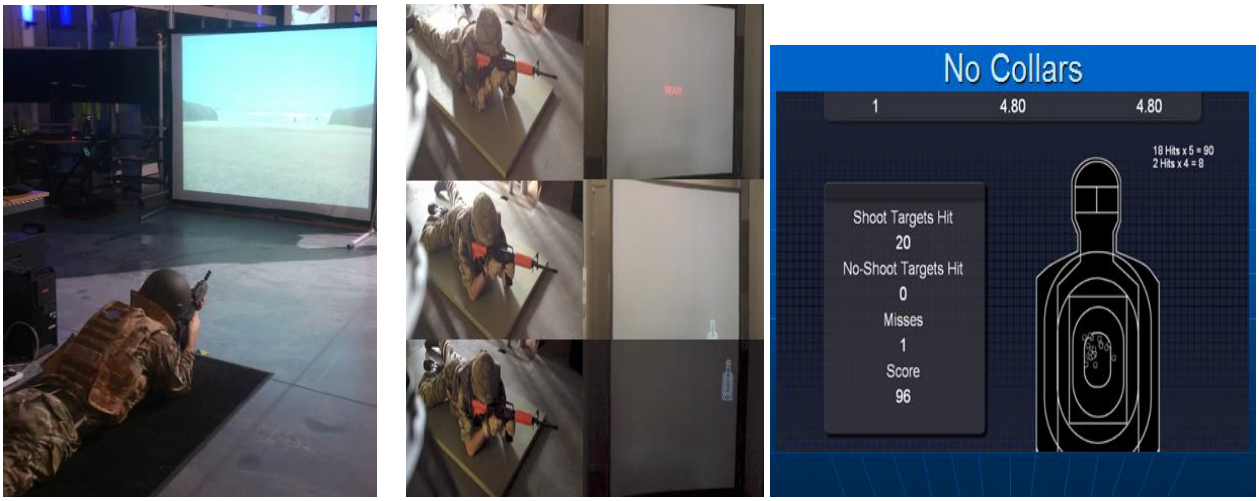


Figure 23 UK Defence Academy Trials Managers Body Armour Trial

Figure 24 shows the two Operations Room layouts given to student to assess the implications of putting RWS at the edge of a patrol base. Here the students are focussing on the suitability of the Human Interface and the associated impact that has on the effectiveness of the RWS. Purely by chance the first time we ran this trial a Danish Officer was on the course, and earlier that year he'd been involved in a live trial looking at exactly the same issue.

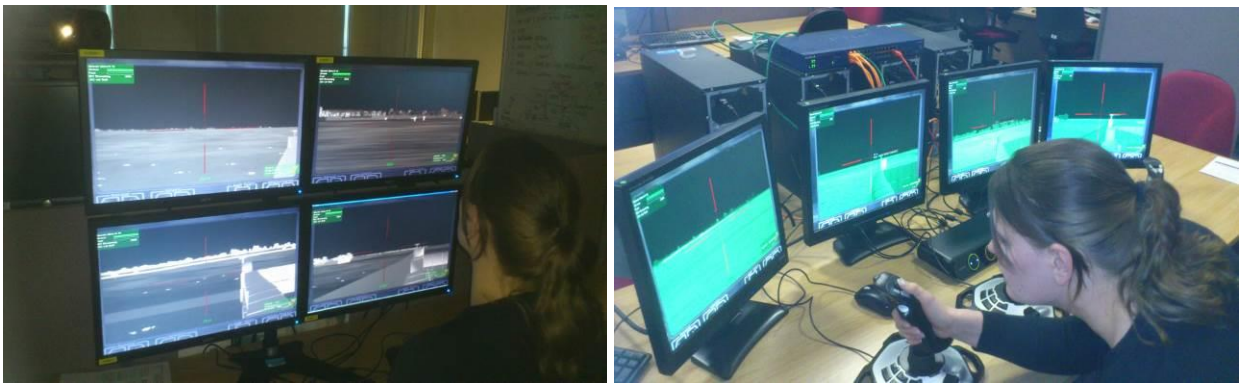


Figure 24 UK Defence Academy Trials Managers RWS Trial

8.2 Commercial Technologies – Teaching in Simulation

As part of the Modelling and Simulation courses taught at the Defence Academy the modelling and simulation group use commercial technologies to demonstrate the technical and organisational issues of M&S including the deployment of commercial technologies. This includes:

- Use in Training, Operational Research and Experimentation
- Hardware Requirements
- Fidelity
- Interoperability
- Networking

During a typical simulation practical even those used as demonstrations to visitors the extensive use of commercial technologies can be seen in the simplified network diagram in figure 25.

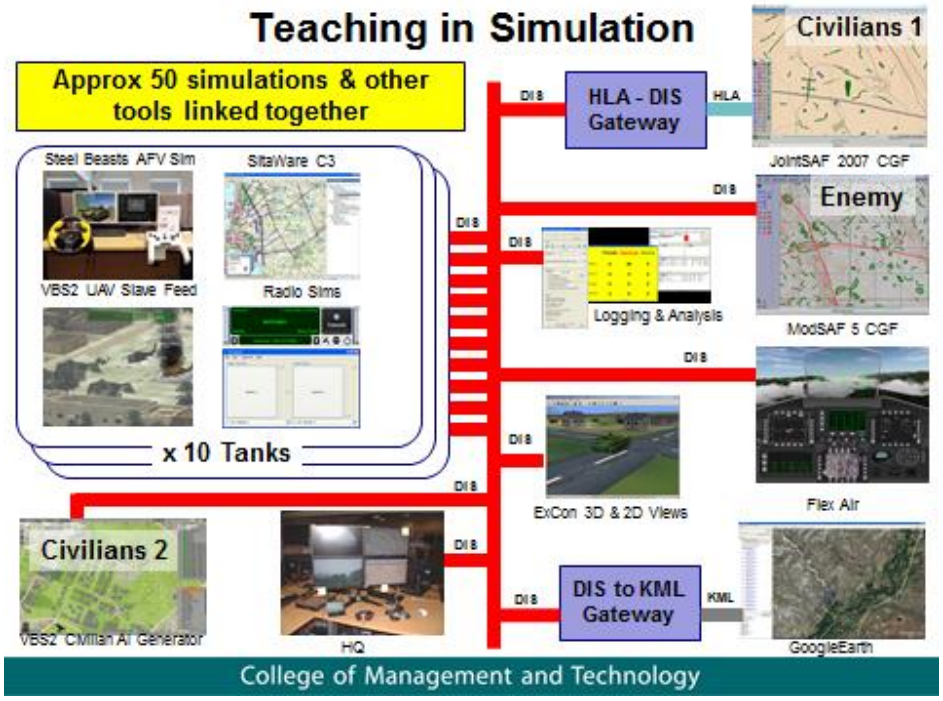


Figure 25 Teaching in Simulation using Commercial Technologies

All of the components of this network use COTS PC and controllers ranging from $15 joysticks to more expensive COTS available replica control like the Challenger 2 Gunner Control from AFV Sim [22]

8.3 Commercial Technologies – Team Building

Artemis [26] is Space Ship Bridge Simulator network game for Windows, IOS and Android machines. Intended to be played in a cooperative face to face mode the crews mission is to:

- Defend Space Stations (DS1 to DS4)
- Prevent friendly casualties
  - Civilians
  - Other small Navy vessels
- Eliminate Enemy Ships in your area

With levels that get progressively harder the crew has to work together and communicate the right information to the captain and each other in order to achieve the missions. The system architecture as depicted in figure 20, means that each station has a specific role and can access only to those systems relevant to that role. The captain has no screen and has to rely on information given to him on the single repeated feed from helmsman's console.

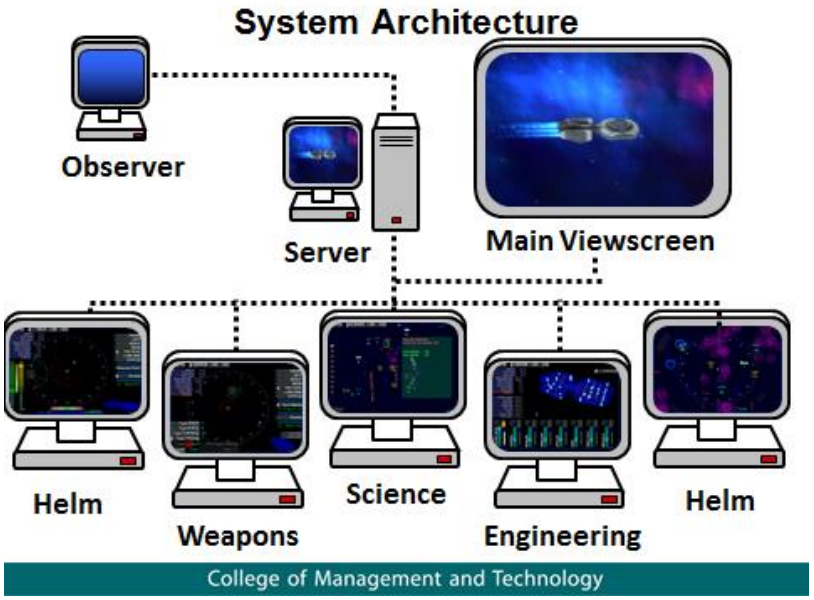


Figure 26 Artemis System Architecture

There a number of opportunities and challenges that a product like this offers. It comes with the ability to build scenarios, edit ship capabilities and play in head-to-head and distributed, and given the unfamiliar environment may encourage creative solutions to realistic problems. It does however pose a few challenges for deployment in a formal training environment, the product is developed by one person, only has limited After Action Review capabilities and because of its genre it's not readily suited to be used with existing capabilities. That said, with the engagement of students, it is used on numerous programmes as an icebreaker but also to encourage team work and communication and to that end it has been successfully used on the UK MOD Senior Leadership Program.

9.0 IT'S NOT JUST ABOUT THE GAME THOUGH

The game and its graphics are only one part of the issue when it comes to deploying commercial technologies to deliver defence simulation. The Who, What, Where, With When and How you intend to use it and integrate it are just as important to delivering the final product. Some of the significant issues we have experienced include:

9.1 Hardware and Software Interfaces Do you have the hardware, purchasing processes to deliver up to date games engine performance. Staying up to generally means a PC refresh every 2-3years maybe 4 with a mid-life upgrade. Are the software interfaces intuitive and whilst accepting that an exact replica of a real system isn't what commercial technologies is about is it close enough and relevant enough to the audience using it.

9.2 Delivery Methods

Does your timetabling allow for a good thorough analysis and After Action Review. There is no point is collecting the data if it's not then appropriately analyses and feedback given to everyone.

Who is best placed to deliver the training, we have found that it doesn't necessarily reduce the amount of instructional staff it just changes the balance. When teaching with simulation you need someone who understands the software being used and the subject matter expert to deliver the teaching.

9.3 Human Interfaces

All of these technologies have a human interface and many different interfaces exist now from Head Mounted Displays like the Occulus Rift to Motion trackers like the Microsoft Kinect or Leap Motion. So more and more we need to understand the way the student learns and other Human Factors Issues concerned with the deployment of commercial technologies. The UK has invested a significant amount of time and research in the area under firstly the Human Factors Integration Defence Technology Centre [27] and currently under the Defence Human Capability Science & Technology Centre (DHCSTC). Under these programs one of its outputs was a booklet entitled Human Factors Guidance for Designers of Interactive 3D and Games-Based Training Systems [28]. In its opening remarks Professor Robert Stone suggests:

"Interactive 3D media has to be designed in conjunction with its end users, identifying the skills that need to be trained or the knowledge that has to be imparted, and then delivering a solution based on appropriate content, fidelity and interactive technologies. Furthermore, the training solutions must be packaged in a form that can be delivered to the end users in their own working environments, as opposed to expecting them to exploit the technology in isolated and restricted laboratory environments. The solutions must be developed so that the end users can understand and benefit from their contents immediately, supporting their own modifications through simple-to-use shape, texture and behavioural editors."

10.0 CONCLUSION

COTS Games Technologies provide significant opportunities and challenges to the military sector especially in the training domain. The military community can take advantage of the millions of dollars spent on development and the markets desire for use creatable content to develop specific military capabilities and training scenarios.

There are however some significant challenges that need to be considered before adopting a commercially derived product. In the military domain there is a need to balance the Entertainment and Fun of a game with the realism and correctness of actions and behaviours to prevent the delivery of Negative training. This

requires the military community to undertake a more modern approach to Verification and Validation of the data used, and the approach to training. Training Design may also need to adapt to experiential learning models. Simply using a game doesn't create a training experience. The military audience needs Games Technology to be designed to impart training and (usually) to be part of a broader training system or progression through a training pipeline.

Military cultural can also provide a challenge; the term *game* has a number of negative connotations to many military personnel. The main fears are that of negative training and the "gaming effect". Simply described negative training comes from having to complete a procedure in the game in a way that is unlike reality, and the gaming effect being trainees begin to think reality is like the game they've just played or begin to think they've invincible or worse still there is no way in that engagement they can be hurt.

Commercial Games technologies need to make use of the latest hardware advances in a market with so many options available they need to have something different and new to offer the consumer. This is achieved using new concepts and employing the latest technology (e.g. motion controllers) leading to hardware that can be obsolete or struggle to keep up in performance terms with the 18-24 month lifecycle of a game.

Traditional military acquisition processes can't keep up with the pace of software and hardware development at the moment. In terms of hardware it is expected that a PC can be used, as bought, for 3 to 5 years. If the lifecycle for a COTS game is 18-24 months and that new game is optimised for the current specification of "good" hardware (Graphics card, CPU) then significant hardware refreshes are required.

Commercial lock-in: Due to the limited influence the military will have on the formats used by the games markets care needs to be taken with proprietary formats, interoperability and the use of networking standards

Generally the $30 commercially available game provides limited Exercise Control, logging or After Action Review facilities and interoperability with other simulations C2 systems and professional instrumentation. Someone will have to create an interface that allows for these capabilities to be developed into a product the military can use.

The use of COTS Games Technologies and the exploitation of SDKs in a complete training programme requires supporting investment in both the operator but also developers to create and modify content.

Engaging with developers who specialise in integrating COTS tech, customers of SGs may be allowed greater flexibility in requirements.

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13.0 USEFUL WEBSITES AND LINKS

The websites provided here are for further reading on the subject and reference. This list is by no means exhaustive or intending to provide any indication of preference by the author, Cranfield University or NATO.

[35] Simulation and Gaming via SAGE Journals www.sag.sagepub.com

[36] The Journal of Defence Modeling and Simulation via SAGE Journals — www.dms.sagepub.com

[37] I/ITSEC — www.iitsec.org

[38] GameTech — www.gametech.com

[39] Simbox — www.simbox.com

[40] Delta 3D — www.delta3d.org

[41] CryEngine — http://www.crytek.com/home

[42] eSim (Steel Beasts) — www.esimgames.com

[43] Bohemia Interactive (VBS2) — www.products.bisimulations.com

[44] Xplane — www.x-plane.com

[45] Microsoft Flight — https://www.microsoftflight.com/en-US/home/

[46] Prepar3D — www.prepar3d.com

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