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The virtual Sydney Rocks: a case study of a virtual heritage environment

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Many heritage objects and places are under threat of being loved to death. Visitor numbers to many popular sites are limited. Virtual heritage offers worldwide audiences the ability to interact with virtual copies of heritage objects and places. Virtual heritage resources vary widely in their range and scope, some models can be viewed at different angles, some offer reconstructions of buildings and places at various times and some offer educational games. The Virtual Sydney Rocks is designed to be an engaging and informative virtual heritage resource that allows users to explore the oldest part of Sydney over a 200-year period. Users set the time and date to determine the sun position, the weather and the buildings and vehicles that are displayed. Users have a first person view and can easily move around and explore the built environment. They can also set the time speed and view a time-lapsed animation of the changing model. The Virtual Sydney Rocks Guidebook is displayed on a second screen and dynamically linked to objects in the Virtual Sydney Rocks. The Virtual Sydney Rocks will be used to conduct research into the effect that different user engagement strategies have on the sense of 'being there'.

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Introduction

Every year six million people shuffle past the Mona Lisa in the Louvre, spending an average of fifteen seconds each looking at the painting (Gentleman, 2004). Between two and three million people a year visit the Taj Mahal, half a million go to Machu Picchu, one million go to Angkor Wat, seven million go to the Forbidden City, two million go to Pompeii, half a million go to the Acropolis and over two million go to the Alhambra. With an estimated world population of seven billion, a great public interest in heritage and easy and cheap mass transit, the pressures faced in preserving heritage items, while at the same time facilitating public access, are only going to increase.

Some sites such as Stonehenge, Machu Picchu and Angkor Wat have introduced limited access to restrict damage while others have had to completely block public access. The Lascaux caves in southwestern France were initially open to visitors but had to be closed due to the damage caused by the humidity from their breath, the presence of lighting and changes in air circulation which promoted the growth of lichens and crystals. The introduction of an air conditioning system did not solve the problem but made it worse, promoting the growth of molds and fungi. (Loubser, 2009)

There is a long tradition of using replicas and models in museums (Noordegraaf, 2004). Individual small heritage items can be replicated with a high degree of accuracy using laser scanning and 3D printing technology. The cost of 3D printing is falling and it is becoming a mainstream manufacturing technique (Newby, 2011). For many heritage sites creating a full-scale replica is either impossible or would be

prohibitively expensive. One of the few that has been done is Lascaux II, an exact replica of the Great Hall of Bulls and the Painted Gallery, two of the cave halls of the Lascaux Caves. Opened in 1983, Lascaux II was constructed 200 metres from the original at a cost of over 500 million francs (76,224,782 Euros) and is the result of 11 years of work by 20 artists and sculptors using the same methods and materials as the original cave painters (FranceForVisitors, 2012).

Film-maker Werner Herzog was allowed extremely limited access to the Chauvet caves in the south of France in 2010 to film his 3D movie *Cave of Forgotten Dreams*. The film crew was restricted to a two-foot wide walkway and used battery-powered lights that emitted no heat. (Olson, 2011). The resulting movie allows the worldwide public to have an immersive experience of a place that very, very few of them will ever have the opportunity to visit in person. However the cinematic experience of both 2D and 3D cinema is passive; the viewer cannot interact with the depicted objects and places.

Virtual heritage

A wide range of mapping, recording and visualisation technologies such as laser scanning, photogrammetry, geophysical mapping, remote sensing, GIS and GPS have become mainstream for field archaeology (Barceló et al., 2000; Forte & Siliotti, 1997). Similarly, interactive technologies combined with computer visualisation are increasingly finding a home in museums. (Anderson et al., 2009; Brogni et al., 2000; Pujol, 2004; Frischer, et al., 2002).

Virtual Reality most commonly refers to the creation, viewing and interaction with computer generated three-dimensional objects. Created in 1994, a computer-controlled laserdisc system showed museum visitors a 3D walk-through of Dudley Castle, England as it was in 1550 (Johnson, 2006). Technological progress now allows the relatively easy creation of 3D models, their integration with interactive systems and their dissemination via the Internet. The resulting virtual worlds run on a standard computer inside a web browser.

There are now numerous virtual models that range from Egyptian drinking vessels to Roman temples and even to entire cities (Brogni et al., 2000; Bonfigli & Guidazzoli, 2000; Jacobson, 2008; Wells et al., 2009). Virtual models offer some advantages over physical models. They can be animated to show alignments such as the midsummer sun at Stonehenge (Pasztor, E. et al. 1998) or to show the changes to an object, building or place over time (Bonfigli & Guidazzoli, 2000). Most Virtual Heritage models are bespoke, one-off builds that come in a wide variety of formats supported by different platforms and offering different levels of interaction.

Kos recognises that places are a palimpsest of information, dense with sometimes contradictory layers of meanings (Kos, 2008). Combining an interactive virtual model with a database of additional information allows users to explore more than just the physical structure of the model. (Bonfigli & Guidazzoli, 2000; Frischer, 2008; Kim et al., 2006.). The Rome Reborn project aims to model the city of Rome between 1000 BC and 550 CE. Conceived in 1974, it got its first funding in 1996. Twelve years later a rough model of Rome in 320 CE had been completed. Currently nearly 8000 buildings have been created and the resulting model can be explored in Google Earth. If a building is selected additional information is displayed via a pop-up window. The interiors of some of the buildings can be explored. (Frischer, 2008) The time of day can be varied but the physical depiction of Rome is limited to the architectural. There are none of the sounds of people and animals that assault the senses in a busy metropolis. (Nor any of the smells!) Digital Karnak also loads into Google Earth. There is an associated website with additional information, including a satellite view of the site with an overlay of the temple buildings. A slider controls the date and, depending on the date selected, the overlay of the temple buildings change. (Digital Karnak, 2012)

Games & serious games

Interactive computer games have been earning more money than the music industry since at least the mid-1990s and many 'state of the art' games have budgets that rival a Hollywood movie. The game *Assassin's Creed* is set during the time of the Third Crusade, CE 1189-1192. The action takes place in Jerusalem, Damascus, Acre and the fictional town of Al Mualim. The city streets are crowded with carts, stalls, piles of hay etc and there are up to sixty computer-controlled inhabitants going about their daily routines. The main streets bustle with shoppers, water carriers, soldiers and thugs while the side streets are much quieter. As can be seen from Image 1, the overall impression is of an inhabited city with distinctive dress and architecture. The graphics are supported by appropriate soundscapes and the result is very immersive. The game won multiple awards including the Best Action/Adventure Game category at the 2006 Game Critic Awards. It took two years and three hundred people to make at an estimated cost of \$20 million US dollars (Video Game Sales Wiki, 2012) It was released in 2007 and has since developed into a very successful franchise. *Assassin's Creed 2*, released in 2009, had a budget 20% larger and was set in Italy in 1476 with much of the action taking place in Venice, Florence and Rome. A total of four games and a number of expansion packs have been released so far, with more in the pipeline.



Figure 1. Assassin's Creed

The use of virtual technologies for training purposes goes back to the 1970s when the first virtual flight simulators were being developed for the military. The wider recognition of the role of game playing in learning, combined with cheap and widely available interactive technologies, has led to the development of Serious Games across a plethora of fields (Anderson et al., 2009; Chatham, 2007; Jacobson, 2008; Kelly et al., 2007; Kirriemuir, 2002; Lewis & Jacobson, 2002; Mayo, 2007; Zyda, 2007). While museums do not have the same budgets as the Games Industry it is increasingly possible to create immersive interactive Virtual Heritage worlds that can be accessed in museums and online.

The Gates of Horus is an immersive interactive game set in an ancient Egyptian temple. It was initially developed to run inside an immersive CAVE system to carry out research into differences in learning on a desktop computer versus in a visually immersive display. It has since been ported to the game development tool Unity (Unity.com, 2012) allowing the creation of a file that can be downloaded and then run in a web browser, making the game widely accessible. (Gates Of Horus, 2008)

Engagement strategies

"The Past is a foreign country, they do things differently there."
L.P. Hartley, 1953

The opening sentence of *The Go-Between* by L.P. Hartley offers a possible insight for builders of virtual heritage environments. Visitors to foreign countries can explore and learn about the country they are visiting in a number of different ways. They can take guided tours or wander freely, they can stay in hotels or with local families, they might learn a bit of the language and culture prior to visiting or they might not, or a mixture of the above. Virtual heritage environments also offer a variety of ways to interact, including virtual tours, free exploration and interactive games but, apart from *Champion*, there has been little systematic study of the effect that different interaction modes have on the user's experience in, and their engagement with, a virtual world. *Champion's* doctoral thesis used three different virtual worlds, all based on Palenque, and three different interaction modes (which he terms observation, activity and instruction), to examine the effect of different interaction strategies on cultural awareness and understanding. His test subjects were randomly assigned to different groups which visited the different worlds in different set orders. He found that 'the order in which people visited the archaeological worlds affected both task and understanding results, but only for the first world that they entered.' and concluded with a call for further research (Champion, 2006).

The virtual Sydney rocks

My own research is into the effect that a user's *preference* for a particular engagement strategy has on their engagement with a virtual heritage environment. To carry out my research I needed to be able to compare like with like so it was necessary to construct an interactive virtual heritage world that offered users the choice of a variety of interaction modes. An ideal place was revealed by an archaeological dig in Sydney in 1994. This uncovered a site rich in personal histories and which was also important in the larger history of the white settlement of Australia (Karskens, 1999). Figure 2 shows the site of the Big Dig and the extent of the Virtual Sydney Rocks.



Figure 2. Extent of the Virtual Sydney Rocks

Sydney Cove is the site of the first white settlement in Australia and remains at the heart and centre of the city of Sydney. The founding and development of Sydney is remarkably well documented (Karskens, 2009). There was great interest in the endeavour from the outset and prior to the sailing of the First Fleet a number of personnel were engaged by London publishers to write accounts of the settlement. In the period between 1788 and 1851, there are maps for April 1788, July 1788, 1792, 1802, 1807, 1822, 1836, 1843 and 1851 (Dawes, 2012; Fowkes, 2012). There are numerous drawings, paintings and written descriptions and, after the 1850s, an ever-increasing number of photographs. (Ashton et al., 2010; Cossu, 2008; Kelly, 2010; Hunt & Davison, 2007). Because of its rocky terrain, the western shore of Sydney Cove became known as The Rocks and was almost immediately settled by the convicts who built rough bark huts. Over the years the haphazard scatter of convict dwellings were replaced by cottages and houses and the dirt tracks by laneways and roads. Some grand houses were built for local shipping merchants who wished to be close to the harbour but in later years the area became an overcrowded slum. Many buildings were torn down in the early 1900s as part of a slum clearance program. Photographs were taken and plan and elevation drawings created by the office of the NSW Government Architect prior to demolition of condemned buildings. In 1994 an archaeological dig lasting 20 weeks was carried out high up in the Rocks on the block bounded by Gloucester Street and Cumberland Street. Over $\frac{3}{4}$ million artefacts were unearthed (Karskens, 1999). This data, combined with other historical records, has revealed a great deal of the history of the site.

Creating a Virtual Heritage place is more akin to world building than architectural modeling (Bartle, 2003). Assuming that the intention is to give the user an idea of what Sydney might have been like, I decided that it was important to build an experiential world. To create a richer sense of place I have included weather and ambient sounds. For the first year of settlement the weather reflects the weather as recorded in the log of HMS Sirius, one of the ships of the First Fleet. For later years the weather is driven by a probability curve. (It would be possible to use actual weather records throughout but I lack the resources to do so at present). The sky has 5 different texture maps and these are blue sky; blue sky with clouds; light overcast; dark overcast and night. In addition there are different levels of rain sounds, light rain, heavy rain or torrential rain and varying levels of lightning and thunder, distant, medium or close. The timing between a flash of lightning and the following sound of thunder is randomised. The sun position and brightness is controlled by the time of day and also the time of year. There are ambient sounds such as native Australian birds, cicadas in summer. After the arrival of the First Fleet there is also the sounds of sheep, pigs, horses, cattle, dogs and goats. By the 1850s these sounds are being replaced by the sounds of people, horses and carts and from the 1900's onwards by the sounds of cars, buses and trams.

All the buildings on the Big Dig site are modeled and textured inside and out. The doors and windows are all interactive and open and close when clicked on by the user. The user sets the date and

time of the master clock. Every object has a Birthday and a Deathday and these are used in conjunction with the master clock to determine what is displayed and active or hidden and inactive. Users can also set the speed of time. This can be set so that 1 second = 1 second, 1 second = 1 hour, 1 second = 1 day, 1 second = month, 1 second = 1 year, 1 second = 5 years and 1 second = 10 years. For any speeds greater than real-time (ie 1 second = 1 second) the sound and weather is disabled. Users can stand at the site of the Sydney Opera House, set the date to 1788 and the speed to 1 second = 1 year. Then by looking over to the Rocks they can see a time-lapse of 200 years of urban change compressed into just over 3 minutes.

During construction of the Big Dig models it became obvious that I was going to have to model some of the surrounding buildings to correctly give an impression of what it might have been like. Sydney is a harbour city and all of the early houses in the Rocks had views of the harbour from at least one room in the house. The comings and goings of ships were part and parcel of daily life for most of Sydney's history and Sydney Cove is still at the centre of a busy network of commuter ferries. I did not have the resources to build the surrounding area in high detail but I have constructed low resolution versions of over 200 surrounding buildings, many of them dating back to the 1850s. All of these buildings, and some objects such as ships, have associated web pages in the Virtual Sydney Rocks Guidebook (<http://virtualsydneyrocks.com/>). Selecting an object causes the associated webpage to open on a secondary screen. Each building on the Big Dig site has an associated webpage with information including old photographs and architectural drawings. The webpages for surrounding lower resolution buildings contain a very brief description of the selected object and links to authoritative information on sites that include the Dictionary of Sydney, the Australian Dictionary of Biography, the Heritage and Conservation Register, the Heritage Council of NSW, the Historic Houses Trust and The State Library of NSW. There is also a Day by Day Journal for 1788 which details the weather information and significant events that took place on that day.

The models have been built in Autodesk® Maya® and then exported into the 3DVIA Virtools development engine where the system clock, weather, sounds and different behaviours were added. The Virtual Sydney Rocks plays in a web browser and offers users the option of Exploring, taking a Tour or playing a Game. The Virtual Sydney Rocks can load into the iCinema AVIE system (<http://icinema.edu.au/technologies/avie/project-overview/>) for an immersive experience (McGinity, 2007). In the Exploration mode users have complete control over when and where they explore. They can teleport quickly around the Virtual Sydney Rocks to the following key locations - The Big Dig site, the Observatory, Dawes Point (site of the southern pylon of the Sydney Harbour Bridge) and Bennelong Point (site of the Sydney Opera House). In the Tour mode users see a pre-recorded walk though of the Big Dig site and surrounds with an instructive voice-over. This is analogous to the walking tours currently available in the Sydney Rocks and relates some of the history of the Big Dig site. The Game is currently in very early development but as part of the game, players will have to travel to different parts of the Virtual Sydney at different times.

Summary & future directions

The Virtual Sydney Rocks is designed to be an engaging and informative Virtual Heritage resource. The first round of user testing is scheduled to take place in April 2012 at the Rocks Discovery Museum. A second round of testing is planned for late 2012 which will include the addition of the Game option, enhancements of the model and revisions based on the feedback from the first round of testing. As well as a questionnaire users will also wear an eye-tracker that will record what users are focusing on. Further testing is planned inside the iCinema's AVIE. The Rocks Discovery Museum and the Big Dig Archaeological Centre have both expressed interest in having copies of the Virtual Sydney Rocks on permanent display. I am considering doing a port to Unity, a version for Google Earth and making the model available to the community for further research. Ideally I would like to continue to develop it as an interactive learning tool.

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