Research-informed Teaching (RiT) Project Report

Development of multi-disciplinary content for the Immersive Vision Theatre

April 2009

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Contents:

1: Project Title:

Development of multi-disciplinary content for the Immersive Vision Theatre

The original RiT bid was for a project in the area of 'Enquiry-Based Teaching' intended to impact upon the first year experience of BEng students. In the event, this proved difficult to implement against the background of the strategic review of the University and the development of a new Teaching and Learning strategy. Accordingly the money was used in another fast developing area of enquiry-based learning relevant to a number of disciplines, including engineering, namely the effective use of immersive content. This project was intended to capitalise on the Immersive Vision Theatre and to interface with the Centre for Creative Design and Technology, hence ensuring synergies and impact. The intent was to develop content for the newly outfitted Full Dome environment. The conversion of the William Day Planetarium from the traditional horizontal dome, circular seating and central Zeiss projector to a digital Immersive Vision Theatre was made possible through funding gained by the Experiential Learning CETL (Centre for Excellence in Teaching and Learning) coordinated by Dr Ruth Weaver. The ambition for the Immersive Vision Theatre (IVT) is to create a transdisciplinary instrument for the manifestation of material, immaterial and imaginary worlds, relevant to many disciplines.

The 'Full Dome' architecture now houses a powerful high-resolution projector fitted with a 'fish eye' lens to wrap data, models, video and images around its inner surface. A second, even higher resolution ultra-high contrast projector focuses an intensely detailed 'central' (to the viewer) section of the dome. The 10-speaker spatialised audio system enables the modelling of acoustic environments as well as playback through virtual speakers, i.e. more speakers than physically exist. The IVT is being used for a range of activities, from cross-disciplinary teaching to cutting edge research in modelling and visualisation.

The full dome is augmented by a 5m diameter portable/inflatable Go Dome with a HL-X2 projector which is used for outreach programmes, exhibitions and site specific experiments. The IVT is also developing a residency and commissioning programme for artists from a range of backgrounds.

A missing ingredient from the IVT project was the ability to generate world class research and teaching content. This RiT project aims to do this, specifically through the generation of 3D content.

2: Project Team:

The project team consisted of:

Professor Neil James, Dean of the faculty of Technology.
Dr Ruth Weaver, Director of the ELCETL.
Mike Phillips, Reader in Digital Art & Technology.

Individual projects developed by the RA appointed to the position of 3D content developer include (see Section 4):

B Aga (i-DAT)
Peter Bond (SEM).
Pete Carss (IVT).
Katina Hazelden (i-DAT).

Craig Hedge (Psych).
Neil Hughes (SoE).
Peter Matthews (SoEOES).
Roy Moate (SEM).
Shaun Murray (i-DAT).
Sian Rees (SoEOES).
Paul Robinson (SoCCE)
Paul Russell (PMS).
Simone Schnall (Psych).
Peter Smithers (SoBS).
Chris Speed (i-DAT)
Bob Stone (SoCCE).

3: Project Aims:

The project appointed a Research Assistant to work with the existing team of content producers for the Full Dome Immersive Vision Theatre. The post set out to develop dynamic content drawn from diverse disciplines located in the Faculty of Technology, developing traditional computer modelling techniques (such as CAD and VRML) through to abstract dynamic data modelling (from areas such as ecological and intelligent buildings, data mining, and computer network activity), through to scanning electron and atomic force microscopy imaging and links with modelling applications for rapid prototyping technologies. The post will work closely with content providers developing support structures to deliver a sustainable programme of high quality productions for the Dome.

The intention was to enhance and extend existing projects initially funded by the Earth Sciences HEFCE funded Experiential Learning CETL (Centre for Excellence in Teaching and Learning). As well as being an integrating force across the disciplines located in the Faculty of Technology, the post will work closely with members of the Centre for Creative Design and Technology contributing to its efforts to unlock transformative uses of visualisation, modelling and simulation which reach from undergraduate and postgraduate education through to research and into industrial and business practice.

The position set out to form constructive and supportive working relationships with non-specialist clients, operate as part of the IVT and i-DAT research team and display a high degree of creativity, energy, enthusiasm and commitment to pushing forward the innovative aspects of this project.

Although there was a shift in the original intention to support ‘Enquiry-Based Teaching in a specific impact upon the first year experience of BEng students, the outcome of this project has been to support a much wider demographic and a much moiré subtle development of enquiry-based learning.

The use of the IVT as and immersive of highly engaging learning and teaching tool has been extended through the development of content which has emerged through a collaborative process between subject expert and media producer. This has enabled a question driven approach at the very core of these developments. The development of specific content has allowed the modeller and the subject expert to focus on a particular theme that drives the development of the model and the process for student engagement. This dialogical approach has encouraged a more reflexive critique of the content being developed by both parties, which in turn can be carried forward to the learning process with students. When incorporated into the students learning programme these highly intensive projects them become triggers for a broader investigation through lab, library and internet investigations.

Each project developed through these subject collaborations has encouraged a self reflexive approach in the subject expert/teacher, which, because of the peculiarities of the media and unfamiliarity of the of the teacher with it, has generated considerable re-thinking of the subject and the learner/teachers relationship to it.

4: Methods:

The development of Full Dome content presents a peculiar set of problems to a media author, problems that are greatly increased when content is required to deliver a particular pedagogy of specific disciplinary content. The RA appointed to this post is required to:

- develop high resolution, dome corrected, immersive content,
- tailor this content to particular pedagogies and disciplines.

The generation of Dome Corrected content is problematic due to a range of technical issues related to the size of the image required (both in term of capturing and playback of an image), technological inadequacies in contemporary cameras (related to the equi-rectangular proportions required for dome images as opposed to normal video and photographic proportions of 4:3 or 16:9) and the fact that, although dome environments have existed for millennia, the development of effective dome media forms is poorly understood.

Consequently the RA appointed to this post has had to struggle with the effective delivery of pedagogy, discipline specific knowledge, subject experts who have little or no understanding of the potential of the media form, and significant technological limitations.

The decision was made to appoint a 3D modeller in order complement existing skills within the IVT and extend a variety of technologies currently embedded into disciplines across the University which include, Architecture, Computing, Engineering, Digital Art, 3D Design, but which can offer solutions to Earth Sciences (for modelling of climate change etc) and bio-medical areas (such as modelling bio-medical data and 3D fly-through, etc). The development of 3D modelling solutions for the delivery of pedagogic and research content has explored the following technical processes:

- 3D environments including: OpenGL, DirectX, OpenSceneGraph, OpenSG
- Coding/scripting environments including: C++, Java, .NET, Python, VRML.
- 5th generation visual programming environments including QuartzComposer, Max/MSP, VVVV, PureData.

• Game engine environments including: Panda3D and Unity 3D.
• 3D modelling applications including: 3D Studio Max and Blender.
• Render farm techniques using distributed multi camera Real-Time Ray Tracing techniques.
• 3D laser scanning, volumetric modelling and Rapid Prototyping output.
• data imports including: bathymetry, xml, population density maps, WMS, KML.

The process of developing an appropriate balance of (technical/aesthetic) form and pedagogic/research) content (in many cases these were interchangeable) evolved through negotiations between the RA and the subject expert. The selection of projects was made on the basis of an open call issued by Ruth Weaver from the IVT, EL CETL, and subsequent developments of key technologies, such as the Open SceneGraph models of insects and architectural forms have been further refined. The recent development of a dome corrected game Engine solution has opened up opportunities for integration into the BA/BSc (Hons) Digital Art & Technology and BA/BSc (Hons) Design for Visualisation Programmes. Individual content development projects included:

Production Processes: The technical processes described above will have little sustainable impact unless they are incorporated into a reproducible production process. This has been achieved through collaboration with other members of the IVT team.

Render Techniques: The technical processes above and media content processes below, along with the production process are dependant on the technical and creative incorporation of the limitations of the rendering process. For example, each animation needs to deliver 25 frames a second at a resolution of around 1400 x 1040. Images will need to be rendered using a variety of techniques to ensure that the production process can be delivered adequately, i.e. a compromise needs to be reached between quality and time. A variety of finely tuned techniques have been developed and are now embedded in the production process of the IVT.

Real-time Ray Tracing: The development of distributed computing techniques, including small render frames of networked machines and more recently the incorporation of a Dell Blade Server for video and 3D networked rendering to generate real-time 3D environments.

PSQ Building Campus Carbon Footprint: A development of the Arch-OS project in collaboration with the CSF CETL. This project attempts to create a real-time 3d visualisation of the carbon footprint of the Portland Square building trhough data feeds generated by the Arch-OS system. This has generated a flexible 3D model of the campus and PSQ building, as well as a number of visualisations used to support another RiT Project (Development of a joint Centre for Creative Design and Technology).
Staff: B Aga, Shaun Murray, Mike Phillips, Chris Speed.

Spatial Memory: The incorporation of the PSQ 3D model to support behavioural experiments derived from experimental psychology, involving tightly controlled manipulations of the immersive experience, random assignment to experimental conditions and appropriate statistical analyses. The 3D model of Portland Square has

been incorporated in a number of spatial memory and immersive environments experiments. School of Psychology,
Staff: Simone Schnall, Craig Hedge

Coastal Engineering: The development of 3D dome visualisation from research and undergraduate work. This has included face to face tutorial support to develop undergraduate student 3D modelling and visualisation skills, and to facilitate the development of a real-time 3d environment.
Staff: Paul Robinson, Neil Hughes, Bob Stone. Department: School of Computing, Communications & Electronics/ School of Engineering .
Module details: DSGN143

Insect Anatomy: The support of a cross disciplinary project modelling high resolution scanning electron microscopy images for use in the IVT. Projected in full panorama within the IVT, the image sets will allow detailed investigation of fine structure in specimens of selected invertebrate groups.
Staff: Roy Moate, Peter bond and Peter Smithers
Department: Plymouth Electron Microscope Centre, School of Biological Sciences

Pore-Core: Video Production for activities in Applied Chemistry used on open days. Incorporates a kix of 3D modelling and animation and dome corrected video footage.
Staff: Peter Matthews.
Department: School of Earth, Ocean & Environmental Sciences

Medical Visualisation: Realisation of 3D models created by PMS. Porting of voxar 3d data (volumetric) to conventional 3d format for visualisation.
Staff: Paul Russell
Department: PMS

Cluny Abbey: Building on existing models of Cluny Abbey virtually reconstructed for a CAVE and stereoscopic flat screen environment by Laboratoire Électronique, Informatique et Image - Équipe Immersion Virtuelle, Arts & Métiers ParisTech / Institut Chalon sur Saône. This project implemented a real time Open Scenegraph solution which has been incorporated into several other projects, such as the Insect Anatomy project above.
Pete Carss, Neil James, Mike Phillips.

BA/BSc Digital Art & Technology Lecturing. Lecturing in 3d modelling, animation and real-time productions. Course details: IDAT206

Lyme Bay: Modifying an existing 3D animation created for Devon marine wildlife trust, into a dome animation / real-time production.
Staff: Sian Rees
Department: School of Earth, Ocean & Environmental Sciences

5: Students:
The project has impacted on student experience in a number of ways. Direct teaching of related skills into the following modules:
DSGN143. Serious gaming workshops creating dome visualisation with undergraduate students through 3d tutorial support and the development of a real-

time 3d environment for Paul Robinson, Neil Hughes, Bob Stone in the School of Computing, Communications & Electronics/ School of Engineering.
20 students.

IDAT201 Trans-Spatial Design (shortly to become IDAT211 Reflexive Design). 3D studio Max tutorials supporting the development of simulations and simulacra. 24 students.
IDAT307 4D. Tutorials supporting advanced development of dome corrected 3D environments through VVVV, PD, 3D Studio max and Quartz Composer. 27 Students.
Final Stage Project student support. Specific advanced modelling and technical support for a range of technologies.
15 Students.

The practices developed through this project are being embedded in the modified BA/BSc Digital Art & Technology Programme. They also form the motivation to the newly approved BA/BSc (Hons) Design for Visualisation course which includes the new IDAT213 Visualisation stage 2 module. DMR attached, Appendix C.
The post holder has been supporting teaching within the Faculty of Technology. He has been involved in two workshops formulated and delivered through another RiT project in strategic areas of creative design and technology, in particular 3D modelling, scanning and render farm development. These have involved vertical teaching from stage 1 to Masters and PhD level, and across institutions, involving Masters students from Unit 20 and A.V.A.T.A.R, Bartlett School of Architecture, University College London, (http://www.avatarlondon.org/) and Advanced Architectural Design, AHO Oslo School of Architecture and Design, Norway (http://www.aho.no/en/)

Workshop support includes:
• Outside / Inside. A trans-disciplinary masters workshop in GPS and Ultrasound. 22nd - 23rd April 2008
• A trans-disciplinary research workshop on Arch-OS . International workshop: AHO+BARTLETT= i-DAT. 25th - 27th February 2009.
Workshop descriptors attached in Appendix D.

The project has supported four students on professional training/Placements located in the IVT, supported by Global Immersion.

The post holder has delivered digital media dome content for WP sessions and material developed specifically for children, including launch content for the INTECH Planetarium the UK's largest capacity planetarium based at Winchester, Hampshire.

6: Impact:
The project leaders believe that the content developed for the IVT will significantly assist in the development of a student experience that is:

- **Research-oriented** (skills) – students learning how to do their own research and critique that of others; research methods training.

- **Research-based** (investigative) – students learning through researching; inquiry-based.

And assists student learning in the areas of:

Knowledge Transfer
- Working with professionals
- Employability
- Problem- based Learning

Knowledge Management
- VLEs – Blended Learning

Knowledge Sharing
- Case studies – Expertise-based case studies

The project has had a significant impact on the development of visualisation, modelling, games development and cross disciplinary teaching and research within the Faculty of Technology and through the Immersive Vision Theatre's delivery of content to other disciplines within Science and Arts.

It has proved critical in developing Immersive content for the IVT and placing the CETL within an international arena. This has been achieved through industrial collaborations and the research that will underpin the future development of the IVT.
The project has enabled a shift in the original thinking about the development of content in the IVT. The EL CETL anticipated a more traditional media production model for the IVT, incorporating video captured on field trips etc. The development of a suite of 3D modelling tools has opened up a series of collaborations and production routes that deliver a highly flexible and world class data modelling capability. This has already enabled the IVT to support the Third European Workshop and Conference in Immersive Vision. 25-28 March 2008 and to partner a successful Technology Strategy Board project with Global Immersion.

7: Future:
The future of the activity is being embedded in undergraduate programmes such as BA/BSc (Hons) Digital Arts & Technology, BA/BSc (Hons) Visualisation and modules such as DSGN143. The activity is critical to the continued development of the IVT's production capabilities. It has managed to identify itself to the Immersive and visualisation community as a world class competitor and these achievements offer opportunities for significant enterprise activity to support teaching and research. This can be accomplished through the contribution of the post as a member of the IVT team and continued contribution to modules and programmes in the new faculty structure. This activity is described in detail in the strategic plan or the IVT.