Institution: University of Sussex

Unit of Assessment: UoA 11 Informatics

Title of case study:

Augmented digital representations of cultural heritage enabling interactive virtual museums

1. Summary of the impact

Research at Sussex has enabled the development of interactive virtual museums, which include the Church of Santa Chiara in the Victoria and Albert Museum's Medieval and Renaissance Galleries, and Sierra Leone digital collections both online and also recently exhibited at the British Museum. These developments apply Internet, XML, 3D visualisation and database technologies in novel ways. Impacts of the research are social and cultural, through support for social cohesion and the public's greater awareness and understanding of their cultural heritage; impacts are also in the area of public services, by enabling 'memory institutions' to improve their service delivery by increasing the global reach of their exhibits and the depth of their engagement with visitors.

2. Underpinning research

The digital heritage research outlined in this case study was led at the University of Sussex by Dr Martin White (Research Fellow 1994–1995, Lecturer 1995–1998, Senior Lecturer 1998–2003, Reader 2003–) and was funded by the EU FP5 programme and, more recently, through third-stream University consultancy activities, the Technology Strategy Board, and the Arts and Humanities Research Council. This research focuses on enabling 'memory institutions', i.e. repositories of public knowledge such as libraries, museums, archives and other entities such as cultural heritage monuments and sites [see Hjerppe, R.A. (1994) 'Framework for the description of generalized documents', *Advances in Knowledge Organization*, 4, 173–180], to solve some of the classic problems they experience concerning preservation and access to heritage in their care:

- The public are often restricted from accessing sites and monuments.
- Collections are often far larger than can be presented to the public in the physical space of a museum.
- Digitising large collections can require expensive ICT expertise and is very time-consuming.
- Curators have to balance the sometimes-conflicting priorities of preservation and access.
- For practical reasons, contextual information about objects is often limited to the object label.

The need for cost-effective and innovative ways to preserve and allow access to cultural heritage in digital space is clear: not everyone can visit the Parthenon or the British Museum; and people want to see objects 'in the round', understand objects in the context of their use, and explore the relationships between these objects and their cultural context. This gives rise to the concept of the virtual museum or exhibition, which relates a museum's digital objects and their context through ICT tools and methods, providing an interactive and engaging experience. The EU IST Key Action 3, Multimedia, Content and Tools, in particular the FP5-IST 4th Call for Proposals, IST-2000-III.1.6: 'Virtual representations of cultural and scientific objects' was specifically designed to address the issues outlined above. The objectives were 'to explore and experiment with novel ways of creating, manipulating, managing and presenting new classes of intelligent, dynamically adaptive and self-aware digital cultural objects, either held by memory institutions (archives, libraries, museums, etc.), or directly involving digitally born objects or art forms'. White and collaborators have investigated such issues through several EU- and nationally-funded projects:

- *Augmented Representation of Cultural Objects (ARCO)*: [White, PI, EU FP5, £520k]. October 2001 to 2004. The ARCO system provided novel ways to create, manipulate, manage and present digital cultural objects organised into virtual museums and exhibitions [R1, R2, R3]. The project developed an innovative cultural-object manager, exhibition manager and other tools that allowed museums to create their own solutions with minimal ICT support. This project provided a new metadata standard for such systems, and demonstrated the innovative application of

augmented reality for presenting digital cultural objects to the public.

- *Marie Curie Training Site: Virtual Reality and Computer Graphics (MAVRIC)*: [White, PI, EU FP5, £77k]. December 2001 to November 2005. This research focused on understanding how computer graphics and virtual reality are best applied to the 3D reconstruction of heritage sites, monuments and artefacts [R1, R2, R3]. The research results allowed large-scale, interactive 3D digital reconstructions, such as the Church of Santa Chiara for the Victoria and Albert Museum's Medieval and Renaissance Galleries.

- *Excellence in Processing Cultural Heritage (EPOCH)*: [White, PI, EU FP6, £19.7k]. May 2004 to March 2008. A main research result was a novel multisensory approach for exhibiting museums' valuable objects, which integrates an electronic system (including an inertial measurement unit) with a physical replica of the Kromstaff in the Ename Museum in Belgium. The replica was used as a tactile multisensory input device to explore a virtual-reality exhibition presenting the Kromstaff in the context of its original use [R4].

- *Reanimating Cultural Heritage (RCH)*: [White, CI (33 per cent), AHRC, £600k]. February 2009 to January 2012. The project created a unique digital heritage repository that connects the Sierra Leonean diaspora (scattered across the world as a result of the country's economic collapse and civil war) to its heritage in digital space through the novel integration of social media and Web 2.0 mashup technologies. The digital repository aggregates several major UK museums' collections with the Sierra Leone National Museum collection [R5].

- *Motion in Place Platform (MiPP)*: [White, CI (36 per cent), AHRC, £532k]. May 2011 to April 2012. Building on motion-sensing research results (i.e. the creation of an innovative upper-body motion-capture suit on the eMove—Personal Motion Sensing project (eMove) [White, PI, TSB £1.4M]) MiPP developed new methodologies for utilising whole-body inertial motion-capture technology, in order to augment virtual reconstructions of early Romano-British buildings at the Silchester archaeology site with real-time motion characters [R6].

3. References to the research

R1 White, M., Mourkoussis, N., Darcy, J., Petridis, P., Liarokapis, F., Lister, P.F., Walczak, K., Wojciechowski, R., Cellary, W., Chmielewski, J., Stawniak, M., Wiza, W., Patel, M., Stevenson, J., Manley, J., Giorgini, F., Sayd, P. and Gaspard, F. (2004) 'ARCO: an architecture for digitization, management and presentation of virtual exhibitions', in Mair, S.G. and Cook, R. (eds) *Proceedings of the 22nd International Conference on Computer Graphics*. Hersonissos, Crete, 622–625, doi: 10.1109/CGI.2004.16.

R2 Wojciechowski, R., Walczak, K., White, M. and Cellary, W. (2004) 'Building virtual and augmented-reality museum exhibitions', in *Proceedings of the Ninth International Conference on 3D Web Technology*. New York: ACM, 135–144, doi: 10.1145/985040.985060.

R3 Walczak, K., Cellary, W. and White, M., (2006) 'Virtual museum exhibitions', *Computer*, 39(3): 93–95, doi: 10.1109/MC.2006.108.

R4 White, M., Petridis, P., Liarokapis, F. and Plecinckx, D. (2007) 'Multimodal mixed reality interfaces for visualizing digital heritage', *International Journal of Architectural Computing*, 5(2): 322–337, doi: 10.1260/1478-0771.5.2.322.

R5 Zhang, W., Patoli, M.Z., Gkion, M., Al-Barakati, A., Newbury, P. and White, M. (2009) 'Reanimating cultural heritage through service orientation workflows, social networking and mashups', in Ugail, H., Qahwaji, R.S.R., Earnshaw, R.A. and Willis, P.J. (eds.) *International Conference on Cyberworlds*. Washington: IEEE, 177–184, doi: 10.1109/CW.2009.45.

R6 Dunn, S., Woolford, K., Barker, L., Taylor, M., Hedges, M., Norman, S.J., White, M., Bailey, H., Fulford, M. and Clark, A. (2011) 'Motion in place: a case study of archaeological reconstruction using motion capture', in *CAA2011 – Revive the Past: Proceedings of the 39th Conference in Computer Applications and Quantitative Methods in Archaeology*, 66–74, http://sro.sussex.ac.uk/40997/1/CAA_Motion_in_Place.pdf.

The underpinning research for the case study comes from EU and UK funded projects, where outputs R1 and R2 illustrate the innovative technology (commercialised) we developed that allows

museums to develop their own 'interactive virtual museums' based on 'augmented digital representations of cultural objects', while R4 adds a more interactive and tactile approach to exploring a museum's cultural objects in a virtual museum through a multimodal interface.

4. Details of the impact

The research outlined in section 2 has improved how museums and other memory institutions are able to engage the public with their cultural heritage, resulting in *social*, *cultural* and *public services* impacts with global reach – illustrated below. The impacts are enabled by research and innovative systems (e.g. ARCO) that allow museums themselves to develop and deploy approaches that go beyond standard multimedia methods (typified by technologies such as Adobe Flash) to create interactive virtual museums and exhibitions that combine Internet and 3D technologies and virtual and augmented realities in novel ways.

In 2008, the University transferred its IP resulting from the ARCO project to a spin-out based in Poland (ARCO Centre), which has commercialised the system targeted at Polish museums [C1]. Although the creation of the spin-out and the receipt by the University of consultancy and licensing income associated with the transfer of IP represents an economic impact, the main impacts are related to end users: members of the public. In particular, virtual reconstructions of sites, monuments and artefacts allow visitors to situate their heritage within its cultural context; 3D, virtual and augmented realities allow visitors to appreciate how such heritage was first created and used; interaction with a 'digital object' or 'augmented representation' can lead to a better understanding than, for example, a museum's physical display of the object; and digital representations can be viewed remotely across the Internet and in combination with Web 2.0 technologies to develop virtual communities around cultural objects.

- One key example is a 3D reconstruction of the Church of Santa Chiara, installed at the Victoria and Albert Museum (V&A) in 2009. The church itself is located in Florence, Italy. However, the V&A purchased the church's chapel and altars in 1861. This dislocation of church, chapel, altars and other artefacts (lost through time) presents a classical problem associated with understanding our past heritage. The 3D reconstruction allows visitors to explore the chapel and altars 'virtually' within the context of the missing church. The Santa Chiara interactive system was installed for the public opening of the new Medieval and Renaissance Galleries [C2].

  In a visitor survey commissioned by the V&A in April/May 2013, 93% of visitors who used the Santa Chiara interactive reported that it had enhanced their enjoyment, and 60% reported that it had caused them to look more closely at the physical chapel exhibit [C3]. This is supported by a V&A evaluation report, which states that the "interactives are well utilized, as 40% of visitors report using a Gallery interactive during their visit", and that the effects of the Gallery interactives influence their users to "see a larger proportion of the Gallery than non-users" [C4]. Recent evaluation "has demonstrated that the digital interactive enhances visitors' understanding of the chapel". The digital model is on the V&A's website, thus "reaching a wider international audience" [C5, C6]. The range of beneficiaries is broad, and impacts span the areas of public awareness and understanding of their heritage, and of museum service delivery.

- A further notable example is the digitisation and aggregation of several major Sierra Leone collections of cultural artefacts, resulting in the SierraLeoneHeritage social media-based digital-heritage repository (online at http://www.sierraleoneheritage.org). For this virtual museum, Sierra Leonean material culture from the Sierra Leone National Museum, the British Museum, Glasgow Museums, and Brighton Museum and Art Gallery were digitised (augmented with appropriate metadata and media objects) to form a unique repository. After its launch, the British Library and the World Museum Liverpool asked for their Sierra Leonean collections to be added to the repository, and, in early 2013, the Cootje Van Oven Collection was also added. The requests to integrate further collections after the end of the associated funded project demonstrate the value that these leading memory institutions place on the repository.

  The British Museum staged a combined physical and virtual display of Sierra Leonean artefacts in spring 2013, with a touchscreen kiosk giving access to http://www.sierraleoneheritage.org. The museum's evaluation report states that there were 66,996 visits, with the touchscreen being used by 22% of those tracked. A number of people were observed spending over 10 minutes

using it. The report concludes, "the touchscreen enabled those who were interested to explore Sierra Leonean heritage further and so appears to have been a useful addition to the display" [C7]. The museum considers that "the digital resource has been extremely useful in encouraging exploration of Sierra Leone's heritage by specialists as well as non-specialists … the unprecedented access it provides to multiple museum collections is impressive". The Sierra Leone National Museum has developed a schools outreach programme supported by a version of the website on DVD, received "with much enthusiasm by teachers and students alike". The website has been "recognised as coming at a key moment for schools", and is being used in extra-curricular clubs in the capital city and in charity-sponsored educational development projects in the poorest rural area of northern Sierra Leone [C8].

In the 50th anniversary of independence celebrations in 2011, the country's president announced in a speech that "Sierra Leone now had a cultural website and congratulated [its creators] on this achievement". The website "provides a way for people in the Sierra Leone diaspora to connect with their home country … they are proud of it too" [C9]. A Sierra Leone Facebook community is integrated within the website, allowing people in this diaspora to connect with each other and discuss their shared culture. The community has global reach: in the period 1 February – 31 July 2013, people in 206 cities/regions in 45 different countries have 'liked' content [C10]. The beneficiaries are thus spread across the world, and impacts include support for social cohesion and greater public awareness and understanding of dispersed heritage.

5. Sources to corroborate the impact

C1 Letter from a representative of ARCO Centrum, Poland.

C2 Callahan, M. and Cooper, D. (2013) 'Sacred space in the modern museum: Researching and redisplaying the Santa Chiara Chapel in the V&A's Medieval & Renaissance Galleries', *V&A Online Journal*, 5, ISSN 2043-667X. http://www.vam.ac.uk/content/journals/research-journal/issue-no.-5-2013/sacred-space-in-the-modern-museum-researching-and-redisplaying-the-santa-chiara-chapel-in-the-v-and-as-medieval-and-renaissance-galleries

C3 'Santa Chiara Chapel Gallery evaluation (room 50) – preliminary draft results'. August 2013. Confidential V&A report; can be made available for audit purposes.

C4 Matthew Petrie (2011) 'Case study evaluation of FuturePlan: Medieval and Renaissance Galleries'. http://media.vam.ac.uk/media/documents/med_ren_galleries_summative_evaluation_2011.pdf

C5 Letter from the lead interpretation specialist for the development of the V&A Medieval and Renaissance Europe Galleries.

C6 http://www.vam.ac.uk/content/articles/i/interactive-explore-the-church-of-santa-chiara/

C7 'Sowei mask: Spirit of Sierra Leone – executive summary'. June 2013. Confidential British Museum report; can be made available for audit purposes.

C8 Letter from the Curator, North African Collections, The British Museum.

C9 Letter from the Acting Curator, Sierra Leone National Museum.

C10 Facebook Insights metrics for Sierra Leone Heritage Community within the website http://www.sierraleoneheritage.org, 1 February – 31 July 2013.