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Serious Games at the University of Birmingham

Capabilities

- Human Factors and Serious Games/Synthetic Environment Specialists
- Personnel with 20 Years of Experience in Intera ctive 3D and Virtual Environments
- Rapid Task Analysis Techniques for Technology-Based Training & Game-B ased Simulation (supporting design, learning outcomes and evaluation metrics)
- Content and Fidelity Specifications for Interactive 3D and Serious Games
- Usability and "Appropriat eness" Evaluation of Interactive Hardware Human Performance Evaluation
- Rapid Demonstrator and Scenario Construction Using Third-Party Engines
- Co-Founder of the UK's Serious Games Alliance
- Member of the MoD Serious Games COTS Evaluation Unit

Applications

- Defence Medicine & Surgery
- Defence Mental Health
- Defence Human Factors (Human Factors Integration Defence Technology Centre – www.hfidtc.com)
- Civilian Medicine & Surgery
- Uninhabited Air/Ground/Subsea Vehicles
- Counter-Terrorism Activities
- Culture & Heritage
- The Environment

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Serious Games – a Brief Introduction

Serious Games (or *Serious Gaming*) is a field of endeavour that focuses on the exploitation of high-quality computer games and associated software tools such as those underpinning the "first person shooter" (FPS) or "role-playing" (RP) games currently being enjoyed by youngsters and adults alike, all around the world. These tools take the form of software development kits (SDKs), regularly released by leading games developers shortly after the publication of a new product, such as *FarCry* or *Half-Life 2*, together with a growing number of content generation packages becoming available – many free of charge – from the Web. These tools enable avid games players to develop their own virtual humans or "avatars", environments, weapons and adversaries, thereby prolonging the longevity of the game they have purchased. However, the availability and affordability of these tools have also very rapidly generated interest from another group – the serious applications community – including those responsible for researching and designing training and real-time visualisation systems for defence, surgery and education, to mention but three examples.

The University of Birmingham's HIT Team has, since 2005, become recognised as an international leader in the human-centred development of serious games, courtesy both of internal research programmes and those associated with the University's major role in the UK's Human Factors Integration Defence Technology centre (www.hfidtc.com).

ACTIVE – Assessment of Context, Tasks and Interactivity for Virtual Environments

The availability of affordable hardware and software packages, such as 3D graphics accelerators and games engines, hosted within commercial, off-the-shelf PC platforms, is resurrecting interest in the adoption of Technology-Based Training (TBT) systems based on interactive 3D ("*i3D*") for applications in training. Attention is now turning to more human-centred issues, focusing on appropriate content, sensory and functional fidelity, interaction style and the need for specialised display and control peripherals. Based on over a decade of research and development, the *ACTIVE* methodology has been designed to overcome some of the logistical, timing and financial restrictions faced by human factors specialists in trying to capture – during live, in-the-field, or operational assessment sessions with actual end users – the key components of training scenarios for the purposes of defining the scope of TBT solutions, particularly those based on i3D (e.g. VR or serious games).

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Interactive Trauma Trainer

A proof-of-concept demonstrator project, part-funded by the Human Factors Integration Defence Technology Centre and developed by TruSim (a division of Blitz Games, UK), in conjunction with the Royal Centre for Defence Medicine. The Interactive Trauma Trainer is the result of an intensive human factors project, based on *ACTIVE* analyses conducted with RCDM and Army Field Hospital specialists. The task of the user is to make appropriate decisions relating to the urgent treatment of an incoming casualty with a "Zone 1" neck fragmentation wound. Appropriate interventions – oxygen provision, blood sampling, "hands-on" body checks, patient visual and physiological observation, endotracheal intubation – must be applied within 5-6 minutes in order to save the virtual casualty's life.

Pulse!!

The University of Birmingham is part of an exciting new US medical serious games project called *Pulse!!*, coordinated by Texas A&M University Corpus Christi. Funded in 2006 by a $4.3 million federal grant from the Department of the Navy's Office of Naval Research, this new " Virtual Learning Space" healthcare initiative will provide an interactive, virtual environment in which civilian and military heath care professionals can practice clinical skills in order to better respond to catastrophic incidents, such as bio-terrorism.

Birmingham University specialists are acting as consultants in the development of the human-centred design aspects of *Pulse!!*, from the performance of task analyses (such as those recently conducted at the Bethesda Naval Hospital in Washington DC) and human interface design to the generation of evaluation metrics.

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Generic Applications Support Tool

A good number of the Birmingham Serious Games Team's projects rely on an ability to develop credible "mini" demonstrators, often at short notice. Therefore, to have access to a reconfigurable generic virtual environment is both important and, ultimately, highly cost-effective. In addition, the ability of that environment to accept static or animated 3D models and other assets reasonably seamlessly, plus provide support for storyboarding and scenario generation, is also of considerable value to human factors personnel. The Generic Applications Support Tool is based on the Crytek *CryEngine* and Sandbox Editor, in conjunction with a large database of 3D assets – some purchased from Web sources, others built in-house. Already used to excellent effect in the early *Alchemy* projects (see below), the Tool has formed the basis of the majority of demonstrators delivered from the HFI DTC research programme.

The first (demonstrator) version of the support tool was developed to demonstrate the capabilities of serious games technologies to the Defence Mental Health Community and consists of a number of short scenarios relating to urban patrol and attendance at an incident in a Middle East-like setting. For example, the user may be confronted with an empty street, containing some burned-out and abandoned vehicles and background distant noise.

A *Warrior* Armoured Fighting Vehicle (AFV) together with a small Army contingent is visible around 400-500 yards from the user's "start" position and he or she has to walk towards the vehicle and climb inside. Another scenario includes a combination of elements, such as overhead helicopter activity, *Adhan* chants emanating from a nearby virtual mosque, a large crowd in the vicinity of the AFV, with accompanying shouts, screams, local gunfire and an explosion during the early part of the Warrior approach.

Significant input was provided by the Yorkshire Regiment in Warminster to help the researchers acquire images and sounds from a Warrior armoured fighting vehicle. The Regiment also provided Army personnel clothed in various assemblies to assist in the accurate modelling of 3D Army avatars. The COMSEC (Communications Security) Unit, also at Warminster, provided sound files of radio "chatter" scenarios relating to fictional incidents, as might be witnessed by a Middle East patrol.

More recently, the same urban scenario has been used to de monstrate how 3D models of explos ive ordnance disposal (EOD) vehicles can be developed quickly for planning and training applications. Loosely based on the Remotec *Cutlass* vehicle design, the demonstrator shows how 3D ass ets can be reused to provide realistic c ontexts for a range of defence applications.

Improvised Explosive Device (IED) Search & Disposal

Following on from the EOD vehicle demonstr ation shown above, the HIT Team has engaged with subject matter expe rts at the UK's National Search Centre (Defence, Explosives, Munitions and Search Schoo l, Rochester) and the Army School of Ammunition (Kineton) to inv estigate further the potential for adopting s erious gaming technologies in search planning, continuation traini ng and EOD system deployment activities.

This work, which commenced early in 2007, involv es developing v irtual terrains based on a hypothetic al Middle Eastern route and a real sear ch training facility near Lydden in Kent. A comprehens ive survey of the latter site has resulted in a large database of imagery and video s equences whic h are being ass embled into a real-time terrain model (hosted by the *CryEngine*) of high fidelity. The ability to be able to model both natural and manmad e features relevant to t he procedures by which IED locations are identified to a high level of vis ual fidelity is cr ucial in this project and, as can be seen in the real (right image) vs. vi rtual image (left) below, current progress is encouraging.

Once complete, this model will be used t ogether with Army avatars (including a virtual Springer Spaniel search dog!) to develop c lassroom planning and training scenarios for search and disposal specialists.

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Civilian Surgical Applications

The internal anatomical structure of the human body is not always as “standard” as text books suggest. Occasionally, and as a result of genetic aberrations or subtle differences to the ways in which organs and their interconnecting vessels have developed, aberrance is witnessed. Such variations can lead to difficulties during surgical interventions, in that surgeons may make false assumptions about the way in which an anatomical structure or group of structures are presented. Inappropriate decisions and actions taken on the part of the surgeon can lead to irreversible procedures being applied, leading to costly and often debilitating mistakes. This research seeks to understand why these surgical errors are made and is based on an experimental gaming implementation (based on the FarCry *CryEngine*) of realistic anatomical structures, particularly those in the hepato-biliary region of the human body. Another application under investigation seeks to foster pathology recognition skills in urology surgical trainees (bladder endoscopy).

Alchemy 1 & 2 Unmanned Vehicle (Land/Air) Demonstrators

Project *Alchemy* was originally conceived to demonstrate how low-cost Virtual Environments could be developed quickly and cheaply, thereby supporting the rapid development of technology demonstrations (military systems, scenarios, etc.) and, ultimately, investigations into the use of different forms of interactive display and control devices. *Alchemy* builds upon a real-time, interactive 3D (*i3D*) demonstrator originally developed by a Birmingham University Undergraduate Final Year project called *TOMSAV* (Teleoperation Of Multiple Semi-Autonomous Vehicles).

TOMSAV was a project investigating human operator situational awareness display requirements for the control of a fleet of robot submersibles deployed to carry out surveillance activities around a disabled nuclear submarine.

Alchemy was subsequently expanded to investigate how low-cost, games technology-based simulations could be used to support the development of new guidelines and standards relating to operator display and control requirements for ISTAR UAVs (Intelligence, Surveillance, Target Acquisition & Reconnaissance Unmanned Air Vehicles), deployed in support of homeland security operations in urban environments and close-combat missions in foreign environments. The original *Alchemy 1* test bed took the form of a zero cost reconfigurable Synthetic Environment (SE) system, based on Microsoft's Managed DirectX 9.0 API, the C# .NET language and appropriate games engine technologies.

More recently, with *Alchemy 2*, the test bed has been ported onto the *CryEngine* and developed further to demonstrate the deployment of ISTAR UAVs in support of special operations. The *Alchemy 2* environment is currently being used to support the introduction of new uninhabited vehicle (medium-altitude / urban combat support). single-person turbofan (*Personal Air Vehicle* - PAV) concepts for Gress Aerospace International, a small, innovative Canadian and British company.

Helicopter Voice Marshalling

This project was designed to assess the role of vibration in the tasks undertaken by Helicopter Voice Marshals – aircrew located in the rear cabin of helicopters whose job it is to guide the pilot using verbal instructions during an approach toward a target (on land or sea) for the purposes of rescue or load deposit. The first phase of the project resulted in the development of a vibration sensing device which was flown on an EC-203 helicopter whilst performing a range of typical marshalling manoeuvres. The data collected were then used to drive a 3-axis modified entertainment simulator motion base, linking the simulator motion and vibration to interactive 3D graphics developed using Microsoft's *Flight Simulator 2004*. A more permanent control system supporting the integration of gaming technologies with the motion base platform is being developed for use in conjunction with developments in the application of games engine technologies to the

design of, and training for future specialised air vehicles (as investigated under the *Alchemy* programme).

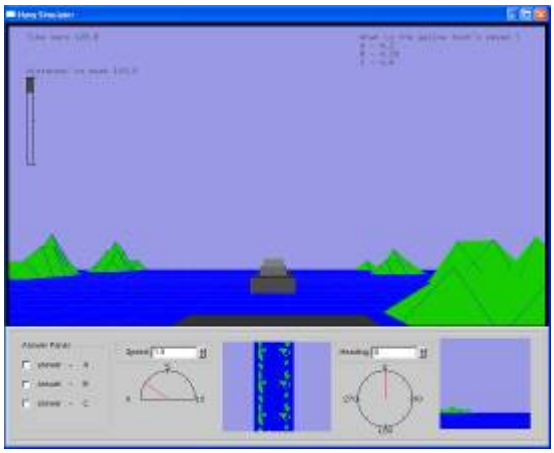
Part-Task Training for the Dillon Minigun

The M134 Dillon Minigun is an electrically powered Gatling Gun capable of delivering 3000+ belt-fed 7.62 rounds per minute. Following experiences in Operation TELIC, the Royal Navy has decided to fit a variant of the M134 to a number of its vessels, for close-in combat and ship protection purposes. The experimental game-based trainer has been developed as part of the HFI DTC research programme is addressing a number of key issues, including the unique "hosepipe tracking" behaviour demonstrated by the weapon aimers and the torque-induced "kick-down" when fired. Videos of tracer streams from the Minigun depict a firing pattern similar to hosepipe spraying in order to improve time-on-target. This, coupled with the fact that the aimer's ship will be undertaking extreme manoeuvres, stresses the need for an appropriate weapon skills and procedural trainer. Delivering such a trainer in *desktop* form will, it is believed, offer greater benefits for familiarisation or refresher training, especially onboard RN Vessels on operational assignments.

The scope of work was defined following *RATaC* analyses of Minigun aiming and firing activities onboard HMS *Roebuck* in the English Channel in October 2005 and the Type 42 Destroyer HMS *Edinburgh* in October 2006.

Pre-Simulator Performance Capture Tool for Junior Warfare Officers (Royal Navy)

Increasing student failure rates during bridge simulator navigation courses have been noted by RN officials. It is suspected that this is occurring as a result of some students' apparent inability to be able to correlate 2D information on charts and radar screens with the actual dynamic 3D situation out of the simulated bridge windows.



The failure rate situation has, apparently, been evolving since the introduction of the Initial or "Junior" Warfare Officer (I/JWO) simulators in December of 1995. There appears to be a very strong case for investigating these issues further, analysing the tasks the JWOs are required to perform, with the aim of collecting performance data from JWOs before they are committed to simulator courses. A recent *RATaC* analysis, conducted within the bridge simulation facilities at HMS Collingwood in Fareham, has confirmed this and a laptop-

hosted test has been designed to investigate such issues as spatial orientation and collision threat detection.

Inspiration for the performance capture tool came from the interface design for the classic game *Elite* (written in 1982). Design features included interrogation of a 360° "situational awareness" radar-like display, collision avoidance and monitoring of spacecraft status and resource histograms. Another key skill was the need to control the approach speed and match the rotation of one's own craft with that of the target space station to effect a successful dock. Different cockpit views (side and rear) were selectable via specified function keys. Consequently, the I/JWO Performance Capture Tool takes the form of a single-screen, multitasking interface, displaying a primary navigational task (including collision threat detection and prioritisation), with secondary task elements, including the monitoring of different digital readouts (including the virtual "radar"), rear-view target detection and numerical calculation

Submarine Spatial Awareness Training

An early (2000) study undertaken for Flag Officer Submarines (FOSM) considered the feasibility of implementing a PC-based Virtual Reality system for naval personnel undertaking classroom-based familiarisation training as part of their submarine qualification course.

The aim of the system, also referred to as *Submarine Qualification (Dry)*, or SMQ(D), was to foster the notion of the *Safe Submariner* – helping students to become familiar with the layout of the vessel, including decks, compartments, key items of equipment, main service routes (e.g. high-pressure air), safety equipment (blow valves, firefighting equipment, breathing apparatus) and so on.

Project *SubSafe* is a more recent project, designed to revisit the virtual SMQ concept and to conduct human factors experiments to investigate transfer of skills and knowledge from a gaming environment onto an actual SSN submarine, and to investigate *skill fade* over time – between initial training and on returning from more career-based training, for example.

This work is being supported by the HFI DTC and involves collaboration with the

MoD's Submarine Integrated Project Team (SUB IPT) at Abbey Wood and the serious games development company Incredible Expanding Box. Source data (images, compartment layout, target object references and so on) were derived from a photographic and video survey of the submarine HMS *Trenchant*, whilst in Devonport, and, for the purposes of this early Ogre3D demonstrator, include all compartments forward of the reactor bulkhead.

Periscope Range Assessment

Another submarine related project has been developed by an MEng student at Birmingham. This project focuses on the training of naval personnel in the skill of assessing the location and status of surface ships, thereby providing the submarine commander with accurate information to enable him to make timely decisions to take the submarine quickly to its "safe depth", thereby avoiding potential collisions. Using the Tactical Television Console onboard SSBN submarines, the tasks of the console user include collating information to establish the submarine's "Go Deep Circle" (GDC; based on calculations made using information from the TTVC – mast magnification, target height bars, etc.) and defining the time intervals between conducting "All-Round Looks" (ARLs) to prevent any unseen vessel from crossing the GDC. The laptop-based Ogre3D trainer replicates the current TTVC interface but also includes a "consequences" display, which uses 3D models of the submarine and surface ship to show the end user the outcome of a contact scenario, based on his performance.

Virtual Scylla (virtualscylla.org)

HMS *Scylla* is a Batch 3 *Leander* Class Frigate that was scuttled in March 2004 off Whitsand Bay near Plymouth by the National Marine Aquarium (NMA) to become Europe's first artificial reef. The current baseline interactive visualisation of the *Scylla* has been developed using industry-standard 3D modelling tools (3ds max) in conjunction with images and plans of the vessel (provided by the National Marine Aquarium), a scale model of the wreck and the results of a recent (August 2006) diving and remotely operated vehicle (ROV) mission to the reef.

The 3D model of the *Scylla* is again visualised in real-time using the *CryEngine* games engine. Users can explore the *Scylla* in its different stages of development by controlling a virtual ROV using, for example, a familiar Microsoft *Xbox* games

controller. To add context to the experi ence, a geographically accurate model of the Whitsand Bay coastline, from R ame Head to Portwrinkle has be en constructed using digital terrain map data and aerial photography.

The University of Birmingham is currently coordinating the early stages of a national research project to take this concept further, in conjuncti on with c ollaborators and marine subject matter exper ts from the National Marine Aquarium, the University of Plymouth, the Marine Biologic al Associat ion and Plymouth Marine Laboratory. The aim of this project is to deliver predictive visualisations of what the reef might look like tens of years (and longer) into the future and, eventually, to ass ess the im pact of possible global climate changes on the sea and ot her factors, such as the effects of pollution or other short-term environmental va riations. As well as predicting possible futures for the *Scylla* Reef, the results of this work will have significant implications for the development of offshor e engineering projec ts, from wave farms and coastal turbines to oil/gas platforms and coastal protection structures.

To achiev e this, the research aims to develop and apply *Artificial Life* (alife) algorithms to model (and predict) the gr owth and propagation of marine organisms over time, taking int o account the e ffects of subsea changes brought about by climatic ev ents and pollution. Birmingha m University has already deve loped a

unique software system, called t he *Seeder Engine*, as part of a Virtual Env ironment project to populate a topograph ical model of the recently-disc overed Mesolithic riverbed ar ea in the s outhern ba sin of the North Sea, as it exist ed prior to flooding caused by glacial melting (12-13,000 years ago). The researchers have already had great success in populating t he original 3D model wit h appr opriate flora (using dat a culled from pollen and other microscopic samples obtained from regions around the North Sea basin). The chal lenge now is to extend th is engine to cope with around 200 flora and fauna species that inhabit (or are expected to inhabit) the *Scylla* Reef.

For Further Information, Visit …

www.eece.bham.ac.uk/Default.aspx?tabid=374
also
www.hfidtc.com (download *Frontline* Magazine Edition 7)

Or Contact …

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