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*Testing times: Virtual heritage, 'time travel' and the user experience of museum visitors: a case study of an enriched time-based virtual heritage world.*

A thesis submitted for the degree of Doctor of Philosophy at

The Australian National University



## **DECLARATION BY CANDIDATE**

This thesis comprises only my original work towards the PhD. Due acknowledgement has been made in the text to all other materials used. The thesis is fewer than 100 000 words in length, exclusive of tables, maps, bibliographies and appendices as approved by the Research Higher Degrees Committee.

Signature: .....

Date: ..... May 2016 .....



## TABLE OF CONTENTS

Title page	1
Declaration by Candidate	3
Acknowledgements	6
Dedication	7
List of Illustrations	8
List of Videos	13
List of Appendix Tables	14
Abstract	15
Introduction	16
Chapter 1: Background	28
Chapter 2: Time travel	74
Chapter 3: An ideal time-based virtual heritage world	92
Chapter 4: Building and evaluating a virtual version of the Sydney Rocks	110
Chapter 5: Results and findings	178
Chapter 6: Conclusions	262
Bibliography	268
Appendix 1a: Big Dig buildings	284
Appendix 1b: Surrounding buildings	287
Appendix 1c: Questionnaire	299
Appendix 1d: Questionnaire data	306
Appendix 1e: Questionnaire data, Two Most Liked	366
Appendix 1f: Questionnaire data, Two Least Liked	373
Appendix 1g: Questionnaire data, Suggested Improvements	379

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## **DEDICATION**

For my parents James and Elizabeth Alston

For my godmother Elizabeth Streetly

For my siblings, Robert, Michael and Susannah

For Stephen Devine

For my friends

## LIST OF ILLUSTRATIONS

1	FA-18 HUD while engaged in a mock dogfight	38
2	Hein's Theory of Knowledge continuum	51
3	Hein's Theory of Learning continuum	52
6	Hein's four educational theories	52
4	Advanced Visualisation and Interaction Environment (AVIE)	59
5	Virtual Room, Melbourne Museum	60
7	Screenshot from <i>Empire: Total War</i>	66
8	Map of Sydney Cove, Port Jackson, March 1788 by William Bradley	115
9	Aerial view of Sydney with Big Dig site circled in red	118
10	Enlarged aerial view of Sydney with Big Dig site circled in red	118
11	Big Dig Site c 1810	122
12	Big Dig Site c 1823	122
13	Big Dig Site c 1860	123
14	View from the roof of the YHA	124
15	Blue sky texture	130
16	Blue sky with clouds texture	131
17	Overcast sky texture	131
18	Thunderstorm sky texture	131
19	Approximate extent of the VSR	139
20	A view of Sydney Cove March 7th 1792, The Port Jackson Painter	143
21	Detail from A view of Sydney Cove March 7th 1792, The Port Jackson Painter	143
22	Wattle-and-daub hut with bark roof parget wooden chimney 1890	143
23	A postcard of a wattle and daub bush farmers homestead in South Australia circa 1900	144
24	Butcher's shop in a slab hut with bark roof, Tambaroora NSW	144
25	Early settlers hut in the Wielangta Forest, Tasmania	145
26	Inside a slab hut	145

27	Lyons Cottage in Tasmania, a humble worker's cottage from the nineteenth century	146
28	Plans for 95 Gloucester Street	147
29	Gloucester Street	148
30	Gloucester Street 1901	148
31	Whalers Arms 1901	149
32	Top level page for the Guidebook	152
33	Webpage with links to all the different streets in the VSR	154
34	Webpage with links to all the street addresses for Gloucester Street	154
35	Webpage with links for a specific address in Gloucester Street	155
36	Guidebook entry for Sunday 15th June 1788	157
37	The VSR and Guidebook at start up	158
38	Screengrab VSR Tour – 1788 pre-settlement	162
39	Screengrab VSR Tour - 1788 arrival of the First Fleet	162
40	Screengrab VSR Tour - c 1800	163
41	Screengrab VSR Tour - c 1820 at the back of the Cribbs House	163
42	Screengrab VSR Tour - time-lapse c 1800	164
43	Screengrab VSR Tour time-lapse c 1850	165
44	Screengrab VSR Tour time-lapse c 1890	165
45	Screengrab VSR Tour time-lapse c 1950	165
46	Screengrab VSR Tour time-lapse c 1965	166
47	The boning knife recovered from the Cribb well	167
48	The alcohol still recovered from the Cribb well	167
49	The china bowls recovered from the Cribb well	168
50	Age of participant	183
51	Sex of participant	183
52	Occupation of participant	184
53	Visited the Rocks	185
54	Visited virtual museums or virtual heritage sites	186
55	Computer use	187
56	Played electronic game	187
57	Game playing on various platforms	187

58	Interaction mode in the VSR	189
59	Number of modes tried	190
60	Order of interaction by respondents who tried all three modes	192
61	Most liked interaction mode by respondents who tried all three modes	193
62	Recommended order of interaction by respondents who tried all three modes	196
63	Responses to the statement ‘the Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times’	201
64	The VSR Tour gave me a feeling of what it was like to be in the Rocks at certain times (58 respondents)	202
65	The VSR Tour gave me a feeling of what it was like to be in the Rocks at certain times (31 respondents)	202
66	Responses to the statement ‘the Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times’	203
67	The VSR Game gave me a feeling of what it was like to be in the Rocks at certain times (58 respondents)	204
68	The VSR Game gave me a feeling of what it was like to be in the Rocks at certain times (31 respondents)	204
69	Responses to the statement ‘Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be In the Rocks at different times’	205
70	Exploring the VSR gave me a feeling of what it was like to be in the Rocks at certain times (58 respondents)	206
71	Exploring the VSR gave me a feeling of what it was like to be in the Rocks at certain times (31 respondents)	206
72	Which way of interacting was the most effective at making you feel like you were actually there (31 respondents)	208
73	Responses to the statement ‘I learned some of the history of the Sydney Rocks by taking the VSR Tour’	212

74	I learned some of the history of the Sydney Rocks by taking the VSR Tour (58 respondents)	213
75	I learned some of the history of the Sydney Rocks by taking the VSR Tour (31 respondents)	213
76	Responses to the statement ‘I learned some of the history of the Sydney Rocks by playing the VSR Game’	214
77	I learned some of the history of the Sydney Rocks by playing the VSR Game (58 respondents)	215
78	I learned some of the history of the Sydney Rocks by playing the VSR Game (31 respondents)	215
79	Responses to the statement ‘I learned some of the history of the Sydney Rocks while Exploring the VSR’	216
80	I learned some of the history of the Sydney Rocks while Exploring the VSR (58 respondents)	217
81	I learned some of the history of the Sydney Rocks while Exploring the VSR (31 respondents)	217
82	Which way of interacting helped you learn most about the history of the Sydney Rocks	218
83	Responses to the statement ‘I saw how the Sydney Rocks has changed over time by taking the VSR Tour’	222
84	I saw how the Sydney Rocks has changed over time by taking the VSR Tour (58 respondents)	223
85	I saw how the Sydney Rocks has changed over time by taking the VSR Tour (31 respondents)	223
86	Responses to the statement ‘I saw how the Sydney Rocks has changed over time by playing the VSR Game’	225
87	I saw how the Sydney Rocks has changed over time by playing the VSR Game (58 respondents)	225
88	I saw how the Sydney Rocks has changed over time by playing the VSR Game (31 respondents)	226
89	Responses to the statement ‘I saw how the Sydney Rocks has changed over time by Exploring the VSR’	227

90	I saw how the Sydney Rocks has changed over time by Exploring the VSR (58 respondents)	227
91	I saw how the Sydney Rocks has changed over time by Exploring the VSR (31 respondents)	228
92	Which way of interacting was the most effective at showing you how the Sydney Rocks has changed over time	229
93	Two things most liked about the VSR	232
94	Two things least liked about the VSR	235
95	Ways to improve the VSR	238
96	Age of participants who did not play the game	241
97	Sex of participants who did not play the game	241

## LIST OF MOVING IMAGE WORKS

(see attached dvd)

- 1 Oculus Rift demonstration
- 2 *Virtual Warrane II* (2012)
- 3 Interview with Prof. Jeffrey Shaw about the *Pure Land* project
- 4 *Pure Land AR Edition*
- 5 CityViewAR in use
- 6 *The Matrix* (1999) Bullet Time
- 7 Bo Derek Running on the beach in the movie *10* (1979)
- 8 The mannequin sequences from *The Time Machine* (1960)
- 9 Time Passing By in *The Time Machine* (2002)
- 10 *The Time Traveller's Wife* (2009)
- 11 The Terminator's arrival from *Terminator 1, 2 and 3*
- 12 Every time travel scene from the *Back to the Future* films
- 13 All the opening titles from *Dr Who* (1963-2011)
- 14 Time travel in *Bill & Ted's Excellent Adventure* (1989)
- 15 Time travel in *Hot Tub Time Machine* (2010)
- 16 Time travel in *A Sound of Thunder* (2005)
- 17 *Star Trek: Original Series* - preview of The City on the Edge of Forever (1967)
- 18 *Star Trek: Original Series* - time travel sequence from Tomorrow is Yesterday (1969)
- 19 *Star Trek: Original Series* - time portal sequence from All Our Yesterdays (1969)
- 20 Time travel sequence from *Star Trek IV* (1986)
- 21 Time-lapse of the Helheim Glacier
- 22 Opening sequence of *Contact* (1997)
- 23 The VSR Training Video
- 24 The VSR Tour

## LIST OF APPENDIX TABLES

1a	Big Dig buildings	284
1b	Surrounding buildings	287
1c	Questionnaire	299
1d	Questionnaire Data	306
1e	Two most liked things	366
1f	Two least liked things	373
1g	Suggested Improvements	379

## ABSTRACT

Time is fundamental to human experience - it is how we make sense of the world. Time is critical to place in general and heritage place in particular. As well as the built environment, it determines both the cultural context and the phenomenological affect experienced at a particular place at a particular time. This thesis argues that time-based virtual heritage supporting navigable time, or time travel with agency, offers two different but complementary opportunities for heritage learning. Going to a specific place at a specific time gives users an informed idea of what it was like then and travelling through time in a time-lapsed fashion reveals the changes that occur over time. Heritage is culture through time yet curiously time is almost entirely absent from virtual heritage despite the power of 3D computer graphics to support time-based virtual worlds. This thesis describes the creation and testing of a time-based virtual heritage world on a museum audience. Navigable time is shown to be a popular and powerful tool for creating affective experiences with virtual heritage and fostering engaging learning opportunities. Additionally this thesis argues for, and the findings support, the importance of providing users with a range of activities in a virtual heritage world.

## INTRODUCTION

‘I design and research virtual worlds for their own sake, because I want to see people develop better ones. I’m pleased for them to be used as objects of research by anthropologists, economists, social theorists, computer scientists or whomever, but our agendas are different. Researchers in these areas want to advance their own fields of study, but I just want better virtual worlds; that is where my emphasis lies.’

Richard Bartle (Bartle 2007: 2)

Time is fundamental to the way we make sense of the world (Hoffman 2009, Bardon 2013, Le Poidevin and MacBeath 2009a). We are beings that exist *in* time (Ozeki 2013). The temporal trajectory, whether linear or circular, that is fundamental to how we make sense of the world. Heritage specifically concerns the transmission and evolution of culture through time and it is common to arrange exhibitions temporally so that as a person progresses through the exhibition the objects on display start with the oldest and end with the youngest (Noordegraaf, 2004). Places are both culturally and phenomenologically dynamic with the weather, the time of day, the season of the year and the calendar date determining the experience of a place which is a gestalt of an individual's sensory impressions of and cognitive engagement with the sights, the sounds, the smells of the physical environment and its inhabitants. Time is therefore critical to heritage place. Yet, despite the fact that virtual environments inherently possess the ability to include time, most virtual heritage represents a frozen moment. The research of this thesis shares the same practical aim expressed by Richard Bartle in the above quote but, in this case, the aim is to make better *virtual heritage worlds*. In pursuit of that aim the author has designed, built and tested a time-based virtual heritage

world that offered users unprecedented control over time, a choice of activities supporting different interaction modes and direct, easy access to a large amount of additional, relevant and authoritative information.

The seminal New Media theorist Lev Manovich has identified databases and 3D computer graphics, which he terms 'navigable space', as the two key forms of New Media (Manovich 2001). The term navigable space perfectly encapsulates the freedom of movement experienced by users in computer-generated virtual worlds. The author believes that what she calls 'navigable time', or time travel with agency, holds great potential for heritage education (Devine 2014). It gives users the same freedom of movement in time that they currently experience in the navigable space of virtual worlds. They can go to a particular time and date of their own choosing, and additionally, by changing the speed and direction of time, they can view forwards or backwards time-lapses to directly observe changes that take place over timescales outside the normal range of human experience.

In 1994 a combined historical and archaeological project, known as 'the Big Dig' excavated a large site in the historic Rocks district on the western shore of Sydney Cove uncovering over two hundred years of history (Karskens 1999). On the 26<sup>th</sup> of January 1788 the First Fleet anchored in the cove and established a penal colony that was the first European settlement in Australia. The eastern headland is currently the site of the Sydney Opera House and the sandy beach at the head of the cove is hidden under a busy ferry terminal and railway station but in 1788 the shore was thickly wooded with a small stream flowing into the cove at the western end of the beach and with high sandstone cliffs rising in steps to the west. The majority of the convict tents were set up on western side of the stream while the tents of the Governor and his staff were on the

eastern side. Within months the convicts were constructing wattle-and-daub huts on the sandstone ledges of what was already known as ‘the Rocks’ (Kelly 1997). The Big Dig site is high up in the Rocks and the excavations revealed traces of some of the early huts overlaid with 200 years of urban development. The dig uncovered over three quarters of a million artefacts and evidence of 42 separate dwellings while the historical research produced a host of documentary evidence. This led to the identification of specific individuals, the houses they lived in and, in some cases, a direct connection with artefacts recovered during the dig (Crook, Ellmoos, and Murray 2005, Karskens 1999).

This site was an ideal subject for the author's research to investigate the user experience of navigable time and to discover what navigable time can offer museum audiences. The dataset was exemplary, the site was of historic significance, the time range of two hundred years was both small enough to be manageable and large enough to show great change. Creating a virtual heritage world is a huge undertaking usually requiring a multi-disciplinary team including, at the very least, an historian, a 3D team of modeler, texture artist and animator, a game designer, a game programmer, a web designer and IT support. However, given the author's previous career in commercial computer graphics, it was possible to use the Big Dig data to construct a prototype that, while lacking the polish of a commercial game world, would demonstrate the functionality of a time-based virtual heritage world sufficiently well for users to have engaging, memorable and educational experiences and to give meaningful feedback.

The author had expected to spend about a third of her time building the Virtual Big Dig but she discovered that all of the early houses on the Big Dig site faced the harbour regardless of the orientation of the street they were on. For most of Sydney's history the harbour played a pivotal role in the life of the city as it was where ships docked with

news, goods and the chance of work. The harbour was clearly visible from the Big Dig site for the first hundred years and today frequent glimpses can be caught between the buildings and over the rooftops. This forced her to reconsider the scope of the project. Given the centrality of place in virtual heritage and the assumption that a museum visualisation of a place is intended to give people an informed idea of what that place is like, she felt that it was imperative to also include much of the area surrounding the Big Dig site including Sydney Cove and its eastern shore. So the Virtual Big Dig became the Virtual Sydney Rocks (VSR) with over 200 additional buildings, albeit in much lower resolution, and this doubled the build time.

Obsolescence is a spectre haunting all technologically-based projects and the author had specifically designed the VSR to be as future-proof as possible. However, the choice of game engine was determined by her association with the iCinema centre for Interactive Cinema Research which was using Virtools. Unfortunately towards the end of the research project the developers of Virtools, Dassault Systèmes, decided to cease all development and support for it. As a result the Virtools version of the VSR can no longer be run, however, due to the modular design approach followed by the author, the models and website were unaffected and, regardless of this major roadblock, the VSR is currently being ported to the Unity game engine for further development.

Very early on in the author's research, contact was established with the Sydney Harbour Foreshore Authority (SHFA), the local government body responsible for heritage in the Rocks. They own the Big Dig site and run the Susannah Place Museum and the Rocks Discovery Museum. The author was put in touch with the chief archaeologist, Dr Wayne Johnson and both he and SHFA have been extremely helpful and supportive of the project. The author evaluated the prototype VSR onsite at the Rocks Discovery

Museum and, once finished, the revised version of the VSR will be made available to the Rocks Discovery Museum for their use.

The background to this research is interdisciplinary in nature. This thesis weaves together theory and praxis concerned with **place, heritage place, virtual environments, virtual heritage, presence, informal learning, serious games, time and time travel in contemporary culture**. Each of these areas is worthy of detailed examination but discussion is restricted here to the parts that are relevant to the user experience of time-based virtual heritage worlds. The salient features of these areas are examined and a discussion is presented on how they might assist or detract from the educational role of time-based virtual heritage.

It is difficult to overstate the impact of New Media and the Internet on contemporary culture. For museums the changes have been both challenging and empowering (Parry 2007, Witcomb 2003). These newer modalities can reach much larger audiences and facilitate exploration along multiple pathways, unlike the majority of exhibitions where there is a defined entry and exit and a curated pathway between the two. This anti-narrative aspect of databases is deeply at odds with the temporal narrative of heritage. Navigable time, when used to jump to specific, but temporally scattered times, is likewise deeply anti-narrative. However, navigable time, when used in a time-lapse fashion re-imposes the temporal order and restores the traditional time-based narrative of heritage (Devine 2014).

Manovich has suggested that the navigable space of 3D computer-generated environments may be to the twenty-first century what cinema was to the twentieth – the key cultural form (Manovich 2001). The current state-of-the-art of virtual environments,

as seen in commercial game worlds, is very impressive and electronic gaming is now a mainstream activity with players who are much more representative of the general population than the predominately young male players who were the early norm (Yee 2005). Massively multiplayer online role-playing games (MMORPGs) such as *World of Warcraft* have millions of players who regularly spend many hours in the game world. These worlds are extensive in scale, richly detailed and populated with both player-controlled characters and non-player characters controlled by artificial intelligence software. Role-playing is an affective and powerful way to directly experience how class and gender-based rules shape a person's life. However, most if not all commercial role-playing games are predicated on the assumption that the player has the power to significantly affect outcomes in the game world regardless of class and gender. Is this level of agency appropriate in a virtual heritage world? How many players would want to play a game where they had to be a lowly slave all the time? Alternative types of games such as puzzles, quizzes and treasure-hunts may be more appropriate for virtual heritage.

‘Virtual worlds are *places*. Remember that and many design issues cease to be issues at all. People go to places, do things there, and then they go home.’

Richard Bartle. *Designing Virtual Worlds* (2004)

Do participants have to play a game at all? It is perhaps unsurprising in this digital age that interactivity has been placed high on a pedestal and lauded as the answer to everything. However, while the author is a keen player of computer games, she also enjoys watching films and reading books. Engagement does not correlate to repeated button pushing or mouse clicking, and any interaction needs to be meaningful. Bartle points out that virtual worlds are places. What can people do in real heritage places?

They usually have a choice of activity. As well as just wandering around, visitors to the real Sydney Rocks can go on walking tours, visit two different local history museums - the Rocks Discovery Centre and the Susannah Place Museum - and see Cadman's Cottage which is the oldest building in the Rocks, dating from 1816. Over half the buildings in the Rocks are on the Heritage and Conservation Register and many of these house shops, restaurants and bars where visitors can discover different aspects of contemporary local culture.

Just as the real world can host a variety of activities so too can a virtual world. As well as games it can provide tours and support free exploration. The author argues that being able to offer users a range of activities based on different interaction modalities has several advantages. It empowers users by adding to their level of agency and this contributes to engagement. In addition, following a Constructivist approach to the informal learning that takes place in museums, it supports users in their construction of knowledge by providing them with a range of learning modes and supporting multiple pathways through the content. George Hein has written extensively about learning in museums and he points out that museum audiences vary widely in age, background and temperament which makes it difficult to design exhibits that appeal to everyone (Hein 1998).

The importance of individual factors is also recognised as a major factor in the experience of presence (IJsselsteijn et al. 2000, Schubert, Friedmann, and Regenbrecht 2001). This experiential phenomenon is commonly described by users of virtual environments as the feeling of 'being there' where 'there' is inside the virtual world depicted on the screen (Lombard and Ditton 1997). Presence is obviously a powerful tool for creating memorable and affective experiences and is therefore of great interest

to game designers, researchers and developers of virtual heritage worlds. There are many factors of presence as well as types of presence but, as with learning in museums, individual user factors are critical (Lombard and Ditton 1997, Devine 2007, Riva, Davide, and IJsselsteijn 2003).

Presence implies a place to be present in and there is a rich body of writing on place with particular relevance to heritage. The philosophy of place espoused by Yi-Fu Tuan in *Space and Place (1977)* concerns itself with the layers of human meanings that overlay geography. Places are locations that have associated human meanings on personal, societal and historical levels. As well as the cultural connotations, there is also a powerful experiential aspect to place that is well known to game designers, cinematographers and landscape archaeologists (Alton 1995, Bartle 2003, Tilley 1994). Virtual environments, with their propensity to evoke an experiential affect in users, lend themselves well to the use of lighting and sound to create an enhanced sense of the phenomenological experience of virtual place. Within the VSR the time and date is used to determine the position of the sun so that users can see how the time of day affects the ambience of the Rocks. For the first year of settlement the meticulous records of the First Fleet make it possible to include weather based on the historical record. During this time there were periods of extremely wet weather at a time when most of the people of the First Fleet were living in tents (Cobley 1987). In the VSR the rainy days feature the sound of rain and random flashes of lightning followed by thunder prompting users to consider the role of weather in daily life.

However, presence in virtual heritage demands more than just a physical sense of being there and a bit of thunder and lightning. What is required is contextualised presence, the additional background knowledge of a place that informs users about the layers of

meanings that contribute to its heritage value (Champion 2007, Chen and Kalay 2008, Roegiers and Truyen 2008, Roussou 2006, Smith 2006, Devine 2007). In the real world people exploring heritage places often pause to consult a guidebook, or an internet-based resource using their smart phone, to find out additional information. It is very easy to provide similar functionality in the virtual world. The simple act of clicking on an object or building can directly connect users to a database of relevant data. When used in this way the entire 3D world should be seen as merely the tip of, and interface to, a huge iceberg of data (Manovich 2001). While Bartle notes that virtual worlds are places that people go to and do stuff and then they go home this assumes that they have something to do. The author deemed it critically important that the VSR have sufficient content to be both a useful resource supporting cultural presence and one that encouraged and rewarded prolonged engagement. The web-based VSR Guidebook, described in detail in Chapter 4, acts as an aggregator of internet content. Each building and important object links directly to a web page containing links to relevant and reputable information from sites such as the Dictionary of Sydney, the National Library of Australia, the Australian Dictionary of Biography and the Heritage and Conservation Register of New South Wales. Users are able to quickly and easily access additional relevant information and they can decide to what depth they wish to go.

The VSR was intended to give the typical museum audience choices in the way they interacted with a time-based and content-rich virtual heritage world so as to find out what worked and what did not, what they liked and what they did not, and why. Supported by the research, this thesis argues that time-based virtual heritage supporting navigable time encourages immersion and promotes understanding, insight and learning. Additionally, the research supports the argument that offering users a range of different activities supports increased user engagement and provides a Constructivist

learning experience. This thesis begins with an examination of the background in theory and praxis of the research, it then proposes a time-based design for an ideal virtual heritage world and reports on the implementation and testing of a prototype virtual heritage world supporting navigable time. It concludes with the analysis of the test findings and calls for continued research into the educational potential of time-based virtual heritage.

Chapter 1 explores the interdisciplinary background to the research beginning with the phenomenological and cultural experience of place and the critical importance of time to both. The chapter continues with a concise summary of virtual environments, an examination of the current state-of-the-art and of the phenomenon of presence, or the feeling of being located in the virtual world displayed on the screen that is commonly reported by users of virtual environments. Presence is capable of evoking a powerful affect in users but it has been found to be highly dependent on individual user factors. The nascent field of virtual heritage is surveyed and concepts of place in virtual environments and place in virtual heritage are explored. A Constructivist framework is used to examine the informal learning that takes place in museums. The emergent field of serious games, which uses game-style interactions for training and learning, is examined and the appropriateness of different game genres for virtual heritage is debated. The combination of navigable space and databases to create enriched virtual heritage worlds is proposed and Chapter 1 concludes with an examination of time-based virtual heritage.

In Chapter 2 the nature of time is examined from the perspectives of the lived life, philosophy and science. As this thesis examines the use of time-based virtual heritage to foster immersion leading to historical insight and understanding in heritage audiences

the focus here is more on time travel than on time itself *per se.* and, in particular, on time travel as it applies in a heritage context. The widespread use of time travel in popular culture from the late nineteenth century to the present day is discussed and the author concludes that time travel is an established trope of the contemporary human imaginary and that time-lapse is a powerful tool for understanding processes that take place over timeframes outside of direct human experience. The chapter concludes by arguing that navigable time offers opportunities for users to engage with virtual heritage in new ways that lead to historical insight, understanding and learning.

In Chapter 3 the author proposes a hypothetical state-of-the-art educationally focused and time-based virtual heritage world, with supporting online database. This ideal virtual heritage world would support a range of interactions intended to foster immersion leading to historical understanding, insight and learning not only of individual historical narratives, but also of wider historical processes and of the public understanding of heritage itself. Issues of authenticity and completeness related to the re-creation in virtual form of tangible and intangible heritage are explored followed by an examination of the relationship between the virtual and the real. The learning opportunities afforded by navigable time, integrated databases and different activities are debated. The chapter concludes with an examination of issues pertaining to user engagement and technical obsolescence.

Chapter 4 examines the creation of a prototype time-based virtual heritage world specifically designed to examine both the user experience of navigable time and user preference for different activities that individually embody three different educational epistemologies and collectively embody a fourth, Constructivist, approach. The chapter begins by describing the rationale for choosing the Sydney Rocks and continues by

examining the design decisions taken by the author. The creation of the various parts of the virtual world such as the buildings and terrain, the sounds and the supporting website are described in detail and this is followed by a discussion of the design and content of the example game and tour developed for testing. The chapter concludes with a discussion about the choice to use a questionnaire for evaluating the Virtual Sydney Rocks and an examination of the questions.

Chapter 5 analyses, discusses and summarises the findings from the testing of the VSR. It is split into two parts, the first of which analyses the responses to the questionnaires completed by testers and the second of which presents the findings. Both journey and destination focused time travel are found to be engaging and educational by users. Additionally, there was no clear favourite among the three different activities available to users, with each activity preferred by a significant minority of users. The chapter concludes with a summary of the additional findings that emerged from the data.

Chapter 6 presents the author's conclusions and contribution to the field of virtual heritage. It is posited that time is central to the human experience and is particularly pertinent to heritage, and argued that both the destination-focused and the journey-focused modes of navigable time are powerful tools for heritage learning. Furthermore it is proposed that navigable time offers heritage audiences memorable, engaging, educational and affective experiences.

## CHAPTER 1: Background

1.1 Place and space	30
1.2 Rethinking place – the role of the body	32
1.3 Rethinking place – the cultural dimension	33
1.4 Heritage place	35
1.5 Virtual environments, presence and place	36
1.6 Virtual heritage place	44
1.7 Authenticity, completeness and spectacle in virtual heritage	48
1.8 Learning in museums	50
1.9 Virtual heritage in museums	55
1.10 On-site AR and heritage	61
1.11 Serious Games in museums	63
1.12 Suitable games for virtual heritage	65
1.13 Enriched virtual heritage	68
1.14 Time-Based virtual heritage	71
1.15 Conclusion	72

Virtual environments are increasingly touted as useful for heritage learning. Museums have a long history of using models and dioramas for public edification and virtual heritage is part of this tradition. The immersive quality of virtual worlds, with their well-documented propensity to make people feel like they are physically present in the virtual environment displayed on the screen, would seem to lend itself well to the re-creation of heritage places as aids to insight and understanding for the general public. However, as this thesis argues, a place is much more than a location, it is a site of human activity layered with stories and meanings - in short there is a cultural dimension to place in general, and heritage place in particular, that needs to be considered. There is a growing consensus that meaningful interactions, both activity-based and social, within virtual worlds are important contributors to the creation of a sense of cultural immersion.

Time is critical to heritage place in two ways. Over years, decades and centuries the activities, habits and customs of people change along with the more tangible changes evidenced in the built environment. A particular date will determine what buildings exist, the dress, behaviours and customs of the inhabitants and the activities that take place. Over time a place will itself acquire multiple historical and cultural narratives. Place makes time visible, acting as a memorial to the past. Time also determines the phenomenological aspect of place. The cycles of day and night, the waxing and waning of the moon, and the progression of the seasons are key contributors to the look, sound and smell of a place. The individual experience of place is an inseparable fusion of the cognitive and sensory, and time is critical to both.

This thesis examines the use of time-based virtual heritage in museums as a tool for historical learning, insight and understanding, using multi-disciplinary research involving place, time, heritage, virtual worlds, informal learning and serious games. This chapter begins with a short overview of the history of the philosophy of place and space then the phenomenological and cultural dimensions of place are explored in greater detail and the concept of heritage place is examined. A concise summary of virtual environments, an examination of the current state-of-the-art and a discussion about the phenomenon of presence are also included. Concepts of place in virtual environments and place in virtual heritage are explored. A Constructivist framework is used to examine the informal learning that takes place in museums. This is followed by an analysis of the place-making potential of, and the learning opportunities afforded by, some significant virtual heritage projects. The chapter concludes with an examination of Serious games, an assessment of some virtual heritage games and a discussion about the most appropriate game genres for heritage learning.

## 1.1 Place and space

*To be (at all) is to be in (some) place*

– Archytas of Tarentum 428–347 BC (Casey, 1997:4)

Place and time are fundamentals of existence. One can only ever physically *be* in a place and only ever *be* in one place at one time. As a result both place and time have been of great interest to philosophers through the ages. Given the importance of place to heritage it is useful to examine different conceptions of place, and the closely related concept of space, and how these have changed over time. Place is both a noun and a verb and its meanings range from being purely locative, such as in ‘Place the vase on the table’ to redolent with individual, historical and cultural meanings such as in ‘New York is a place like no other’. Place is also used metaphorically such as in the term ‘knowing your place’ where it refers to an individual’s awareness of their position with regard to social hierarchies. Place is always particular, referring to somewhere specific and unique.

Space, like place, has a range of meanings. It is used to describe un-occupied place such as in ‘There is some space on the bottom shelf.’ It is also used to describe an infinite cosmos containing within it individual places as in ‘The Earth is a tiny speck in the vast infinity of Space.’ Generally space is considered homogeneous and empty while place is particular and filled. Place is the instantiation and space is the potential.

In his comprehensive history of the philosophy of place, *The Fate of Place* (1997), Edward Casey charts the changing emphasis on place versus space from the ancient Greeks to the present day (Casey 1997). He identifies several different conceptualisations of place that were proposed in Hellenic times and argues that these

have shaped and influenced the subsequent philosophical discourse. For Plato (c425 BC – c347 BC), as detailed in the *Timaeus*, the world is a created and finite world of discrete places. Existence can only be in place and the act of creation creates the place to be in. This act of creation happens in the Receptacle, which is that in which all becoming takes place. For Plato place is eternal and place and time are indivisible. However, for Aristotle (c384 BC-c322 BC) place is an innate attribute of a body. His interest in place is in the context of physics not cosmology or cosmogony. Aristotle argued that there was a place for everything and everything was in its place and he proposed a closed and finite world of discrete places. For the Atomists the Cosmos was an eternal and infinite spatial universe with discrete places within it, but for Philoponus (c. 490 – c. 570) the Cosmos consisted of discrete places within a homogeneous and finite space.

The rise of Christianity saw a shift in emphasis away from place and towards space. For Christian philosophers, the infinite and eternal Christian god presupposed an eternal and infinite universe. Therefore philosophical investigation tended to focus on the infinite and eternal space of the cosmos not the unique and particular places within it. Ideas to do with space replaced those to do with place. Concepts such as the absolute, the infinite and the immense replaced those of limit, boundary, and setting. In the seventeenth century many of the leading philosophers of the day, such as Pierre Gassendi (1592-1655), Isaac Newton (1642-c1726), René Descartes (1596-1650) and John Locke (1632-1704), were also scientists. Newton, a firm Christian, believed in eternity and infinity and in his *Philosophiæ Naturalis Principia Mathematica* (1687) he argued that both space and time are absolute and universal. Place was reduced to being purely locative and was subsumed by space which was infinite, largely empty and contained objects that were located using a reference system based on space itself.

Newtonian physics dominated scientific thought until the early twentieth century when Albert Einstein (1879-1955) proposed in his general theory of relativity that space and time are interwoven into a single continuum known as space-time. As a result, events that occur at the same time for one observer can occur at different times for another. In other words the location of the observer is critical: place matters. This shift in thinking is echoed in the change from a modernist to a postmodernist stance in heritage. There is now wide recognition that the past is experienced in the context of the present. The location of the observer in time is critical: time matters.

### **1.2 Rethinking place – the role of the body**

Philosophers such as Immanuel Kant (1724-1804), Alfred Whitehead (1861-1947), Edmund Husserl (1859-1938) and Maurice Merleau-Ponty (1908-1961), recognising that consciousness is embodied, acknowledged that the feeling of being embedded in the physical world was a complex qualitative whole experienced kinesthetically. Kant noted the fundamental relational aspect of up and down, left and right, and back and front while Husserl noted that his body placed him at the centre of things (Casey 1997). George Lakoff and Mark Johnson point out in the now-classic *Metaphors We Live By* (1980) that ‘Most of our fundamental concepts are organized in terms of one or more spatialization metaphors’ (Lakoff and Johnson 1980: 17). The experience of being in a place is, for each individual person, a fusion of the physical and the cognitive. It is an amalgam of the sensory impression of the place, the cultural associations of the place and the unique personality of the individual.

In *A Phenomenology of Landscape: Places, Paths and Monuments (Explorations in Anthropology)* (1994) Christopher Tilley examines Neolithic sites and the trackways connecting them from a first person perspective. He describes how various features in

the landscape are in turn hidden and then revealed as a person walks a trackway. This would not be apparent when studying a two-dimensional map and Tilley argues convincingly that directly experiencing a landscape offers important insights into how earlier inhabitants related to it (Tilley 1994).

The phenomenological aspect of place is an integral part of the experience of place. The immediate sensory impression of place is highly variable. The light, sounds and smells of a place are determined in part by the weather and in part by the seasons of the year, the time of day or night and the phases of the moon. Time is a critical factor in the experience of place, as this thesis will demonstrate.

### **1.3 Rethinking place – the cultural dimension**

Concurrent with the re-appraisal of the role of the body in creating a sense of place has been an exploration of the contribution of culture to the experience of place. Casey identifies a renaissance of interest in place from a wide range of disciplines including history, the natural world, politics, gender relations, geographic experience, architecture and the sociology of the polis and the city. For these writers place is not conceived of as a fixed thing but it is an ‘ongoing and dynamic, ingredient in something else’ (Casey 1997: 286). The author would add archaeology, computer graphics, heritage and virtual heritage to the list of disciplines that are re-thinking place.

Yi-Fu Tuan’s classic *Space and Place: The Perspective of Experience* (1977) establishes the field of human geography. It explores relations with and across space and place that concern peoples and communities, cultures and economies. According to Tuan, space and place require each other, and time is a critical dimension of place-making. “From the security and stability of place we are aware of the openness,

freedom, and threat of space, and vice versa. Furthermore, if we think of space as that which allows movement, then place is pause; each pause in movement makes it possible for location to be transformed into place.” (Tuan 1977: 6). For Tuan the act of spending time in a location is critical to creating the experience of place.

The central theme of Tuan’s book is the individual experience of the world. That experience begins in infancy with direct sensory interaction with the physical world and over time deepens as greater conceptual and symbolic understanding is developed. Place is the amalgam of direct sensory impressions and the web of individual memories, human meanings and connections that overlay the topography of homes, environs, regions and countries. Tuan’s recognition of the centrality of individual experience supports this thesis that argues that individual factors play an important role in the experience of virtual heritage. Tuan also recognises the important role that time plays in the transformation of space to place declaring that “What begins as undifferentiated space becomes place as we get to know it better and endow it with value” (Tuan 1977: 6). Tuan also notes the way that place makes time visible, acting as a memorial to the past. While the personal experience of place is limited to a single lifetime the cultural timescale of a place can span many lifetimes. Tuan’s insights into the rich and dynamic relationship between place and time support this thesis which argues that time is a critical and neglected affordance of virtual heritage.

For Edward Relph, as for Tuan, place is more than just a geographical location. Relph identifies three irreducible and interrelated components of place. These are the physical setting, the observable activities and the cultural encodings of the place. However, he argues for the primacy of the human perspective with the meaning of places being a property of human intentions and experiences (Relph 1976). Place is much more than

just sensory impression - it is also richly layered with historical, cultural and personal meanings. Particular places have been officially designated as heritage places, a concept examined in greater detail in the following section.

#### **1.4 Heritage place**

In 1972 the general conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) adopted a recommendation concerning the protection, at national level, of cultural and natural heritage (UNESCO 1972). A World Heritage Site is a place that is listed by UNESCO as being of outstanding universal value from the point of view of history, art or science. Australia in turn defines its national heritage as comprising 'exceptional natural and cultural places that contribute to Australia's national identity' (Australia 1999). However, heritage is not just made up of tangible objects. Song, music, dance, drama, cuisine, crafts and skills are all examples of intangible culture. The 2003 Convention for the Safeguarding of the Intangible Cultural Heritage identifies living heritage as the mainspring of humanity's cultural diversity (Ahmad 2006).

Laurajane Smith proposes that heritage is not limited to material culture with associated age and aesthetically related social values (Smith 2006). She defines heritage as a multilayered performance that constructs a sense of place, belonging and understanding in the present through acts of remembrance and commemoration. She uses place to mean not only location in space but also metaphorically to mean cultural immersion. She defines heritage as a cultural practice that constructs and regulates a range of understandings and values. Furthermore she argues that heritage is not decided by institutions or experts but comes from the meanings people construct for it in their daily lives. Heritage places are not just the places themselves but also the cultural meanings

associated with them and the activities that take place within them. The meanings of heritage places are not frozen but change over time, not only due to temporal wear and tear on material fabric, but also due to wider societal changes that affect attitudes about those places and the activities within them. Heritage places are dynamic and experienced in the context of the present. Smith is useful for this thesis in that, like Relph and Tuan, she identifies the dual contributions of individual experience and culture to place. She also recognises the deep interconnection between time and place, an idea which is central to this thesis.

### **1.5 Virtual environments, presence and place**

This thesis concerns itself with the use of time-based virtual heritage in museums to provide immersive experiences that encourage historical understanding, insight and learning. This section begins with a short summary of 3D computer-generated environments and related technologies such as Augmented Reality (AR). It then explores the phenomenon of presence which is frequently reported by users of virtual environments and which offers a powerful tool to evoke affect in users of heritage-based virtual worlds and contribute to the creation of a sense of place.

Seminal New Media theorist Lev Manovich has identified virtual space, or what he terms ‘navigable space’, as a media form that is so uniquely suited to New Media that he considers it to be culturally transformative in its New Media implementation and he has speculated that it may be the key cultural form of the twenty-first century, essentially what cinema was to the twentieth century (Manovich, 2001). It allows users to interactively explore three-dimensional virtual worlds viewed from a first-person perspective.

Initially the costs were high and the quality was low but improvements in hardware, software and pricing over the last thirty years mean that creating virtual worlds is much more affordable than it has ever been. The current state-of-the-art is embodied in the extensive, richly detailed and populated worlds of commercial game franchises like *Grand Theft Auto* and *Assassin's Creed*. The budgets for these games rival those of big budget Hollywood movies and the huge financial rewards generated by a successful commercial game mean that multi-million dollar development costs are increasingly common. *Assassin's Creed* (2007) reportedly took a team of 300 people two years to make at a cost of \$US20 million dollars. However, with over six million copies of the game sold in the first year of its release it generated hundreds of millions of dollars in revenue, guaranteeing an even bigger budget of \$US24 million for the sequel (Most Expensive Video Games, 2013). This is dwarfed by *Grand Theft Auto V* (GTA 5), the latest in the *Grand Theft Auto* franchise, which was created over four years by a team of 250 people, and is reputedly the most expensive computer game to date with the production costs put as high as \$US265 million (Farnham, 2013). These are not so much games as expansive worlds in which numerous stories play out. Game reviewer Hollander Cooper describes *GTA 5*, as 'absolutely, brutally, amazingly massive, and features so much content you could play for months without seeing it all.' (Cooper, 2013).

Virtual game worlds are no longer restricted to single player experiences. Increases in networking speeds mean that geographically separated people can play together in richly detailed virtual worlds hosted on the Internet. *World of Warcraft* is one of the most well known of what are termed Massively Multiple Online Role Playing Games (MMORPGs) and it hosts thousands of players at a time (Ducheneaut et al., 2006; Williams et al., 2006).

Currently most consumer experiences of virtual worlds are in games played on a home computer where the images are displayed on a single screen. More immersion is experienced by delivering a left eye and a right eye view individually to the corresponding eye and this is commonly referred to as ‘virtual reality’ (VR). Traditionally this has required a fairly heavy and bulky helmet but the Oculus Rift, acquired by Facebook for two billion US dollars in 2014, is one of a number of products under development that aim to bring the same functionality to a low-priced, light-weight and robust consumer product (Dredge, 2014)<sup>1</sup>.

The Google Glass project is different in that it seeks to overlay text and graphics onto the real-world view of the user. The term augmented reality (AR) is often used to describe this and it is commonly seen in the HUDs or Heads-Up Displays used by action movie characters such as Iron Man. The first HUDs were developed by the military in the 1960s and they are now a common feature of many first person shooter games (see Figure 1).



Figure 1: FA-18 HUD while engaged in a mock dogfight

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<sup>1</sup> Video 1 on the accompanying dvd shows an Oculus Rift demonstration. The video is also available at [https://www.youtube.com/watch?v=hZ8Xj\\_I3aNU](https://www.youtube.com/watch?v=hZ8Xj_I3aNU)

Navigable space is not limited to virtual versions of physical environments. The virtual world can just as easily serve as an interface to data (Manovich, 2001; Devine, 2007). For example, selecting an object or building could open up relevant text, photographic, video or audio data and provide important contextual information. Used in this way the virtual world is just the visible tip of a large iceberg of data.

Many people experiencing virtual environments report a feeling of presence or 'being there' where 'there' refers to the virtual world. Lombard and Ditton's comprehensive overview of the presence literature in 1997, *At the Heart of it All: The Concept of Presence*, describes presence as the illusion that a technologically mediated experience is not mediated (Lombard and Ditton 1997). The phenomenon of presence is of great interest to researchers in a wide variety of fields including communication, psychology, cognitive science, computer science, engineering and philosophy. In 1992 the MIT journal, *Presence: Tele-operators and Virtual Environments*, was set up. Presence is also of interest for commercial reasons to game designers, ride simulator designers and training simulator designers. Presence comes in many 'flavours' and has many factors (Devine 2007). Tele-presence or remote presence refers to the feeling of being in a different, but real, location. Social presence, also termed co-presence, is the feeling of sharing a space with other people (Schroeder 2002, Schroeder 2006). Social presence may be experienced during a telephone conversation or in a virtual environment that supports multiple users. Contextualized or cultural presence is the feeling of being in a place rather than a location (Champion 2006, Lombard and Ditton 1997). Researchers have also identified embodied presence (Schubert, Friedmann, and Regenbrecht 1999), physical presence, spatial presence, hyperpresence (Biocca 1997), tangible presence and imaginary presence (Herrera, Jordan, and Vera 2006). Research has revealed a large number of factors that influence presence in virtual environments and these can be

grouped into the three main categories of experiential realism, social interaction and individual user characteristics.

The more realistic the virtual environment, the more presence will be felt. The realism is not limited to how it looks but also extends to how things behave physically. The goal of a flight simulator is to make the user feel like they are really in the aircraft. This is achieved by making the simulator look, sound and behave as closely as possible to the real aircraft. The pilots are enclosed in a capsule mounted on a platform that moves in response to their actions. The capsule contains a working replica of the cockpit of the plane and the view out of the windows is an image that changes in response to the motion of cockpit capsule, so that as the pilots move the controls the view outside the cockpit changes accordingly. In addition, the platform tilts and moves up and down to give a bodily sensation as close as possible to the real. The result is a training environment that is considered of such worth that hours spent flying a simulator count towards the required flight hours per year that commercial pilots must do to retain their licenses. Simulators also exist for train crews, ship crews and medical procedures (Mueller-Wittig et al. 2002).

However, it must be noted that reality itself is often not enough to keep people engaged. Someone who is bored in the real world will ‘drift off’ as the focus of their attention shifts from the physical world to their internal thoughts. And yet, despite lacking the very sophisticated feedback mechanisms of a state-of-the-art flight simulator, presence is commonly reported by players of computer games. In addition, while the graphics in some computer games aspires to be photo-real, other games opt for a highly stylised look. So, while higher realism may get noticed and appreciated by users, it is not key to their engagement (Nunez 2006). In fact presence appears to largely depend on personal

factors, with researchers noting that ‘differences among individual users often account for more variability in performance than system design factors’ (Kaber, Draper et al. 1999: 379).

Social engagement is a very powerful way to create a sense of presence. Two people talking on the telephone, despite the low bandwidth and audio-only connectivity, have a strong sense of a shared space that is neither physical nor computer generated but psychological. Social presence was not a factor in the popularity of the early computer games like *Doom* (1993) and *Quake* (1996) because they were single player. Later games such as *Counter-Strike* (1999) supported multiple players and team play, while in MMORPGs such as *World of Warcraft* tens of thousands of players are online simultaneously in 3D environments so large that it would take someone days to fully explore them (Navigating Azeroth with a World of WarCraft Map, 2007). Team play is a common option in many games and social interaction is considered the key dynamic for the long-term success of multi-player online game worlds (Bartle 2003, Yee 2005).

Researchers have put forward a range of theories for presence. Some focus on physical factors such as quality of image and sound (Doornbusch and Kenderdine 2004, Reeves, Detenber, and Steuer 1993) and others on psychological factors such as attentiveness and personality type (Jurnet, Beciu, and Maldonado 2005, Nunez 2006). Central to all of them is the concept of engagement or immersion, where the immersion is not only of the senses but also of the mind. No matter how convincing the virtual environment, presence is diminished or lost completely if the user becomes bored and their mind wanders. This should not be a surprise to anyone who has ever been ‘lost in thought’. If reality itself cannot hold attention reliably, then there is no reason that a digital approximation of reality, no matter how photo-real, will be any different. The conscious

engagement of the user with the virtual world would appear to be the key factor of presence. To put it simply, you are present wherever your attention is.

Sportspeople and gamers talk about being 'in the flow' to describe their complete absorption in the game they are playing. The idea of 'flow' was formulated by Mihaly Csikszentmihalyi in the mid-1970's to explain happiness (Csikszentmihalyi and Hermanson 2009) and he identified the following eight major contributing components:

- A challenging activity requiring skill
- A merging of action and awareness
- Clear goals
- Direct, immediate feedback
- Concentration on the task in hand
- A sense of control
- A loss of self-consciousness
- An altered sense of time

Games would appear to concur with most of this list and some game designers have embraced the idea of flow to explain presence (Chen 2007). There are clear goals, the player has to concentrate on the task in hand, she gets instant feedback and develops the mastery of specific game skills that she needs to complete the game through the playing of the game itself. But while flow may describe the experience of someone playing their way through a computer game it does not properly describe the experience of a group of people who meet regularly in an online virtual world to hang out and maybe go kill a dragon. During the killing of the dragon there is certainly most, if not all, of the components of flow involved (a clear goal, concentration on the task in hand, the

merging of action and awareness, skill, a sense of control, a loss of self-consciousness and an altered sense of time). However, after the dragon has been killed, the loot is sorted out and people hang out together. It is argued that during this phase very few of the components of flow come into play yet the participants are as immersed as they were during the battle.

Richard Bartle co-created *MUDI*, the first multiple user fantasy world, in 1978. His seminal and encyclopaedic *Designing Virtual Worlds* (2003) is a key text for designers of virtual worlds (Bartle 2003). He has identified four key player types: explorer, achiever, socialiser or dominator and identifies the evolution of players from one type to another over the course of playing (Bartle 1996, 2007). He argues that the reasons people play in online worlds is because it is ‘fun’ and not because they get a sense of ‘being there’ or because they get a sense of ‘being in the flow’. But what is meant by fun? He believes that the key component is immersion but not as it is meant in the presence community. For presence researchers immersion can refer either to how realistic the virtual environment is, or to how much the user accepts the virtual environment. In cinema terms this is referred to as ‘the willing suspension of disbelief’. Bartle asserts that, for players in a virtual game world, immersion is ‘the extent to which the entity in the virtual world which they control is *them*. It’s all to do with identity’ (Bartle 2007). This strong sense of identity that a player has with the character they are controlling is supported by a small study carried out in 2009 that used brain imaging to show that when users thought of their avatars, they thought of themselves (Callaway 2009). With regard to flow, Bartle argues that immersion on its own cannot create flow stating that ‘players no more experience flow from being immersed in a virtual world than they do from being immersed in Rome’ (Bartle 2007: 10).

Presence has been ascribed to experiential realism, social interaction, individual user characteristics and individual identity, and it continues to be a rich area of research for many disciplines. Regardless of the factors of presence, in and of itself presence presumes a place to be present in. With respect to virtual game worlds the author agrees with Bartle that ‘others may debate whether or not virtual spaces are actual places, but for players and designers there is no conception that they might not be. The five million people who enjoy *World of Warcraft* certainly look upon it as a world, and in the face of this any argument to the contrary is pretty well moot’ (Bartle 2007: 2). Virtual worlds are undoubtedly real places in their own right to the people who spend time in them and virtual game worlds provide important practical examples of virtual place-making. Virtual heritage worlds are likewise real, though virtual, places in their own right, but what is the nature and purpose of virtual heritage places, and what is their relationship with real heritage places? These questions are examined in the following section.

### **1.6 Virtual heritage place**

Walter Benjamin’s influential essay *The Work of Art in the Age of Mechanical Reproduction* (1968) introduces the idea of a unique ‘aura’ that objects acquire from their particular presence in time and space (Benjamin 1968). The importance of the ‘real thing’ to people is readily apparent in the prices paid in auction rooms where objects owned by famous people or present at important historical moments are worth much more than otherwise identical objects with unknown owners and histories. The power of the ‘real thing’ is particularly evident in museums. A diorama featuring a life-sized wax model of the murdered French Revolutionary Jean-Paul Marat, in the actual bathtub that he had been murdered in, went on display at the Musée Grévin in Paris in 1886. The annual report to stockholders reported that the authenticity of Marat’s bathtub increased

the attraction of the tableau tenfold and resulted in a significant rise in receipts for two months (Schwartz 1995).

Objects can carry many meanings only some of which are fixed. Susan Pearce proposes that heritage is always seen through the eyes of the present and uses the example of a broadsword to illustrate this (Pearce 1992). The sword was carried at the Battle of Culloden in 1745 by a Scottish chieftain. The sword, by its design, manufacture and ownership, reveals much about the culture, material technology and social structure of the Scottish Highland clans. At the time of the battle the defeated Highland Scots were considered barbaric by the victorious English but by 1840 they were depicted as noble and romantic in popular novels. Culloden is now a tourist park and the sword is part of a museum display. The sword represents not only a particular moment in history (the Battle of Culloden) but also the changing attitudes to the Highland Scots over the following 250 years. Pearce argues that ‘because, unlike we ourselves who must die, it [the sword] bears an eternal relationship to the receding past, and it is this that we experience as the power of the actual object’ (Pearce 1992: 28).

While a virtual heritage place is clearly a real place in its own right, it is obviously not the same as the actual place it has been modeled on as it has none of the history of the actual place. So exactly what kind of a place is a virtual heritage place? It is useful at this point to consider the difference between virtual archaeology (virtual reconstructions of heritage sites that have been built by archaeologists) and virtual heritage (virtual reconstructions of heritage sites that have been built for public edification). The audience for a virtual archaeology reconstruction is assumed to be expert while for virtual heritage a general audience is assumed. Virtual archaeology is therefore an exploration tool for specialists while virtual heritage is an educational tool for the

general public. There is an inherent and central pedagogical dimension to virtual heritage.

In the last 30 years 3D computer graphics has evolved from simple graphical representation to interactive and populated environments with image and sound qualities that approach realism. These immersive environments, with their propensity to evoke a sense of 'being there', would seem to be ideal for giving people a feeling either of what an extant but remote or otherwise inaccessible heritage place is like in the present or of what a heritage place used to be like in the past. Bharat Dave argues that virtual heritage is now able to move beyond the early focus on reconstruction to interpretation. He believes that virtual technologies offer 'passages through time and space that are qualitatively different from what may be possible using traditional media and narratives' (Dave 2008: 40).

A number of writers have analysed virtual heritage place-making by the affordances supported within the virtual environment (Champion and Dave 2007, Chen and Kalay 2008, Roegiers and Truyen 2008, Roussou 2006). Erik Champion and Dave note that exactly what a virtual heritage place might be remains an elusive question despite the centrality of place in virtual heritage discussion. They identify three levels of 'place-ness' in virtual heritage based on Relph's three components of place - physical setting, observable activities and cultural encodings. The first level, the physical setting, has visual fidelity and supports passive wandering. The second level, observable activities, adds activity based interactions and the third level, cultural encodings, uses human or computer controlled agents to show inhabitation and provide social interaction. They distinguish between the three levels by the degree to which the environment supports tasks and activities that enable the forming of understanding about, and insight into,

another place and time. They argue that something more than moving and looking around is needed to modify an individual's understanding of the cultural importance of a heritage place. They identify social agency, modifiable artefacts and dynamic environments as the key features of hermeneutic environments that can deliver cultural immersion (Champion and Dave 2007).

Sara Roegiers and Frederik Truyen propose a three-fold framework for meaningful historical representation. They identify time, space and community as the key ingredients for responsible heritage representation (Roegiers and Truyen 2008). For Xiaolei Chen and Yehuda Kalay place is both setting and activity and virtual heritage design needs to take both into consideration (Chen and Kalay 2008). Maria Roussou considers the main components of virtual heritage environments to be representation, experience design and interaction with one of the key challenges being to design meaningful interactions for users (Roussou 2006). Common to all is the recognition that the cultural dimension is an integral aspect of virtual heritage places. This aligns with the writings, discussed earlier, of Tuan, Relph and Smith with regard to place and heritage place.

Central to this thesis is the idea that virtual heritage worlds are inherently pedagogical and the opportunities for learning they provide are shaped by the affordances of the virtual environment. Passive wandering provides limited opportunities for learning and insight but activity-based interactions with meaningful content provide opportunities to engage more deeply with cultural content. Social interaction is widely considered to provide the richest opportunities for cultural immersion.

### **1.7 Authenticity, completeness and spectacle in virtual heritage**

All heritage studies face a two-fold dilemma. As discussed earlier the past is viewed from the perspective of the present, with each generation finding its own meaning, and in addition that view is based on incomplete data so an historical reconstruction can only ever be an interpretation. However, there is widespread concern that the strong visuals and immersive affect of virtual heritage may cause the general public to conflate the interpretation with reality (Affleck and Kvan 2008, Roegiers and Truyen 2008, Silberman 2008).

The issue of fragmentary data raises the tangled issues of completeness and authenticity. There is much about the past that is unknown and unknowable. For example for many ancient cultures there is no surviving evidence of clothing or hairstyles so any depiction of them is purely speculative. All social behaviour prior to the invention of writing is completely lost to time. Did Neolithic peoples kiss hello? How many kisses? The London Charter for the Computer-based Visualisation of Cultural Heritage (2006) prompted discussion which has led to an emerging international consensus on best practice in heritage visualisation across disciplines (*London Charter for the Computer-based Visualisation of Cultural Heritage*, 2006). The Charter seeks to address the very legitimate concerns that have been raised regarding the authenticity of virtual heritage by ensuring the methodological rigour of computer-based visualisation used for researching and communicating cultural heritage. It does this by identifying principles concerning the importance of a clear purpose for the model, the transparency of data sources, a commitment to authenticity and historical rigour with clear distinctions between fact and speculation (Lopez-Menchero and Grande 2011).

However, if only what is known is included then a reconstruction will be incomplete. Adding things for which there is no evidence – even if done by experts – is speculative. Either one has an incomplete model or one has a model with parts that are made up and neither is a true representation of how it actually was. Presenting only what is known with certainty and relying on the imagination of the public to fill in the details is problematic. Many popular film and TV shows contain historical inaccuracies that are then accepted by the public as truths (Umanath, Butler, and Marsh 2012). An extreme example would be the public imagination of Neolithic life which, for English speaking people of a certain age, is likely to include caveman archetypes from popular culture such as the film *A Million Years B.C.* (1966) and the TV show *The Flintstones* (1960-1966). Both of these examples have humans and dinosaurs co-existing when in reality humans evolved many millions of years after the demise of the dinosaurs. It is therefore better to use the informed speculation of the experts instead of relying on the imagination of the general public. This issue will be revisited in the following chapter.

Tuan believes that the cult of the past as manifested in museums calls for illusion rather than authenticity (Tuan 1977). Strategies for engaging the general public via spectacle are not new. Nor is the debate about the relative merits and possible tensions of information versus entertainment. Indeed spectacle was intrinsic to the ‘cabinets of curiosity’ that were the seeds of what are now major public museums such as the Kunstkamera in St. Petersburg, Russia (Noordegraaf 2004). Sarah Kenderdine argues that virtual heritage is the interface between heritage content and digital visualisation technologies and sits within a long tradition of immersion and spectacle in museums. She traces the rise and fall of the panorama and related forms, such as the diorama and cyclorama, from the late 1700s to the early 1900s and its replacement in contemporary times by virtual panoramas (Kenderdine 2006).

Given the strong affect of the real it is unlikely that users will conflate the virtual place with the real place but, the imprimatur of the museum gives a stamp of authenticity to the model and the audience expectation will be that, unlike Hollywood, truth will not be sacrificed for spectacle. There are a number of ways to address these concerns that are in keeping with the London Charter. The more speculative parts could be built in less detail, colour-coded, or annotated with additional information.

Heritage places are locations imbued with rich layers of historical and cultural meanings. An individual's experience of a heritage place is the gestalt of the primary sensory impression of the place itself, the individual's unique perspective and those rich historical and cultural layerings (Smith 2006). A virtual heritage place is not, and can never be, the place itself but it can be an environment that seeks to engender the kind of immersion that leads to historical insight. Before examining how such learning might be supported in virtual heritage it is important to examine both interactivity in museums and informal learning more closely.

### **1.8 Learning in museums**

Museums are widely seen as having a number of roles that include the collection, conservation, and study of culturally important artefacts along with the education of the general public about those artefacts in context. However, assessing learning in museums is difficult as, unlike formal learning, there are no set classes and regular assessments. People visit museums for individual reasons most of which do not involve the intention to learn something specific. Eileen Hooper-Greenhill notes that 'learning is characterised as meaning-making' (Hooper-Greenhill 2007: 40) and that 'human beings strive after meaning and this is what provokes learning' (Hooper-Greenhill 2007: 42). Visitor studies reveal that the museum audience ranges widely in age, background and

temperament. Some of them come singly, others in pairs, some in family groups or in school parties (Falk and Dierking 2000, Hein 1998, Hooper-Greenhill 2007). This cross-section of visitors makes designing educational experiences for museum audiences difficult. Some people may prefer more organised while others prefer less organised exhibits. However, as George Hein points out, ‘the same users can fall into either category depending on their reasons for visiting, the company they are in, or the mood generated by the situation that they find as they enter the museum’ (Hein 1998: 137).

Learning strategies by museums have varied as different theories of education have gained and lost acceptance. In *Learning in the Museum* (1998) Hein describes an educational theory as consisting of a theory of knowledge (an epistemology), a theory of learning and a theory of teaching. He outlines the shift in theories about learning, away from the idea of the mind as a *tabular rasa* on which new facts are inscribed, to the idea that the mind constructs meaning by linking new knowledge with existing knowledge. He proposes a continuum of knowledge theory that encapsulates this spectrum (see Figure 2). At one end of the range knowledge is completely independent of the learner and at the other end knowledge is actively constructed by the learner.

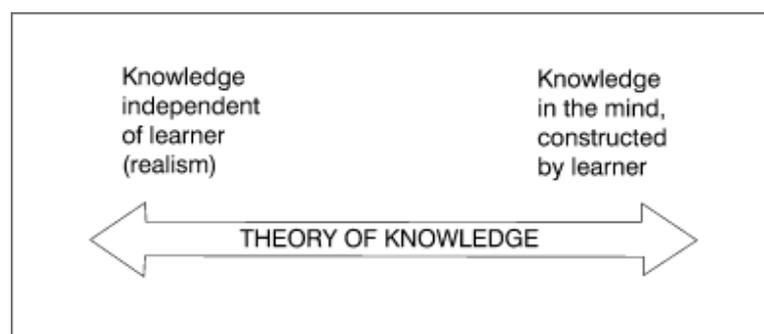


Figure 2: Hein's Theory of Knowledge continuum

Hein also proposes a continuum of learning theory that is bounded at one end by the belief that learning takes place in incremental steps and at the other end by the belief that meaning is constructed by the learner (see Figure 3).

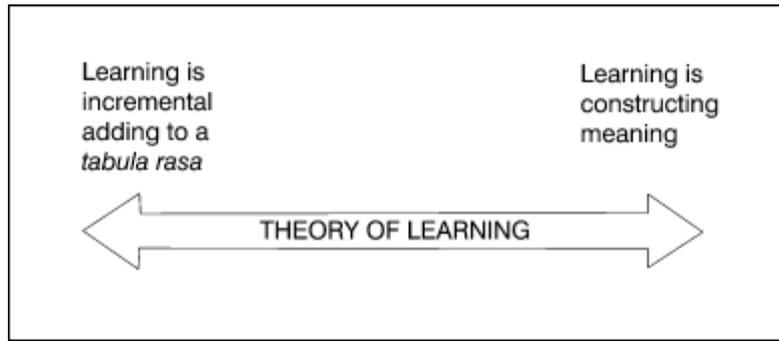


Figure 3: Hein's Theory of Learning continuum

Hein combines the two and uses the four different quadrants so delineated to identify four educational theories. These he terms Traditional lecture and text, Behaviourist learning, Discovery learning and Constructivism (see Figure 4).

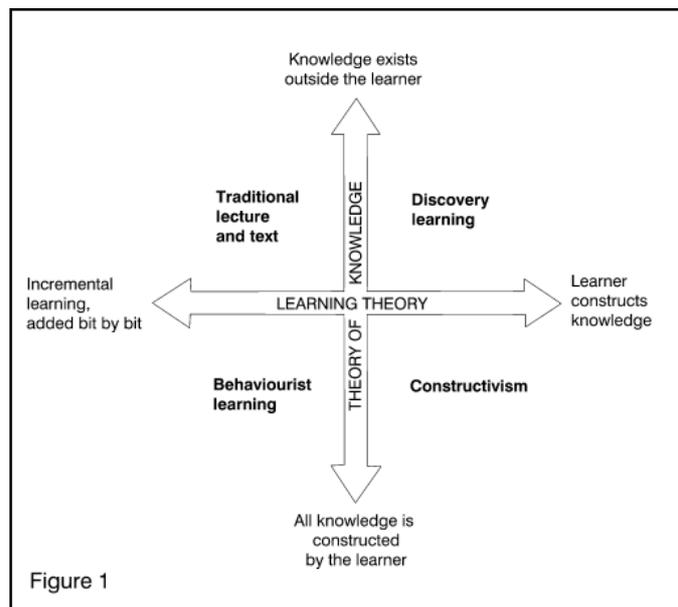


Figure 4: Hein's four educational theories

The didactic-expository approach of the traditional lecture and text model assumes knowledge exists outside of the learner and that it is disseminated in a top-down incremental fashion by teachers to students in bite-sized chunks. Discovery learning

assumes that knowledge exists outside of the learner and that learners discover it for themselves through active engagement. This approach is familiar to science students who have to carry out experiments in the laboratory to confirm what they are being told in the classroom and is widely used in science museums and discovery centres where many of the exhibits are specifically designed for user interaction. For Behaviourists, such as Lev Vygotsky (1896-1934), learning assumes that knowledge is constructed by the user incrementally. In practice this equates to practical training where the 'what' to do is more important than the 'why' to do. An example of this would be a trainee pilot for whom learning how fast she needs to be travelling before lifting up off the runway is of immediate and pertinent practical importance while knowing the details of the theory of lift are not.

Constructivist learning assumes that the learner constructs knowledge from their real life experience, through a wide range of learning modes, along multiple paths and with a range of perspectives. Key to the idea of Constructivist education is the active engagement of the learner. However, attracting and maintaining engagement across the diverse demographics of museum visitors is difficult. The arguable notion of museum fatigue adds to this. Hein notes that the majority of visitors spend about 30 minutes looking at or otherwise interacting with an exhibition. Individual items often only get a few seconds worth of attention and rarely more than a minute. Simple measures shown to increase visitor engagement include adding labels, pictures, sound and interactivity to an exhibit (Hein 1998). But having exhibits with buttons that visitors can push, sliders they can slide and knobs they can turn are not sufficient. The interaction must be meaningful for any learning to take place (Bugg 2011, Roussou 2006).

Within museums there is a growing acknowledgement of the multiple voices and perspectives of history and heritage (Parry 2007, Witcomb 2003, Hein 2000). Communication between the museum and the public is moving away from top-down dissemination of knowledge to a dialogue. Andrea Witcomb believes that visitors should be able to ‘play a part in producing its meaning, challenging the authority of the Museum to produce and regulate their subjectivity’ (Witcomb 2003: 129). She identifies three types of interactivity in museums. The first is *technical interactivity* and this describes physical interaction, such as button pushing, that is often only used to support the delivery of a linear top-down narrative, preventing any negotiation of meaning. The second, *spatial interactivity* describes the use of a non-linear exhibition design to encourage visitors to follow multiple equally valid paths through the museum. Visitors have the opportunity to make their own connections and contrasts between the multiple stand-alone displays. The third is *dialogic interactivity* in which the public is encouraged to engage with ideas. Witcomb uses the Museum of Sydney as an example of this type of interactivity. The Museum is situated on the site of the First Government House in Sydney and its focus is on the ideas and historical processes of colonisation rather than the specific history of the building itself (Witcomb 2003). As discussed earlier, the London Charter states the importance of a clear purpose for virtual heritage and the different types of interactivity identified by Witcomb offer a useful framework for developers of virtual heritage.

The role of play in learning is widely acknowledged, particularly by museums catering to younger audiences. The Walker Art Center in the USA has developed three different activity packs for families based on the game I Spy (Alderman 2011). The Museum Casa do Infante in Portugal has developed a group-based activity, *Porto Through a Game*, for children aged 6 to 11 that involves assembling a number of cushions and

fabric pieces to create a map of the city of Porto and then colouring, cutting out and assembling paper models of the principle buildings which are then placed on the map (Alexandre 2011). The term ‘serious games’ is used to describe games which are primarily intended as vehicles for learning (Anderson et al. 2009a, Kelly et al. 2007, Michael and Chen 2005, Mortara et al. 2013). The book *Museums at Play* (2011) contains the insights of over fifty museum and gaming experts from a total of fourteen different countries (Beale 2011). There is currently great interest in and development of computer-based serious games. Sections 1.11 and 1.12 of this chapter examine heritage-based electronic serious games in detail.

The Constructivist model of learning is widely accepted in virtual heritage (Affleck and Kvan 2008, Roegiers and Truyen 2008, Roussou 2006). Learning opportunities in virtual heritage are dependent on the supported interactions. If only passive wandering is supported then only one interpretation on the data can be presented and the interaction is limited and technical in nature. However, if the virtual world is linked to an integrated database it is possible to support multiple narratives and different interpretations supporting both spatial and dialogic interaction. A modifiable and inhabited virtual heritage world supporting meaningful activities and multiple voices demands the active social engagement of users creating cultural immersion as well as encouraging Constructivist learning by creating opportunities for cultural insight and understanding (Champion and Dave 2007, Champion 2008, Chen and Kalay 2008, Kenderdine et al. 2008, Roussou 2006).

### **1.9 Virtual heritage in museums**

Much has been written about how museums are adapting to the major cultural, technological and institutional changes of the last quarter century (Cameron and

Kenderdine 2007, Hein 2000, Hooper-Greenhill 2007, Parry and Arbach 2007, Witcomb 2003). Here the discussion is restricted to the use of New Media by museums for public edification and, in particular, to examining the use of virtual worlds for heritage (virtual heritage). In the early days of virtual heritage the costs were very high and there was a very real danger of rapid obsolescence (Roussou 2000). Now that the technology has matured and the costs have fallen significantly, virtual heritage is poised to make a significant contribution to heritage learning.

Kalay discusses the challenges of using New Media for heritage in his introduction to *New Heritage: New Media and Cultural Heritage* (2008). He uses two analogies to explore the relationship between technologies, affordances and practice. The first, forcing a square peg into a round hole, describes the inappropriate use of New Media for something it is not well suited to do. The second, the horseless carriage, describes the use of New Media to do something old media can do while missing the fact that it can do much, much, more besides (Kalay, Kvan, and Affleck 2008). Virtual worlds seem to fall into the latter category with most virtual heritage being used to create the virtual equivalent of a diorama and completely ignoring its ability to include the dimension of time.

Interaction is seen by museums as a way of increasing visitor engagement and this is leading museums to experiment with interactive virtual heritage. It must be noted that interactivity in museums is often restricted to the technical interactivity identified by Witcomb (discussed in the previous section) which usually only serves the delivery of a single top-down narrative. The first use of interactive 3D computer graphics in a museum was a hybrid system that interactively displayed pre-rendered images of Dudley Castle in England. Created in 1994, it provided a walk-through of Dudley Castle

as it existed in 1550. The technology at the time was too slow for real-time rendering so single still frames for each of the rooms of the digital reconstruction were pre-rendered and stored on a laser disc. As the visitor navigated through the virtual castle the images were displayed one by one. The term ‘virtual tour’ comes from the Virtual Royal Tour of the system given to HRH Queen Elizabeth II when she opened the visitors’ centre (Virtual Heritage 2013). Learning opportunities are limited as only tangible heritage for a single time period is displayed while user interaction is restricted to moving from room to room.

*Rome Reborn* is an on-going project to create a digital version of Rome from an early Bronze age settlement (circa 1000 B.C.) to the early Middle Ages (circa C.E. 550). The most recent version of *Rome Reborn* shows Rome in A.D. 320 when it was at a peak of urban development with a population of about a million. Contained within the Aurelian Walls are over 7000 buildings that are divided into two classes. Class I buildings are landmark buildings whose location, size, function and appearance are known from documentary information. Class II buildings include apartment buildings, single-family homes, warehouses and shops that are mentioned in documents but whose size, appearance and precise location is not known. This model proved too big to run in real time over the Internet. A lower resolution version was created and could be loaded as a layer in Google Earth. Each landmark building had an information pop up which could hold information including text, images, video and links to external webpages (Frischer 2008, Wells et al. 2009). The *Rome Reborn* layer is no longer available as it has been removed at the request of the original provider. Learning opportunities were limited in this virtual world as only tangible heritage for a single time period was displayed while interaction was limited to navigating through the city. Users could however access additional information and gain some insight and understanding of the cultural context.

This provided opportunities for multiple voices to be heard and different interpretations to be presented supporting spatial and dialogic interaction.

Several research projects have created populated virtual worlds. *Virtual Uruk* is a virtual heritage project that uses artificial intelligence (AI) to create an inhabited historical world. Implemented in the online world of *Second Life* it is an example of a cross-disciplinary collaboration between historians and artificial intelligence researchers. *Virtual Uruk* shows the simple daily routines of a fishing family in the ancient Mesopotamian town of Uruk. Every morning the family wake in their mud hut and the father leaves the house to go to the river and spend the day fishing and in the evening he returns home (Bogdanovych et al. 2010). The *Digital Songlines* project developed a toolkit using the Torque game engine for indigenous groups in Australia to use to build virtual worlds that depicts Aboriginal life in Australia. It was used to create *Virtual Warrane* (2007) and *Virtual Warrane II* (2012) which depict indigenous life in Sydney Cove prior to white settlement (Head 2007). Both *Virtual Uruk* and the two versions of *Virtual Warrane* show visual fidelity, support passive wanderings and activity-based interactions (games) and provide social interaction with inhabitants (Wyeld et al. 2007). Users can actively engage with the virtual world through a range of learning modes offering different opportunities for educators. Both *Virtual Warranes* meet Relph's three requirements for place-ness - physical setting, observable activities and cultural encoding. Time however is completely ignored and this limits the re-creation of the phenomenological affect that is an important contributor to place-ness. It also neglects key details of lives lived in a close relationship with nature and dependent upon fluctuating food sources dictated in part by diurnal, tidal and seasonal cycles<sup>2</sup>.

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<sup>2</sup> Video 2 on the accompanying dvd depicts a demonstration of *Virtual Warrane II*. The video is also available at <https://www.youtube.com/watch?v=MwM8t6vs-c>

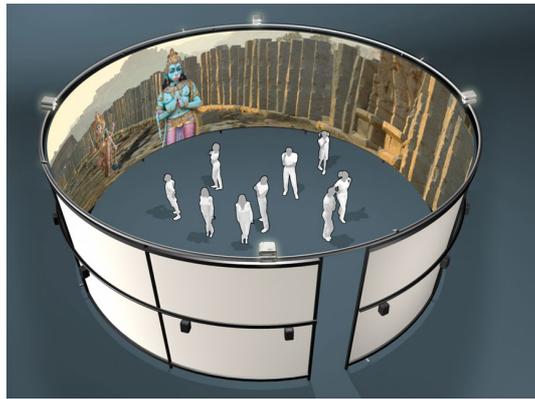


Figure 5: AVIE

A number of researchers have been experimenting with more immersive, stereoscopic VR systems. The iCinema Research Centre has developed a 360-degree stereoscopic immersive interactive visualisation system called the Advanced Visualisation and Interaction Environment (AVIE) (see Figure 5). It has multi-channel audio, a motion tracking system and can be experienced by up to 30 people at the same time (McGinity et al. 2007). Professors Jeffrey Shaw and Sarah Kenderdine have created a number of heritage works for the AVIE including *Place Hampi* and *Pure Land*. *Place Hampi* combines very high resolution stereo photographs with 3D rendered characters. *Pure Land: Inside the Mogao Grottoes at Dunhuang* is an immersive digital experience of one of the Mogao Caves, a UNESCO World Heritage Site in China. The site was an important stop on the Silk Road and the richly decorated caves contain important examples of Chinese Buddhist art covering over a thousand years beginning in 366CE. Many heritage sites are in great danger of being ‘loved to death’. This is particularly true of caves where the humidity from people’s breath will damage the wall paintings (Loubser 2009). A virtual rendition of Cave 220, created with high resolution photographs and laser scans is displayed inside the AVIE. Some of the murals are interactive and 3D animations of ancient musical instruments, digital recolouring of the

murals and video re-enactments of dancers can be played (Kenderdine 2013)<sup>3</sup>. Immersive systems like the AVIE combine very high visual and auditory fidelity with limited interaction. They satisfy two of Relph's three components of place-ness – physical setting and observable activities. However, interaction is limited to navigation through the top down content and does not support spatial or dialogic interaction.

A number of visualisation systems have experimented with combining real and virtual space. Created in 2003, the Virtual Room at the Melbourne Museum was a unique viewing environment consisting of eight large screens arranged so as to enclose a central space, the virtual room (see Figure 6). Viewers experienced a changing perspective as they walked around the Virtual Room and were provided with the illusion that whatever was displayed on the screens was physically contained within the Virtual Room (*The Virtual Room: Journey into another reality* 2003)



Figure 6: Virtual Room, Melbourne Museum

An interactive system for viewing a virtual Egyptian flute in a real museum used a viewing tablet as a window into a virtual space containing a (virtual) flute. Users moved and rotated the tablet to view the virtual flute. The system detected the position and

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<sup>3</sup> Video 6 on the accompanying dvd is an interview with Prof. Jeffrey Shaw about the Pure Land project. The video is also available at <https://www.youtube.com/watch?v=rrTKARGeUfQ>.

angle of the tablet and displayed on it the view of the flute as seen from the perspective of the tablet (Brogni et al. 1998). Additional information in the form of text and images could be called up on the screen. This approach of using a tablet as a window into a virtual world was used to create *Pure Land: Augmented Reality Edition*. In this version users enter a room that is the same size as Cave 220. The walls have a wireframe scan of the cave and an ipad is used as a window that reveals a very high resolution digital copy of the cave paintings<sup>4</sup>. These examples combine very high visual and auditory fidelity with very limited interaction and so satisfy two of Relph's three components of place-ness – physical setting and observable activities. But again, the contribution of time to place is completely ignored and interaction is limited to the physical interaction of positioning the ipad. The content does not feature multiple voices and there is no mechanism for a dialogue between user and museum. However, the embodied nature of the experience is novel and supports group participation providing an affective, though limited, opportunity for engagement and learning.

### **1.10 On-site AR and heritage**

Augmented Reality (AR) is most usually used to describe the real-time overlaying of computer-generated imagery on top of a view of the real world. As mentioned earlier in this chapter, heads up displays (HUDs) are routinely used by military pilots. Information from important instruments and armaments is displayed on the inside of the visor worn by the pilot and overlaid on the real view. HUDs are beginning to appear in consumer products such as in the Prius car where the speedometer is projected onto the windscreen. The Google Glass project is at the Beta stage and this suggests that this technology is on the cusp of being robust and cheap enough for the mass consumer market.

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<sup>4</sup> Video 4 on the accompanying dvd is a recording of *Pure Land: Augmented Reality Edition* in use. The video is also available at <http://vimeo.com/70756977>.

AR, with its ability to combine the view of a place with an overlay of historical data, offers exciting opportunities for on-site heritage. Researchers have already conducted some interesting early tests. The old Summer Palace, known in Chinese as Yuan Ming Yuan, and its associated Garden of Perfection and Brightness, also known as the Garden of All Gardens, was the culmination of works during the reigns of six successive Emperors of the Qing Dynasty. In 1860 the Palace and Gardens were destroyed by British and French troops during the Second Opium War. In 2006 the Digital Yuan Ming Yuan project tested an on-site AR system that combined a virtual model of the Guanshuifa (Throne for Watching the Waterworks) with the actual location. As users moved their heads the view of the virtual model would update so that it remained correctly aligned with, and overlaid onto, the real world (Liu et al. 2006). A fixed position AR viewer has since been installed at the site (Huang, Liu, and Wang 2009). GPS-enabled smart phones can be used in the same way and there are an increasing number of apps that exploit this capability. Researchers in Korea developed *AR View* to display historical photographs of the location detected by the GPS of the phone (Kang and Wohn 2013). HITLabNZ (Human Interface Technology Laboratory New Zealand) has developed *CityViewAR* to allow users in the city of Christchurch in New Zealand to see a pre-earthquake view of the city<sup>5</sup>. Researchers are also experimenting with using GPS to track the location of people for heritage-based virtual treasure hunt/hide-and-seek games (Benford et al. 2001). The ability to combine the affect of the real place with computer generated content has the potential to create rich and memorable learning opportunities using social and activity-based interactions. AR immediately satisfies one of Relph's three components of place-ness – physical setting – and, depending on the

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<sup>5</sup> Video 5 on the accompanying dvd is a recording of CityViewAR in use. The video is also available at <http://vimeo.com/70756977>.

level of augmentation, social and activity-based interactions can also be supported. Time in CityViewAR is present but limited to before and after the earthquake.

### **1.11 Serious Games in museums**

A growing number of interactive computer games are being developed for educational purposes. These games exist in many forms (e.g. text-based, two-dimensional and three-dimensional) and genres (e.g. puzzle, action, strategy) (Kelly et al. 2007, Michael and Chen 2005). Given the early high costs involved, and the rapid evolution and equally rapid obsolescence of the technology, it is not surprising that to date, very few museums have developed virtual heritage games. The interaction in interactive games to date is normally limited to button pushing in contexts that deliver linear narratives. This does not have to be the case as careful game design can showcase multiple voices that invite a more nuanced understanding of history. New Media can also support a dialogue between the museum and its audience that negotiates the meanings of heritage.

As part of the Athens Olympics in 2004 a number of heritage games were produced by the Foundation of the Hellenic World. One was a puzzle-type game that featured a broken pot that players had to re-assemble. Another involved the creation of one of the seven wonders of the ancient world, a 15 metre tall statue of the god Zeus made of gold and ivory. Players take the role of the sculptor's assistants and apply the finishing touches to the construction. In the third game *Walk Through Ancient Olympia* players travel through a virtual model of the historical site, visiting the many buildings there including the sanctuary of Hera, the temple of Zeus, the Gymnasium and Palaestra and interacting with the (virtual) competitors for the pentathlon (Anderson et al. 2009b).

Constructivist learning assumes the active engagement of the learner. Re-assembling a broken pot requires interaction but no engagement with Hellenic culture other than

exposure to the decoration on the pot. The activity has no contextual meaning unlike the role-playing game assisting in the creation of the statue of Zeus which actively engages the player in specific and meaningful tasks that give insight into the materials and technologies used at the time. The exploration of the Olympic site helps users to begin to develop a sense of place as they create their own narrative. The social interaction supports engagement with intangible culture and encourages the kind of immersion that leads to historical insight. However, users have no control over time and there is no weather. This limits the display of the physical setting, a key component of virtual place identified by Relph.

Although not designed for a particular museum the *Gates of Horus* project is worthy of mention. The research group PublicVR originally developed the *Gates of Horus* game to run inside an immersive CAVE system but have since created a version that will run on a standard desktop computer. (A CAVE is an immersive virtual environment where the user is surrounded by multiple large screens on which the virtual environment is projected.) The game takes place inside the virtual model of a generic Egyptian temple of the Third Dynasty. Players engage in a question-and-answer dialogue with a (virtual) temple priest about the major features of the temple and their meanings. If the player correctly answers the questions put to her by the priest she proceeds to the next part of the temple. The goal of the game is to reach the inner sanctuary and unlock the final mystery. This mirrors the ancient Egyptian belief that the souls of the dead have to correctly answer questions in the Hall of Final Judgement if they want to make it to the Afterlife (Jacobson 2011). This project skilfully combines gameplay with some of the cultural insight it seeks to impart. The aim of the game (to correctly answer the question and proceed to the next stage) aligns perfectly with the cultural information (the soul of the dead has to correctly answer the question to move to the next stage). Constructivist

learning assumes that learners are actively engaged in knowledge construction and the making of meaning that occurs during learning. Role-playing is widely recognised as a powerful way to provide the social interaction and cultural immersion that leads to historical understanding (Bowman 1949, Mortara et al. 2013, Shaw 2010).

### **1.12 Suitable games for virtual heritage**

James Gee has written extensively on the learning that takes place in first-person shooter and role-playing games (Gee 2007). These games typically take at least 50 hours to play through and are very carefully designed to be neither too hard nor too easy as players want to feel a sense of achievement when they win. Good games deliver the necessary induction into the rules and logic of a particular game world as part of playing the game. During the course of gameplay the challenges a player faces increase in difficulty in line with the player's growing abilities and knowledge. Gee identifies 36 learning principles in first-person shooter and role-playing games that he argues should be used to inform the delivery of education in schools. The first of these is that all aspects of the environment are set up to encourage active and critical learning.

Many of his principles currently have limited application to museum-based virtual heritage because most of virtual heritage is developed with much shorter engagement times in mind. Museums, while happy to see engagement in visitors, would have legitimate concerns if one visitor were to monopolise an exhibit for long periods of time to the detriment of other visitors. As a result the games developed for virtual heritage in museums are usually kept very simple so that they can be played quickly and easily. However, museums are increasingly using New Media to engage with remote audiences and Gee's insights are directly applicable to the design of downloadable and web-based virtual heritage intended for repeated and prolonged engagement.

Michela Mortara, Chiara Catalano, Francesco Bellotti, Giusy Fiucci, Minica Houry-Panchetti and Panagiotis Petridis' survey of two-dimensional and three-dimensional cultural heritage games identified five main genres: strategy, simulation, quiz/puzzle, adventure and action (Mortara et al. 2013). The author argues that some of these genres are less suited to heritage education than others. For example, historically-based strategy games are a popular and commercially successful sub-genre of games with antecedents in the war games played at military academies. They allow players to re-fight famous battles and campaigns and the graphics often display an aerial or God's eye view of unfolding events (see Figure 7). The company Total War have developed games based on the Roman Empire, the Japanese Shogunate, the Napoleonic Wars and the British Empire.



Figure 7: Screenshot from *Empire: Total War*

It could be argued that the players in a heritage game such as this should be restricted to actions that will not change history. Certainly, if the aim of the game is to teach a particular history, then that makes sense. It could also be argued that allowing people to change history gets them to think about the forces that shape history but in reality it can never be known with 100 per cent certainty what those forces are. When these sorts of games are played, real alternative histories are not explored only the assumptions of the game programmer. In any case these games are limited to battlefield outcomes and not

to the entwined political and social changes that would be part of any alternative history. Heritage learning opportunities are limited to the visual fidelity of the armies, and the design and efficacy of the weapons.

*Dogfight: 80 years of Aerial Warfare* is an example of a simulation game. It features a wide variety of aeroplanes from World War 1, World War 2 and the Korean and Vietnam wars and runs on a personal computer. While it lacks the sophisticated feedback systems of commercial flight simulators it is accurate in other respects such as the layout of the instrument panels and the performance of the aircraft. Learning opportunities in this case are restricted to the particularities of the different aircraft and the strategies of air-to-air combat at the individual level. As discussed earlier, simulators are essentially designed to train people to carry out tasks and any learning that takes place is related to that particular task. Heritage learning opportunities are limited to the visual fidelity of the planes, their capabilities and the efficacy of their weapons.

With action and adventure games it is much harder to state categorically that one or the other genre is or is not suited to virtual heritage. It depends on the particular content of the game in question and the role and level of agency of the player. Mortara et al (2013) note that action games were the least represented in their study. In commercial action games the gameplay is based in large part on a player's ability to manoeuvre quickly and skillfully in the virtual world. This dexterity is facilitated by the training that is delivered in the early phases of the game and the process of learning to play the game is part of the enjoyment experienced by gamers (Gee 2007). However, considering the diversity of the heritage audience and the short engagement times of museum-based

virtual heritage, an over-emphasis on dexterity is likely to cause frustration to many users.

In action and adventure games the actions of the player are pivotal to the outcome of major events that take place in the virtual world, whereas in a heritage world the actions of a player should not, as argued earlier, be able to change history. The *Assassin Creed* games are very cleverly designed to fit into the history of a particular period in an integrated but parallel way so historical outcomes are not affected by any in-game actions. However, role-playing is recognised as a powerful way to create cognitive and affective learning (Bowman 1949, Mortara et al. 2013, Shaw 2010) and it is an approach being trialled by archaeologist Bernie Frischer in his Digital Hadrian's Villa Project which is described in greater detail in the following section.

Quiz and puzzle games are undoubtedly the most conducive to the pedagogical remit of heritage but may lack the immersive engagement of other game genres. It is possible that combining genres so that users role-play non-historical characters while solving puzzles offers a possible way to maximise engagement and learning. It must be noted that the type of game does not determine the level of interaction which is provided by the content and design of the game in question. Games can deliver linear narratives or multiple voices. They can also be used to encourage audiences to consider heritage itself more deeply. So while the interaction *mode* may be that of a game, the *type* of interactions it supports may vary.

### **1.13 Enriched virtual heritage**

A number of researchers have pointed out the benefits of combining a virtual world with a database of related and relevant information and created prototypes (Kadobayashi, Nishimoto, and Mase 1998, Kim, Kesavadas, and Paley 2006). A virtual

model can be much, much, more than just a visualisation. It can serve as an interface to a larger database of relevant multimedia (audio, text, image and video) data. Rieko Kadobayashi proposed the idea of the Meta-Museum in 1995. The Meta-Museum would allow experts to carry out research, the wide diversity of museum visitors to learn, and for experts and museum visitors to easily communicate with each other opening up opportunities for dialogic interaction.

Primarily intended as a research tool for archaeologists and as an educational tool for archaeology students, the Digital Hadrian's Villa Project consists of a digital model of the entire 250 acre site at Tivoli outside Rome. There are over 30 buildings that comprise the second century villa, populated by the Emperor Hadrian, Imperial Court members, Roman senators, scholars, freemen, soldiers and slaves taking part in daily tasks such as sentry duty, feasting, bathing and religious rituals. Users can role-play these characters and discover how gender, class and ethnicity influenced social interaction in Roman times. (Users select from a menu of possible interactions.) There is a related website accessed via a menu button at the top of the screen with paradata geared towards expert users. Users can set any time and date during the year 130AD and this has already been used to uncover unsuspected solstice alignments (*IU digital archaeologist to unveil ancient Roman emperor's villa* 2013). Prof Bernie Frischer, director of the Virtual World Heritage Laboratory, has been a key figure in the development of both Rome Reborn and the Digital Hadrian's Villa Project. This project, directed at expert audiences, supports the exploration of a range of social perspectives via role-playing, creating rich opportunities for cultural immersion. The use of time is limited to daily and annual rhythms for 130AD and is currently only used to explore astronomical alignments. It is not used to control cultural behaviours such as seasonal ceremonies and festivities or to create phenomenological affect.

The *Virtual Site Museum* is a multi-purpose resource for archaeological research, education and public demonstration. The first site to be documented was the Northwest Palace of the Assyrian King Ashurnasirpal II. The model has in-built links to photos, drawings and notes used to create the model. Over 75 per cent of the original artefacts have been removed from the site and are currently held by various museums around the world. The virtual model allows these objects to be recombined and seen in their original context revealing the important placement of various carvings. In the throne room the winged deities behind the throne are seen to protect both the carved images of the king and also the seated monarch. There is a ten minute introductory tour for public demonstration and classroom use after which users can explore at their own pace and can activate pre-calculated animations at various parts of the Palace. In the throne room the king will stand up, step down from his throne and walk across the throne room, his heavy garments moving naturally, and explain the history of his reign. There is also an interactive puzzle where users can re-assemble fragments of a broken bas-relief (Kim, Kesavadas, and Paley 2006). This project offers Constructivist learning through a range of learning modes. Audiences are first primed with a ten minute tour and then they are able to engage in self-directed exploration and interactive activity. The re-assembly of the broken bas-relief, like the re-assembly of the broken Hellenic pot, offers no engagement with Assyrian culture other than exposure to the design of the bas-relief. The social interaction is limited to triggering a pre-rendered animation. The cultural engagement of users is minimal as there are no social activities taking place. However, the physical setting and interaction are two components of place identified by Relph. The pre-rendered animation of the king does not provide much in the way of social interaction but does help imply inhabitation contributing to a broader and deeper sense of place. Time is completely absent.

### **1.14 Time-based virtual heritage**

The Nuovo Museo Elettronico della Città di Bologna (Nu.M.E) is a virtual model of Bologna between 1000 C.E. and 2000 C.E. Users start in the present day and navigate back in time using a time-bar control. There is a different ambient soundtrack for each century and each building has an HTML document compiled by a historian. Originally developed as a tool for historians it is also considered a powerful tool to increase cultural knowledge of the city for the general public (Bocchi 2004, Bonfigli and Guidazzoli 1998). The area around Piazza di Porta Ravegnana was the first to be modelled and can be viewed at the virtual theatre of CINECA (The Virtual Theatre + New Electronic Museum: The City in Four Dimensions 1999, New Electronic Museum: The City in Four Dimensions: Virtual Bologna 1999).

A version of it has been implemented in the online virtual world of Second Life. Users are able to download the 3D models and re-purpose them for their own projects (Lecari et al. 2011). Despite the time control the phenomenological aspect of place is ignored for the most part with time limited to controlling the display of certain buildings. The ambient soundtrack hints at social changes but as neither social interaction nor activity-based interaction is supported the sense of place evoked by the model and the opportunities for immersion leading to historical understanding is limited.

Google Earth is a virtual globe, map and geographical information viewer which supports the grouping of assets in layers which can be time-based. Overlaid on the globe are placemark icons, which, when selected, will open up a pop-up window with additional relevant information (text, image and links to more data). Additional layers of 3D buildings can be loaded and a version of *Rome Reborn* was released as a layer in

2008 but it was withdrawn in 2012. The model was of Rome in 320AD and comprised thousands of buildings, eleven with interiors. Each placemark opened a pop-up window with some additional data and hyperlinks to additional data and also to the *Rome Reborn* project website. The learning opportunities are minimal with no support for social interaction and cultural immersion.

Google Earth also has what they call an Historical Imagery layer that uses aerial and satellite photos combined with a time slider to let users explore the changes to the cities of Beijing, Berlin, Las Vegas, London, and Warsaw over time. The time range begins at the date of the earliest photo and ends with the most recent image available. However, the 3D buildings are not integrated with the timeline and are always visible regardless of the date. The learning opportunities are minimal with no support for social interaction and there is only one learning mode. In addition the persistence of the 3D buildings throughout time is confusing.

## **1.15 Conclusion**

This chapter explored the multi-disciplinary background to virtual heritage. Philosophies of place and virtual place were discussed. Heritage places were found to be not only the physical places themselves but also the cultural meanings associated with them and the activities that take place within them. Heritage place was found to be experienced both physically and cognitively with cultural associations, the phenomenological affect of the environment and the unique memories and disposition of the individual all contributing to create the experience of heritage place. Time was found to be a key factor in the experience of place from phenomenological, cultural and individual perspectives.

The informal learning that takes place in museums was examined using a Constructivist framework. Examples of so-called serious games, which use game-style interaction for training and learning, were assessed and the most appropriate game genres for heritage learning discussed. Applying Constructivist learning theory to virtual heritage lead to the development of a range of interaction modes that give users opportunities to craft interactive user-centred social and activity-based experiences that support learning opportunities. Time was found to be critical to the experience of place. Yet the use of time in virtual heritage was found to be minimal despite the fact that virtual heritage is often likened to a type of time travel (Ch'ng 2009, Kaylan 2010). The time of day or night, phase of the moon and season of the year directly influence the light, sound and smell of a place and the rhythm of the activities that take place within it. But in most virtual heritage no clocks mark time, the sun does not move in the sky, and there is a general absence of life. Timeless virtual heritage represents a frozen moment, a still from a movie, and the bigger story is missing. The absence of time is especially curious given that time is an inherent affordance of most of the programs used to create virtual heritage.

In conclusion, 3D computer graphics is currently being used to create virtual heritage worlds that support a range of interactions intended to encourage the kind of immersion that leads to insight, understand and learning. However, time is a crucial factor of virtual heritage place that was found to be widely ignored. In the next chapter, time and time travel will be examined from the perspectives of science, philosophy, popular culture and the lived experience.

## CHAPTER 2: Time Travel

2.1 The lived experience of time	76
2.2 The philosophy of time	77
2.3 The philosophy of time travel	80
2.4 The science of time travel	81
2.5 Time travel in popular culture	83
2.6 Period drama as time travel	89
2.7 Conclusion	89

Chapter 1 detailed the multi-disciplinary background to virtual heritage involving place, time, heritage, virtual worlds, informal learning and serious games. The phenomenological and cultural dimensions of place were explored and the concept of heritage place examined. This was followed by a description of the current state of the art for virtual worlds and a discussion about the phenomenon of presence. A Constructivist framework was used to examine the informal learning that takes place in museums. This was followed by an analysis of the place-making potential of, and the learning opportunities afforded by, virtual heritage. The chapter concluded with a discussion about the most appropriate game genres for heritage learning. It was noted that time is critical to the experience of place as it determines both the cultural and the phenomenological contexts and yet it was found to be largely absent from virtual heritage.

The absence of time in virtual heritage is seen as a lost opportunity to create engaging and diverse learning opportunities for heritage audiences. This absence of time is particularly curious as heritage is, after all, all about time. It concerns human culture located in space AND time. We are temporal beings, we live in time (Ozeki 2013). Just as water surrounds and defines the life of a fish, so does time define the lived life. Perhaps it is this very pervasiveness that renders it assumed and invisible. This chapter

examines time in general and time travel in particular.

The emphasis of this thesis is on building better virtual worlds for heritage audiences that will encourage the kind of immersion that leads to historical insight and understanding. So while time is a fundamental aspect of the lived existence the focus here is more on time travel than on time itself *per se*. and, in particular, on time travel as it applies in a heritage context. However, the different philosophies of time necessarily inform different ideas about time travel in popular culture and these ideas are then reflected time travel narratives in literature and on screen.

In this chapter the lived experience of time will be discussed briefly, followed by an outline of key ideas in the philosophy of time. Then the science of time is examined, beginning with the ever-more accurate measurement of time and ending with Einstein's space-time continuum. However, the majority of this chapter is devoted to notions of time travel, particularly as imagined in popular culture. The time travel section of this chapter begins with an eclectic selection of time travel in popular culture to demonstrate that it is an established trope of the human imaginary. A close look at time travel in literature and on screen reveals the term 'time travel' to be an umbrella term that hides important distinctions. Time travel can be instantaneous, or take time. In the former, time travel is destination-focussed and in the latter it is journey-focussed. These different modes of time travel offer different learning opportunities. Time travel to a particular time lets people explore a place, its inhabitants and its culture at a particular moment in history while travelling through time lets people see the unfolding history of a place over timeframes outside of direct human experience. The chapter concludes by arguing that both modes offer opportunities for users to engage with virtual heritage in new ways that provoke and support historical insight, understanding and learning.

## Time

*Time and tide wait for no man*

*(earliest recorded use by St. Marher, 1225 CE)*

### 2.1 The Lived Experience of Time

We experience life as an eternal conscious moment, the *now*, which divides the past-which-cannot-be-changed from the future-which-is-unknown. Interestingly, the constant *now* that fills our conscious awareness is an illusion. We are actually living about 80 milliseconds in the past (Musser 2011). When we see something it takes a finite measure of time for the light to travel to our eye, react with the retina and send a cascade of signals through our brain and then for our brains to process the information so that we *see* whatever that something is. Recently it has been proposed that the brain is essentially a prediction machine (Barras 2013, Huang 2008). Research into gaze and grasping indicate that on a subconscious, automatic level the body anticipates our movements and interactions with the world. As someone reaches out to grasp something their hand automatically and unconsciously shapes itself to grasp the cup that they are reaching for in anticipation of the shape it will make when the cup is in their hand (Goodale and Milner 1992).

As well as experiencing the *now*, we also experience a sense of the passage of time. However, the speed at which time passes can seem to change. Unlike the exactitude of clock time where each second is the same length, the lived experience of the passage of time is subjective and can be affected by many factors including engagement, danger, sexual attraction and drugs (Hoffman 2009). When the mind is busy, time seems to pass

quickly but when you are bored time slows and the hours drag slowly by. Conversely, time can also seem to slow down in moments of danger. Cinema makes extensive use of slow motion to artificially re-create this sensation. The bullet-time of the *Matrix* (1999, 2003, 2003) films is an extreme example of what is now an established cinema trope<sup>6</sup>. Slow motion is also used to emphasise romantic attraction and was parodied in the iconic slow motion shot of Bo Derek running along a beach in the movie *10* (1979)<sup>7</sup>. Psychoactive drugs are well known to affect the subjective passage of time. At high doses of LSD, psilocybin and mescaline, time may stop, speed up, slow down, seem out of sequence or go backwards. Regardless of the subjective experience of the passage of time the inescapable reality of life is that the flow of time is relentless and one-directional. (This assertion is based on the assumption that time is linear. Linear versus circular notions of time are explored in the next section.)

## 2.2 The philosophy of time

Time is a fundamental aspect of the lived experience and has therefore attracted philosophical interest through the ages (Bardon 2013, Hoffman 2009, Le Poidevin and MacBeath 2009b, Savitt 2014). The Greek philosopher Heraclitus (c. 535 – c. 475 BCE) believed that nothing in the world was constant except change. The universe and everything in it is constantly in the process of *becoming* (McFarlane 1998). This concept raises questions. Are there things that don't change over time? (A topic of particular relevance to Christian theological discussions about the nature of God and the soul.) And what about identity? How does an individual consciousness maintain its enduring sense of me-ness from moment to moment, day to day, year to year?

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<sup>6</sup> Video 6 on the accompanying dvd shows an example of bullet-time from the *Matrix* (1999). The video is also available at <https://www.youtube.com/watch?v=WhxbYTMNMxo>.

<sup>7</sup> Video 7 on the accompanying dvd shows the slow motion shot of Bo Derek. It can also be viewed at <https://www.youtube.com/watch?v=p8TUWilKb6M>.

Heraclitus' near contemporary, Parmenides (c.515 – c. 460 BCE), argued that only the *now* was real and therefore change was an illusion (McFarlane 1998). Both the future and past could not be real because if they were, how could they be separated from the present? And if past and future are not real then nothing can pass from the future to the past. There can be no change, and without change there is no time. He argued that the universe and everything in it was in an eternal state of *being* (Bardon 2013). J.M.E. McTaggart's influential paper *The Unreality of Time* (1908) expanded on Parmenides' argument. McTaggart uses his 'A series' and 'B series' to describe the two different ways of ordering events in time. His A series orders events according to how they relate to the present. Time is split into past, present and future, for example, yesterday, today and tomorrow. His B series eliminates all reference to the present and orders events according to how they relate to each other. Time is split into units, for example, the day before my birthday, my birthday and the day after my birthday. McTaggart argues that time is unreal because the A-series is inconsistent and the B-series alone cannot account for the nature of time as it depends upon the A-series (McTaggart 2009).

Aristotle (342 - 322 BCE) argued that time is a way of measuring change (Bardon 2013). Regular motions like the rotation of the earth are used as units of duration and we can say for example that a journey will take three days. Time in this sense is merely a unit system based on observed regular motions.

The question of the origin of temporal concepts became a central concern for philosophers during the Age of Enlightenment (seventeenth and eighteenth centuries CE). Kant argued that the key to cognition lay in the interpretation of individual experience in terms of time (Bardon 2013, Le Poidevin and MacBeath 2009a). This is innate and, just as there is no way to think about objects except spatially, there is no

way to think about experience except temporally. Time is the way in which we organise our experience of the world.

In his influential *The Principles of Psychology*, published in 1890, William James declared that ‘the prototype of all conceived times is the specious present, the short duration of which we are immediately and incessantly sensible’. He went on to say ‘We are constantly aware of a certain duration – the specious present – varying from a few seconds to probably not more than a minute, and this duration (with its content perceived as having one part earlier and another part later) is the original intuition of time.’ James proposed that consciousness is saddle-shaped with the *now* extending slightly into the future and trailing slightly in the past (Field 1983). This idea of a single moment that encapsulates within it past, present and future is at the centre of the theory of time consciousness propounded by the German philosopher Edmund Husserl, founder of phenomenology (Kelly 2008, McFarlane 1998, Smith 2008).

Consider reading a sentence or listening to music. The mind is aware of the individual words or notes but also that they are part of a larger whole. Husserl considers the *now* as conscious life’s absolute point of orientation but he, like James, argues that just as a sentence or a musical phrase occurs across time, so consciousness must also extend across time and in such a way as to preserve the temporal order of the words and the notes. In essence, consciousness must be spread out across time. Husserl describes consciousness as being made up of three distinguishable but inseparable moments: primal impression, retention and protention. Retention is distinguished from memory by Husserl who argues that memory is an active, mediated, objectifying awareness of a past object and retention is a passive, immediate, non-objectifying, conscious awareness of the elapsed phase of conscious experience (Kelly 2008).

Not all conceptions of time are linear. Plato and Aristotle both thought that time was circular and the concept of eternal and cyclical time is central to many Eastern religions including Hinduism, Taoism and Buddhism. For both Hindus and Buddhists the wheel of life represents the eternal cycle of birth, life and death (Bardon 2013).

## **Time Travel**

### **2.3 The philosophy of time travel**

Time travel is a curious concept. In one sense we time travel all the time. Past and future are entwined with the '*now*' that stamps our consciousness. Memory and anticipation are continuously interwoven with the *now*. Constant mental time travel is the very stuff of consciousness. However, to really travel in time is considered the stuff of fantasy and science fiction.

The possibility of time travel depends upon there being a time, either past or present, to travel to. If the universe is in a constant state of becoming then there is no past or future to travel to. However, assuming that one can travel in time, the philosophy of time travel is dominated by concerns regarding the possibility of altering the past and hence the future. The so-called Grandfather paradox details a thought experiment where a person goes back in time and kills their grandfather before their father was conceived (Nahin 2011, Kane 2013, Callender 2011). Logic would appear to rule this out but a possible solution is offered by the Many Worlds interpretation of quantum physics (Vaidman 2015). This postulates a multiverse of alternative worlds in which all alternatives play out. The act of killing your grandfather spawns two universes, one where you killed him and one where you did not (Nahin 2011). An alternative view is

that the future is already determined and cannot be changed (Kane 2013). Therefore a time traveller to the past can only act in ways that bring the future into being. This has obvious implications for free will. These different ideas inform time travel stories in popular culture.

#### **2.4 The science of time travel**

Dr Peter Riggs, Visiting Fellow in the Australian National University's Department of Quantum Science, separates time travel into two types, time travel to the future and time travel to the past (Riggs 2013). Einstein predicted in his general theory of relativity that two synchronized clocks would no longer tell the same time if one was moved away and then brought back. Time would be slower for the travelling clock and its time would lag behind the clock that had stayed put. In 1911 Einstein re-stated and elaborated on the result with an example involving a pair of twins, one of whom remains on Earth while the other travels into space for a while before returning to Earth where he finds his twin has aged greatly. The result appears paradoxical as, if motion is considered relative to each twin, then it could be argued that each stays still while the other does the travelling. However, the twins are not equivalent as the space twin experiences additional, asymmetrical acceleration when switching direction to return home (Riggs 2013).

In 2010, C. W. Chou, D. B. Hume, T. Rosenband and D. J. Wineland reported on some long running experiments that focussed on two different scenarios predicted by Einstein's theories of relativity. In the first experiment, two clocks were positioned at different heights above the ground, subjecting them to unequal gravitational forces. The higher clock, which experienced a smaller gravitational force, ran faster, just as predicted. The second experiment was designed to test the twin paradox. This time

researchers altered the physical motion of the ion in one clock, so that it gyrated back and forth at speeds equivalent to several meters per second. As predicted by relativity, that clock ticked at a slightly slower rate than the second clock with the moving ion acting like the travelling twin in the twin paradox (Chou et al. 2010).

Sergei Krikalev, a Russian cosmonaut, holds the world record for time travel by a human being. He has orbited the Earth for a total of 803 days, 9 hours and 39 minutes on board the Russian MIR space station and the International Space Station (ISS) and in so doing has travelled about 0.021 seconds or 21 milliseconds into the future (Jamieson 2011). NASA is currently carrying out some research with Mark and Scott Kelly, identical twins and astronauts. Scott is going to spend a year on the ISS while Mark is going to remain on Earth. NASA is primarily interested in comparing the difference in how their bodies respond with regard to weight versus weightlessness but it is also estimated that Scott will be ten milliseconds younger than his brother when he returns to Earth (Aron 2013).

So time travel to the future is not only possible but has been demonstrated (Chou et al. 2010). Time travel to the past is more problematic. The Tipler cylinder is a hypothetical solution to time travel that does not violate general relativity (Nahin 2011, Riggs 2013). The cylinder would need to contain a significant mass of the universe and it would need to be spinning fast on its long axis. If a spaceship flew a spiral path around the cylinder at close to the speed of light it would travel forward or backward in time (dependent upon the direction of the spiral).

Another hypothetical solution is a traversable wormhole that connects different parts of space-time, but the creation of such a wormhole would require the existence of exotic matter with negative energy (Nahin 2011, Riggs 2013). Stephen Hawkins has argued

that time travel might be possible if a region of space-time is warped in the correct way (Hawkins 1995). However, until such a warp has been created no time traveller from the future can reach it. Therefore time travellers cannot travel back to a time before the creation of the space-time warp. A theory that successfully combines quantum mechanics and general relativity (currently the Holy Grail of modern physics) should reveal if time travel to the past is possible (Riggs 2013).

The following section examines time travel narratives in popular culture. As will be seen, these stories are informed in part by philosophical assumptions about the nature of time. They also feature time travel that is occasionally informed by scientific feasibility.

### **2.5 Time travel in popular culture**

While to all intents and purposes meaningful time travel is impossible, it is a recognised motif in contemporary popular culture. The seeming impossibility of time travel has not dampened the imagining of it. The astounding miscellany of stories that exist in print and on screen, each with its own particular mechanism for time travel, is ample evidence that time travel is a widely accepted trope of the human imaginary. Many cultures have folk tales of time travel. The Mahabharata has a story of King Revaita who travels to heaven to meet Brahma. When he returns to Earth he discovers that many ages have passed. Irish folk tales tell similar stories of the perils of visiting the faery kingdom. The American story of Rip Van Winkle tells the tale of a man who takes a nap on a mountain and wakes twenty years later to find his wife dead and his daughter a grown woman.

Time travel established itself in the popular imagination with *The Time Machine* by H. G. Wells, a book that has not been out of print since it was first published in 1895. For the eponymous Time Traveller the act of travelling through time took time, and

travelling through time was physically unpleasant. His machine remained fixed at the same geographic point and he was able to see the changes taking place in the area surrounding the time machine as he journeyed through time. He describes not only the ‘the peculiar sensations of time travelling’ which he found ‘excessively unpleasant’ but also the movement of the sun and moon across the sky and ‘trees growing and changing like puffs of vapour, now brown, now green’ as they ‘grew, spread, shivered, and passed away’ and ‘huge buildings [that] rise up faint and fair, and pass like dreams’ (Wells 1895)<sup>8</sup>.

Time travel is now a significant and well-established sub-genre of science and fantasy fiction in text and on screen. Paul Nahin’s *Time Travel: A Writer’s Guide to the Real Science of Plausible Time Travel* (2011) is an excellent guide for writers who want to write scientifically informed time travel-based fiction (Nahin 2011). However, time travel in popular culture ranges from the plausible to the ridiculous. In movies often powerful energies are involved with all the associated lightning, flames, lightning and flames, multi-coloured plasma discharges and the like that the film makers can afford. But sometimes, possibly on smaller budgets, time travellers just fade from one time to another. Curiously usually only males can time travel (Anders 2013, Smith 2013) and sometimes they can only do it in the nude. What follows is not an exhaustive survey of time travel in television and cinema, but rather a mixed selection from the last 50 or so years to illustrate the wide and enduring use of time travel in popular culture. These examples show that time travel, despite being completely outside of human experience in reality, is a powerful and popular narrative tool. The audience willingly suspends its sense of disbelief if they are engaged in the story unfolding on the screen in front of them.

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<sup>8</sup> Chapter III The Time Machine HG Wells 1895

*The Time Machine* has been turned into a movie on two occasions. The two films are very faithful to the book and do not involve any time paradoxes. However, they illustrate the impact digital visual effects have brought to film-making. The 1960 version used the changing fashions on a time-lapsed mannequin in a shop window to show the passage of time and won an Oscar for Special Effects<sup>9</sup>. A second version of *The Time Machine* was made in 2002 and used computer graphics to depict a time-lapse effect similar to that described in the book. However, in a nod to the first film, the mannequin sequence was recreated<sup>10</sup>.

The mechanisms of time travel in the films vary widely. In both *Time Machine* films, time travel is achieved by using the eponymous time machine of the title, in *Midnight in Paris* (2011) time travel just happens at midnight while wandering the streets of Paris, and in *A Connecticut Yankee in King Arthur's Court* (1949) time travel comes about due to a blow to the head. A genetic illness causes the time traveller in *The Time Traveller's Wife* (2009) to dissolve out of one time and into another, losing his clothes in the process<sup>11</sup>.

Time travel in the various *Terminator* (1984, 1991, 2003, 2009) movies is much more dramatic. It begins with displays of forked lightning that build in intensity and then a sphere inflates from nothing. The sphere vanishes to reveal the naked (male) time traveller<sup>12</sup>. The *Terminator* movies conform to the Noviko Self-Consistency Principle which states that logical paradoxes (such as killing the grandfather before the father is

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<sup>9</sup> Video 8 on the accompanying dvd shows the sequence and it can also be viewed at [https://www.youtube.com/watch?v=BVlr24zD\\_KQ](https://www.youtube.com/watch?v=BVlr24zD_KQ).

<sup>10</sup> Video 9 on the accompanying dvd shows the sequence and it can also be viewed at <https://www.youtube.com/watch?v=uPb8InotRTI>.

<sup>11</sup> Video 10 on the accompanying dvd shows a time travel sequence from *The Time Traveller's Wife* (2009) and it can also be viewed at <https://www.youtube.com/watch?v=R5NksZzD0yo#t=152>.

<sup>12</sup> Video 11 on the accompanying dvd shows time travel in the first three *Terminator* movies. The video is also available at <https://www.youtube.com/watch?v=LPpQBZpFEUc>.

born) are mathematically impossible (Nahin 2011, Kane 2013). Therefore any action by an agent from the future is already part of what will bring that future into being. In the *Terminator* movies, it is the attempts by Skynet to kill John Connor that give him the strength and skills to destroy Skynet. Similarly, in the movie *Twelve Monkeys* (1995), it is the actions of an agent from the future sent to the past to stop a plague that actually set the plague loose.

In *Back To The Future I, II and III* (1985, 1989, 1990) a modified deLoren car travelling at 88 miles per hour achieves time travel with a flash of white and burning tyre tracks. The journey itself takes no time with the car leaving one time and immediately appearing in another<sup>13</sup>. However, in the *Back to The Future* films the past, and therefore the future, is malleable. In the first film the main character Marty McFly discovers that he can alter the past when he accidentally prevents his parents falling in love. He starts fading in and out of existence and must find a way to get his parents together before he disappears completely.

In the long running British television series *Dr Who* (1963-89, 2005-current) the Doctor has a time machine known as the Tardis that can travel in both time and space. The Tardis looks like an old British police phone box and is larger on the inside than it appears from the outside. Travelling through time takes time. The opening and closing credits usually depict the Tardis travelling through the time vortex which is also referred to as the space-time vortex. Over the many years of the program there have been regular re-designs of the vortex and the most recent version shows the vortex as a twisting

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<sup>13</sup> Video 12 on the accompanying dvd shows all the time travel sequences from the *Back to the Future* films. The video is also available at <https://www.youtube.com/watch?v=wwTj7SwzCHI>

cloud-wreathed tunnel pieced and illuminated by bolts of forked lightning<sup>14</sup>. Avoiding time paradoxes created by altering the past are a key concern for the Doctor.

Time travel in *Bill & Ted's Excellent Adventure* (1989) involves a modified telephone box which, unlike the Tardis, is as small inside as it is outside. It travels up and down through time like a lift and displays orange electrical activity, sparks and trails of flame. The time travel is not instantaneous but there is no time-lapsed view of the changing world<sup>15</sup>. In the movie *Hot Tub Time Machine* (2010), spilling a Russian sports drink into the controls of a hot tub creates a waterspout, with lightning, that transports people through time<sup>16</sup>.

In the film *A Sound of Thunder* (2005) a point of nothingness pops into being and grows to become the open mouth of a time tunnel connecting two different points in time. The time travellers are strapped into position for the journey in a manner similar to people on a roller coaster ride. The journey itself takes no time but there are warning sirens, flashing yellow lights, and much shaking and juddering as the machine prepares to initiate the jump into the past<sup>17</sup>. The central story concerns time tourists who accidentally interfere with the past with critical ramifications for the future.

No mention of time travel in popular culture is complete without mentioning the *Star Trek* franchise. The original television series ran from 1966-69 and featured Captain James T. Kirk exploring the galaxy in the starship the U.S.S. Enterprise. It was followed

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<sup>14</sup> Video 13 on the accompanying dvd shows all the opening titles from the *Dr Who* series. The video is also available at [http://www.youtube.com/watch?feature=player\\_embedded&v=MQb-yRE7mfo](http://www.youtube.com/watch?feature=player_embedded&v=MQb-yRE7mfo)

<sup>15</sup> Video 14 on the accompanying dvd shows time travel in *Bill & Ted's Excellent Adventure* (1989). The video is also available at <http://io9.com/5946990/12-greatest-time-travel-effects-from-movies-and-television>

<sup>16</sup> Video 15 on the accompanying dvd shows time travel in *Hot Tub Time Machine* (2010). The video is also available at <http://io9.com/5946990/12-greatest-time-travel-effects-from-movies-and-television>

<sup>17</sup> Video 16 on the accompanying dvd shows time travel in *A Sound of Thunder* (2005). The video is also available at <http://io9.com/5946990/12-greatest-time-travel-effects-from-movies-and-television>

by *Star Trek: Next Generation* (1987-1994), *Star Trek: Deep Space 9* (1993-99), *Star Trek: Voyager* (1995-2001) and *Star Trek: Enterprise* (2001-2005). There are also twelve films, the most recent two of which, directed by J.J. Abrams, take place in an alternate timeline informed by the Many Worlds interpretation of quantum physics discussed in Chapter 2, Section 2.3. A Romulan travels to the past, destroys the Vulcan homeworld and kills Captain Kirk's father but not before Kirk was born, thereby creating an entire alternate universe, and permitting a complete re-boot of the series. Five of the movies and numerous individual episodes of the series deal with time travel (Anders 2009). Time travel in the *Star Trek* universes is usually instantaneous and can be enabled by alien technology, such as the time portal in the City at the Edge of Forever episode of the original series, or attempts to be scientifically plausible such as by travelling very fast in the vicinity of a very massive object such as a star or black hole (Memory-alpha 2014, Krauss 2007)<sup>18</sup>.

As can be seen by these disparate examples, despite the inability to actually achieve meaningful travel in time in real life, time travel by methods ranging from the sublime to the ridiculous is widely accepted in popular culture. The outcome of actions in the past vary depending on the underlying philosophy of time assumed by the story world so that either the past can be changed as in *Star Trek* (2009) or it cannot as in *Twelve Monkeys* (1995).

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<sup>18</sup> Videos 17, 18, 19 and 20 show time travel excerpts from different Star Trek episodes. Video 17 shows a preview of the episode titled The City on the Edge of Forever (1967) from *Star Trek: Original Series*. The video can also be viewed at [http://www.startrek.com/watch\\_video/episode-preview-the-city-on-the-edge-of-forever](http://www.startrek.com/watch_video/episode-preview-the-city-on-the-edge-of-forever). Video 18 shows a time travel sequence from the episode titled Tomorrow is Yesterday (1969) from *Star Trek: Original Series*. The video can also be viewed at <https://www.youtube.com/watch?v=YdwSo53aO94>. Video 19 shows the time portal sequence from the episode All Our Yesterdays (1969) from *Star Trek: Original Series*. The video can also be viewed at <https://www.youtube.com/watch?v=Fc0irneMHU>. Video 20 shows the time travel sequence from Star Trek IV. The video can also be viewed at <https://www.youtube.com/watch?v=65nSJrF-zgw>.

## **2.6 Period drama as time travel**

Arguably period dramas that strive for accuracy deliver a form of time travel. The television series *Downton Abbey*, a period drama praised for its historical accuracy, is just the latest in a long line of such programs by the BBC. As well as paying careful attention to the clothing, speech and set dressing that are critical to the realistic portrayal of a particular period, thought must also be given to contemporary lighting. When making the historical drama *Barry Lyndon* (1975) the director Stanley Kubrick had special camera lenses devised so that he could film using candlelight only. While watching the screen the audience is willingly complicit in accepting that the depicted events are happening in a particular historical period. Period re-enactments and heritage buildings seek to create the same rich sense of immersion in the past experienced by viewers of well-researched historical dramas.

## **2.7 Conclusion**

It is obvious from this very brief and eclectic overview of time travel in popular culture that it is an established trope of the human imaginary. In some cases the time travel is merely the backdrop to the story and in other cases it plays a critical role. ‘Story is King’ is the motto of the highly successful animation company Pixar and it should be noted that the most important ingredient in time travel stories is the story itself because, at the end of the day, it is the narrative that engages the audience. Time travel is revealed as a powerful tool of the human imaginary that can be used to create connection and empathy with people from other times and cultures. Time travel is also revealed to be an umbrella term that hides two important distinctions. Time travelling can consist of an instantaneous jump to another time or time travelling itself can take time allowing, in some cases, a time-lapse of the changing world to be seen.

In considering time travelling for virtual heritage audiences it is important to consider both the advantages and also possible disadvantages of navigable time. Databases are inherently anti-narrative and this poses challenges to museums as visitors to the website can follow very different paths through the online collection whereas visitors to the museum itself will get a curated presentation of carefully selected objects, often with a well-defined beginning, middle and end (Parry 2007, Manovich 2001). However, each individual path taken through a database is, in and of itself, an individual narrative and an explicit trace of the construction of knowledge that takes place in informal learning.

Timothy Barker writes in *Time and the Digital: connecting technology, aesthetics, and a process philosophy of time* (2012) that ‘Time seems to have been given short shrift in descriptions of digital interactivity in place of space’ (Barker 2012). He argues that digital technologies have created new ‘experiences of temporality’. He cites the use of TiVo and related technologies to allow time-shifting and he proposes, based on Whiteheadian/Deleuzian temporal theory, ‘a temporal thickness where multiple modes or scales of time coexist in the viewing present’ (Barker 2012). Time-lapse is a powerful technique used to great effect by scientists and documentary makers to literally show processes that take place over timespans outside the normal range of human experience. The description of a glacier as a river of ice has an immediate and powerful impact when it can actually be *seen* to flow<sup>19</sup>.

Navigable time allows virtual heritage audiences to experience place in two ways. The first is of being in a particular place at a particular time and the second is of being in a particular place over time and seeing the changes that take place over tens and hundreds of years. A series of random jumps forwards and backwards through time runs the risk

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<sup>19</sup> Video 21 on the accompanying dvd shows a time-lapse of the Helheim Glacier. The video can also be viewed at <https://www.youtube.com/watch?v=ovMhspvwpmw>.

of creating confusion with regard to the temporal narrative of a place but this can be counteracted by the time-lapse which re-asserts the temporal narrative (Devine 2014). The following chapter examines in detail the design of an ideal time-based virtual heritage world.

## CHAPTER 3: An Ideal Time-Based Virtual Heritage World

3.1 The future for virtual heritage	92
3.2 An ideal virtual heritage world	94
3.3 Tangible heritage	96
3.4 Intangible heritage	97
3.5 The real and the virtual	101
3.6 Navigable time	103
3.7 Enriched virtual heritage	104
3.8 Engagement	105
3.9 Obsolescence	108
3.10 Conclusion	109

The last chapter briefly examined the nature of time before discussing the widespread use of time travel in popular culture. Time travel was revealed to be an established trope of the contemporary human imaginary and time-lapse was revealed to be a powerful tool for understanding processes that take place over timeframes outside of direct human experience. In this chapter a hypothetical state-of-the-art educationally focused and time-based virtual heritage world, with supporting database and website, is imagined. It would support a variety of interactions intended to encourage immersion leading to historical understanding, insight and learning. The chapter explores issues of authenticity and completeness to do with the re-creation in virtual form of tangible and intangible heritage. It then examines the relationship between the virtual and the real. The learning opportunities afforded by navigable time and an integrated database are then discussed, followed by a consideration of different forms of interaction and the learning opportunities that they create. Finally issues of user engagement are examined.

### 3.1 The future for virtual heritage

Manovich has proposed navigable space as the key media form of the twenty-first century (Manovich 2001). This is supported by Shilo McClean (McClean 2010). 3D

computer graphics is routinely used as a visualisation tool and interactive workspace by fields as diverse as architecture, medicine, science, entertainment and heritage (Sideris 2012, Obst et al. 2004). Improvements in hardware and software combined with falling costs mean that it is now easier and cheaper to create virtual worlds than it has ever been (Fredrick 2013). Free versions of the game engines Unreal, Trinigy, Shiva and Unity3D are available for academic and non-commercial use. The virtual worlds created using these engines can run on smart phones, tablet computers such as the Apple iPad and desktop computers. Products like Google Glass and the Oculus Rift herald new ways to interact with virtual worlds and augmented reality (AR) is moving out of the laboratory, beyond gimmicky advertising, and into the real world (Huang, Liu, and Wang 2009, Serrarens 2013, Kang and Wohn 2013).

We are on the cusp of an explosion of virtual worlds delivered on a wide variety of devices and for every imaginable purpose. It is not a question of whether or not there will be virtual heritage worlds but rather a question of what types of virtual heritage worlds there will be. As discussed in Chapter 1, the London Charter for the Computer-based Visualisation of Cultural Heritage (2006) set out principles establishing the importance of a clear purpose for the model, the transparency of data sources and a commitment to authenticity and historical vigor with clear distinctions between fact and speculation (Lopez-Menchero and Grande 2011). However, other issues remain such as the relationship between the virtual and the real, the role that game-based interaction can play in informal learning and the degree of agency provided to users of virtual heritage. These issues, touched on in Chapter 1, are explored in greater depth in the following sections.

### **3.2 An ideal virtual heritage world**

The assumed purpose of the hypothetical state-of-the-art virtual heritage world proposed below is to encourage the type of immersion that leads to historical understanding, insight and learning. While a virtual heritage place is not, and can never be, the real place, it can be a powerful tool for heritage learning, one that goes beyond simply replicating the place and its inhabitants as faithfully as possible. Interaction need not be limited to navigation and social interaction but can also include multiple voices and material designed to provoke thought and invite a dialogic interaction between museums and their audiences.

An ideal virtual heritage world would be a virtual environment that faithfully recreates the phenomenological and cultural dimensions of the real place. It would be time-based because, as discussed earlier, time is a key factor of place. Places look, sound and smell different at different times of day and on different days of the year as diurnal, lunar and seasonal cycles influence the activities of humans, animals and insects and the displays of the flora. The built environment of places also changes over many generations as buildings are constructed, altered and demolished. Time-based virtual heritage contributes to physical immersion as the environment is dynamic and therefore more realistic phenomenologically. It also contributes to cultural immersion as it allows time-based human activities and patterns of activities to be reproduced. In addition, time-lapsed virtual heritage makes visual the evolution of place over timespans outside the range of direct human experience inviting insight into place as a memorial to the past.

An ideal virtual heritage world would be populated with inhabitants that interacted with each other and with users. As discussed in Chapter 1, social interaction and role-playing

offer rich opportunities for users to experience cultural immersion and allow multiple stories to be explored, inviting users to make connections and encouraging insight leading to understanding. The virtual world would be integrated with a supporting database that allows users to find out more about what is represented in the virtual world and so provide another layer of cultural engagement. The database would provide additional information about the model such as the data sources used and make clear distinctions between fact and speculation.

As discussed in Chapter 1, Section 1.4, the past may be fixed but our interpretation of it is dynamic. Heritage is a perspective that changes with time. Heritage is also personal and individual. An ideal virtual heritage world would support opportunities to provoke thought about the nature of heritage and enable conversations between users and the museum. New Media allows users to upload comments and new content to museums enabling ongoing dialogic interaction. A range of activities and games can be designed so that users have the choice of a range of interactions. As well as traditional top-down narratives, these activities and game-style engagements would be used to explore questions about both historical processes and the nature and role of heritage.

Assuming a budget similar to the reputed US \$265 million of *Grand Theft Auto V*, one could build a richly detailed, phenomenologically affective, time-based, interactive, populated and enriched virtual game world (Brustein 2013). But a heritage world is very different to a game world. While a game world may be based on a real place and time, it does not have historical accuracy as a key goal. Practical and theoretical issues for virtual heritage include authenticity and completeness, the relationship between the virtual and real and what type and range of interactions are supported. These issues are explored in the following sections.

### **3.3 Tangible heritage**

As discussed in Chapter 1, Section 1.7, a key concern for virtual heritage is authenticity and completeness. When creating a virtual heritage world there is much that may not be known, which in turn raises the question of whether it is better to leave things out or to fill them in with the informed speculation of an expert. Most re-creations of past places, either dioramas or computer-generated 3D, will be incomplete if only that which is one hundred per cent known is included. David Frederick makes this point clearly when he discusses his virtual re-creation of Roman houses (Frederick 2013). Only the ground floor survives of the many multi-storey houses in Pompeii. The designer of a virtual Pompeii is confronted with a number of questions. Do they build the upper levels? How do they decorate and furnish them? Do they fill in the missing bits with an expert's best guess or do they leave them blank? If they are filled in then a degree of speculation enters the visualisation while if they are not then the visualisation is incomplete and it is left to the viewer's imagination to fill in the blanks. As discussed in Chapter 1, Section 1.3, most people have been exposed to multiple depictions of ancient life via cinema and TV and these depictions vary greatly in historical authenticity. Therefore the author argues that it is better to use the informed speculation of an expert than rely on the imagination of the general public.

The affordances of New Media lend themselves to the display of levels of uncertainty inherent in any heritage visualisation. At the heart of the London Charter is the principle that heritage visualisations should clearly show the differing levels of certainty that are implicit in any reconstruction. The modeling and the texturing detail of an object or building can be used to indicate levels of authenticity. A highly detailed, near photo-real object or building would indicate that a great deal was known about it while a low

resolution model with a simple colour would indicate a more speculative object or building. The different levels of authenticity would thus be immediately apparent to the viewer. In addition, by directly linking a building or object in the virtual world to a database of relevant information, users are able to easily access additional information including the reference data that underlies the model. This opens up opportunities for conversations between museum and audience with regard to the interpretation and depiction of heritage.

Unlike a diorama, a virtual model can incorporate a degree of randomness in the placement and texturing of buildings, parts of buildings and individual objects. In the case of urban environments, one option could be that each time the virtual world is run the neighbourhoods would be re-built as a different mosaic of generic buildings. The overall result of a densely urban environment would be the same, but the individual placements of buildings would be different. This could be utilised to show users that the model is not exactly what existed but shows only a range of ‘maybes’ based on the best guess of the creators, who – one hopes – will have embraced the basic tenets of the *London Charter*.

### **3.4 Intangible heritage**

The problems of authenticity and completeness identified for tangible heritage are compounded for intangible heritage. Even in literate cultures there is often little recorded information regarding gestures, mannerisms, clothing and hairstyles, to mention just a few of the many considerations that go into creating a populated world. For ancient cultures with no written record the degree of speculation involved may be so high that any depiction is unacceptable to an expert. For example, nothing is known about the social structures and hierarchies of the people who built Stonehenge and how

that played out in their individual adornment and their day-to-day interactions with each other.

As discussed in Chapter 1, place is more than just a location, it also includes the layers of multiple meanings that come from the cultural behaviors of the inhabitants and their activities. Unlike dioramas and tableaux, virtual heritage worlds can be populated with Artificial Intelligence (AI) controlled inhabitants going about their daily business. Most existing virtual heritage is unpopulated but this is likely to change with the growing ease of use of AI plugins for game engines (Sequeira, Morgado, and Pires 2014, Bogdanovych et al. 2010, Lewis and Jacobson 2002). This raises the question of whether a bustling dynamic crowded city is more realistic, though less truthful, than the deserted virtual models of much current virtual heritage.

Prior to audio and video recording, what little is known of social interactions in the past comes from contemporary accounts that have survived to the present day. As a general rule, the further back one goes the less information survives. Creating a populated virtual heritage world that was one hundred percent accurate would be an impossible task. Human culture is not fixed but is constantly in flux. There are culturally-driven changes at every level including the details of speech, gestures, hair and clothing styles to name but a few. The codification that goes on is very finely grained and encompasses sex, class, profession and cultural affiliation. As well, there are all the myriad variations that come from individual personalisation.

However, there is often sufficient information about society, mannerisms and dress that it is possible to create a dynamic and diverse population. It is useful at this point to discuss the role of the non-player characters in the *Assassin's Creed* franchise. The first

Assassin's Creed takes place in the cities of Jerusalem, Damascus and Acre at the time of the Third Crusade in the late tenth century. The second Assassin's Creed takes place in Venice, Florence and the Vatican City in the late fifteenth and early sixteenth century. However, all the cities are populated by similar categories of non-player characters such as city guards, local thugs, merchants and beggars, just the faces, clothes and culturally encoded gesticulations such as greetings are different. The overall impression for game players is of an inhabited city with crowded main streets and squares and quieter back streets. The AI controlled non-player characters (NPCs) are given enough social intelligence that the player needs to be mindful of them but not much more. For example, pushing rudely through the crowd or openly climbing buildings will attract unwelcome attention but other social interactions are not supported. Players can only converse with particular NPCs that are crucial to the game story. There is a generic behavior to the crowd that is the same from city to city and from time to time. The clothes may change but the human dynamics of life in the big city remain much the same creating the general ambience of a large city that, regardless of country or culture, is familiar to anyone who has travelled widely. The author argues that while virtual heritage worlds populated by AI controlled inhabitants cannot offer the richness of interactions with real humans they can nonetheless evoke sufficient social presence that users experience a level of cultural immersion that encourages historical understanding, insight and learning.

Given the drop in price, the evolving expectations from a public that is informed by state-of-the-art computer games and the growing ease of creation, the author argues that it is not a question of *if* there should be populated virtual heritage worlds but a question of *what kind* of populated virtual heritage worlds will there be (Sequeira, Morgado, and Pires 2014). A major advantage of populated virtual heritage is the opportunity for users

to directly experience spatial aspects of cultural immersion. Every society creates delineated areas where different rules apply and different activities are regulated (Foucault 1984). These spaces can be sex-based such as in male and female public toilets. Spaces can be class-based such as on aeroplanes with their separate First Class, Business and Economy areas. The use of spaces can be based on religious reasons with some parts of a religious building reserved for the priests and others for the congregation. The congregation space may also be subdivided by sex or age.

As discussed in Chapter 1, Section 1.12, role-playing is widely recognised as a powerful tool to create cognitive and affective learning (Bowman 1949, Mortara et al. 2013, Shaw 2010). The Virtual Hadrian's Villa project is exploring the use of avatars, both user and AI controlled, to create a populated virtual heritage world. Users can control the avatar of specific individuals such as the Emperor Hadrian or more generic figures such as slaves, guards and senators. The avatars have a library of gestures such as the Roman raised arm salute used upon greeting. Limiting a user's activities based on the social class and sex of their avatar is a powerful way to create cultural immersion by showing the everyday importance of these factors in Roman times (IDIA 2012, 2013).

The mind of the museum visitor is not a *tabula rasa*. It is already richly detailed from exposure to life and culture. If the sound of a horse walking on cobblestones is heard it will probably be recognised, even if the listener has never heard a horse on cobblestones in real life, because they will have seen and heard the sound numerous times in movies and on television. In today's media saturated world most people have been exposed to all manner of depictions of life in, to name just a few, ancient Greece, Rome and Egypt, medieval Europe, Victorian Britain, First World War Europe and a wide range of global locations during the Second World War. However, not all productions share the same

attention to historical detail as *Downton Abbey*. Therefore what exists in cultural memory is a mishmash of ideas, of varying historical accuracy, of how people in the past lived, dressed, spoke and behaved. Following a Constructivist approach to knowledge and learning the author argues that it must be assumed that these pre-conceptions will shape a visitor's experience of the virtual world. A populated virtual heritage world, if it adheres as closely as possible to the London Charter, will be better than one that is populated by the imagination of the museum visitor.

### **3.5 The real and the virtual**

Virtual versions of real world heritage places pose other questions besides their accuracy and completeness. Important heritage sites like Machu Pichu in Peru, Angkor Wat in Cambodia and the Dunhuang Caves in China curtail visitor numbers to prevent damage while some sites, such as the Lascaux Caves, are completely closed to the public (Loubser 2009). One proposed benefit of virtual heritage is that it can provide access to real heritage places that are currently inaccessible or have limited accessibility due to fragility or location (Devine 2007).

*Pure Land: Inside the Mogao Grottos at Dunhuang* and *Pure Land: Augmented Reality Edition* are two virtual heritage projects that meld high resolution images with immersive interactive display systems (Kenderdine 2013). The Mogao Grottos in North West China, a designated UNESCO World Heritage site, contain important paintings that are extremely fragile. Cave 220, due to the importance of its Tang dynasty paintings, is closed to the public and is the subject of the exhibition *Pure Land: Augmented Reality Edition*. The exhibition space is the same size and proportions as Cave 220 and the walls are covered with a wire-frame image of the cave. A tablet device functions as a viewing window into the virtual cave. The position and angle of

the tablet determine the display on the tablet. Holding the tablet against the wall displays a 1:1 digital image of that part of the cave. Users can take their time and minutely examine particular details in a way impossible in the real cave due to the need to limit the deterioration and damage caused by the humidity of peoples' breath and by exposure to light. But, despite the distinct advantages of the virtual experience, users report that it increased their desire to experience the real cave, demonstrating the power of the real in terms of the affective experience of heritage (Kenderdine 2013).

A virtual heritage model is not the real thing, nor is it likely to be mistaken for it. Virtual heritage therefore has not disrupted and challenged the heritage establishment in the same way that Digital Art challenged the value system of an art market predicated in part upon rarity and individual history. The Mona Lisa is one of the most well-known paintings in the world. It appears on all manner of objects including t-shirts, tea towels, mugs and fridge magnets. It is a pop icon that has inspired numerous parodies and provided inspiration for artists like American pop artist Andy Warhol and the subversive British street artist Banksy. The original Mona Lisa shows no signs of being reduced in importance by all this exposure. In fact, quite the opposite. The more copied an object is then the more valued is the original, both in monetary terms and in cultural heft. The Mona Lisa currently hangs behind bullet-proof glass as six million people a year shuffle past, spending an average of 15 seconds each looking at the real thing (Gentleman 2004). Going to the effort and expense of creating a virtual model implies a certain value in the real thing in the first place. So, by virtue of creating a digital copy, the value of the real is enriched not diminished. It must not be forgotten that a virtual heritage model is a real thing just as is any other digital file (Cameron 2007). Virtual heritage models are cultural artefacts in their own right and situated in time. They are, in and of themselves, revealing about conceptualisations of the past at the time they were

made.

### **3.6 Navigable time**

This thesis argues that navigable time is a critical, and under-utilised, affordance of New Media with direct relevance to virtual heritage. Creating a virtual model covering a span of time involves much more work than having to model a single frozen moment. However, the ability to literally *see* change over timescales outside that of normal human experience has a powerful affect that is undeniable. Time-lapse promises to be as powerful a tool for creating insight and understanding in heritage as it is for science.

In addition, building a time-based virtual heritage world supports all manner of time-based phenomena such as sound and movement. It is particularly well suited to the recreation of phenomenological aspects of place. Weather, time of day, season of year all affect the general ambience of a place. Sound is a critical factor. This is recognised in the commercial game industry but somewhat neglected in virtual heritage. As hardware and software have become faster and cheaper the technical quality of commercial 3D computer games has improved to the point that the sound of individual shell casings can be calculated on the fly as they collide with surfaces that vary from hard metal floors to soft carpeting, the bounce and sound of the colliding shell casings being determined by properties of the surfaces. The importance paid to sound in virtual games is revealed in the following quote from Christian Schilling, the lead audio designer for the game *Crysis* (2007).

*Sneaking through nature means you hear birds, insects, animals, wind, water, materials. So everything -- the close and the distant sounds of the ambience.*

*Firing your gun means you hear birds flapping away, and silence. Silence of*

*course means, here, wind, water, materials, but also -- and this was the key I believe -- distant sounds (distant animals and other noises). We left the close mosquito sounds in as well, which fly in every now and then -- because we thought they don't care about gun shots. (Kastbauer 2010)*

One possible downside of navigable time is that it may confuse users as they can visit times out of sequence. This thesis proposes that this is unlikely if users are able to travel *through* time as well as to particular times. The two modes of time travel identified in Chapter 2, journey-focused and destination-focused time travel, complement each other as teaching tools. The author argues that destination-focused time travel enables a richer phenomenological re-creation of place. In addition it supports deeper cultural immersion as many activities and cultural practices take place at particular times. Journey-focused time travel has a strong cognitive affect. Users *see with their own eyes* the changes wrought by time on scales outside of normal experience inviting them to consider historical processes. While time-based virtual heritage might seem obvious, examples are few and limited in scope (El-Hakim et al. 2006). More research is clearly needed to explore this potentially powerful aid to learning (Chen and Kalay 2008).

### **3.7 Enriched virtual heritage**

Virtual heritage can be much, much more than an interactive populated world. The virtual world can also function as an interface to a database. For many heritage sites there is a wealth of archival data ranging from primary sources to dig reports. The web-enabled always-on technology of the twenty-first century has created an expectation of instant access to information. The author argues that providing users within a virtual heritage world with access to additional related data will support self-directed engagement and cultural immersion. Contextual presence relies upon knowledge of the

richly layered cultural and historical meanings of a place and enriched virtual heritage is a powerful mechanism for making those layers of meaning immediately accessible to users (Devine 2007). Several recent virtual heritage projects include the ability to access additional information with pop-up text windows or links to web-based material (Frischer 2008, Kim, Kesavadas, and Paley 2006).

The supporting database can be implemented in a number of ways. It can be internal to the virtual heritage world or it can exist as a stand-alone website. The latter option allows administrators to edit existing content and create new content without having to re-program the virtual heritage world each and every time. In addition the website can host a facility that allows users to upload their own contributions and engage in dialogic interaction with the museum. However, the ongoing development of new content and management of the existing database, along with interaction with users, requires ongoing commitment and allocation of resources by the museum.

### **3.8 Engagement**

Researchers have determined that engagement is a key factor in presence (Ellis 1996, Herrera, Jordan, and Vera 2006, IJsselsteijn et al. 2000, Jurnet, Beciu, and Maldonado 2005, Lombard and Ditton 1997, Nunez 2006, Riva, Davide, and IJsselsteijn 2003, Schubert, Friedmann, and Regenbrecht 2001, Witmer, Jerome, and Singer 2005). While more realistic graphics and sound enhance presence, users are happy with simple non-photoreal environments so long as there is responsive interaction (Barfield and Hendrix 1995). The non-criticality of visual realism to engagement in a virtual environment is not surprising given that reality itself, in and of itself, is not enough to hold a person's attention if they are bored. This thesis argues that creating and maintaining engagement

is critical to evoking the kind of immersion that leads to insight, understanding and learning and that individual user factors are critically important.

Museum visitors are predisposed to engagement and learning (Hein 1998). Museums are seen as places of public edification and by going to a museum a visitor reveals their interest in, and openness to, learning something new. However, museum visitors typically only spend a few minutes with any particular exhibit and many museum interactives are designed with this very short timeframe in mind. By comparison, video game players typically spend many hours in commercial game worlds (Gee 2007). While museums may wish to encourage prolonged engagement problems may well arise if an exhibit is monopolised for long periods of time by one person or group of people. However, New Media allows museums to extend the reach of the museum beyond its geographic location and outside of opening hours. Museums are increasingly developing content, including games, for smart phones and tablet computers and this supports prolonged engagement for large numbers of remote users (Jackson 2011). In the transformed museums of the twenty-first century the number of visitors to a museum's website can vastly exceed the number of visitors that come through the door. It is important therefore for museums to develop and deliver virtual heritage to online as well as on-site audiences. Tablet computers and smart phones are viable platforms and there are exciting new possibilities for virtual heritage as AR/Mixed Reality technologies mature. In addition, content designed for prolonged engagement can utilise the learning principles identified by Gee (Gee 2007).

Another issue when it comes to engagement is the wide diversity in age, background and temperament of museum visitors. In considering how to keep users of a virtual heritage world engaged, lessons can be drawn from the real world. In real-world

heritage places visitors often have a range of options and activities. They can explore the place in a self-directed manner. They can take organised tours to particular heritage sites and museums. Within museums there are often play-based activities for younger visitors (Beale 2011). They can stay at a variety of places ranging from a local family to a hostel or a luxury hotel. They can go and see a range of cultural activities. They can explore the local cuisine. Likewise, as this thesis argues, users of an ideal virtual heritage world should have a range of activities that support different modes and types of interaction. Self-directed exploration of the virtual world and its database will maximise user agency but, as it is unguided, important heritage details may be missed. Tours, games and the integrated website can all be used to deliver additional content that includes linear narratives, multiple voices, discussions and analysis of historical processes and heritage meaning-making. This variety of content would support spatial and dialogic interaction as well as simple story telling.

Interactive games are increasingly touted as a brave new world for education (Kelly et al. 2007, Michael and Chen 2005). But, as discussed in Chapter 1, Section 1.12, many immersive role-playing computer games are premised on the imperative that the player must (and can) save the world. This level of agency is not suited to a virtual heritage world intended to be a teaching aid about what ‘was’, versus what ‘might-have-been-if-only’. It must be noted that the role-playing opportunities in the *Virtual Hadrian’s Villa* of slave, soldier and senator lack the excitement, action and agency experienced when playing a commercial game. However, this may not be an issue as users have different expectations of games and virtual heritage. The latter, stamped with the imprimatur of the museum, is assumed to have authenticity as a key and central tenet and, for museum audiences, role-playing provides a type of cultural immersion that is cognitively

engaging and can lead to insight and understanding as users get to directly experience the way that social roles shape an individual's life experience.

Treasure hunt and detective games in populated worlds may be much more suited to deliver heritage narratives as players are socially immersed as they seek to 'win' the game by finding the treasure or identifying the culprit. These formats can support a central narrative that encompasses multiple stories from different perspectives allowing users to engage both emotionally and cognitively with the content. However, as there are so few examples, more research is clearly needed.

### **3.9 Obsolescence**

While the cost of 3D computer graphics is a fraction of what it was even five years ago it is still a significant investment to make and the technology (software and hardware) is still evolving, so there remains the danger of obsolescence. *The Computer Visualisation of Dudley Castle c1550 A Virtual Tour by Royal Appointment* was the first virtual heritage tour and it ran using pre-rendered images stored on a laser disc. It is no longer in use and the project has been archived and backed up (Johnson 2006). However, with the establishment of standardised data formats New Media projects are not doomed to obsolescence in the same way. *The Gates of Horus* originally ran on two different platforms, an immersive CAVE environment and a standard desktop computer but has since been ported to Unity. Standardised file formats for geometric data has made it easy to move assets between the different game engines. However, any behaviours associated with the data need to be re-written for each different game engine.

### 3.10 Conclusion

This chapter has argued that an ideal virtual heritage world would be time-based, populated and directly integrated with a supporting database. It would support phenomenological and cultural presence within the virtual world and invite cognitive engagement with the ideas represented by the world. Users would have a range of activities to choose from and these would include self-directed exploration, tours, role-playing activities and interactive games. A downloadable version would be available for home use with content designed for prolonged and repeated engagement. The content should not be restricted to single perspective narratives but would also include material intended to provoke thought about wider historical questions and about the meaning of heritage itself. Ongoing communication between users and the museum would be supported, allowing a dialogue between the public and the museum to take place. Both destination-focused and journey-focused time travel would also be supported. Destination-focused time travel allows users to experience the combined phenomenological affect and cultural immersion of a particular place at a particular time. The time-lapse of journey-focused time travel allows users to see a place over time in a way that is impossible in real life. Both time travel modes create opportunities for insight, understanding and learning. As well as self-directed exploration of the world and its database, users would be able to play a variety of games and take part in a range of activities. Games would include treasure hunt, detective and role-playing scenarios that delivered interactions that range from simple linear narration to dialogic interactions that invite deeper engagement with heritage. The following chapter examines in detail the *Virtual Sydney Rocks* project which uses a specifically designed virtual heritage world to explore time-based virtual heritage and user preference for particular activities.

## **CHAPTER 4: Building And Evaluating A Virtual Version Of The Sydney Rocks**

4.1 The Sydney Rocks	112
4.2 The Big Dig	117
4.3 Limitations of the VSR	124
4.4 Navigable time	126
4.5 Weather	129
4.6 Audio	132
4.7 The VSR Guidebook	133
4.8 Interaction modes	136
4.9 Tours and games	137
4.10 The importance of the view	138
4.11 An unpopulated VSR	139
4.12 Aboriginal Sydney	140
4.13 The game engine	140
4.14 The scope of the VSR	141
4.15 Big Dig buildings/VSR hero buildings	142
4.16 The weatherboard cottage	145
4.17 Surrounding buildings and terrain	149
4.18 Watercraft	150
4.19 The VSR Guidebook	151
4.20 Day to Day 1788	156
4.21 Using the VSR	158
4.22 The VSR training video	159
4.23 The different interaction modes for the VSR	159
4.24 The Tour	161
4.25 The Game	166
4.26 The questionnaire	171
4.27 Conclusion	176

The last chapter proposed a hypothetical state-of-the-art time-based virtual heritage world. This chapter examines the creation of the Virtual Sydney Rocks (VSR), a time-based virtual heritage world specifically designed to explore certain aspects of the hypothetical state-of-the-art, time-based, enhanced Virtual Heritage world described in the previous chapter. In particular the VSR is used to examine the user experience of

navigable time and user preference for different interaction modes. As discussed in Chapter 1, most current virtual heritage is a frozen moment that offers just one mode of interaction to users. This is despite the fact that time is a critical component of place and that visitors to real heritage places usually explore them in a variety of ways including taking tours and wandering serendipitously. The author was particularly curious to discover what contribution, if any, navigable time and a choice of interaction modes would have on user engagement with virtual heritage.

A project of this type would normally require a multi-disciplinary team made up of, at the very least, a heritage professional such as an historian or archaeologist, a web designer, a modeler, a texture artist, a user experience (UX) designer, a game designer and a games programmer. However, the author had previously worked for many years creating 3D computer graphics for film and TV and additionally possessed sufficient web and programming skills to construct a working prototype - provided the right dataset could be found. The author strongly believed that a prototype time-based virtual heritage world, while not as detailed or graphically polished as a commercial game world, would still prove to be engaging for museum audiences and create the sort of immersion that leads to insight, understanding and learning.

This chapter begins by describing the rationale for choosing the Sydney Rocks area as the subject of the prototype time-based virtual heritage world. The chapter continues by examining the design decisions taken by the author as, due to limited resources, it was not possible to include all the features of the state-of-the-art virtual heritage world outlined in the previous chapter. However, the VSR includes key features such as navigable time, weather, an integrated guidebook and the provision of a range of interaction modes. The decision to expand the model to include the whole of the Sydney

Rocks is discussed, as are key omissions including inhabitants and dialogic content. The chapter then describes the creation of the *Virtual Sydney Rocks* (VSR), the integrated guidebook and an example tour and game. Given the scale of the project the creation of each individual building is not detailed in full but instead there is an examination of the creation of representative examples of a high resolution building and of a low resolution building<sup>20</sup>. The design and creation of the terrain, the ships of the First Fleet and other watercraft are also detailed. The design of the supporting website, the *Virtual Sydney Rocks Guidebook*, is discussed and some example pages are included to illustrate the scope of the external resources available via the *VSR Guidebook*<sup>21</sup>. This is followed by an examination of the design and content of the example game and tour, the *George Cribb Game* and the *George Cribb Tour*. The chapter concludes with a discussion about the choice to use a questionnaire for evaluating the VSR and an examination of the questions.

#### **4.1 The Sydney Rocks**

This section outlines the history of the Sydney Rocks and argues that it is uniquely suited as a subject for time-based virtual heritage due to its historic significance, the relatively short time period of two hundred years and the rich and extensive historical records. Sydney is the capital city of the state of New South Wales, Australia. Facing north, Sydney Cove is the iconic heart of Sydney. It is now a busy commuter ferry terminus, flanked to the east by the Sydney Opera House, and to the west by the Sydney Harbour Bridge. It is also the site of the first European settlement in Australia (Karskens 2009, Morris 1993, Turnbull 1999). Following the loss of the American colonies in 1776 the British Government decided to establish a penal settlement in Australia. In 1787 a small fleet of eleven ships set sail from England for the east coast of Australia.

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<sup>20</sup> Appendix 1a lists details for all the buildings on the Big Dig site and Appendix 1b lists all the buildings in the surrounding area.

<sup>21</sup> Found at <http://virtualsydneyrocks.com/>

Upon arrival in early 1788 the original site of Botany Bay was found to be completely unsuitable and Governor Phillip was forced to look elsewhere.

Exploring north of Botany Bay he entered what he describes in a letter to Lord Townsend in July 1788 as '*affording a more eligible Situation for the Colony, & being with out exception the finest Harbour in the World*' where '*a Thousand Sail of the Line may ride in the most perfect Security*' (Phillip 1788). Among the many bays of Sydney Harbour he found a small thickly wooded cove that provided a safe anchorage and, most importantly, a source of fresh water. It has also been speculated that Governor Phillip chose that particular cove because, unlike much of the rest of Sydney Harbour, there were no obvious signs of inhabitation by the local Aboriginals (Karskens 2009). The cove was named Sydney Cove after Lord Sydney, the Home Secretary at the time and, on the 26<sup>th</sup> January 1788, the First Fleet anchored there and established the first European settlement in Australia.

Sydney Cove faces north and is bounded to the east and west by ridges that run north-south and form the arms of the cove. Originally a small stream ran along the floor of the valley between the two ridges and entered the harbour on the western side of the cove. Governor Phillip established his quarters on the eastern side of this stream. The marines were encamped on the western side of the stream and the convicts were encamped to the north of the marines and next to the western shore of Sydney Cove. There was no need for prison buildings as, without a boat, there was nowhere to escape to. A hospital was set up half way down the western arm of the Cove and behind it the land rose steeply in a series of rough sandstone ledges. Within the first few months this area was being referred to as 'The Rocks' and convicts began to build rude wattle and daub huts there. William Bradley's drawing from March 1788 is the first map of Sydney (see Figure 8).

Over time these rough huts were replaced with stone cottages, and then brick houses, terraces, pubs, bakeries, warehouses and factories, and later still gleaming skyscrapers of glass and steel. At the same time the foreshore was transformed from a sandy cove to an unbroken quay busy with ships, ferries and the hustle and bustle of a modern metropolis (Karskens 2009, Bridges 1995, Turnbull 1999).

The first European colony in Australia was approximately 1,350 people in size, 780 were convicts and the remaining 570 consisted of four companies of marines, freemen, women and children. The exact number is uncertain as there are no surviving crew lists for nine of the eleven ships. In just over 200 years this small penal colony has grown into a major world city with a population of just over 4.5 million. Approximately 165,000 convicts were transported to Australia between 1788 and 1869 but they and their descendants are but a fraction of the current population. There have been many waves of emigration to Australia with the Gold Rush bringing 370,000 new immigrants to Australia in 1852 alone.



The Rocks, with its close proximity to the Harbour, encapsulates the changes that occurred as the colony grew in size. Grand houses began to replace the small cottages in the Rocks as merchants and ship owners wanted to live close to the quayside. The jumbled dirt laneways were straightened where possible and paved. From 1851 onwards the population of Sydney rose substantially. The transportation of convicts ended in 1840 but the gold rush saw the population of Sydney grow from 39,000 in 1851 to 200,000 by 1871. The wealthy moved away from the Rocks and the land was repeatedly subdivided for more housing. The large houses became boarding houses and the Rocks as a whole was widely considered to be a slum. An outbreak of the bubonic plague in 1900 resulted in the wholesale demolition of some parts of the Rocks including the Big Dig site. The building of the Sydney Harbour Bridge in the 1920s entailed more demolition with Princes Street destroyed in its entirety to make way for the southern approaches to the bridge. A proposal by developers in the 1970s consisted of a plan to completely demolish all the remaining old buildings and replace them with commercial tower blocks. However, the Builders Labourers Federation under union leader Jack Mundey declared a Green Ban for the project and the plan never went ahead. The Green Bans in Australia in the 1970s represent an important moment in the histories of unionism, environmentalism and heritage appreciation in Australia. Currently over half of the buildings in the Rocks, many dating to the mid-nineteenth century, are on the Heritage and Conservation Register of New South Wales and the district supports a thriving tourist industry based on its heritage value (Turnbull 1999, Karskens 2009, Kelly 1977, Flannery 1999, Messent 1995, Park 1973, Ashton et al. 2010, Brodsky 1965). Heritage-related tourism goes back to the Romans (Perrottet 2003) if not much further and Sydney, like many cities, has a number of museums that concern themselves with the history of the city itself, including the small Rocks Discovery Museum housed in a heritage-listed building on Kendall Lane in the Rocks.

The Sydney Rocks lends itself extraordinarily well to the idea of time-based virtual heritage. The European settlement of Sydney is ‘only’ 200 or so years old which is considerably less than the oldest parts of major world cities such as Rome, Paris, London and Beijing. The establishment and subsequent growth of Sydney is extremely well documented (Karskens 2009). As well as the eleven surviving first-hand accounts by members of the First Fleet (Cobley 1987, Irvine 1988) there are maps, drawings and paintings created at the same time (Di Tommaso 2012). Any government project will generate paperwork and the establishment of a penal colony is no exception. Researchers have access to a large amount of material in various government archives. In addition to the bureaucratic records and personal accounts there are numerous maps, drawings and paintings that depict early Sydney (Collis 2007, Dawes 1788, Fowkes 2012, Hunt and Davison 2007, Kelly 1997, Fowles 1973, Macle hose 1977). From the 1850s onward there are photographs and from the 1900s, moving images (Brodsky 1965, Gray and Brash 1986, Russell 1975, Hurley 1948, Messent 1995, Mist 1969).

#### **4.2 The Big Dig**

In 1994 an extensive archaeological dig, the ‘Big Dig’, uncovered over three quarters of a million artifacts at a site high up in the Rocks sandwiched between Cumberland and Gloucester Streets<sup>22</sup>. Prior to the dig an extensive examination of the archival record was conducted and compiled to create a detailed history of the site. The team of nine archeologists, assisted by 400 volunteers, spent twenty weeks painstakingly excavating the site and evidence for 42 buildings was uncovered including postholes from some of the early huts (Karskens 1999). The dig was one of the largest in Australia and generated a great deal of publicity. Thousands of people came to visit the site during the dig and many people contacted the research team to offer additional information in the

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<sup>22</sup> The Big Dig site is indicated by the red circle in Figures 9 and 10.

form of family letters, diaries, photographs and stories. As a result it was possible to identify many of the individuals who lived in specific buildings on the site at certain times. In addition, it has been possible to build a rich understanding of individuals, families and daily life against a backdrop of significant social and societal change (Karskens 1999, Crook, Ellmoos, and Murray 2003, 2005).



Figure 9: Aerial view of Sydney with Big Dig site circled in red



Figure 10: Enlarged aerial view of Sydney with Big Dig site circled in red

The award-winning author and historian Grace Karskens, a recognised authority on Sydney, was the project historian for the dig. Her book *Inside the Rocks: The Archaeology of a Neighbourhood* summarises the main findings (Karskens 1999). No direct evidence of Aboriginal inhabitation was found on the Big Dig site itself but a shell midden excavated very close by attests to the long occupation of the area by Aboriginals. The cove is described as ‘thickly wooded’ in 1788 but within a few months most of these trees were gone. Early views of the Sydney Rocks dating to the 1790s and early 1800s show lines of small row-huts following the contours dictated by the sandstone ledges of the Rocks and few if any trees (Hunt and Davison 2007). Postholes discovered during the dig indicate that three or four of these early huts stood on the site in the 1790s. The remains of 42 separate dwellings were identified on the site and the archaeology confirms the importance of the harbour to daily life. The houses were aligned, not with the paths and roadways, but so as to face the harbour. The arrival of a ship remained an important event well into the middle of the twentieth century bringing with it news, people, goods and work.

One of the earliest identified residents for the Big Dig site was George Legg who had been on the First Fleet in 1788. A shoe-maker by trade, he had been sentenced to seven years for stealing a gold watch and other items with a combined value of 140 shillings. He drowned in 1807 in a boating accident while fishing on Botany Bay (Chapman 1988, Karskens 1999). His wife Anne Armsden had arrived in the colony in 1790 having being found guilty of highway robbery. After George’s death she married their neighbour, the baker George Talbot. They built a small house with thick stone walls which was not demolished until 1891. By the 1820s the crude huts on the rest of the Big Dig site had been replaced by cottages of weatherboard and several two-storey stone houses.

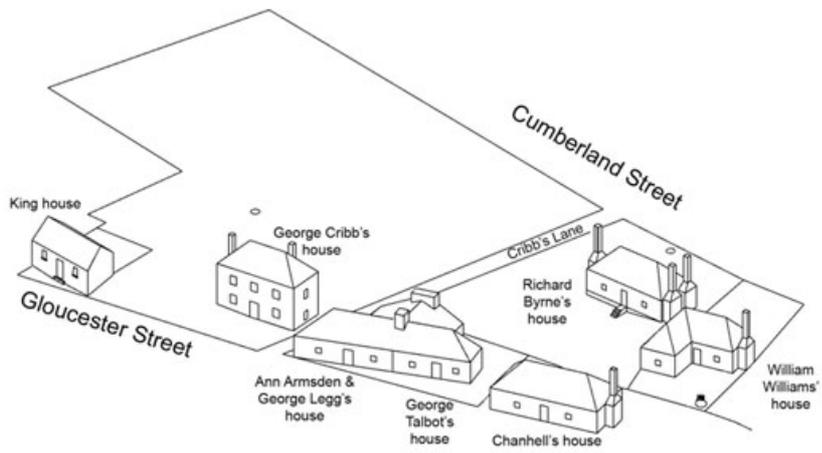
The Big Dig project identified George Cribb as an important figure with a fascinating personal history. His story, used for the example Tour and Game developed for the VSR, is one of rags-to-riches-to-rags with the added spices of bigamy and crime (Karskens 1999). He arrived in Sydney as a convict aboard the *Admiral Gambier* in 1808. A butcher by trade, he had been sentenced to 14 years for being in possession of forged banknotes. He initially prospered, began buying land, and by 1813 he owned about half the Big Dig site. He married fellow convict Fanny Barnet in 1811 at St Philips Church and they lived in a new two-storey house on the corner of what is now Gloucester Street and Cribb's Lane. As well as the house, he owned a row of property on Gloucester Street, including a butcher's shop and a two-storey hotel, while on the land behind them he established a slaughterhouse and stockyard. He also owned land on the Cumberland plain in the Minto district and he kept racehorses. He supplied meat and wheat to the government stores and also meat and vegetables to ships.

Meanwhile, back in England, his wife Martha (also known as Mary) had heard that he was doing well and she decided to join him in Sydney. She arrived in 1814 and George paid Fanny the large sum of three hundred pounds, which was about ten times the annual salary of a skilled housekeeper, to leave Sydney and return to England. In 1818 Martha died and he married Sophia Lett, a widow with five children. She had run the Punch Bowl hotel further up Gloucester Street with her late husband Stafford. Sophia left George in 1823 for his nephew and she died in 1827, aged 43.

Throughout his time in Australia George continued to have brushes with the law. In 1812 he was arrested and accused of attempting to smuggle rum. The charges were unproven but the rum, his cart and his horse were all confiscated by the Crown. In 1819 he was fined for illegally selling meat. In 1823 he was accused of stealing cattle and bribing a witness and in 1827 he was again suspected of cattle theft and raided. Each

time he managed to avoid being convicted but after 1821 he lost a number of civil suits and had to re-mortgage his properties. By 1824 he had lost them all to creditors except for the corner house. George sold the house in the same year and the last record of him was a court appearance for cattle theft in Parramatta in 1830. A trace of him remains in the laneway running off Gloucester Street that is still known as Cribb's Lane.

As the population of Sydney grew the land on the Big Dig site was progressively subdivided and developed. Five cottages and several rows of terraces were built in the 1830s. George Cribb's house was converted into an hotel by James and Sarah Byrne. They kept the old Cribb house and extended the building towards Gloucester Street. It was initially called the St. Patrick's Inn but was later known as the Whalers Arms. Robert Berry established a bakery at the corner of Cribb's Lane and Cumberland Street. Robert's sister Jane and her husband Robert Share ran the Plymouth Inn on the other side of Cribb's Lane. Many of the houses on the Big Dig site were rented and inhabited by immigrants from Ireland, England and Europe. By the 1890s the Rocks was widely regarded a slum and in 1900 there was an outbreak of bubonic plague. One of the three victims, a boy named James Foy lived in Cribb's Lane. The government decided on a demolition program and from 1901 began to buy up the properties on the site and elsewhere in the Rocks. Over the next few years the site was almost completely demolished. Prior to demolition the NSW Government Architect photographed and drew up architectural drawings for many of the buildings, noting the building materials and conditions. The changing urban density on the site is clearly visible in the series of images produced from data uncovered by the Big Dig team (see Figures 11-13).



Cumberland / Gloucester Streets Archaeological Site  
Occupants c1809-12

Figure 11: Big Dig Site c 1810 (Image courtesy SHFA)

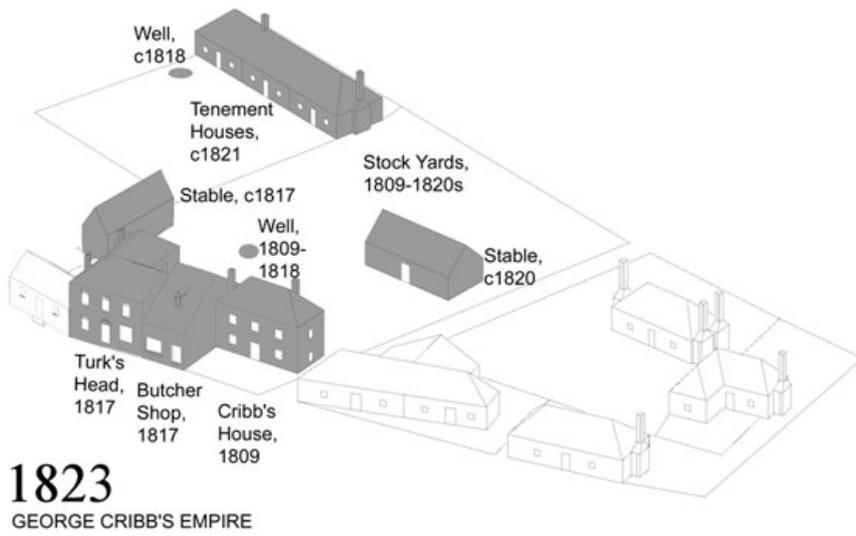


Figure 12: Big Dig Site c 1823 (Image courtesy SHFA)

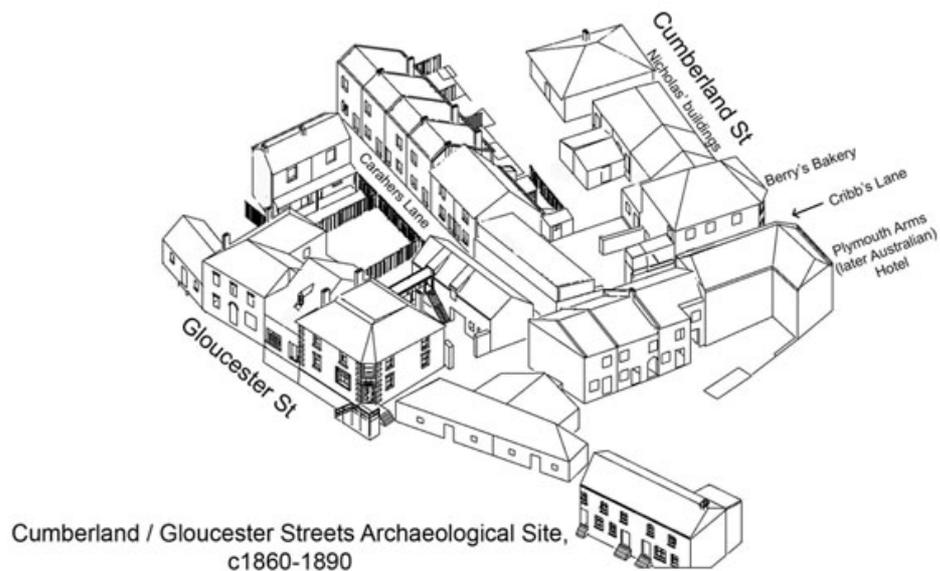


Figure 13 - Big Dig Site c 1860 (Image courtesy SHFA)

From 1917 the site was home to a large engineering shed. The shed was demolished in the 1950s and the site was covered with tarmac and used as a parking station for buses until 1972. After that it was used as a storage area for the Sydney Cove Authority until the commencement of the Big Dig in 1984 (Karskens 1999). A Youth Hostel Association hostel has since been built on the site. The hostel, raised on pillars to preserve most of the archaeology, won the S4B Studio Award for Best Heritage & Adaptive Reuse at the 2011 Property Council of Australia/Rider Levett Bucknall Innovation and Excellence Awards. The photograph in Figure 14 shows the view from the top of the Youth Hostel looking east across Sydney Cove to the Sydney Opera House and beyond it to the Harbour.



Figure 14: View from the roof of the YHA, courtesy YHA

The combination of the archaeological finds along with the abundant archival evidence has made it possible to identify many of the owners and tenants of the buildings at different times and to build a rich understanding of individuals, families and daily life against a backdrop of social and societal changes (Crook, Ellmoos, and Murray 2005). When combined with weather records this wealth of data supports a rich phenomenological and cultural re-creation of place, and the relatively small time span and the major historical significance of the site, make the ‘Big Dig’ site the ideal subject of a time-based, enriched and interactive virtual heritage world intended to create the kind of immersion that leads to historical insight, understanding and learning.

### **4.3 Limitations of the Virtual Sydney Rocks**

As stated previously, due to a lack of resources the author knew that she would be unable to create all of the features of an ideal state-of-the-art virtual heritage world. However, the author believed that it was possible to create a prototype of a time-based world and test it using a museum audience. The core features of the VSR was that it would be time-based, supporting navigable time, and it would also offer users a range of

activities. Navigable time gives users the power to move through, and control the speed of, time. Users are able to set both the current date *and* the speed of time. This supports two different types of time travel. Destination-focused time travel allows users to go to a particular place at a particular time. Journey-focused time travel lets users see time-lapses at different speeds. Time-based virtual heritage offers several unique advantages when it comes to creating place. It supports a world that is phenomenologically richer, contributing to the sensory experience of place, and it also supports time-lapses that show dynamically how place changes over timeframes outside of direct human experience, giving insight into historical processes and contributing to the cognitive experience of place. The second key feature was that the VSR would support several different interaction modes.

A key limitation of the VSR was the lack of inhabitants to evoke social presence and cultural immersion. The resources needed to model, animate and program a suite of behaviours for multiple inhabitants over a two hundred year time span were simply unavailable. The author wanted to focus on the issue of time in virtual heritage and, with limited resources, was not able to re-construct two hundred years of the built environment and also populate it. However, she was able to include an integrated database of highly relevant supporting data that allowed users to discover historical and cultural information closely related to the Sydney Rocks. She believed that a time-based though unpopulated VSR, while not ideal, would still prove engaging and educational for users and encourage historical understanding, insight and learning.

There was also limited support for spatial interaction and none for on-going dialogic interaction. As there was only one example tour and game, both based around the life of George Cribb, the only opportunity users had to explore multiple stories and voices was

via the Guidebook resulting in limited opportunities for spatial interaction. In addition, given the short engagement times typical of museum visitors, both the game and the tour were designed to take less than five minutes and limited to the tried-and-true format of a good story about an interesting person. A restricted form of dialogic interaction occurred during testing in conversations between the author, acting as docent, and the testers. In addition, the questions and responses captured by the returned questionnaires in effect record a short conversation between museum and testers that is examined in detail in the following chapter. Further development of the VSR will allow the creation of additional content that supports all a range of interaction types as well as modes. Using Gee's insights it will be possible to develop games that encourage prolonged and repeated interactions while creating deep immersion and rich learning opportunities (Gee 2007).

#### **4.4 Navigable time**

As discussed in Chapter 1, a person's experience of a heritage place is a unique mélange of phenomenological affect and cultural, historical and individual associations. In the real world sight, sound, smell, taste and touch all contribute to the phenomenological affect of a place. The importance of the sensory affect on a person who is physically located in a place is the central tenet of *The Phenomenology of Landscape* (Tilley 1994). As discussed in Chapter 1, Section 1.5, the experience of virtual environments, usually restricted to the senses of sight and sound, is widely acknowledged as likely to engender a phenomenological sense of physical immersion in a virtual environment. Given this affect, and knowing from personal experience the role that light and weather play in creating a sense of place, the author deemed it important to give users a phenomenologically dynamic virtual world. While archaeologists have used time-based virtual models for research purposes such as looking for astronomical alignments (Sims

2006, IDIA 2012), they have not examined the affective responses caused by daily, seasonal and weather related ambiences. In the museum sector, where the extremely detailed and richly immersive heritage installations of Jeffrey Shaw and Sarah Kenderdine are based on high resolution photography and the audio capture of existing sites, the focus is on re-creating a particular moment rather than trying to create dynamically rendered environments (Kenderdine 2004; 2006; 2013). With the limited resources available for this project it would not be possible to achieve the same level of photo-realism as a commercial game world but the author argues that the ability to explore the role of light and weather in the VSR would still prove engaging for users.

Time is a critical factor of place. Quite apart from the very particular affect engendered by specific alignments, such as that which occurs at Stonehenge on Midsummer's Day, there are the everyday changes that occur through the daily cycle of the sun, the variation of the moon over the lunar month and the annual cycle of the seasons. These all contribute to the phenomenological affect of a place. The same place will look very different at dawn versus under the light of a full moon. The four-day Inca Trail to Machu Picchu is timed so that people arrive at Macchu Picchu at dawn on the last day. They enter via the Sun Gate along with the light of the rising sun. Seasonal events like the blossoming of the cherry trees in the spring in Japan and the fall of the leaves in autumn in North America also have a widely recognised phenomenological affect and significant cultural momentum. In Japan the sakura, or blossoming of the cherry bud, symbolises the transience of life as a bud can flower and lose its petals in a single day. Hanami, or flower viewing, is a popular event at this time and outdoor parties are held underneath the cherry trees at all times of the day and night.

As discussed in Chapter 1, Section 1.5, the navigable space of virtual environments is widely recognised for evoking the phenomenological affect of presence. As discussed earlier, navigable time describes the freedom users have to determine the manner and path of their journey through time, in the same way that navigable space describes the ability of users to determine their path through a virtual world. This freedom to move at will through time and additionally control the speed of time and view a time-lapsed view of a changing virtual world, creates a memorable affect for the viewer and provides rich opportunities for insight, learning and understanding. Time-lapse is widely acknowledged to be both engaging and educational. As discussed in Chapter 2, the cognitive impact of literally seeing a glacier flow brings an immediate visceral understanding to the description of a glacier as ‘a river of ice’. And, just as a time-lapse of a glacier makes plain a geological process, so a time-lapse of a heritage place makes plain the change that occurs in the built environment of a city over many years.

Navigable time is central to the design of the Virtual Sydney Rocks. Users specify the date and then the time of day in hours and minutes and these values are used to determine the sunrise and sunset times and the resulting direction and strength of the sunlight. The result is a virtual model that captures some of the variation in lighting that users experience in the real world and so tries to create a more affective experience. The influence of lighting on mood and atmosphere is an important aspect of filmcraft and the cinematographer (also known as the director of photography) is a key member of every film crew (Alton 1995). Virtual heritage that explores the phenomenological affect of different lighting conditions should help to create more memorable and affective experiences in users. The moon was not implemented in the VSR due to a lack of resources but is being included in the revised VSR along with starfields.

Users have control over the speed of time and there are eight different rates ranging from real-time, where one second in the real world equates to one second in the virtual world, to a rate where one second in the real world equates to ten years in the virtual world. Given that Sydney is just over 200 years old a time-lapse of the changing built environment viewed at the fastest speed will take twenty seconds. The other available speeds are one second in the real world being equal to one hour, one day, one week, four weeks, one year or five years in the virtual world. The author believed that users would find that the time-lapse affordance both memorable, engaging and educational as it allows them to literally *see* changes that occur over timescales that are outside the normal range of experience. Only forward time-lapse was implemented in the prototype but backward time-lapse is being implemented in the revised VSR.

#### **4.5 Weather**

As discussed in Chapter 1, Section 1.2, the phenomenological contribution to the experience of place is affected not only by the time of day and year but also by the weather. Among the surviving records of the First Fleet is the log of the flagship HMS Sirius in which Lieutenant William Bradley kept daily records of the weather conditions along with temperature (Cobley 1987). Also surviving are the meticulous records kept by Lieutenant William Dawes which include barometer and temperature readings, wind speed and direction, cloud cover and rainfall (Stevenson 2008). These records are used to determine the weather for 1788 on a day by day basis. The weather data can be drawn in its entirety from the historical record but, due to a lack of resources, the weather for 1789 onwards is currently controlled by a simple cycle but this will be revisited for the revised VSR.

Currently there are four types of weather and these are sunny with blue skies, sunny with clouds, overcast and thunderstorm (See Figures 15-18 for the sky texture map used in each case). For the years 1789-2014 the weather is determined on a daily basis and can be sunny, sunny with clouds, overcast or rainy. An earlier version of the weather system had the weather being driven by the average annual rainfall combined with a randomly generated value. This had the drawback of appreciably slowing the performance of the system down so it was dropped in favour of a simple cycle through the four different weather states. So if one day is sunny the next will be sunny with cloud, the next overcast and the next stormy and then the next sunny and so on. If the speed of time is faster than real-time the weather is disabled. This is for two main reasons. The author realised that it would be confusing for users if the weather kept changing as they sped through time with the background flickering between the four weather states and secondly it would increase the computational overhead and cause the virtual world to run slowly. The quality of the images used in the texture maps differs markedly, with the 'blue sky with clouds' texture map being of a lower quality than the others. This is an example of a temporary texture used during the process of building the prototype. The sky system in the revised VSR uses procedurally generated clouds so this is no longer an issue.

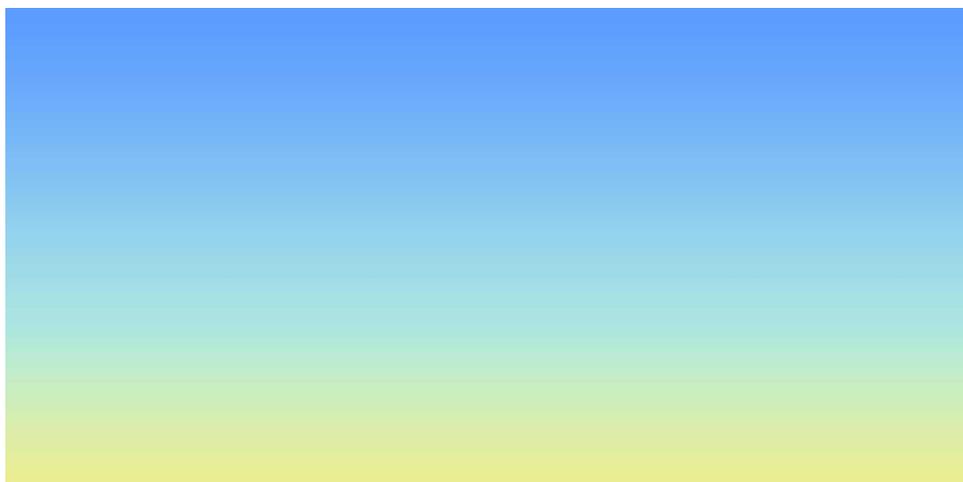


Figure 15: Blue sky texture



Figure 16: Blue sky with clouds texture



Figure 17: Overcast sky texture



Figure 18 - Thunderstorm sky texture

## 4.6 Audio

Weather is not only a visual phenomena. For example there is strong audio component to thunderstorms with flashes of lightning followed by rolls of thunder with the time lag between light and sound giving an indication of the distance from the observer to the lighting strike. Thunderstorms in the Virtual Sydney Rocks are indicated not only by the stormy-looking sky but also by randomised flashes of lightning followed, after a random time, by the sound of thunder. Given the importance of audio, discussed in Chapter 3, Section 3.6, the decision was made to include an ambient soundtrack for particular historical periods in addition to the weather-related audio. Prior to the arrival of the First Fleet the audio consists of native bird sounds. For the rest of 1788 the audio consists of native bird sounds and also the noises of the introduced animals brought on the First Fleet such as dogs, horses, cattle, pigs, sheep, chickens and turkeys, as well as the sounds of tree felling and construction. From 1800 to the present day there are ambient audio tracks for the periods 1800-1825, 1825-1850, 1850-1900, 1900-1950 and 1950-2010. There are two versions of each audio track, one nine and a half minutes long and the other fourteen and a half minutes long<sup>23</sup>. Both tracks are looped individually so that the combined audio does not seem repetitive to the casual listener. The changing audio mirrors the changing city as the sound of horses on cobbles gives way to cars and the farmyard noises and native birds of the early years are replaced with the hustle and bustle of a highly urbanized place. The author believed that the different soundtracks would make a positive contribution to the experience in the VSR, hinting at human activity, sparking the imagination of users and encouraging engagement.

In the three minute long opening scene of the film *Contact* (1997) the camera does a long pullout, first from the Earth, past the Solar System, the Milky Way and out into the

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<sup>23</sup> All the audio tracks can be found on the accompanying dvd.

universe<sup>24</sup>. The audio begins with a contemporary radio broadcast followed by a series of sound samples that get older and older in time as we get further from the Earth. To be strictly accurate according to the laws of physics the audio samples should have been played backwards but then they would not have been recognisable. The effect on the viewer is the revelation of the immense scale of the universe when compared with the speed of the radio waves broadcast from Earth. A similar technique is used by the Pepsi Family Centre at the North Carolina History Centre. Visitors enter it via a ‘Time Machine experience’ which depicts a ‘swirling multimedia countdown of iconic photos, moving images, and period-appropriate music that reels backward to 1835’ (Gish and Zaia 2011: 143). Visitors then exit the virtual Time Machine to explore the museum. At the end of their visit they exit via the Time Machine which plays the sounds and images in reverse order, from 1835 to the present (Gish and Zaia 2011). Unfortunately it was not possible to implement something similar into the prototype Virtual Sydney Rocks due to a lack of resources but it may be explored in the revised VSR.

#### **4.7 The VSR Guidebook**

The VSR Guidebook is intended to serve two main functions. The first is to directly connect each object in the virtual world with authoritative data related to it, satisfying the London Charter’s principle calling for clear attribution of the sources used in the reconstruction. The second function is to provide cultural context for users. This is particularly important in the case of the VSR as, lacking the social dimension of a populated world, it is limited in the amount of cultural immersion it is able to provide. The popularity of heritage-based tourism forcefully underlines the interest that historical cultural context holds for the general public. In the real world visitors to historic places wanting more information can consult a guide, a guidebook or, via a smart phone or

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<sup>24</sup> The sequence is Video 22 on the accompanying dvd and can also be viewed at <http://www.youtube.com/watch?v=PLQF-4uyD4Y>.

similarly enabled device, the internet. The VSR uses direct links between objects in the virtual world and a dedicated website to provide similar support for contextualised presence (Devine 2007).

The VSR is designed as a two-screen display where the main screen shows the first person perspective view of the virtual world while the second screen shows the Virtual Sydney Rocks Guidebook, referred to here as the Guidebook. This web-based resource consists of individual pages for each building and each ship of the First Fleet. Each page has a short description and links to relevant information at authoritative web-based resources such as the Heritage and Conservation Register for New South Wales, the Heritage Council of New South Wales, the State Library of New South Wales, the Dictionary of Sydney, the Office of Environment and Heritage for the NSW Government, the Dictionary of Sydney and the Australian Dictionary of Biography. It also includes some links to less authoritative, but still useful, sites such as Sydney Architecture and Wikipedia. Selecting an object in the Virtual Sydney Rocks will cause the related page in the Guidebook to open in a new tab of the web browser.

There are several advantages to linking an object in the VSR to the Guidebook rather than directly to a particular web-based resource such as the Heritage and Conservation Register for New South Wales. Most of the buildings in the VSR have more than one useful resource and all those links can be aggregated together and hosted on the dedicated Guidebook page for that building. Users can follow the different links and engage with different accounts and perspectives provoking spatial and dialogic interaction. Another advantage is that the on-going task of maintaining the website, such as fixing expired links, can be carried out by a website administrator rather requiring a complete rebuild of the virtual world. The need for easy on-going

maintenance was made clear when, shortly after the author had spent eight weeks creating the webpages for the Guidebook, the Heritage and Conservation Register for NSW reorganized their website and all the links had to be updated. In this situation it was far easier to edit the webpages than to revise the game code.

The information held in the Virtual Sydney Rocks Guidebook is not restricted to the buildings, ships and other tangible objects in the Virtual Sydney Rocks. There are also sections of the website that tell the stories of individuals, address the Aboriginal history of Sydney, give a day to day summary of events in the first year of the colony and discuss historical processes that have affected the Sydney Rocks. These sections provide additional cultural context and encourage spatial interaction and so invite cognitive engagement and create opportunities for insight, understanding and learning.

The main page of the Virtual Sydney Rocks Guidebook offers information on specific individuals associated with the Big Dig site such as George Cribb, links to resources about Aboriginal Sydney, the history of the Rocks, maps of Sydney, a daily summary for 1788 and links to digital copies of local newspapers. In addition, there was planned to be a daily summary of events for 1788 based on the accounts of Surgeon Arthur Bowes, Lieutenant William Bradley, Lieutenant Ralph Clark, Lieutenant Philip Gidley King, Watkin Tench, Captain David Collins, Daniel Southwell, Henry Waterhouse, Surgeon John White and Surgeon George Bouchier Worgan. Interested readers are directed to *Sydney Cove 1788* by John Copley for an in-depth compilation of the various diary accounts (Copley 1987). This part of the website was only partially implemented and will be reported on in more detail later in this chapter.

For the prototype stage of the VSR it was premature to enable an online on-going dialogic interaction by setting up a comments page or forum. The responses from the testers represent the opening conversation of a dialogic interaction with the public about the VSR. A comments page will be added to the website when the revised VSR is released for public download.

#### **4.8 Interaction types and modes**

As discussed in Chapter 1, Section 1.7, there are both different types and different modes of interaction. The three types of interaction identified by Witcomb are technical interaction which describes the simple button pushing that is used to deliver strong linear narratives, spatial interaction which describes the presentation of multiple narratives which demand user engagement in the making of meaning and dialogic interaction which describes two-way engagement between museums and their audiences over all aspects of heritage including the nature of heritage itself. As discussed in the previous section, the integrated Guidebook is used to deliver cultural context by providing content that offers linear narratives, multiple voices and historical processes, providing spatial interaction and so inviting cognitive engagement with the making of meaning.

As discussed in Chapter 1, Section 1.8, different interaction modes align with the different educational theories identified by Hein. Traditional lectures and text presume the didactic/expository model where knowledge is assumed to exist outside of the learner and delivered incrementally in bite-sized chunks. Behaviourist learning assumes that knowledge is constructed by the user incrementally. Discovery learning assumes learners discover pre-existing knowledge through active engagement. Constructivist learning demands active engagement by the learner as they construct knowledge from

their own life experience, along multiple paths and with a range of perspectives via a range of learning modes. The VSR provides users with a choice of interaction modes that, in the case of tours and free exploration are familiar to visitors to real heritage sites. In addition, users can choose to play a game. This activity is not widely used at heritage sites but is familiar to museum visitors, particularly children and those with children (Beale 2011). The next section examines the example tour and game more closely.

#### **4.9 Tours and games**

There are a number of significant events in the history of Sydney that would be good candidates as subjects for tours and games. These events include the arrival of the First Fleet in 1788, the Rum Rebellion of 1808 when the Governor of New South Wales, William Bligh (who would later survive the mutiny on the *Bounty*) was deposed in an armed rebellion by the New South Wales Corps, the fire and explosion on the convict ship the *Three Bees* in 1814, the fire that destroyed the Garden Palace in 1882, the outbreak of bubonic plague in 1900, the building of the Sydney Harbour Bridge from 1923-1932, the construction of the Sydney Opera House from 1959-1973 and the Green Bans of the early 1970s. In addition there are the individual stories of many people uncovered during the Big Dig including George Legg, George Cribb, the Berry family, the Byrne family and the Fennelly family. Both the Rocks Discovery Museum and the Visitor Centre at the Sydney Rocks Youth Hostel use the story of George Cribb to reveal the history of the Big Dig site during a period of significant change in Sydney. The author, recognisant of the enduring power of personal narrative, also decided to use George Cribb as the subject of the example game and tour developed for the VSR. Given that the testing would occur onsite at the Rocks Discovery Museum, the example tour and game were designed to last about five minutes each. The revised version of the

VSR will include content informed by Gee's insights and intended to encourage repeated and prolonged immersion (Gee 2007).

#### **4.10 The importance of the view**

As discussed in Chapter 1, Sections 1.2 and 1.3, the landscape and its associations are ineluctable parts of place. Early in the author's research she discovered that all the early houses in the Rocks were orientated to give a view of the harbour, regardless of the layouts of the roads and laneways. This graphically illustrates the importance of Sydney Harbour to the lives of the people who lived in the Rocks. The arrival of a ship meant news, goods and possible work. The inclusion of Sydney Cove and its foreshores was essential to creating a virtual place that replicated the ambience of the real place. The option of using a series of matte paintings as a background panorama was considered but the author decided that this would not support the dynamic lighting that was to be implemented. It was therefore necessary to model the surrounding area as well. This task was made manageable by the local topography. The views to the east and west are curtailed by the ridges that run north-south and form the arms that enclose Sydney Cove. The main view of Sydney Harbour is to the north east of the Big Dig site so it would only be necessary to model as far south as Bridge Street. Figure 19 shows the size of the VSR with the solid red area showing the Big Dig site. With limited resources, and over 180 additional buildings to construct along with accompanying website pages, the author had to curtail development of parts of the Guidebook. This decision is discussed in more detail in Section 4.14 of this chapter.



Figure 19: Approximate extent of the VSR

#### **4.11 An unpopulated Virtual Sydney Rocks**

The author decided at the outset that there were not sufficient resources to populate the Virtual Sydney Rocks. However, this is something that is being explored for the revised VSR. There is sufficient data with respect to the dress, speech and behaviours of people from the 1780s to the present day that a populated world would have historical validity. The social immersion engendered by such a world would be a significant contributor to cultural presence. In addition, it is easy to imagine role-playing games that would allow players to learn more about life in Sydney at different times. In the early years of settlement players could choose to be a male or female convict or an Aborigine, a soldier, a sailor or the wife or child of a soldier or sailor with each particular role revealing the impact of status and gender on life at that time. In later years players could experience the Rum Rebellion from the perspective of a soldier, the burning of the Garden Palace from the perspective of a fireman, the outbreak of bubonic plague from

the perspective of a rat catcher, explore crime from the viewpoint of a member of the Razor Gangs of the 1930s and explore politics from the perspective of a union member during the Green Bans of the 1970s.

#### **4.12 Aboriginal Sydney**

Indigenous people have been part of Sydney's history for at least 20,000 years. It has been speculated that Governor Philip chose Sydney Cove in part because, unlike much of the rest of the Harbour, he saw no evidence of Aboriginal occupation. However, Bennelong, a well-known indigenous man, claimed that the small island at the tip of Bennelong Point was his and Governor Philip had a small cottage built for him nearby. However, given the absence of any Aboriginal contribution to the built environment in the surrounds to Sydney Cove in 1788 and subsequently, an unpopulated VSR ran the risk of making invisible the very real and enduring presence of Aboriginal people in Sydney. The author therefore decided to include Aboriginal women fishing in their small canoes, a common sight on the Harbour up to the 1830s. Selecting one of the canoes opens a link to a dedicated page in the Guidebook. In addition there are prominent links to Aboriginal content on the main page of the Guidebook.

#### **4.13 Choosing the game engine**

The first step in building the VSR was choosing the game engine. A perennial problem with any digital project is the danger of obsolescence of both hardware and software. A key consideration was the longevity of the platform and, in that regard, commercial products such as the Sony PlayStation and Microsoft's Xbox, would seem ideal. However, the development kits for these are in the order of tens of thousands of US dollars and so were prohibitively expensive. The more affordable options of the Unreal Engine, which came free with one of the Unreal games, and the Unity 3D engine were

evaluated. Unity 3D had been released in 2005 and for the first few years only ran on Apple Macintosh computers. While Unity 3D looked very promising there was no certainty that it would have staying power in the marketplace. The Unreal engine was an unknown quantity and lacked much in the way of support.

3DVIA Virtools, a product of the French software company Dassault Systèmes, was being used by the iCinema Centre for Interactive Research and, as a research student associated with them, it made sense at the time to use 3DVIA Virtools also. There would be ready access to a team of developers who were familiar with Virtools and the resulting model would load into the AVIE, a 360 degree stereoscopic immersive interactive visualisation system (McGinity et al., 2007). Unfortunately, towards the final stages of development of the VSR, 3DVIA Virtools was discontinued and the iCinema switched to using Unity 3D. This switch occurred too late to move the VSR to Unity 3D. Fortunately the VSR was sufficiently developed to proceed with the testing but there was little point to further development using the Virtools platform. The VSR is currently in the process of being moved to Unity.

#### **4.14 The scope of the VSR**

According to the London Charter, it is imperative that there is a clear purpose for the model. The project, lacking the resources to create all the features of an ideal virtual heritage world, focused on exploring the potential of navigable time. The addition of the area surrounding Sydney Cove meant the creation of over two hundred extra buildings and each one of those needed its own webpage. The author decided that the story of George Cribb would be used in the example Tour and Game therefore any buildings associated with him were created in high resolution. By using George Cribb as the

subject of both the Game and the Tour the author believed that users would be able to make meaningful comparisons between the Game and the Tour.

Given the available resources, it was not possible to establish the history of every plot of land in the surrounding area so the author decided that the surrounding buildings would be limited to the buildings that exist in the present day and also the buildings that appear on maps in the first twenty years of the colony. These buildings would all be untextured. This approach to detailing follows the recommendation of the London Charter that different levels of authenticity in the model should be easily apparent to users. Each building however had its own webpage with links to additional information. The following sections report on creating the VSR by detailing the construction of several different high resolution buildings, a low resolution building and the terrain, watercraft and the Guidebook. These sections are necessarily somewhat descriptive and are included to illustrate the commitment felt by the author to adherence with the London Charter.

#### **4.15 Big Dig buildings/VSR hero buildings**

The earliest buildings on the site were crudely constructed huts of wattle-and-daub roofed with bark or the leaves of the cabbage palm. The excavation uncovered postholes for several of these early huts. Early drawings and paintings of Sydney Cove, such as *A View of Sydney Cove, Port Jackson, March 7<sup>th</sup> 1792* by an unidentified artist known only as the Port Jackson painter, show a scattering of these huts behind the hospital on the western shore (Figures 20 and 21). Huts like this continued to be constructed throughout Australia by early settlers and there are quite a few photographs of huts dating from the late eighteenth and early nineteenth centuries. These were used as reference when modeling the early buildings (Figures 22-26).

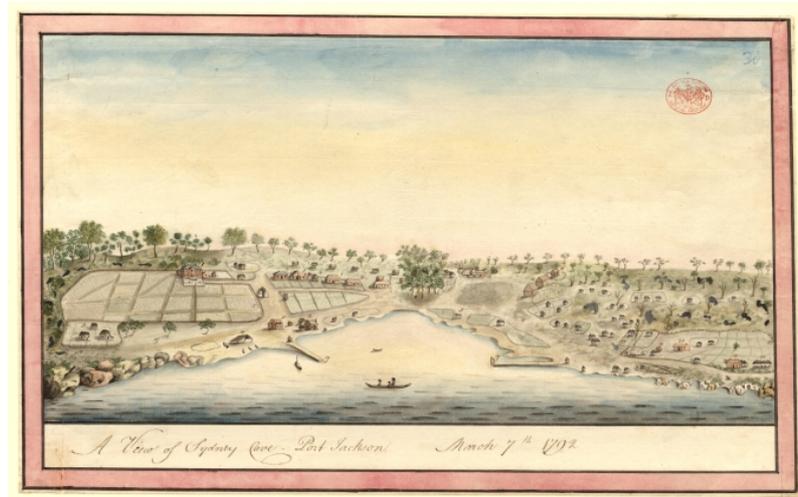


Figure 20: A view of Sydney Cove March 7th 1792  
The Port Jackson Painter

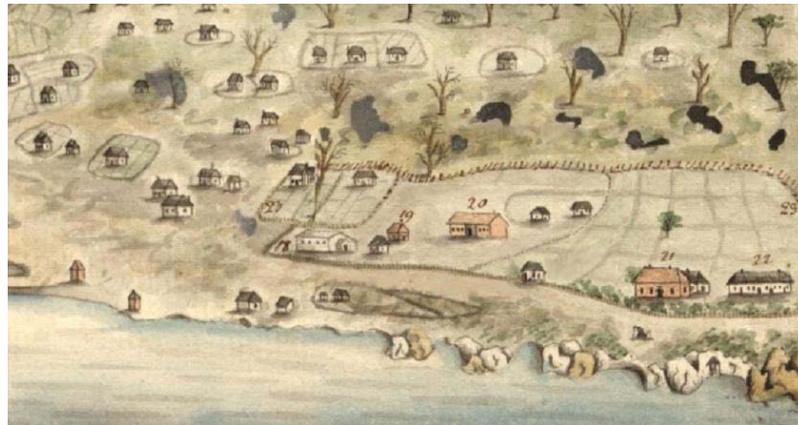


Figure 21: detail from A view of Sydney Cove March 7th 1792  
The Port Jackson Painter



Figure 22: Wattle-and-daub hut with bark roof parget wooden chimney 1890  
<http://home.iprimus.com.au/foo7/houses.html>



Figure 23: A postcard of a wattle and daub bush farmers homestead in South Australia circa 1900

<http://home.iprimus.com.au/foo7/houses.html>



Figure 24: Butcher's shop in a slab hut with bark roof, Tambaroora NSW

<http://home.iprimus.com.au/foo7/houses.html>



Figure 25: Early settlers hut in the Wielangta Forest, Tasmania.



Figure 26: Inside a slab hut.

#### **4.16 The weatherboard cottage**

The Byrne house was a simple weatherboard cottage constructed circa 1807. It was the home of Richard Byrne, Margaret Kelly and their seven children. It was sold and demolished circa 1860. And, like the wattle-and-daub huts there is no direct photographic evidence from the site itself but early photographs show similar buildings and examples still survive in other parts of Australia (Figure 27).



Figure 27: Lyons Cottage in Tasmania is an example of a humble workers cottage dating back to the nineteenth century.

<http://www.aussietowns.com.au/town/stanley-tas>

Following the outbreak of bubonic plague in the Rocks in 1900 the majority of the buildings on the site were resumed by the state government and then demolished. Prior to demolition many of these buildings were photographed and architectural plans were drawn up for thirteen of them and the plans for another seven can be inferred. For example numbers 120 to 126 Gloucester Street were a row of four terraced houses. There are plans for 124 and 126 and the author has assumed that the layout of numbers 120 and 122 will be of similar design. For the sake of brevity only the details of the re-creation of one high-resolution building are given. Appendix 1a lists all the buildings on the Big Dig site along with the web address for each building's webpage. The plans and photographs used to re-create the building are available on each individual webpage.

The two-storey house built in 1809 by George Cribb at 95 Gloucester Street was later incorporated into the hotel that was built by James and Sarah Byrne in 1830 (originally called the St. Patricks' Inn and was later renamed the Whalers Arms). The old Cribb's house is clearly visible in the difference in position and size of the windows of the rear





Figure 29: Gloucester Street, National Library of Australia

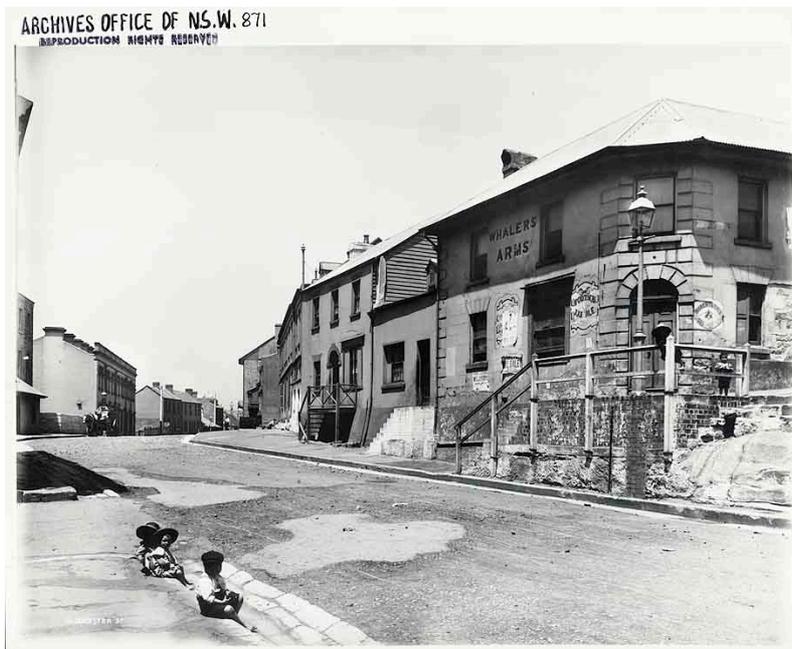


Figure 30: Gloucester Street 1901  
Rocks Resumption photographic survey

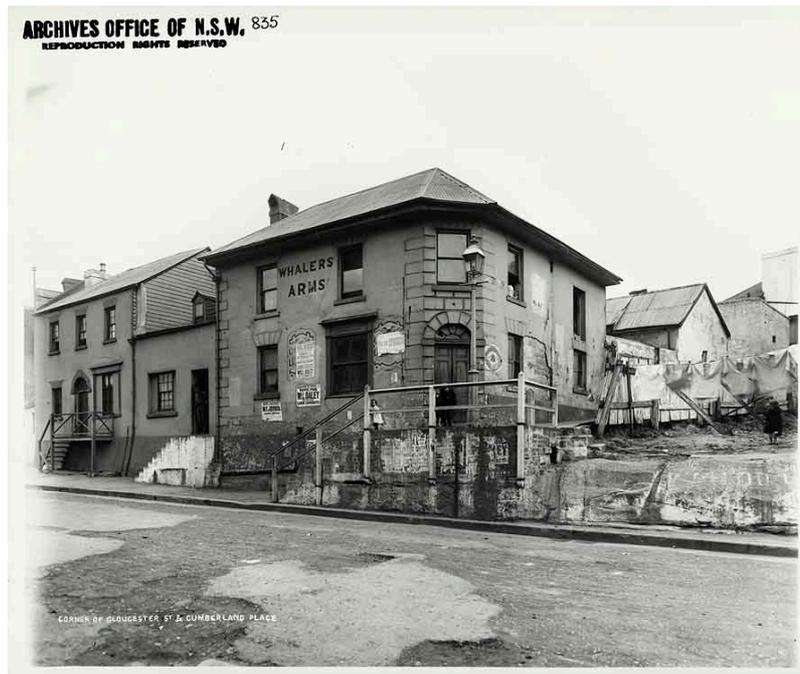


Figure 31: Whalers Arms 1901  
Rocks Resumption photographic survey

#### 4.17 Surrounding buildings and terrain

For the period immediately after settlement the placement of buildings in the surrounding area was based on archaeological evidence and the many early maps, paintings and drawings. Photographic evidence was gathered for the buildings that exist today by the author. This, along with a satellite view of the area from Google Maps, was used to build a simple low-resolution version of each building. A dataset of existing roof-lines and road-lines in the Rocks area was used to correctly place the extant buildings and calibrate their height. This dataset was also used to calibrate the height of the roads. There are 182 additional street addresses, some of which have multiple buildings. Due to time constraints it was not possible to research the phases of building at every address but exceptions were made for certain key places such as Bennelong Point which was the site of a number of iconic buildings before the Opera House. These include Fort Macquarie, constructed in 1817, and demolished in 1901 to make way for the Fort Macquarie Tram Depot which was demolished in turn in 1958 to make way for the Sydney Opera House.

As well as the more iconic buildings there are 116 extant heritage-listed buildings in the area surrounding Sydney Cove which are included in the VSR. The oldest surviving building in the Rocks is Cadman's Cottage. It was built in 1815 as the 'Coxswains Barracks' and originally sat next to a small beach but, after the completion of Circular Quay in the 1850s, it was 70 metres from the water. The re-creation of the terrain is by necessity one of the more speculative parts of the VSR. It is impossible to know the exact details of the sandstone cliffs prior to the arrival of the First Fleet. The area at the northern-most part of the Big Dig site was initially a place where sandstone was quarried, as were other sites in the Rocks. The Argyle Cut that extended Argyle Street to Millers Point took sixteen years to construct. It was started in 1843, using convict labour, and was finished in 1859, with dynamite. Much of the rubble was used in the construction of Circular Quay in the 1850s, a project that hid from view the natural rock and sand of the shoreline and enclosed the Tank Stream. For the VSR the current terrain was created based on the existing road levels. This was then used to generate new terrain meshes at roughly 50 year intervals and these were edited to create versions that reflected the changes that had taken place. In total there are seven different terrain meshes with associated texture maps and these were used for the different periods of pre-Settlement 1788, post-Settlement 1788 to 1799, 1800 to 1849, 1850 to 1899, 1900 to 1949, 1950-1999 and 2000 onwards.

#### **4.18 Watercraft**

The Harbour and the craft upon it are part and parcel of daily life in Sydney. It had been initially planned to show ferries and other craft moving in and out of Sydney Cove. Unfortunately due to resource constraints it proved to be impossible to create and animate the various ferries from 1861, when the first formal ferry service began

operation, to the present day (Wotherspoon 2008). The visible watercraft are limited to the ships of the First Fleet and their long boats, Aboriginal women in canoes, and a scattering of ships at berth at Circular Quay. The First Fleet boats are positioned according to the first map of Sydney Cove drawn by William Bradley in March 1788 (Figure 8). Once the nine transport ships of the First Fleet had unloaded their convicts and stores they set sail and left for other ports. The two navy vessels HMS Sirius and HMS Supply remained with the colony. HMS Sirius was wrecked on the 19<sup>th</sup> March 1790 at Norfolk Island leaving the fledgling colony dependent upon HMS Supply. The current date of the VSR is used to determine which, if any, of the First Fleet ships are visible. Clicking on any of the ships of the First Fleet opens the dedicated webpage in the Guidebook for that ship.

#### **4.19 The VSR Guidebook**

As described earlier in this chapter, the Guidebook is an integral part of the VSR. This web-based resource is accessed through a standard web browser and, at start up, defaults to display the top level of the Guidebook (See Figure 32). Users can navigate through the website via the web browser. The website is designed primarily to be an aggregator of content. The level of content, in both quality and quantity, that is available via websites such as the Heritage and Conservation Register for New South Wales, the Heritage Council of New South Wales, the State Library of New South Wales, the Dictionary of Sydney and the Australian Dictionary of Biography is substantial. The reader is invited to follow the links at the webpage for 58-64 Gloucester Street<sup>25</sup>.

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<sup>25</sup> [http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt\\_58to64.htm](http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_58to64.htm)

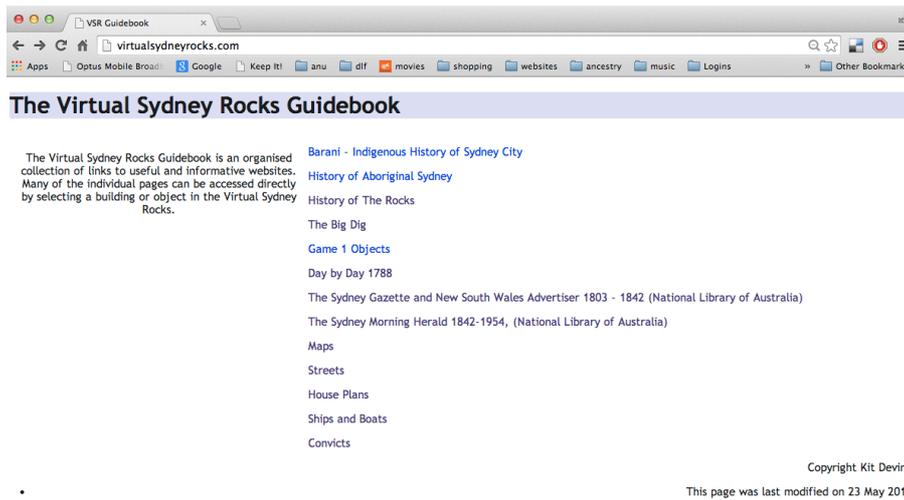


Figure 32: Top level page for the Guidebook

The graphic design aspect of the Guidebook is rather basic. However, as each webpage references the same cascading style sheet (CSS) to determine the font, font size, font colour and text border colours it is extremely easy to re-design the look of the website by editing the CSS file.

The Main Menu of the Virtual Sydney Rocks Guidebook contains links to a variety of different resources<sup>26</sup>. These include the City of Sydney's *Barani – Indigenous History of Sydney City* website and the Sydney University's *A History of Aboriginal Sydney* website. Indigenous people were present in the area of the VSR for much of its history but, as mentioned earlier, in the unpopulated prototype version of the VSR the absence of any Aboriginal contribution to the built environment risks rendering them invisible. However, Aboriginal women fishing in canoes were a common sight on the Harbour for the first 50 years of settlement despite the disastrous loss of life that Aboriginals suffered after the arrival of the First Fleet and they have been included.

<sup>26</sup> <http://virtualsydneyrocks.com/index.html>

There are an ever-increasing number of excellent articles relating to the history of the Rocks online and a link on the main menu opens a page of links to reputable sites such as *the Dictionary of Sydney* and *the Heritage and Conservation Register of New South Wales*. There are likewise some excellent online articles and interesting news stories related to the Big Dig excavation and a link on the main menu opens the page containing a collation of all the Big Dig links.

The main menu has a link to a page dedicated to the objects that are the subject of the game. (The game will be discussed in full detail later in this chapter.) Users who are interested in discovering the events of a particular day can follow links on the main menu to three different daily news resources. These are the Day to Day 1788 summary that was written using surviving original accounts, the archives of *The Sydney Gazette and New South Wales Advertiser* covering 1803-1842 and the archives of *The Sydney Morning Herald* from 1842 to 1954. The main menu also links to a page dedicated to the maps used to create the VSR.

The Streets link on the main menu links to a page for each different street and each of those contains links to the individual street addresses of the surrounding buildings (See Figures 33-35). Users can access the individual page for each street address via the Guidebook or they can click on a building within the VSR and so cause the relevant page to open in a new tab of the browser on the second screen. The web page for each street address lists the buildings that existed at that site and the dates of construction and, if relevant, demolition. The architect is listed if known and, if possible, linked to an entry for them in *the Australian Dictionary of Biography*. If the building is still currently extant, there is at least one photo of the building and links to useful and reliable resources such as the *Heritage and Conservation Register of New South Wales*,

the Office of Environment and Heritage (OEH) for the Government of New South Wales and the State Library of New South Wales. Links that are less authoritative but still useful, like *Sydney Architecture* and *Wikipedia*, are also included.

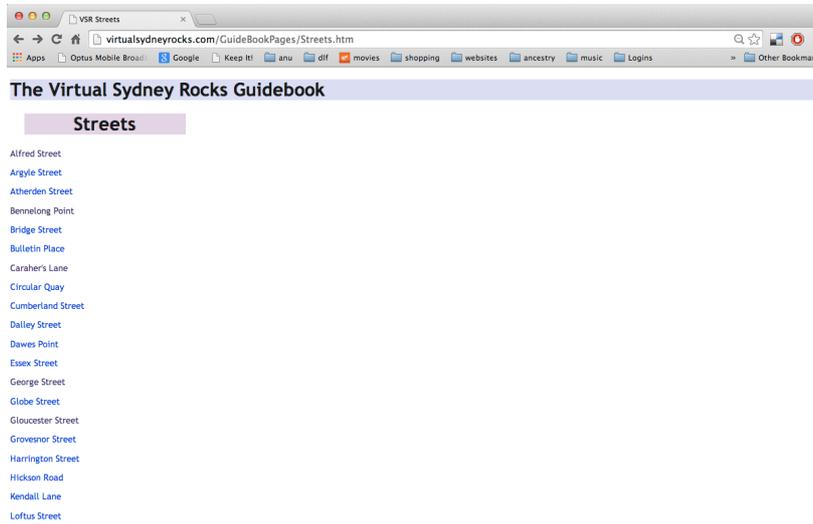


Figure 33: Webpage with links to all the different streets in the VSR

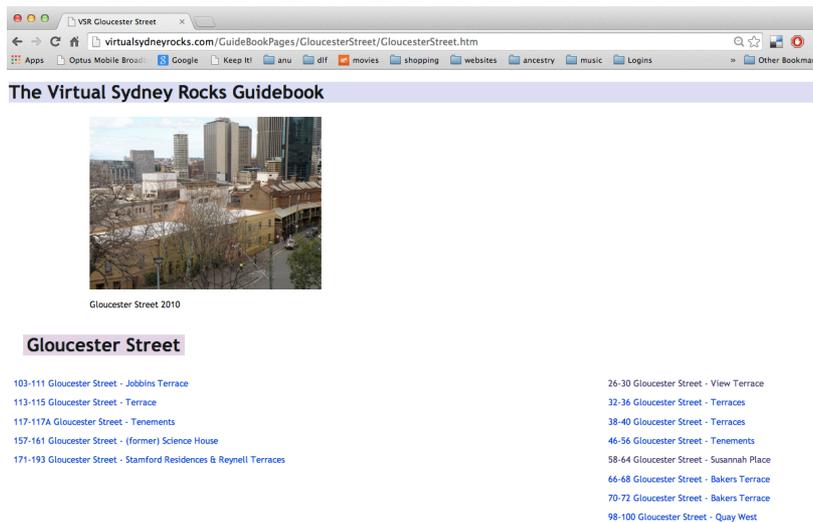


Figure 34: Webpage with links to all the street addresses for Gloucester Street

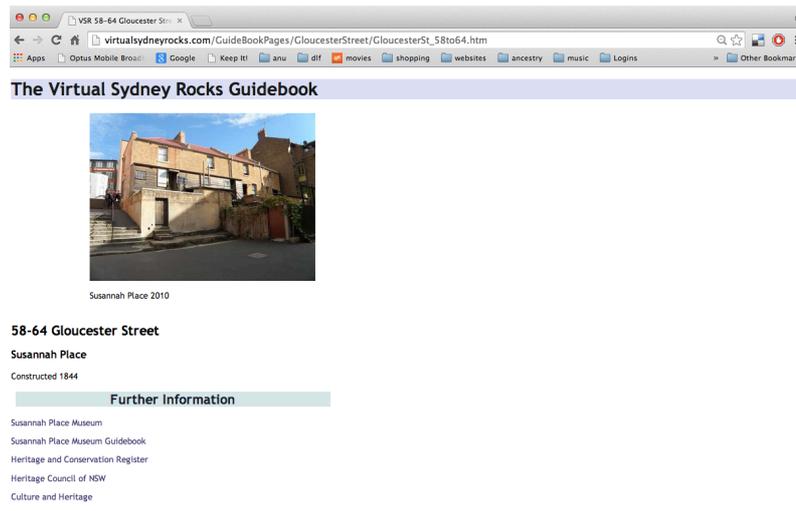


Figure 35: Webpage with links for a specific address in Gloucester Street

The author had originally intended to make all the architectural plans for the demolished buildings from the Big Dig site available via a link from the main menu of the Guidebook. During the creation of the initial main menu for the website a link to an ‘under construction’ page was included. Later on the author decided to include the plans and other reference material for each building in the individual building’s webpage so as to centralise the information used to create the virtual model. The link to the ‘under construction’ page was left so as to remind users that the VSR and Guidebook were only a prototype and not a finished project. The museum audience consists of a wide cross section of the general public and is increasingly familiar with the level of detail and realism that is par for the course in state-of-the-art computer games such as *Grand Theft Auto* and *Crysis*. By reminding testers that the VSR was an early prototype the author hoped that they would see past the relatively low level of finish to the VSR and focus on the quality and quantity of the content and the various ways to access it.

The penultimate link on the main menu is for Ships and Boats. Currently most of the sub category pages are ‘under construction’ however the links for Aboriginal canoes and the First Fleet are active. As mentioned earlier, the sight of Aboriginal women

fishing in Sydney Harbour was common for the first fifty years of settlement. Selecting one of the canoes opens the Ships and Boats page in a new tab of the browser and users can follow two different links for more information about Aboriginal canoes. The First Fleet webpage aggregates the various different First Fleet resources such as provided by the State Library of New South Wales, the Australian Maritime Museum and the University of Wollongong's First Fleet website. Links to useful resources compiled by First Fleet and convict descendants and interested members of the public have also been included. Examples include The First Fleet Register website with its searchable database of all the convicts aboard the First Fleet and the Convict Stockade website which also has a searchable database for all the convict records from 1788 to 1868. Using these it is possible to find out the ages, sex, occupations, crimes and sentences of the convicts on the First Fleet and, often, where the trial had taken place.

In addition to the resource links outlined above, the Ships and Boats page contains links to pages devoted to each of the ships of the First Fleet. The page for HMS Sirius includes links to specific pages devoted to the Sirius at the websites of the Norfolk Island Museum, the Powerhouse Museum and the Dictionary of Sydney<sup>27</sup>. There is also a link to the entry in the Australian Dictionary of Biography for the captain of the Sirius, John Hunter. The final link on the Main Menu is for the Convicts. There are several links here to convict records and these are of interest to researchers, family historians and genealogists.

#### **4.20 Day to day 1788**

Due to a lack of resources, it proved impossible to complete a daily summary for the entire year of 1788. Daily summaries for the following scattering of dates were created

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<sup>27</sup>[http://virtualsydneyrocks.com/GuideBookPages/ships\\_boats/FirstFleet/HMS\\_Sirius.htm](http://virtualsydneyrocks.com/GuideBookPages/ships_boats/FirstFleet/HMS_Sirius.htm)

but unfortunately time constraints meant that the rest of the entries were not created to link them all up – 18<sup>th</sup>-31<sup>st</sup> January, 6<sup>th</sup>, 10<sup>th</sup> and 17<sup>th</sup> February, 4-10<sup>th</sup>, 14<sup>th</sup>-16<sup>th</sup>, 20<sup>th</sup> and 24<sup>th</sup> March, 1<sup>st</sup>-16<sup>th</sup>, 19<sup>th</sup>-20<sup>th</sup> and 26<sup>th</sup> May, 1-30<sup>th</sup> June and 1<sup>st</sup>-12<sup>th</sup> July. If the reader opens the page for 15<sup>th</sup> of June<sup>28</sup> they will see a short summary for the day and they can use the back and forward arrows to step backwards and forwards through the daily summaries (See Figure 36). Readers can follow the links of many of the named individuals to their entries in either the Australian Dictionary of Biography or the University of Wollongong’s First Fleet convict records.

**Virtual Sydney Rocks Guidebook**

**Day by Day 1788**

**Sunday, 15th June**

◀ ▶

**Weather**

Squally with rain  
Wind: Southerly Gales  
Temperature: 59 F 15 C

**Events**

CHRISTENINGS  
Mary Ann Turner, daughter of John Turner, a marine, and his wife Susannah.

WEDDINGS  
Edward Pugh, convict, and Hannah Smith, convict, both transported on the *Friendship*.

DEATHS  
John Batchelor, marine, in a boating accident at Norfolk Island.

**People of the First Fleet**

Marine Officers, Marines, Ships Crews and Officials, with families  
The First Fleet Register (Convicts only)  
First Fleet Convicts, First Fleet Online

◀ ▶

Main Menu  
Sydney Day by Day  
June 1788

Figure 36: Guidebook entry for Sunday 15th June 1788

<sup>28</sup>[http://virtualsydneyrocks.com/GuideBookPages/DayByDay/1788/June/15\\_06\\_1788.htm](http://virtualsydneyrocks.com/GuideBookPages/DayByDay/1788/June/15_06_1788.htm)

## 4.21 Using the VSR

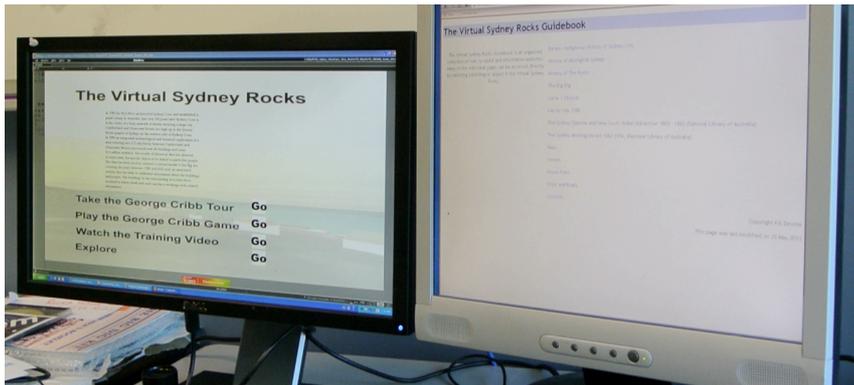


Figure 37: The VSR and Guidebook at start up

Once there was a working prototype of the VSR and Guidebook for the explore mode an example tour and an example game were implemented. A short training video was created to show users how to navigate in space and time using the VSR and introduce them to the Guidebook. The main menu displays the following short text summary of the project and gives the user the choice of four options: they can take the George Cribb Tour, they can play the George Cribb Game, they can watch the VSR Training Video or they can Explore at will (See Figure 37).

*In 1788 the First Fleet anchored in Sydney Cove and established a penal colony in Australia. Just over 200 years later Sydney Cove is at the centre of a busy network of ferries servicing a large city. Cumberland and Gloucester Streets are high up in the historic Rocks quarter of Sydney on the western side of Sydney Cove. In 1994 an integrated archaeological and historical exploration of an area covering two and a half city blocks between Cumberland and Gloucester Streets uncovered over 40 buildings and some 3/4 million artefacts. The wealth of historical data has allowed, in some cases, for specific objects to be linked to particular people. The data has been used to construct a virtual model of the dig*

*site covering the years between 1788 and 2010 with an associated website that has links to additional information about the buildings and people. The buildings in the surrounding area have been modeled in lower detail and each one has a webpage with related information.*

Introductory text on the main menu of the VSR

#### **4.22 The VSR training video**

Users who choose to watch the VSR Training Video will see a video which explains to them how to set the time and date. It then shows them how to move around in the VSR using the joystick. The various different speeds of time are described and users are told how to switch between the user-controlled first person viewpoint camera and the fixed overhead camera. It introduces viewers to the Guidebook and explains how to open the webpages for individual buildings within the VSR, either by opening the front door of a high resolution building, or by clicking on a low resolution building. Viewers are told that clicking on the Main Menu button will return them to the opening menu <sup>29</sup>.

#### **4.23 The different interaction modes for the VSR**

Given the importance of individual factors for engagement with virtual environments, discussed in Chapter 1, Section 1.5, and the range of activities available to people at heritage places, the author decided that the VSR should support a range of activities. Some people when they go to a foreign place prefer to explore on their own while others prefer to take tours and the VSR would offer both. In addition game-based interaction has been proposed as a way to enhance learning in virtual environments. Therefore it made sense to also include the option of playing a game in the range of interaction options on offer. The author was curious to discover how users would

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<sup>29</sup> The VSR Training Video is Video 23 on the accompanying dvd.

interact with the VSR when given a choice of activities and, if there was a pronounced preference for one activity in particular, what it would be. If this turned out to be the case then future creators of virtual heritage with limited resources might choose not to implement the least popular activities.

The three activities have interaction modes which align them with three of the four educational theories outlined by Hein discussed in Chapter 1, Section 1.8 (Hein, 1998). The Tour is a pre-recorded movie file that consists of screen captures from the VSR with a voice-over that gives some background to the settlement of Sydney, then talks about the life of George Cribb and concludes with a time-lapse showing the changes in the built environment from 1788 to 2012. This is essentially a didactic presentation. The Game is an interactive treasure hunt that involves players travelling to different times and exploring the surroundings to locate three items known to have been associated with George Cribb and so reveal both his story and the changing built environment during his life. This way of interacting with the VSR fits within the stimulus-response domain. Players have set goals regarding retrieving several items and they can ignore anything outside of those goals. In the free-ranging Explore mode the user is at the heart of self-directed engagement with the VSR. This is Discovery learning in essence. The author argues that the VSR itself represents a Constructivist approach in its support of multiple interaction modes.

As described earlier in this chapter, the Big Dig project identified George Cribb as an important figure with a fascinating personal history. His story is central to the game and the tour that were developed for testing. The author decided to make the content of the George Cribb's Tour very similar to the George Cribb Game. This was done so that meaningful comparisons could be drawn between the learning experience of playing the

game versus taking the tour. The tour lasts four minutes and consists of screen recordings from the VSR with a voice-over. The following sections describe the example tour and example game in detail.

#### **4.24 The Tour**

The George Cribb's Tour is an example of the didactic learning model identified by Hein. Viewers cannot interact and ask questions but can only passively absorb what they see and hear. The tour lasts four minutes and five seconds and it opens with a view of Sydney Cove as seen from the Big Dig site in early January 1788 before the arrival of the First Fleet. It relates the life of George Cribb and then finishes with a looping time-lapsed animation showing the changes in the built environment of the Rocks from 1788 to 2013 as seen from an overhead camera looking north east over the Big Dig site, across Sydney Cove to Bennelong Point<sup>30</sup>.

Text of the George Cribb's Tour with screengrabs

*Welcome to the Virtual Sydney Rocks. Our tour today starts in 1788. It is early January and we are standing high up in the sandstone cliffs that surround what will be Sydney Cove. We can see Aboriginal women fishing in canoes and in the distance a small island that will be the site of the future Sydney Opera House*

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<sup>30</sup> The VSR Tour is Video 24 on the accompanying dvd.



Figure 38: Screenshot VSR Tour – 1788 pre-settlement.

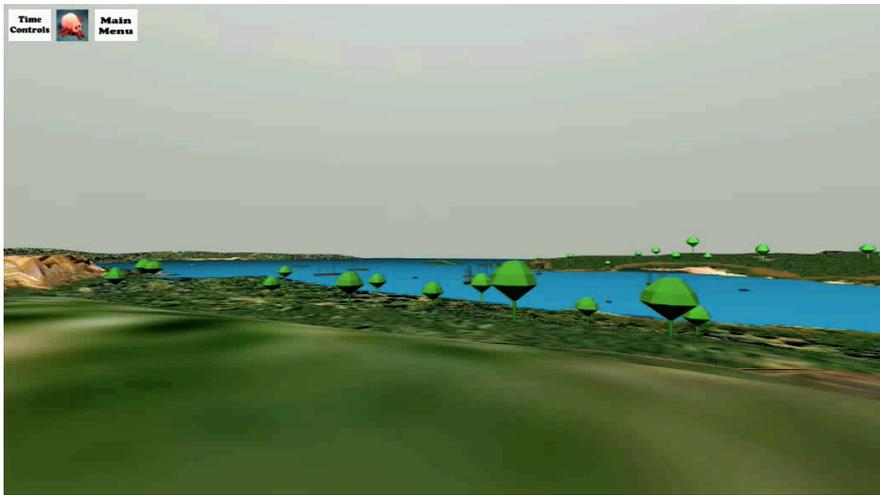


Figure 39: Screenshot VSR Tour - 1788 arrival of the First Fleet.

*It is early evening on the 26<sup>th</sup> of January 1788 and the First Fleet has taken up anchor in Sydney Cove establishing the first European settlement in Australia. Within a year of settlement the convicts had built numerous wattle-and-daub huts, roofed with bark, or thatched with the leaves of the cabbage tree, high up on the sandstone ledges in the area that was already known as the Rocks.*



Figure 40: Screenshot VSR Tour - c 1800.

*It is 1820 and Sydney now has over 11,000 inhabitants. All of the early buildings in the Rocks face onto the harbor underlining the importance of maritime comings and goings to the people who live here. In front of us is a 2-storey house built by George Cribb. He arrived in 1808 as a convict. A butcher by trade he initially prospered, buying up land. By 1813 he owned a number of adjoining properties in the Rocks including the house and the butcher's shop next door. At the back he set up a stockyard and slaughterhouse.*



Figure 41: Screenshot VSR Tour - c 1820 at the back of the Cribbs House.

*He had a complicated personal life. In 1811 he married Fanny Barnett, a fellow convict. But in 1814 his wife Martha from England came out to join him and he paid Fanny the very large sum of three hundred pounds to return to England. Martha died in 1818 and he married for a third time to Sophie Lett. In 1823 she left him for his nephew. In the 1820s he was forced to re-mortgage his properties to pay debts and by 1824 he had lost them all. The last mention of him is in the records of the Parramatta local court for cattle theft.*



Figure 42: Screenshot VSR Tour - time-lapse c 1800.

*In 1851, after 60 years of settlement the population of Sydney had risen to 39,000. The discovery of gold in Australia however led to large waves of migration and just 30 years later the population had grown 10 fold from 39,000 to 210,000. We are currently viewing a time-lapse where 1 second = 5 years.*

*Thank you I hope you enjoyed the tour.*



Figure 43: Screenshot VSR Tour time-lapse c 1850.

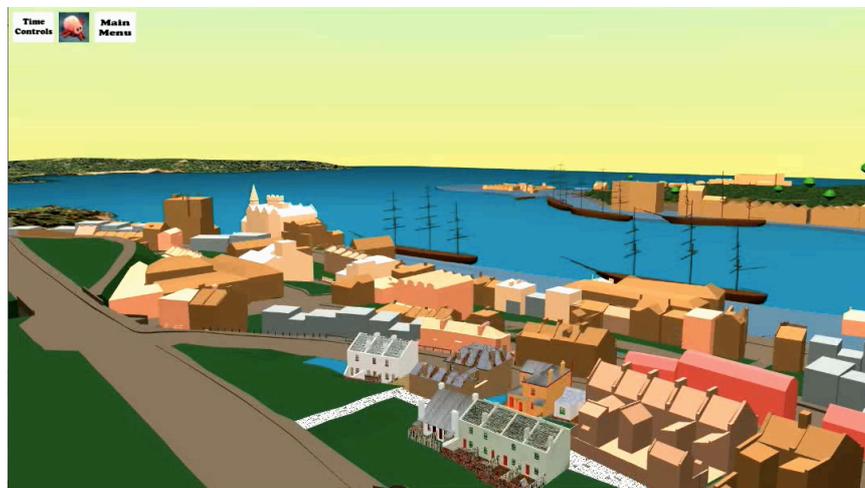


Figure 44: Screenshot VSR Tour time-lapse c 1890.



Figure 45: Screenshot VSR Tour time-lapse c 1950.



Figure 46: Screenshot VSR Tour time-lapse c 1965.

#### 4.25 The Game

The game is a treasure hunt type of game and takes at least three minutes to play through from start to finish. Users have to find three objects: a boning knife, an alcohol still and some china, that are linked to the life of George Cribb (See Figures 47-49). When an object is found a text screen displays some information about the life of George Cribb that is relevant to the particular object. At the start players are told that there are several objects that had been excavated from a well during the Big Dig and players have to find the objects in their original places and *times*. Players use the same controls as are available in the exploration mode to move at will through space and time. This interaction mode fits within the stimulus-response domain. Players have particular tasks to undertake and they can ignore anything outside of those tasks as they carry no meaning in the context of the game.



Figure 47: The boning knife recovered from the Cribb well.



Figure 48: The alcohol still recovered from the Cribb well.



Figure 49: The china bowls recovered from the Cribb well.

The game begins by displaying the following text on the main screen.

*George Cribb arrived in Sydney on the 20th December 1808. He had been sentenced to 14 years for being in possession of forged banknotes. He was a butcher by trade and initially prospered. He moved into a house on the Big Dig site in 1809 and over the next 4 years acquired over half the site from the various owners. He used the land to establish a slaughter yard at the back of his butcher's shop. During the Big Dig a number of objects were discovered in a filled-in well that date to the period of the Cribb's occupancy. They include a boning knife, an alcohol still and a set of fine china. You must travel in time and find each object in its original setting.*

There are three buttons at the bottom of the screen that players use to get hints. If the cursor is moved on top of a button the appropriate hint will display at the bottom of the screen.

*Hint 1: Look in the butcher's shop sometime between 1817 and 1825*

*Hint 2: Look in the stables in Cribb's yard sometime between 1810 and 1825.*

*Look out for the guard dog!*

*Hint 3: Look in George Cribb's house sometime between 1813 and 1814.*

### **Game item 1 – The boning knife**

Players need to go to a time and date within the range specified for item 1 (the boning knife). The knife is located on a wooden table in the backyard of the butcher's shop. The butcher's shop can be recognised when viewed from Gloucester Street by the strings of sausages hanging in the window. Alternatively the back yard can be accessed directly via the laneway running behind the row of houses on Gloucester Street. When the player selects the knife the following text is displayed.

*Item 1 found*

*George Cribb arrived in Sydney on the 20th December 1808. He was a butcher by trade and within 6 months was advertising 'fresh fine pork' in the newspaper. In 1817 he opened a renovated butcher's shop with stockyards and stables at the back. In 1819 he was charged with illegally hawking meat. In 1823 and again in 1827 he was suspected of involvement in cattle stealing.*

### **Game item 2 – The alcohol still**

Players need to go to a time and date within the range specified for item 2 (the alcohol still). The still is in one of the two stables in the back yard. There are horses in both stables and a black dog outside the stable where the still is hidden. When the player selects the still the following text is displayed.

### *Item 2 found*

*George Cribb had many brushes with the law after his arrival in Sydney but he escaped conviction on most occasions. In October 1812 he was arrested for trying to smuggle 20 gallons of Bengal rum under the firewood of a cart. The charges were not proven but the horse, cart and rum were seized by the Crown. In 1819 Cribb was fined for illegally hawking meat. In 1823 Charles Throsby alleged Cribb had trespassed on his land and 'used' his bulls. In 1823 Cribb and his nephew Thomas Cribb were accused of cattle-stealing and bribing a witness. In 1827 Cribb was suspected of cattle theft and his properties were raided. In 1830 he appeared in a Parramatta court charged with cattle theft.*

### **Game item 3 – The china bowls**

Players need to go to a time and date within the range specified for item 3 (the china bowls). The bowls are in one of the downstairs rooms of the Cribb's house on a wooden sideboard. When the player selects the bowls the following text is displayed.

### *Item 3 found*

*George Cribb had quite a complicated personal life. He arrived in Sydney in 1808 and in 1811 married Fanny Barnett a convict who had also arrived in Sydney in 1808 but on a different ship. In 1814 George learnt that his wife Mary was coming out from England to join him. He paid Fanny the considerable sum of 300 pounds to 'get her freedom and leave the colony forthwith'. Three pairs of high quality bowls and three expensive glass tumblers were found in the well dating to around this time. The items appear to have been dropped whole into the well as almost all the pieces were present. It has been speculated that Fanny*

*may have not have reacted well to the news of George's bigamy and threw the 'good' china away so that Mary could not use it! Mary died and George married Sophia Lett in 1818. Sophia left him in 1823 for his nephew Thomas Cribb and she died in 1827.*

The testing would take place in the same room as the glass case that housed the excavated objects and the author was curious to discover if players would notice and how they would react. The following section discusses the reasons for using a questionnaire and details its design and content.

#### **4.26 The questionnaire**

The prototype VSR was tested on-site at the Sydney Rocks Museum so the test audience was the intended audience. Passively recording people using the prototype and assessing the resulting video was not going to give the depth of feedback that the author wanted and, as the author would be acting as a docent during testing, it would not be possible to conduct interviews at the same time. Follow up in-depth interviews would be extremely difficult as over three quarters of the visitors to the Rocks Discovery Museum are from interstate or overseas (SHFA 2011). The author decided therefore to use a mixed methods single questionnaire which would, at the very least, give some quantitative data and, at best, would elucidate some interesting, highly relevant and informative qualitative data (Driscoll et al. , Johnson and Christensen 2010). A key concern was not to impose too great a time burden on testers. The Tour ran for four minutes, the Game took between three and five minutes to play and the author assumed that people would spend at least three to five minutes in self-directed exploring. This meant that a tester who tried all three would already have spent about fifteen minutes engaged with the VSR. The questionnaire was designed so that someone could answer

the multiple choice questions in less than five minutes but there was ample space for respondents to elaborate on their responses in depth if they wanted to. This resulted in a rough estimate of about 25 minutes in total for testers who used all three modes and who also gave answers to the open response qualitative questions as well as to the multiple choice quantitative questions. Research into museum visitors indicates that 30-40 minutes is an average time for them to engage with museum content (Hein 1998). The author decided that 25 minutes was towards the upper range of time commitment to ask of testers but would still be acceptable to many.

Two issues were particularly important to the author<sup>31</sup>. One was the educational potential of time-based Virtual Heritage and the other was user preference with regard to the three engagement modalities of Tour, Game and Explore. However, the author was concerned about prompting the testers on these issues and therefore decided to make the questions as general as possible but to give testers ample opportunity to elaborate their answers in depth if they wanted to. As well as the main questions, the author was curious to discover what aspects of the VSR would resonate with testers to the extent that they bothered to mention them in their responses.

The author decided to use a six point Likert scale for the multiple choice questions. Testers were asked to indicate the strength of their agreement or disagreement to a statement by circling one of the following six options:- strongly disagree, disagree, slightly disagree, slightly agree, agree and strongly agree. An even-numbered Likert scale of six instead of a seven point Likert scale with a neutral option in the middle of the range was chosen because it forced users to express either a negative or a positive response. In accordance with university procedures, once the wording and order to the

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<sup>31</sup> A copy of the questionnaire can be found in Appendix 1c.

questions had been decided the questionnaire was submitted to and approved by the Ethics Committee.

The first page of the questionnaire contains the following short introduction describing the project.

*“In 1788 the British established a penal colony at Sydney Cove. In just over 200 years the site has evolved from a collection of tents to the heart of a large city. The Virtual Sydney Rocks is a prototype interactive virtual world designed to teach people about the history and development of the area surrounding Sydney Cove. My goal is to make an immersive, interactive and engaging learning resource. Your feedback is invaluable and very much appreciated.”*

There is a single page of demographic questions that request age, sex and occupation data followed by three questions about computer and computer game usage. These are followed by 21 numbered questions specifically to do with the VSR and Guidebook.

There are six questions under the heading on the questionnaire of **Interaction Questions**. Questions 1, 2 and 3 ask in turn ‘*Did you take the virtual Tour?*’, ‘*Did you play the Game?*’ and ‘*Did you Explore?*’. Testers answer these simple questions by circling either the words ‘yes’ or ‘no’ on the questionnaire. These questions are followed by subsidiary questions asking testers if they had tried more than one interaction mode and, if they had, in what order. Users then have the opportunity to say which mode of interaction they liked best and why.

Questions 4, 5 and 6 in this section are designed to find out if testers would recommend that someone should take the three different engagement modes in any particular order and what that order would be. A subsidiary question invites testers to elaborate as to why they recommend a particular order.

There are 12 questions under the heading on the questionnaire of **Place, Presence, History and Culture Questions**. The first four questions seek to find out about the tester's experience of temporal, spatial and cultural immersion, via the three different interaction modes of Tour, Game and Explore. Testers are asked to indicate their level of agreement/disagreement to the following three statements in turn.

- *The Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times.*
- *The Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times.*
- *Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times.*

Testers are asked to circle a number to indicate their agreement/disagreement with the statements where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree.

These three questions were followed by the question '*Which way of interacting was most effective at making you feel like you were actually there?*' and testers were asked to circle either Tour, Game or Explore. This was followed by a subsidiary question inviting testers to elaborate as to why they had chosen that particular mode as being most effective at making them feel like they were actually there.

The second set of four questions seek to find out about the tester's experience of learning. Testers are asked to indicate their level of agreement/disagreement to the following three statements in turn.

- *I learnt some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour.*
- *I learnt some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks Game.*
- *I learnt some of the history of the Sydney Rocks while Exploring the Virtual Sydney Rocks.*

Testers are asked to circle a number to indicate their agreement/disagreement with the statements where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree. These three questions were followed by the question *Which way of interacting helped you learn most about the history of the Sydney Rocks?* and testers were asked to circle either Tour, Game or Explore. This was followed by a subsidiary question inviting testers to elaborate as to why they had chosen that particular mode as being most effective in teaching them about the history of the Rocks.

The third set of four questions seek to find out about the tester's experience of change over time. Testers are asked to indicate their level of agreement/disagreement to the following three statements in turn.

- *I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks Tour.*
- *I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks Game.*

- *I saw how the Sydney Rocks has changed over time by Exploring the Virtual Sydney Rocks.*

Testers are asked to circle a number to indicate their agreement/disagreement with the statements where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree.

These three questions were followed by the question *Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time?* with testers being asked to circle either Tour, Game or Explore. This was followed by a subsidiary question inviting testers to elaborate as to why they had chosen that particular mode as being most effective showing them how the Rocks had changed over time.

Finally there are three questions under the heading on the questionnaire of **Design Feedback**. Testers were asked in turn to write down

- *‘the two things you liked most about the Virtual Sydney Rocks’*
- *‘the two things you liked least about the Virtual Sydney Rocks’*
- *‘any ways that you think the Virtual Sydney Rocks could be improved’*

#### **4.27 Conclusion**

This chapter details the design and creation of Virtual Sydney Rocks, a time-based virtual heritage world with supporting website. It discusses the selection of the site and the major design decisions that were taken by the author. These include the implementation of navigable time and weather, the use of ambient audio, the content of the supporting website, the size and scope of the model and the detailing of the built environment. It examines the range of activities, supporting different modes of interaction, that are available to users. Finally it discusses the use of a questionnaire to

evaluate the VSR during testing, and the design and content of the questionnaire. The following chapter reports on the testing and analyses the returned data.

## CHAPTER 5: Results and Findings

5.1 Testing	181
5.2 Demographic questions	182
5.3 Familiarity with the Rocks and virtual heritage	184
5.4 Computer and electronic game use	186
5.5 Summary of demographics and computer use responses	188
5.6 Interaction Strategy Questions	188
5.7 Interaction modes tried by respondents	189
5.8 The order that the different interaction modes were tried in, by respondents who tried all three	191
5.9 Most liked interaction mode by respondents who tried all three and why	192
5.10 Recommended order of interaction mode by respondents who tried all three modes and why	195
5.11 Summary of responses to the questions relating to interaction modes	198
5.12 Place, Presence and Learning questions	199
5.13 The Feeling of Being in the Rocks at Certain Times	200
5.14 Responses to the statement ‘The Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times.’	201
5.15 Responses to the statement ‘The Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times.’	203
5.16 Responses to the statement ‘Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times.’	205
5.17 Responses to the question ‘Which way of interacting was the most effective at making you feel like you were actually there and why?’	207
5.18 Responses to the question ‘Why was Exploring the most effective at making you feel like you were actually there?’	208
5.19 Responses to the question ‘Why was playing the Game the most effective at making you feel like you were actually there?’	209
5.20 Responses to the question ‘Why was taking the Tour the most effective at making you feel like you were actually there?’	210
5.21 Responses to the question ‘What way of interacting with the VSR was the most effective at making you feel like you were actually there?’	210
5.22 Summary of responses to the questions relating to the feeling of being in the Rocks at certain times	210
5.23 Learning some of the history of the Sydney Rocks	211
5.24 Responses to the statement ‘I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour.’	212
5.25 Responses to the statement ‘I learned some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks Game.’	214

5.26 Responses to the statement ‘I learned some of the history of the Sydney Rocks while Exploring the Virtual Sydney Rocks.	216
5.27 Responses to the questions ‘Which way of interacting helped you learn most about the history of the Sydney Rocks and Why?’	218
5.28 Responses to the question ‘Why was Exploring the most effective interaction mode for helping you learn some of the history of the Sydney Rocks?’	219
5.29 Responses to the question ‘Why was taking the Tour the most effective interaction mode for helping you learn some of the history of the Sydney Rocks?’	219
5.30 Responses to the question ‘Why was playing the Game the most effective interaction mode for helping you learn some of the history of the Sydney Rocks?’	220
5.31 Summary – Which way of interacting helped you learn most about the history of the Sydney Rocks?	220
5.32 Seeing how the Sydney Rocks has changed over time	221
5.33 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks Tour’.	222
5.34 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks Game’.	224
5.35 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by Exploring the Virtual Sydney Rocks’.	226
5.36 Responses to the questions ‘Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time and why?’	228
5.37 Responses to the question ‘Why was Exploring the most effective interaction mode for showing you how the Sydney Rocks has changed over time?’	229
5.38 Responses to the question ‘Why was taking the Tour the most effective interaction mode for showing you how the Sydney Rocks has changed over time?’	230
5.39 Responses to the question ‘Why was playing the Game the most effective interaction mode for showing you how the Sydney Rocks has changed over time?’	230
5.40 Summary – Which way of interacting was most effective at showing how the Sydney Rocks has changed over time?	231
5.41 Things Most Liked in the Virtual Sydney Rocks	231
5.42 Summary - Things Most Liked in the Virtual Sydney Rocks	234
5.43 Things Least Liked in the Virtual Sydney Rocks	235
5.44 Summary - Things Least Liked in the Virtual Sydney Rocks	237
5.45 Suggested Improvements	238
5.46 Summary – Suggested improvement for the Virtual Sydney Rocks	240
5.47 Analysis of testers who did not play the game	240
5.48 Report Summary	241
5.49 Time-based virtual heritage	244
5.50 Findings for navigable time	249
5.51 User activity preference	252
5.52 Findings for user activity preference	258

5.53 Other findings	258
5.54 Conclusions	260

The last chapter described the creation of the Virtual Sydney Rocks, a prototype time-based virtual heritage world. As well as supporting navigable time the VSR also offered users a range of activities that individually embodied three of the four different educational epistemologies identified by Hein and discussed in Chapter 1, Section 1.8, (didactic, stimulus-response and discovery), and collectively embodied the fourth, a Constructivist approach. This chapter analyses, discusses and summarises the findings from the testing of the VSR. It is split into two main parts. The first part, Sections 5.1 to 5.48, analyses the responses to the questionnaires completed by testers. These data included basic user demographics, the interaction choices and preferences of users, and their experience of place, presence and learning. Testers were also asked to list their most-liked and least liked features of the VSR.

The second part of this chapter, Sections 5.49 to 5.54, presents the findings. This part begins by examining time-based virtual heritage and the importance of time to place. It argues that time of day, season of the year and phase of the moon all contribute, at an immediate phenomenological level, to the light, smells and sounds of a particular place and time. Time also determines the cultural context, the makeup of the built environment, the inhabitants and the activities that take place in that place, at that time. Time is therefore crucial to both the phenomenological and the cultural experience of place. The chapter continues by arguing that time-lapse provides a new way of seeing, one that literally makes visible the transformation of place over timescales outside of direct human experience, creating powerful affect in viewers, enhancing engagement and creating opportunities for historical insight, understanding and learning. The chapter continues by summarising the findings with regard to the author's investigation

into the power of different activities to promote historical understanding, insight and learning. It also summarises the findings relating to the importance of user preference for particular activities. The chapter concludes with a summary of the additional findings that emerged from the data.

## **5.1 Testing**

Testing was carried out at the Rocks Discovery Museum from Monday 17th to Sunday 23rd June 2013. The Rocks Discovery Museum is a small museum located in a heritage-listed building situated in the historic Rocks district, and is dedicated to local history. The museum attracts a wide range of visitors of all ages and nationalities, including international, interstate and local tourists, school parties and individuals with a specific interest in the Rocks (SHFA 2011). During the week of testing museum staff at the entrance to the museum made a point of informing visitors of the presence on-site of the prototype Virtual Sydney Rocks and encouraged them to try it out. The computer running the VSR was set up in the same room as a glass cabinet that contained items recovered from the Cribb's well. These items had been dated to different periods of George Cribb's occupancy and among them were the china bowls, the alcohol still and the butcher's knife that were featured in the George Cribb game. After testers had played the game the objects were pointed out to them by the author so as to connect the virtual content of the VSR with real tangible objects that were physically present. Testers were invited to give feedback by filling in a questionnaire and they were advised that the questionnaire would take about five minutes to complete if they only completed the multiple choice questions, and about 10 to 15 minutes if they answered all questions.

The overall impression received from testers was one of helpful engagement. They were generally extremely positive about the educational potential of the VSR, appreciated the intent to make an immersive, interactive and engaging learning resource, and were eager to give constructive feedback. The museum recorded the total number of visitors for the week of testing as 1008 but this includes some large school parties that came for short visits. A total number of fifty-six questionnaires were returned. One of the questionnaires contained data for three individuals (a mother and her two sons) giving a total of fifty-eight individuals. Some respondents did not answer all the questions. Thirty-one respondents tried all three modes and only those responses will be used when discussing any comparisons between the three modes. When discussing other questions the results may use data from both the groups but it will be clearly indicated if the data are from the full set of fifty-eight responses or the reduced set of thirty-one responses. The questionnaire responses are in Appendix 1d. The results from the 31 respondents who tried all the modes are shown on a grey background and the results from the other 27 respondents are shown on a white background. The following sections of this chapter analyse the responses for each question.

## **5.2 Demographic questions**

Respondents were asked the very basic demographic questions of age, sex and occupation. Out of the 58 respondents, 53 indicated their ages. Seven were aged between 10 and 19, 14 were aged between 20 and 29, nine were aged between 30 and 39, 14 were aged between 40 and 49 and nine were aged between 50 and 59. As can be seen from the pie chart in Fig. 50 the ages of the respondents were not clustered in a particular age band but were evenly spread. Similarly, as can be seen in Fig. 51, the sex

ratio of the participants was roughly evenly split between male and female with a slight preponderance of females<sup>32</sup>.

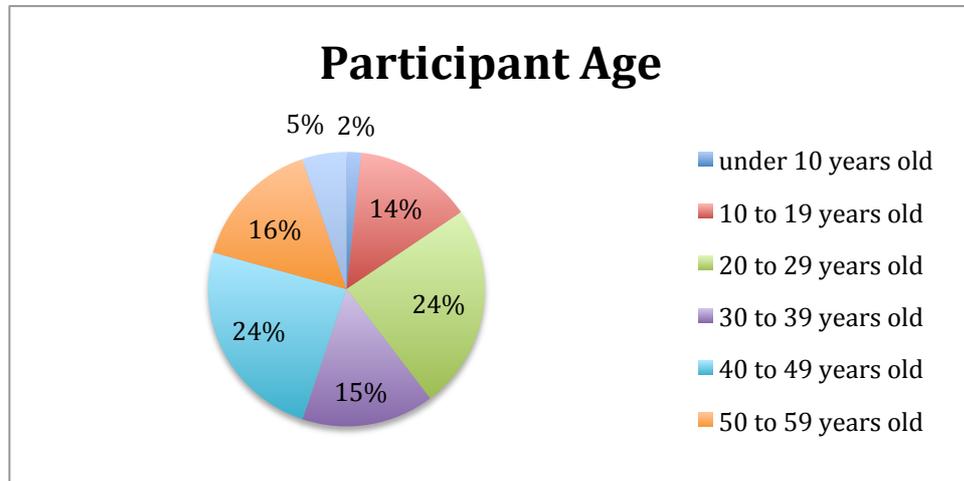


Figure 50

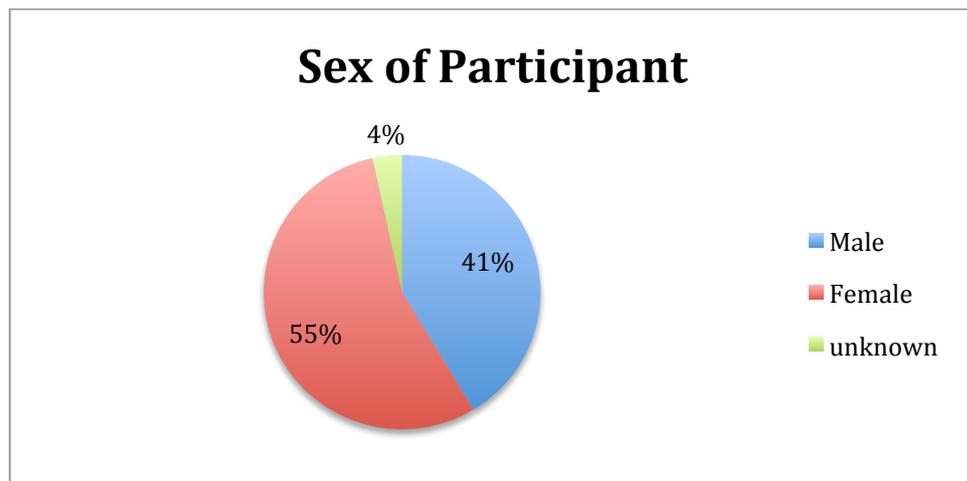


Figure 51

The occupations of participants were quite varied, though students and media professionals together made up just under half (See Figure 52). The largest single group of 16 comprised students, both secondary and tertiary. The second biggest group of 13 worked in a variety of media roles including media producer, director, digital producer, 3D artist, iPad developer, designer, video editor, television producer, media production, illustrator, visual effects artist, writer and marketing. The two groups of student and

<sup>32</sup> See Appendix 1d for the complete transcript of the responses to the questionnaire.

media professionals together accounted for just under half the participants. There were four participants from the heritage sector including a museum host, a tour guide/education officer and an archaeologist. The remaining participants were made up of two teachers, one researcher, six professionals (engineer, scientist, lawyer, horticultural field officer, process technician, IT), four administrators (payroll manager, admin, account manager, administrator), a police officer and a public servant, one performer, one retail worker, one employee, one self-employed, one unemployed, one investor and four no responses. Overall, the participants represent a broad cross-section of the general community in age, sex and profession.

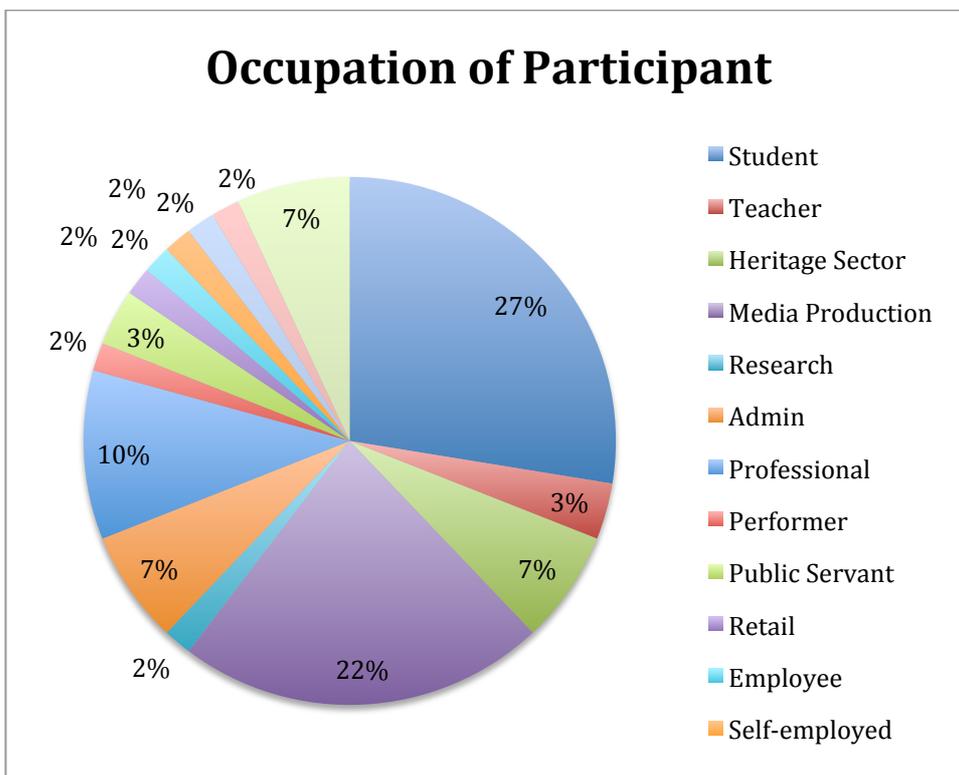


Figure 52

### 5.3 Familiarity with the Rocks and virtual heritage

There was some confusion over the question ‘Have you visited the Sydney Rocks?’ A better form of the question would have been ‘Have you previously visited the Sydney Rocks?’ During testing one participant asked if this, their first visit to the Rocks,

counted and they were told no. Given the high number of overseas and interstate visitors it was expected that there would be a preponderance of no answers to this question. The confusing nature of the question, and the fact that the Rocks is a major tourist destination with many hotels, may well explain why nearly four in five respondents (79%) indicated that this was not their first visit to the Rocks.

In contrast to the high percentage of participants who had previously visited the Rocks, fewer participants had any experience of virtual museums or virtual heritage, though at just over one in four respondents (27%), it was not an insignificant number. These respondents may have been referring to visiting a museum website rather than virtual heritage specifically<sup>33</sup>.

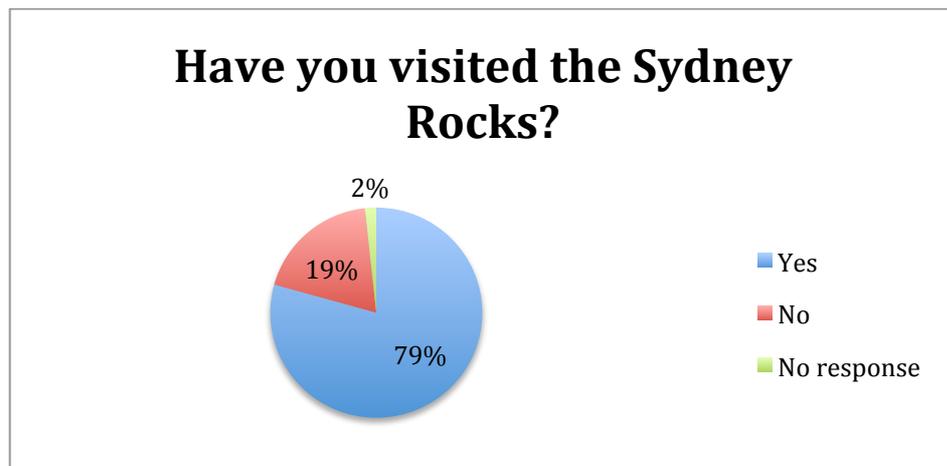


Figure 53

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<sup>33</sup> See Figs. 53 and 54 for a graphical depiction of the responses. See Appendix 1d for the complete transcript of the responses to the questionnaire.

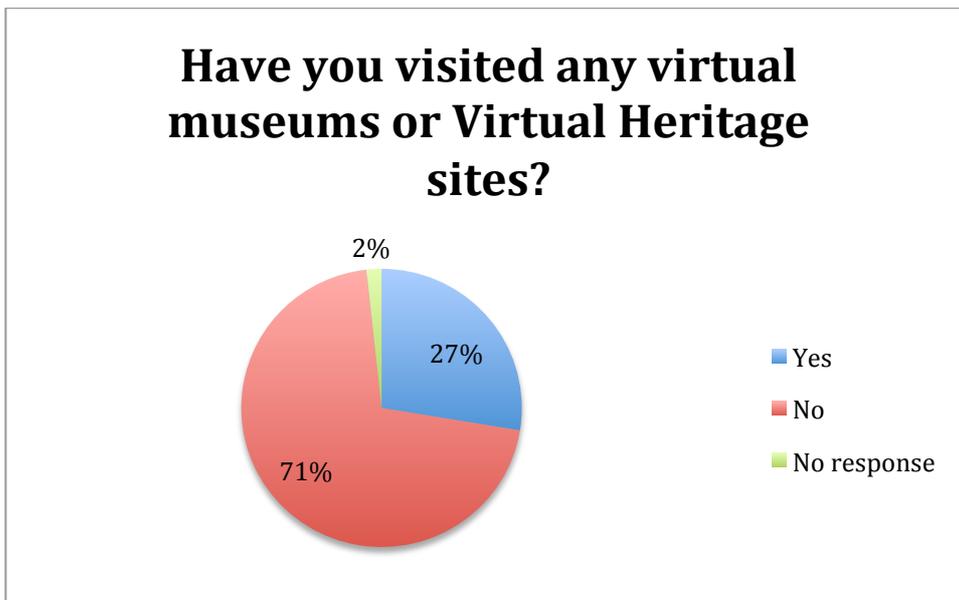


Figure 54

#### 5.4 Computer and electronic game usage

As expected in the electronically enmeshed world of the twenty-first century, computer use among participants was high, with just over four in five respondents (85%) reporting daily usage. Electronic game playing was popular, with only one in three respondents (33%) reporting that they never played. For the game players, the least popular platform was console games which accounted for one in three players (33%) when compared with just over one in two playing on a phone (55%) and one in two playing on a computer or tablet device (50%). Interestingly, several respondents remarked to the author that they used to play a lot of games but no longer did. This suggests that the number of people familiar with games was higher than the number of people who reported that they were currently game players. The author suggests that a revised version of the question ‘Do you play electronic games?’ should include an additional response of ‘I used to but not any more’<sup>34</sup>.

<sup>34</sup> See Figs. 55-57 for graphical depictions of the responses. See Appendix 1d for the complete transcript of the responses to the questionnaire.

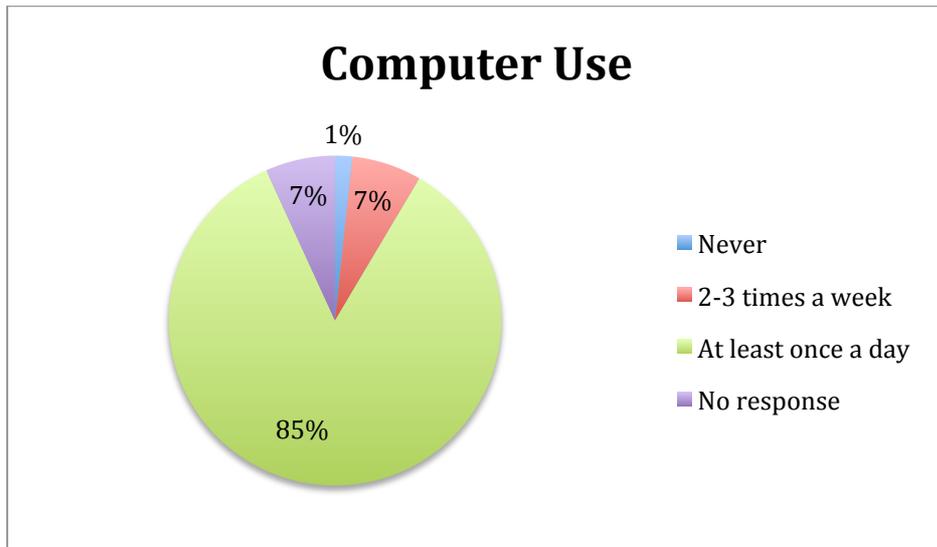


Figure 55

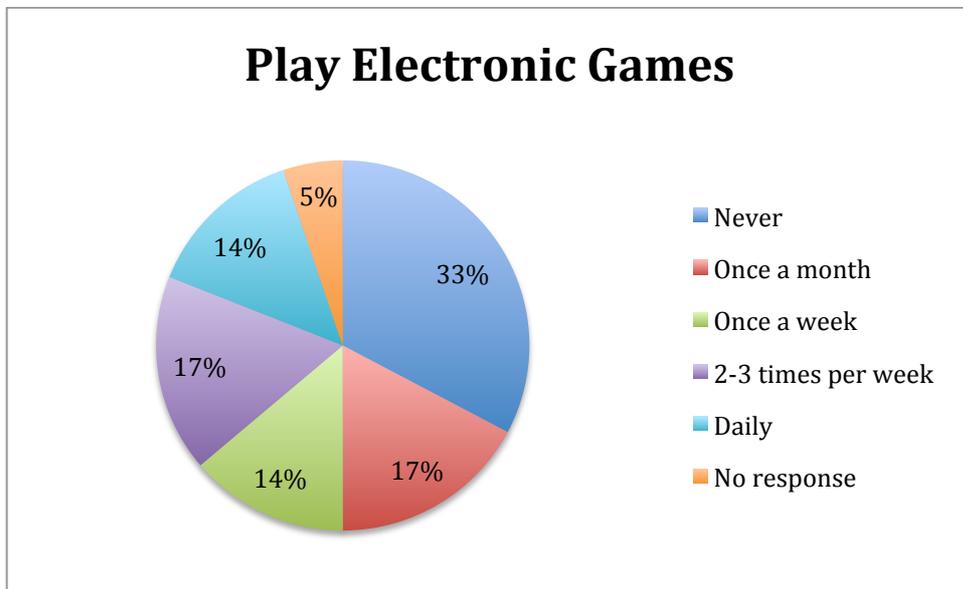


Figure 56

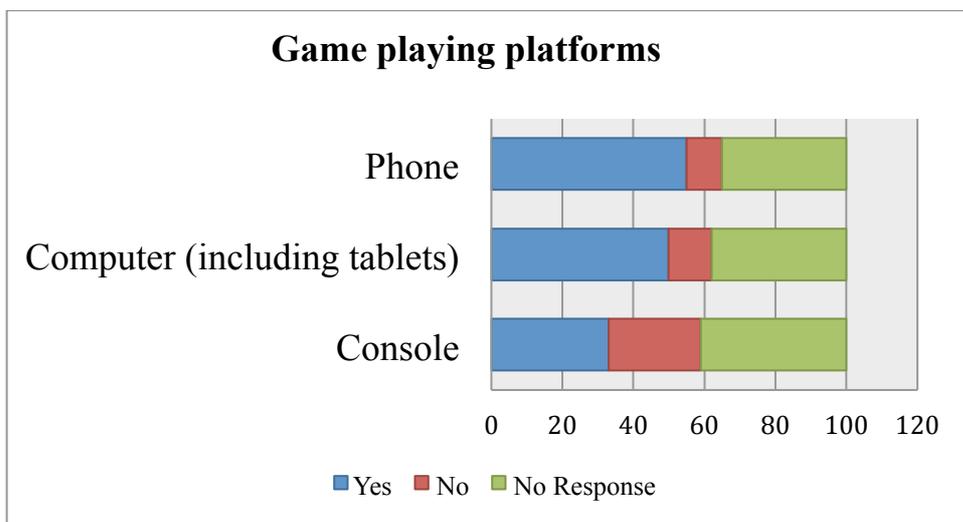


Figure 57

## **5.5 Summary of demographics and computer use responses**

Overall the respondents represent a wide range of ages and professions and an almost even number of each sex. The museum audience in general is equally wide-ranging in size and background (Falk and Dierking, 2000) so it is argued that the sample size, though on the small side, is representative. The respondents were overwhelmingly familiar with computers and nearly two thirds (62%) were currently, though to differing degrees, players of electronic games (See Figures 55 and 56). Over three quarters (79%) were familiar to some extent with the Rocks and just over a quarter (27%) were familiar with virtual museums or virtual heritage (See Figures 53 and 54).

## **5.6 Interaction strategy questions**

The author was particularly interested in discovering the user's response to having a choice of activities that used different interaction modes. She was curious to find out if users would try the different modes in a similar order, and what that order might be. She was also interested in finding out if, after trying all three modes themselves, testers would recommend the same order, or a different order, to someone else and why. She wondered if testers would have a particular mode they preferred over the other two and why. There is currently a great deal of interest in the educational potential of interactive game-styled scenarios (Looseley 2011, Mayo 2007, Michael and Chen 2005, Todd 2007, Chatham 2007, Cutting 2011, Gish and Zaia 2011, Kelly et al. 2007, Gee 2007) but in the area of heritage there is only very limited data as relatively few interactive virtual heritage games have been created (Anderson et al. 2009b, Anderson et al. 2009a). The author was interested in finding out how the passive didactic experience of the Tour would contrast with the interactive and user-directed experiences of the Game

and Explore modes. The results for these questions will be discussed in the next paragraph<sup>35</sup>.

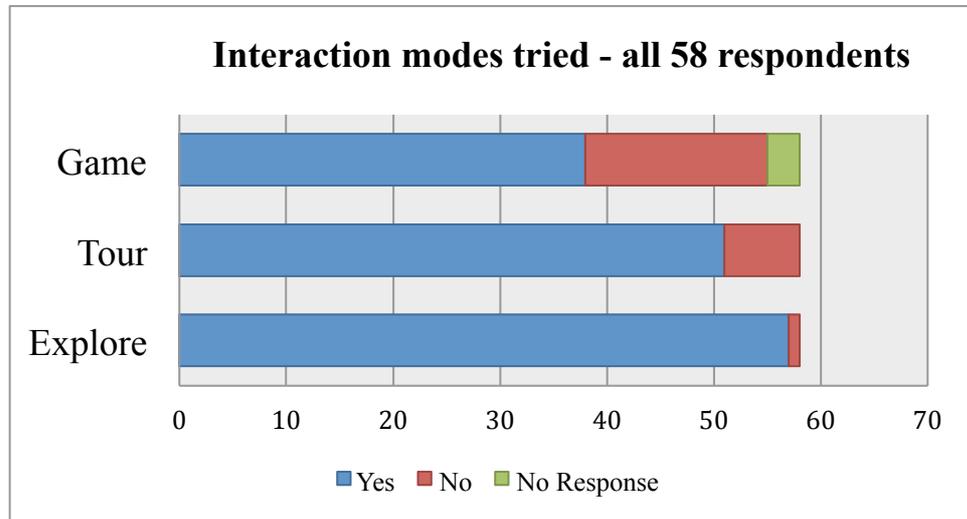


Figure 58

The Explore mode of interaction was the most popular with 57 of the 58 respondents (98%) choosing it. The Tour was the second most popular interaction mode with 51 of 58 testers (88%) or about nine in ten choosing it and the Game was the least popular with 38 of 58 (66%) or about two in three respondents opting to try it. While not as popular as the other modes, two in three represents a significant percentage of users. The author argues that it is therefore worthwhile, despite the additional work, to continue to implement all three engagement modes of Game, Tour and Explore in the revised VSR. She believes that this finding should be of interest to future developers of virtual heritage worlds.

### 5.7 Interaction modes tried by respondents

As can be seen in the pie chart in Fig.59, not all 58 respondents tried all three modes of interaction and three respondents failed to answer all the multiple-choice questions

<sup>35</sup> See Fig. 58. See Appendix 1d for the complete transcript of the responses to the questionnaire.

related to this topic. Two different interaction modes were tried by 17 respondents and a further three indicated that they had tried two modes but failed to answer yes or no to the third mode. One respondent reported trying only one mode of interaction and two respondents failed to answer the question. The remaining 34 of the 58 respondents indicated that they had tried all three modes. However, one of those reported trying the Tour first followed by the Game followed by the Tour and two others reported trying Explore followed by Game followed by Explore. Those three responses have been labeled as inconsistent responses in Fig.59 and they were not used in the following analysis. Using just the 31 respondents who tried all three modes, the following reports look at the order in which they tried the Game, Tour and Explore modes, which mode they liked the best and why and what order respondents would recommend to other people and why.

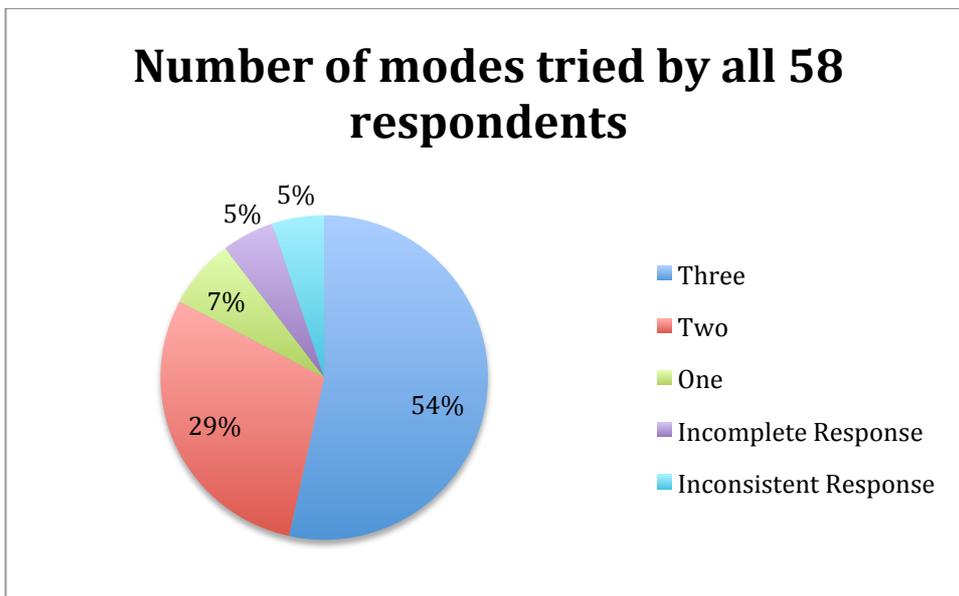


Figure 59

### **5.8 The order that the different interaction modes were tried in, by respondents who tried all three**

For the 31 respondents who reported trying all three modes of interaction there was considerable variation in the order that they tried them. There are six possible orders of interaction and these are Game-Tour-Explore, Game-Explore-Tour, Tour-Game-Explore, Tour-Explore-Game, Explore-Game-Tour and Explore-Tour-Game. As can be seen in Fig.60 three main mode orders emerged from the six possible variations. Just over a third of respondents (39%) reported doing the Tour first followed by the Game and finally the Explore mode. Just over a quarter of respondents (26%) reported doing the Tour first followed by Exploring and finishing with the Game. And just under two in five respondents (19%) decided to Explore, then play the Game and to take the Tour last. Despite the emergence of the Tour-Game-Explore (39%), Tour-Explore-Game (26%) and Explore-Game-Tour (19%) as the three main preferred orders of interaction it should be noted that each possible order of interaction was tried by at least one respondent. The author argues that it is therefore wise to continue to support user choice with regard to the three engagement modes of Game, Tour and Explore in the revised VSR. This finding should be of interest to other developers of virtual heritage worlds.

### Order of Interaction Mode by the 31 respondents who tried all three modes

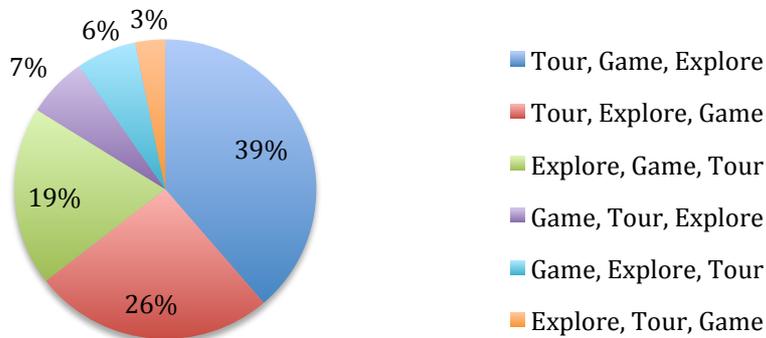


Figure 60

#### 5.9 Most liked interaction mode by respondents who tried all three modes and why

Respondents were asked to indicate which mode of interaction they liked the most and why. The Explore mode was the most liked with just under four in 10 respondents (38%) nominating it. The Game mode was the second most liked mode with three in 10 respondents (30%) choosing it and the Tour mode was the third most liked mode with just over two in 10 respondents (21%) choosing it. One respondent indicated that they preferred all three and another that they preferred the Game and Explore modes best. Respondents gave a mixture of reasons as to why they liked one mode in particular and four respondents failed to give a reason for their preferred mode. As can be seen in Fig. 61, the results indicate that while there was a preference for the Explore mode it was not an overwhelming preference. This finding provides further evidence of the wide variation in individual users with regard to interaction modes and should be of interest to future developers<sup>36</sup>.

<sup>36</sup> See Appendix 1d for the complete transcript of the responses to the questionnaire.

### Most Liked Interaction Mode by the 31 respondents who tried all three modes

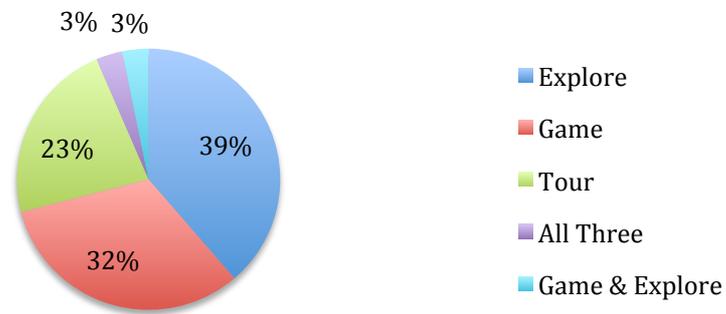


Figure 61

The popularity of the Explore mode appears to be primarily due to the amount of agency users had in that mode and to the amount of extra information they were able to access. Respondent 4 indicated that Explore was her most liked mode of interaction because there was *‘Open ended play and exploration. Let me go at my own pace.’* Respondent 14 liked the Explore mode most because she was *‘Able to go through the whole history year by year. Each building has a link to it which further elaborates on the history.’* Respondent 15 also preferred the Explore mode because it *‘Covers more of the area from first person perspective and gives more information about each specific part of the Rocks. Also lets me play with different time periods and observe the changes.’*

Several respondents who liked the Game most commented about the presence of the actual items. (The game involved finding items relating to George Cribb uncovered during the Big Dig. The actual items were on display in a glass case in the same room where the testing took place and were pointed out to testers when they had completed the Game.) Respondents 21, 33 and 34 all chose the Game as the mode they liked the

most and when asked why they commented *'The articles (objects) in the game were behind me sitting in a cabinet.'* (Respondent 21), *'Was interesting finding the historic items that are held in the museum.'* (Respondent 33) and *'Very interactive and allowed for central exploration. The items to be found in the museum adds extra appeal'* (Respondent 34).

Interestingly, nobody seemed to notice that the Game and the Tour repeated the story of George Cribb. The author had wondered whether people would notice and whether it would cause them to consider that either the Tour or the Game was redundant. So instead of boring them it is probable that hearing the George Cribb story twice, in the Tour and the Game modes, reinforced the narrative and assisted learning (Osguthorpe and Graham, 2003).

Respondents who said that the Tour was their preferred mode of interaction indicated that they liked the structured delivery of the information. Respondent 13 wrote *'Very well informed, easy to understand'* and Respondent 26 wrote *'Enjoyed the guidance and the added information about Mr Cribb - Made it more personal and engaging.'*

A number of responses indicate that some users appreciated the mixture of modes and felt that they each had something to contribute to the experience. When asked to nominate a favourite mode respondent 38 declared that *'Each had things I like (hard to nominate my favourite)'* and elaborated that *'The tour was good to give a historic backdrop to where Sydney/European settlement began. The game was fun & really helped bring the life of the butcher to life! Could have mucked around with exploring a lot more (liked the different features that showed different weather, time of year.'* Respondent 40 nominated Explore as the mode she liked the most *'Because it was fun.'*

but then goes on to say *'However the tour was necessary so as to get an idea what was going on.'*

### **5.10 Recommended order of interaction mode by respondents who tried all three modes and why**

The final question in the series of questions on interaction modes asked respondents to indicate which order of interaction they would recommend to someone else and why. As can be seen in Fig. 62, of the 31 users who tried all three modes an overwhelming majority (88%) recommended doing the Tour first. One respondent put down Tour, Explore, Third as their preferred order and that response has been included among respondents who nominated the order of Tour, Explore and then Game. The main reason given for recommending doing the Tour first was that it gave users an introduction to the VSR. The responses included *'Just to get some background on the story'* (Respondent 1), *'Good to start with a mini-explore of the history'* (Respondent 12), *'Touring first to understand the concept and the story'* (Respondent 13), *'Virtual tour gives an overview of the project'* (Respondent 15), *'Virtual tour first to give an understanding of how the landscape can come alive especially when thinking about the real people that lived here in the Rocks.'* (Respondent 20), *'Tour is a general intro'* (Respondent 21), *'Tour gives background'* (Respondent 23), *'Because I think it's good to do the tour first to get the background info'* (Respondent 29), *'If they don't know the history prior suggest tour is best intro'* (Respondent 38) and *'Tour gives you an overview'* (Respondent 44).

## Recommended order of interaction mode from the 31 respondents who tried all three modes

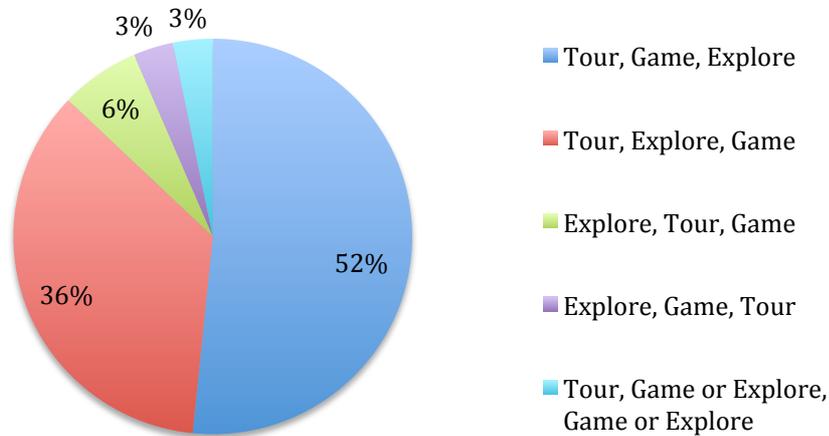


Figure 62

Opinion was more evenly divided between which was the best mode to do second with just over half of respondents (52%) recommending playing the Game after taking the Tour and just over one third of respondents (36%) recommending Exploring after taking the Tour. The reasons given for playing the Game second included ‘*Touring first to understand the concept and the story, game to better understand the tour, then explore to discover new sights*’ (Respondent 13), ‘*You need background info to understand the game and you need the game to understand what you are exploring*’ (Respondent 17), ‘*Tour is a general intro, game engages in a guided way, exploring could then go on for ages*’ (Respondent 21), ‘*Tour gives background, game gives detail, explore gives overview*’ (Respondent 23), ‘*The tour gave a good overview of George Cribb to get the player into the world of George. The game was fun and explore allowed you to make choices about the year and to watch the Rocks site change. Tour - provides an overview. Game - entertaining. Explore - more instructive and educational*’ (Respondent 36) and

*'Tour gives you an overview Game takes you through the space in a planned way which then makes your exploration an informed experience (Respondent 44).*

The reasons given for Exploring second and playing the Game last included *'Gamers may get interface immediately whereas non-gamers struggle. For mainstream user would suggest this order - giving prompt for game after 2 mins of exploration'* (Respondent 4), *'Have an overview of the tour then follow through by exploring yourself before ending it by playing the game seeing if you remember the places'* (Respondent 14), *'Virtual tour gives an overview of the project, the exploring then allows one to familiarise themselves with the Rocks, which then makes the game play more familiar in terms of navigating around & finding the right places'* (Respondent 15), *'I like the notion of learning by accident. Serendipity. Surprise. Discovery.'* (Respondent 24) and *'Overall intro to Sydney - better able to understand what you are searching for in the game. History first!'* (Respondent 30).

Comparing the actual mode order of respondents using the VSR for the first time with their recommended mode order after using all three modes reveals a significant change that reflects their evolution from inexperienced to experienced users of the VSR<sup>37</sup>. Nearly four in 10 respondents (39%) tried the Tour followed by the Game followed by Exploring but, after testing, just over five in 10 respondents (52%) recommended it as the best order to try out the different modes. This is a change of 13%. Similarly just over one in four respondents (26%) tried the Tour followed by Exploring followed by the Game and, after testing, over one in three respondents (36%) recommended it as the best order. This is a 10% difference.

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<sup>37</sup> See Figs. 60 and 62. See Appendix 1d for the complete transcript of the responses to the questionnaire.

### 5.11 Summary of responses to the questions relating to interaction modes

When users were asked which mode they liked the most there was no single mode that emerged as strongly preferred. Respondents gave considered reasons for their choice of most liked mode. For example Respondent 15 chose the Explore mode because it *'Covers more of the area from first person perspective and gives more information about each specific part of the Rocks. Also lets me play with different time periods and observe the changes'*. Respondent 29 chose the Game because it *'it was fun & interactive & informative'* and Respondent 26 chose the Tour because she *'Enjoyed the guidance and the added information about Mr Cribb - Made it more personal and engaging.'* It is clear from the responses that each individual respondent had their own preferred interaction mode and a good reason for that preference.

Respondents were also asked to recommend a particular mode order for new users and to give reasons why. Similarly there was not an overwhelming preference for one particular mode order (See Figure 62). Respondents gave very reasonable explanations for their choice of recommended mode order revealing that they had an appreciation of the ways that the different modes might be best combined so as to improve the educational aspects of the experience. For example, respondent 13 wrote *'Touring first to understand the concept and the story, Game to better understand the Tour, then explore to discover new sights'*. However, the fact that just over half recommended Tour-Game-Explore and just over a quarter recommended Tour-Explore-Game indicates that importance of different individual user preferences. Interestingly, a number of users suggested a mode order that was different to the one they undertook themselves. 39% of respondents did the modes in Tour-Game-Explore but that order was recommended by 52% of respondents. Similarly 26% of respondents did Tour-Explore-Game and 36% recommended it as the best order. Rather than there being a

single preferred interaction mode for all users, what emerges from the data is that different users like different interaction modes. Also, given the strong, though differing, recommendations from experienced users for new users to do either the Tour, Game, Explore order (52%) and the Tour, Explore, Game order (36%), the best option would be to support the ability of users to choose the individual mode order that suits them best. Imposing the order of Tour, Game and Explore on all users would, on the strength of these results, leave nearly half of them (48%) unhappy.

Given that individual user factors are a significant contributor to engagement/presence in virtual environments, then catering for a range of different user preferences with regard to interaction mode should improve user engagement and the resulting user experience of the VSR. It is therefore argued that the revised VSR should retain the three interaction modes and should continue to give users choice as to which modes they use and in what order. Agency is a powerful contributor to presence and it should be noted that, within the VSR, user agency in the Explore and Games modes is not limited to navigable space but also includes navigable time. This finding should be of interest to future developers of virtual heritage worlds.

### **5.12 Place, Presence and Learning questions**

The next section deals with the responses to the Place, Presence and Learning questions. The first four questions were concerned with Place and Presence. Users were asked to indicate how much of a *'feeling they had of being in the Rocks at different times'* in the three different modes of Tour, Game and Explore. Then they were asked to indicate which interaction mode was the most effective at making them feel like they were actually there. This question was intended to draw a distinction between the basic sense

of physical immersion experienced in a virtual environment and a feeling of cultural immersion in virtual heritage world.

The second set of four questions were concerned with learning in a virtual heritage context. Respondents were asked to indicate if they had learned some of the history of the Rocks in the three different modes of Tour, Game and Explore. They were then asked to indicate which interaction mode was most effective at teaching them the history of the Rocks and invited to say why.

The third set of four questions were concerned with learning in a time-based virtual heritage world. Respondents were asked to indicate how much they had learned about how Sydney had changed over time in the three different modes of Tour, Game and Explore. They were then asked to indicate which interaction mode was most effective at showing how the Sydney Rocks had changed over time and invited to say why.

### **5.13 The Feeling of Being in the Rocks at Certain Times**

Respondents were asked to rate the degree to which the different interaction modes of Tour, Game, and Explore gave them '*the feeling of being in the Rocks at different times*'. A six point Likert scale was used where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree. As discussed in Section 4.26 the author decided to use a six point Likert scale because it forced testers to indicate either a negative or a positive response to the question. Respondents were then asked '*Which way of interacting was most effective at making you feel like you were actually there?*' and '*Why?*' The responses from all 58 respondents are summarised in Figs.14-16 along with those of the 31 respondents who tried all three modes.

**5.14 Responses to the statement ‘The Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times.’**

For the Tour, 30 out of 58 respondents (52%), or just over half, agreed with the statement ‘*The Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times.*’ And just over a fifth (21%) strongly agreed. This gives a combined positive feedback of 73% of respondents who either agreed or strongly agreed. A similar pattern emerges when looking at the responses from the 31 respondents who tried all three modes. Just over half agreed (55%) and just over a quarter (26%) strongly agreed, giving a combined positive feedback of 81% of respondents who either agreed or strongly agreed (See Figures 63-65).

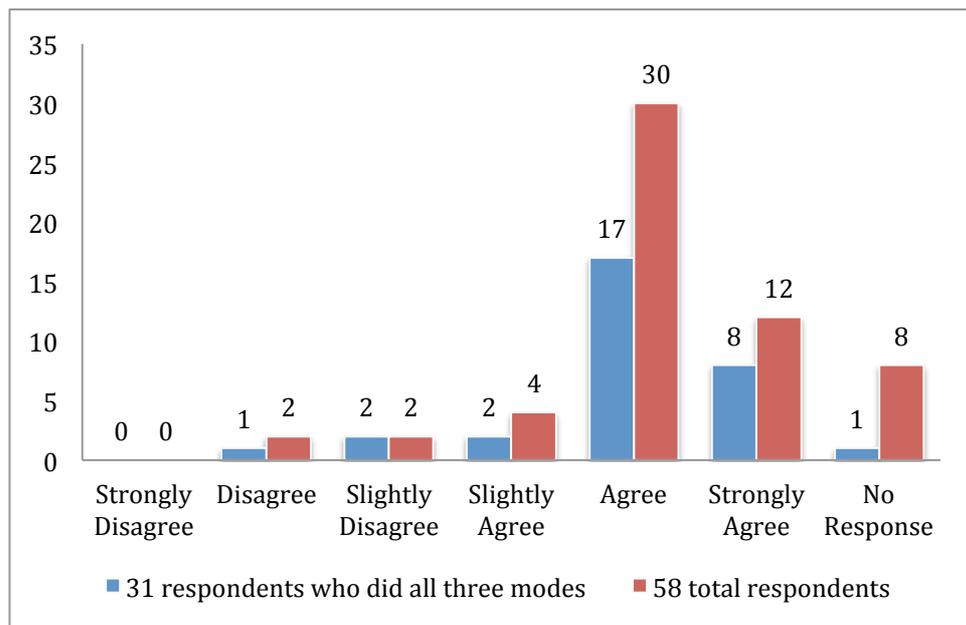


Figure 63 Responses to the statement ‘the Virtual Sydney Rocks Tour gave me a feeling of what it was like to be in the Rocks at different times’

**The VSR Tour gave me a feeling of what it was like to be in the Rocks at certain times - responses from all 58 respondents**

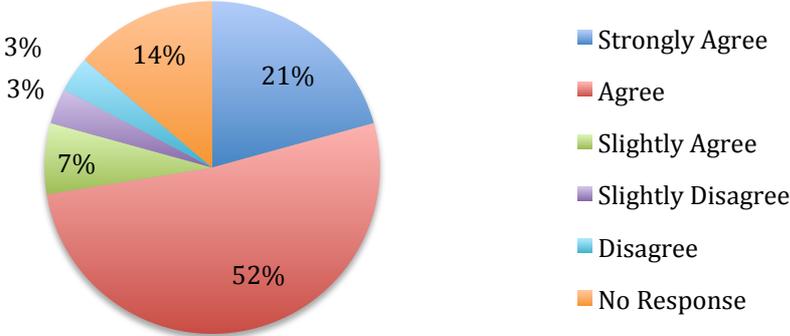


Figure 64

**The VSR Tour gave me a feeling of what it was like to be in the Rocks at certain times - responses from the 31 respondents who tried all three modes**

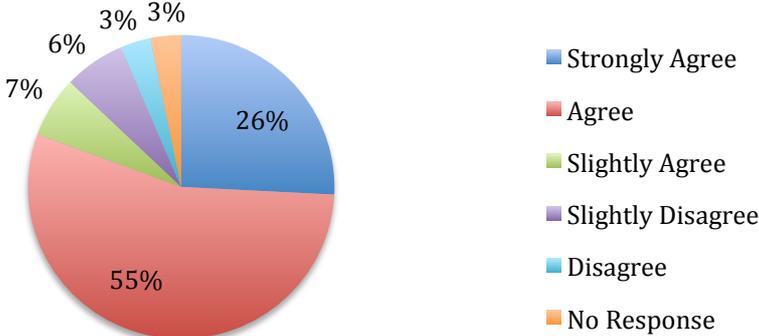


Figure 65

**5.15 Responses to the statement ‘The Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times.’**

For the Game, 18 out of 58 respondents, or just under a third (31%), agreed with the statement ‘*The Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times*’ and just over a fifth (21%) of respondents strongly agreed. This gives a combined positive feedback of 52% from all respondents (See Figures 66-68).

However, a number of people did not play the game and if the ‘no response’ responses are removed then just under half (45%) of respondents agreed with the statement and nearly a third (30%) of respondents strongly agreed. This gives a combined positive feedback of 75%.

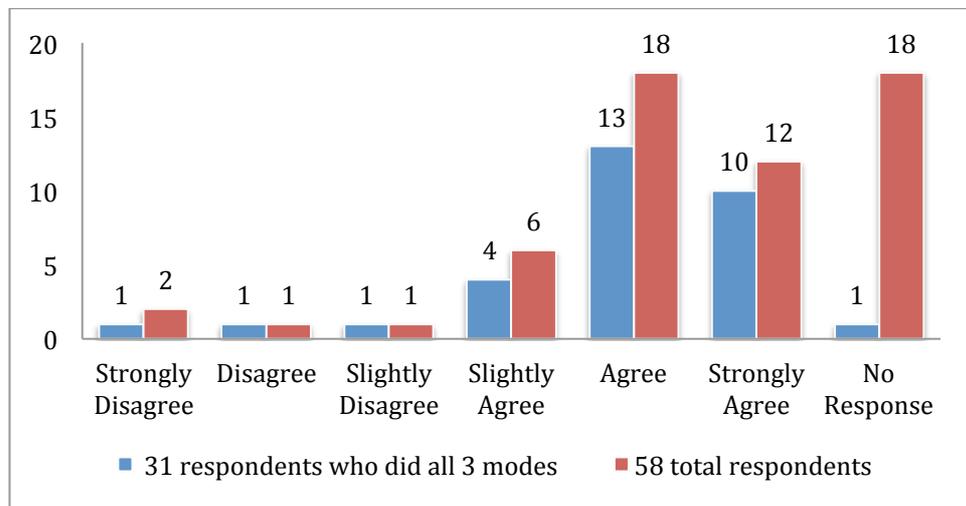


Figure 66 Responses to the statement ‘the Virtual Sydney Rocks Game gave me a feeling of what it was like to be in the Rocks at different times’

**The VSR Game gave me a feeling of what it was like to be in the Rocks at certain times - responses from all 58 respondents**

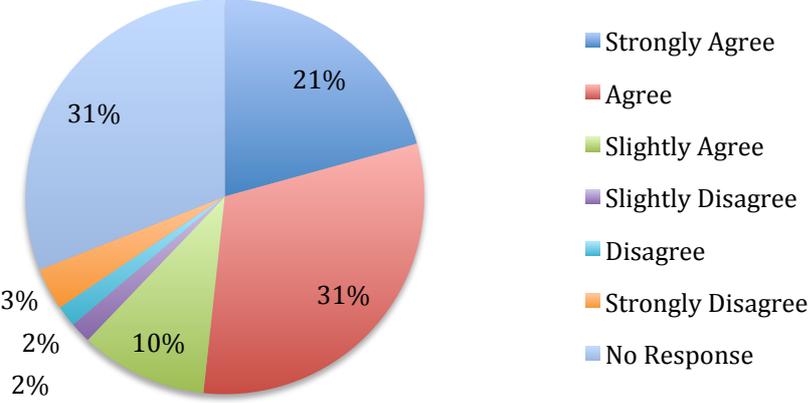


Figure 67

**The VSR Game gave me a feeling of what it was like to be in the Rocks at certain times - responses from the 31 respondents who tried all three modes**

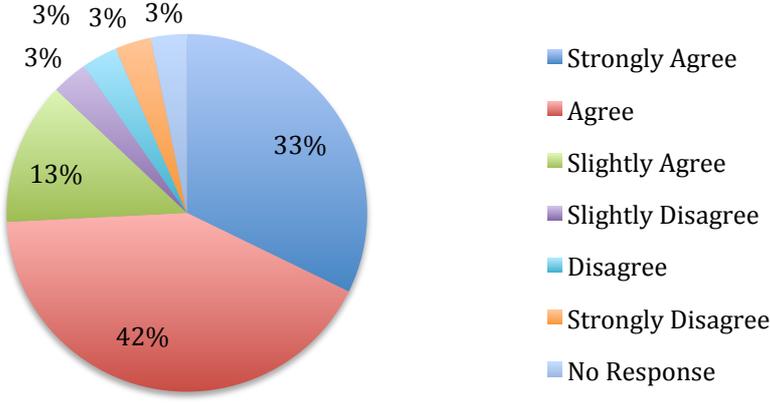


Figure 68

**5.16 Responses to the statement ‘Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times.’**

For the Exploring mode, exactly half (50%), agreed with the statement ‘*Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times.*’ And just under a third of respondents (31%) strongly agreed. This gives a combined positive feedback of 81% from all respondents. A similar result emerges when looking at the responses from the 31 respondents who tried all three modes. Just under a half (45%) agreed and the same number (45%) strongly agreed giving a combined positive feedback of 90% (See Figures 69-71).

All three interactions modes were able to give users a feeling of being in the Rocks at certain times but both the Tour (81%) and the Explore (90%) modes were better than the Game mode for doing this (75%).

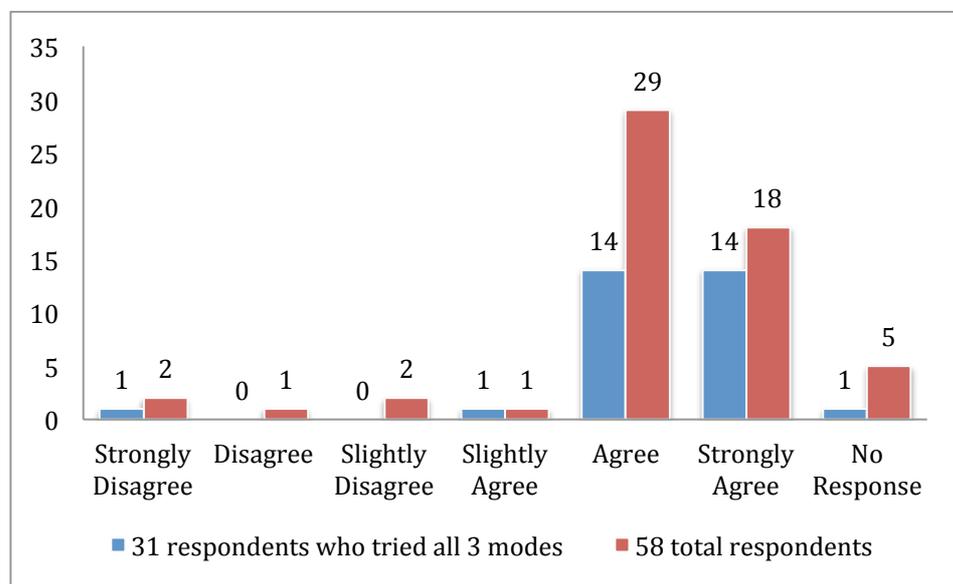


Figure 69 Responses to the statement ‘Exploring the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times’

**Exploring the VSR gave me a feeling of what it was like to be in the Rocks at certain times - responses from all 58 respondents**

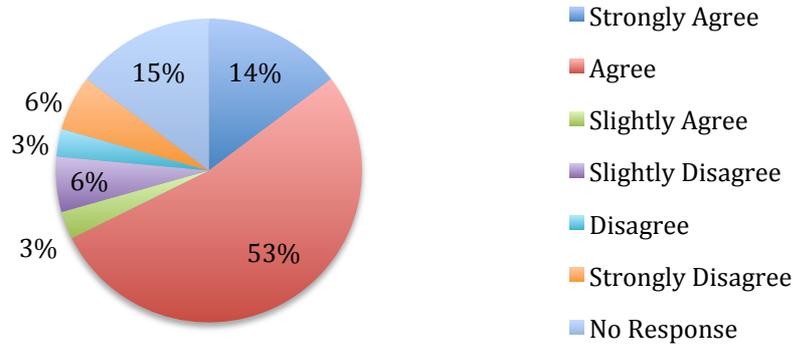


Figure 70

**Exploring the VSR gave me a feeling of what it was like to be in the Rocks at certain times - responses from the 31 respondents who tried all three modes**

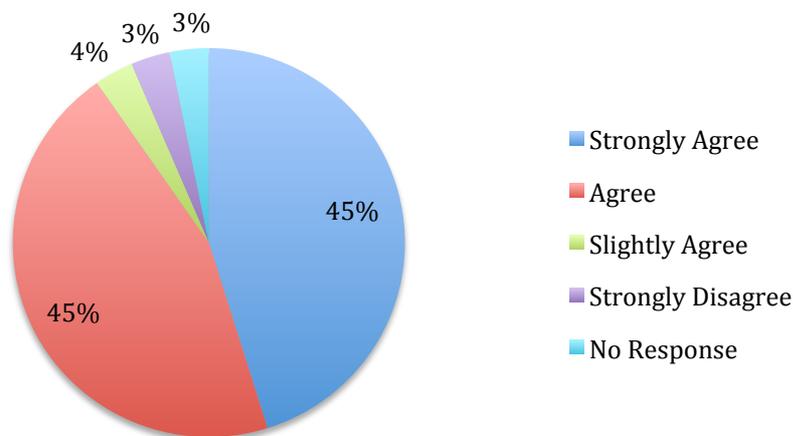


Figure 71

### **5.17 Responses to the questions ‘Which way of interacting was the most effective at making you feel like you were actually there and why?’**

As this question asked respondents to compare the three different interaction modes the analysis of the responses has been restricted to the 31 respondents who completed all three modes. The author had hoped that the responses to this question would shed some light on the difference between virtual physical presence (a phenomenological experience) and cultural presence (a cognitive experience). However, the answers seem to reveal that the question was answered as if it had been asked *‘Which way of interacting was the most effective at making you feel the most engaged and why?’* In retrospect this would make a better question anyway.

The Explore mode, which offered respondents the ability to explore at will in space and time, was considered the most effective at making users feel like they were actually there. Just over half of respondents (55%) chose it and just under a quarter (23%) chose the game mode (See Figure 72). It is not surprising that the two modes which gave the user more agency were preferred by users. What is surprising is that four respondents considered that the Tour was the best at making them feel like they were actually there. The main reason for this seems to be the structured information they received. The next section examines in detail some of the individual responses.

**Which way of interacting was the most effective at making you feel like you were actually there? - responses from the 31 respondents who tried all three modes**

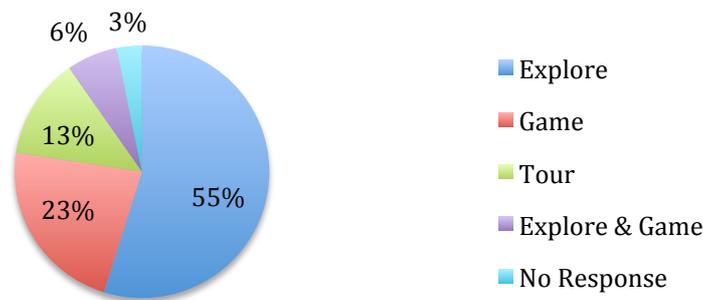


Figure 72

**5.18 Why was Exploring the most effective at making you feel like you were actually there?**

Most of the reasons people gave as to why they preferred Exploring had to do with personal preference. Respondent 4 declared that *'Story/game mission did not grab me but historical research did'* and Respondent 20 speculated that *'Probably because I know the area well it was easy to imagine walking down the very same streets 100 or 150 or 180 years ago!'* Several respondents indicated that they preferred the freedom of movement with comments such as *'The game was a good concept because it forces you to look closely at the details and interact with a time and a place. However I prefer freestyle exploring and asking questions about what I see.'* (Respondent 40), *'Freedom of movement'* (Respondent 43) and *'Make your own way'* (Respondent 19). Respondent 24 said that *'I found myself not thinking about the creator's intention so much. It is in a sense the least directed and there is more self determination. The tour is great but narration gives it a more historical rather than experiential feel.'* (Respondent 24).

Another popular reason given for preferring the Explore mode was the freedom to travel through time at will. Some comments specifically mentioned the navigable time affordance of the VSR, such as *'Exploring through time in particular, wandering around'* (Respondent 21), *'Speed functionality made it possible to see change visually'* (Respondent 31), *'Being able to jump through different times and the graphics of exploring'* (Respondent 33), *'Allowed for freedom to explore different areas and times more freely. As well as giving information on the different buildings and aspects.'* (Respondent 34) and *'See different areas, change date'* (Respondent 39)

### **5.19 Why was playing the Game the most effective at making you feel like you were actually there?**

People who chose the Game as being most effective at making them feel like they were actually there cited the extra engagement that resulted from having tasks to do in a virtual world. Comments included *'Having to search for items that then relate to main figures in history gave it a more immersive feeling. Exploring is also really good but the game adds another level to the experience.'* (Respondent 15) and *'The game enforced a goal-based direction'* (Respondent 26). Other respondents mentioned the higher level of detail for the buildings associated with George Cribb. Respondent 1's response was *'More detailed and closer view of artefacts and buildings'* and respondent 36 said *'Moving through the laneways, up & into George's house, the animals in the backyard - priceless!'* (Respondent 36).

### **5.20 Why was taking the Tour the most effective at making you feel like you were actually there?**

People who chose the Tour as being most effective at making them feel like they were actually there seemed to prefer to have information delivered in a structured format. Respondent 44 said that *'It was nice to have such a great overview without having to navigate'*, Respondent 30 said *'More info given - quicker coverage of info'* and Respondent 29 said *'I think because I saw this first & I enjoyed the voice-over and historical information & I really enjoyed George's personal story'*.

### **5.21 What way of interacting with the VSR was the most effective at making you feel like you were actually there?**

Respondents have expressed a range of preferences with 55% opting for the Explore mode, 23% for the Game mode and 13% for the Tour mode as being the most effective at making them feel like they were actually there. Individual user preference is a significant factor in engagement in virtual worlds (Devine, 2007; Kaber et al., 1999; Jurnet et al., 2005; Howe and Sharkey, 1998) and these results suggest that supporting a range of interaction modes will increase user engagement with virtual heritage. Restricting the interaction mode to only that of Exploring would disappoint the 36% of users who preferred the Game and the Tour (See Figure 72).

### **5.22 Summary of responses to the questions relating to the feeling of being in the Rocks at certain times**

Looking at the quantitative data from the multiple choice questions it is clear that there was an overwhelmingly positive response from respondents with regard to the three interaction modes and the creation of *'a feeling of what it was like to be in the Rocks at various times'*. This positive response is backed up by the detailed individual responses

to the questions asking respondents why they thought a particular mode was better at making them feel like they were ‘actually there’.

Also what emerges from the data is that there is not one particular mode that works best. Individual user preferences among the museum audience translate into a range of preferred interaction modes among museum visitors. Giving users a choice from a range of interaction modes that address individual user preferences results in a more enjoyable experience for each individual user.

### **5.23 Learning some of the history of the Sydney Rocks**

The second four questions in this section on Place, Presence and Learning are concerned with learning in a virtual heritage context. Respondents were asked to indicate if they had learned some of the history of the Rocks in the three different modes of Tour, Game and Explore. They were then asked to indicate which interaction mode was most effective at teaching them the history of the Rocks and invited to say why.

Respondents were asked to rate the degree to which they *‘learned some of the history of the Sydney Rocks’* from the different modes. A six point Likert scale was used where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree. As discussed in Chapter 4, Section 4.26 the author decided to use a six point Likert scale because it forced testers to indicate either a negative or a positive response to the question. Respondents were then asked *‘Which way of interacting helped you learn most about the history of the Sydney Rocks?’* and *‘Why?’* The responses from all 58 respondents are summarised in Figs. 73-75 along with those of the 31 respondents who tried all three modes.

**5.24 Responses to the statement ‘I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour.’**

For the Tour, 17 out of 58 respondents, or just under a third (29%), agreed and nearly a half (48%) strongly agreed with the statement ‘I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour’. This gives a combined positive feedback of 77% and an even stronger endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. Just under a third (29%) agreed and nearly two thirds (65%) strongly agreed giving a combined positive feedback of 94% (See Figures 73-74).

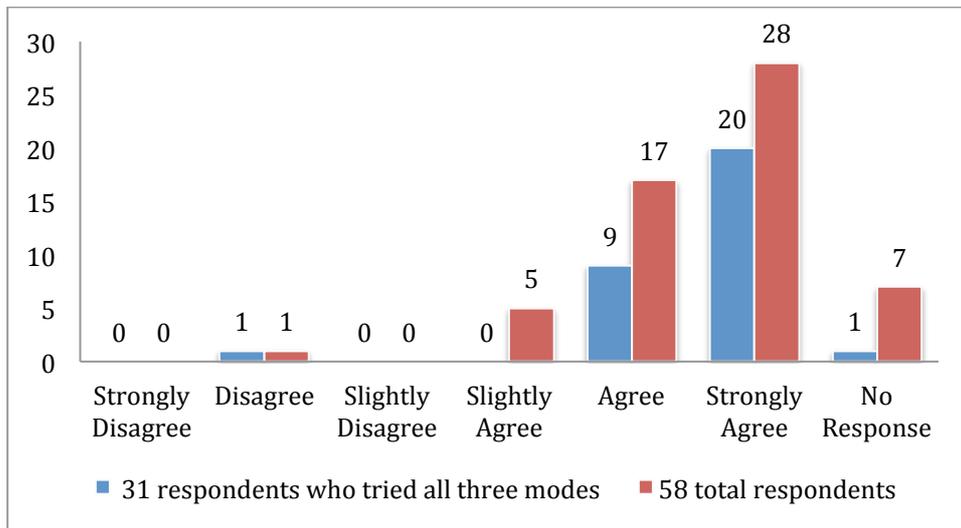


Figure 73 Responses to the statement ‘I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour.’

**I learned some of the history of the Sydney Rocks by taking the VSR Tour - responses from all 58 respondents**

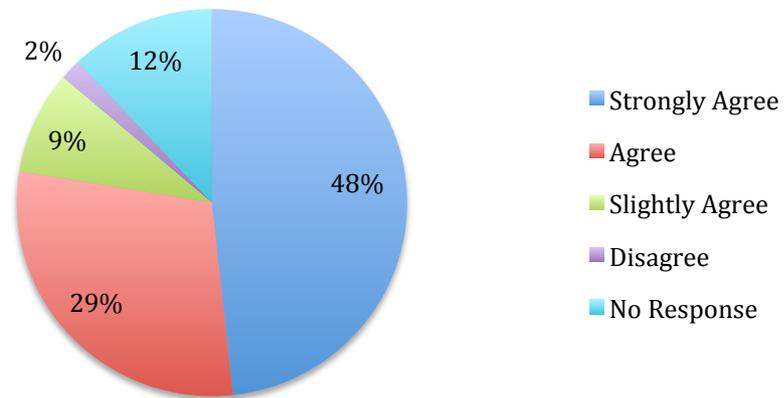


Figure 74

**I learned some of the history of the Sydney Rocks by taking the VSR Tour - responses from the 31 respondents who tried all three modes**

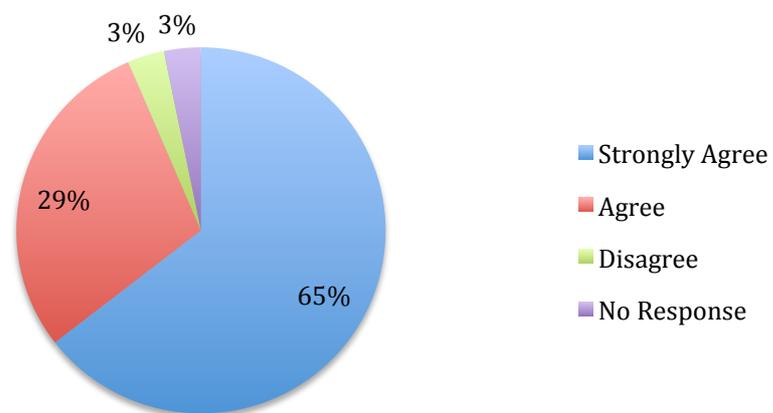


Figure 75

### 5.25 Responses to the statement ‘I learned some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks Game.’

For the Game, just over a fifth (22%) of respondents agreed, and just over a third (35%) strongly agreed, with the statement ‘I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks Tour’. This gives a combined positive feedback of 57% from all 58 respondents. A much stronger endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. Just under a third (29%) agreed and just over a half strongly agreed (65%) giving a combined positive feedback of 94% (See Figures 76-78).

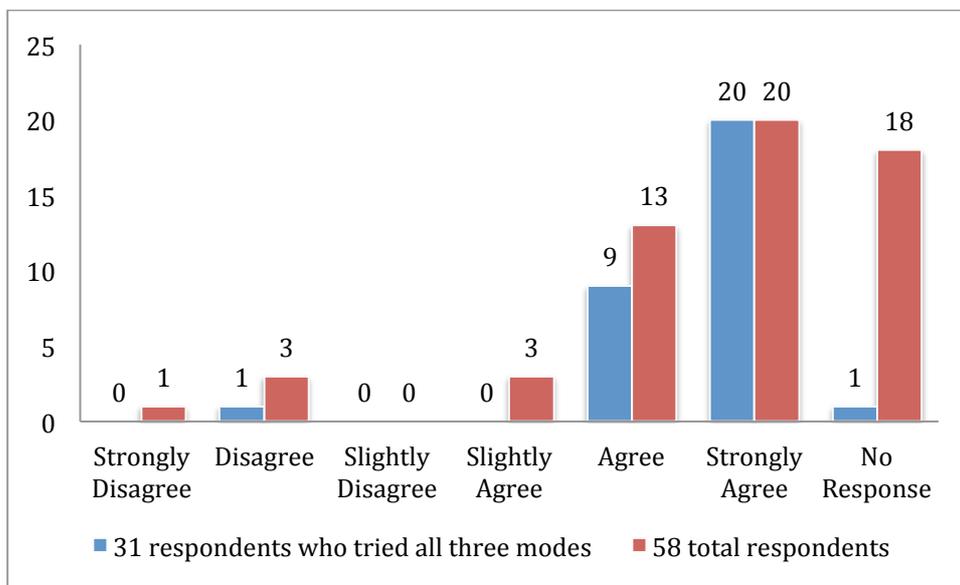


Figure 76 Responses to the statement ‘I learned some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks Game.’

**I learned some of the history of the Sydney Rocks by playing the VSR Game - responses from all 58 respondents**

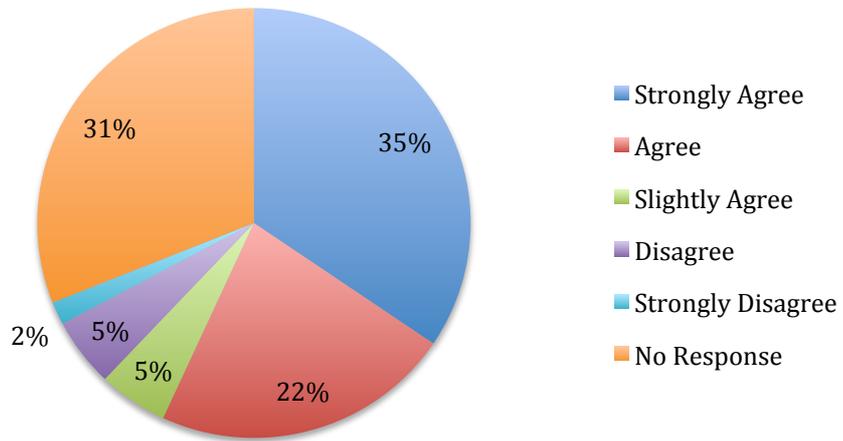


Figure 77

**I learned some of the history of the Sydney Rocks by playing the VSR Game - responses from the 31 respondents who tried all three modes**

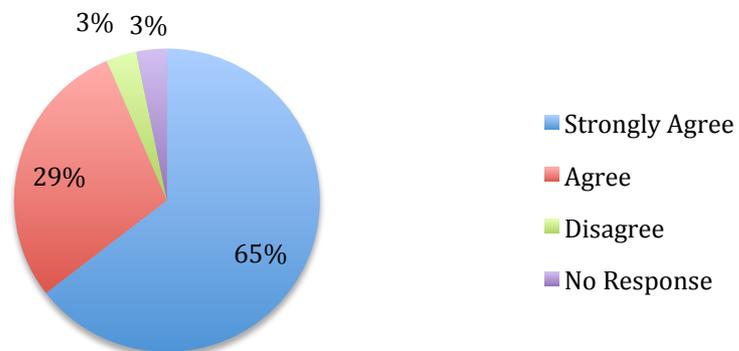


Figure 78

### 5.26 Responses to the statement ‘I learned some of the history of the Sydney Rocks while Exploring the Virtual Sydney Rocks.’

In the Exploring mode, just under a third (29%) of respondents agreed, and just under a half (48%) strongly agreed, with the statement ‘I learned some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks Game’. This gives a combined positive feedback of 77% from all 58 respondents. A slightly stronger endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. Just under a quarter agreed (23%) and nearly two thirds (61%) strongly agreed giving a combined positive feedback of 84% (See Figures 79-81).

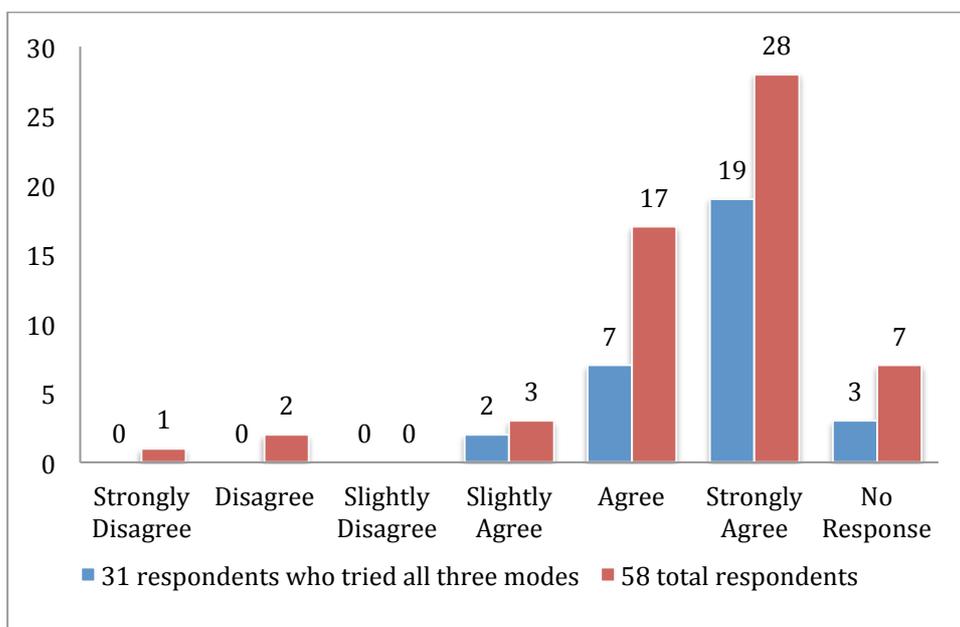


Figure 79 Responses to the statement ‘I learned some of the history of the Sydney Rocks while Exploring the Virtual Sydney Rocks.’

**I learned some of the history of the Sydney Rocks while Exploring the VSR - responses from all 58 respondents**

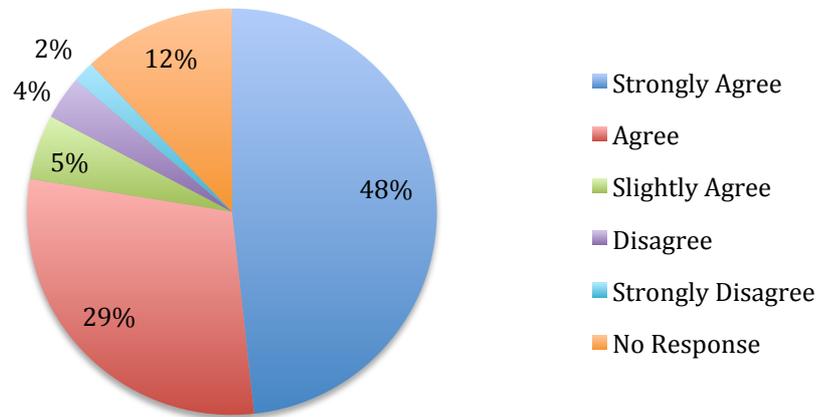


Figure 80

**I learned some of the history of the Sydney Rocks while Exploring the VSR - responses from the 31 respondents who tried all three modes**

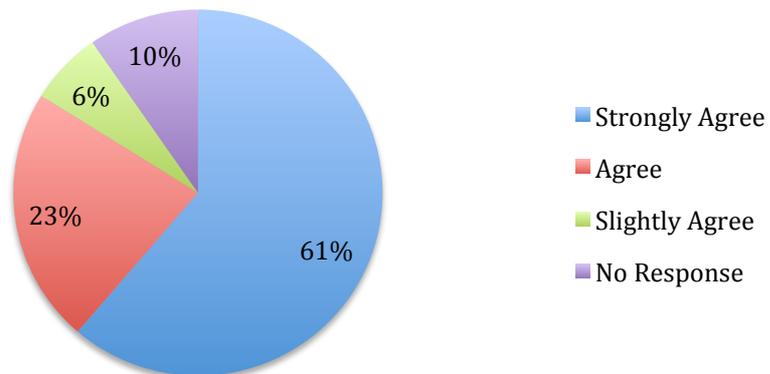


Figure 81

### 5.27 Responses to the questions ‘Which way of interacting helped you learn most about the history of the Sydney Rocks and Why?’

As this question asks respondents to compare the three different interaction modes this analysis is restricted to the 31 respondents who completed all three modes. The Explore mode, which offered respondents the ability to explore at will in space and time, was considered the mode that helped the most with learning about the history of the Rocks. Over a third of respondents (39%) chose it and just under a third (32%) chose the Tour mode (See Figure 82). The next section examines some of the individual reasons given by respondents.

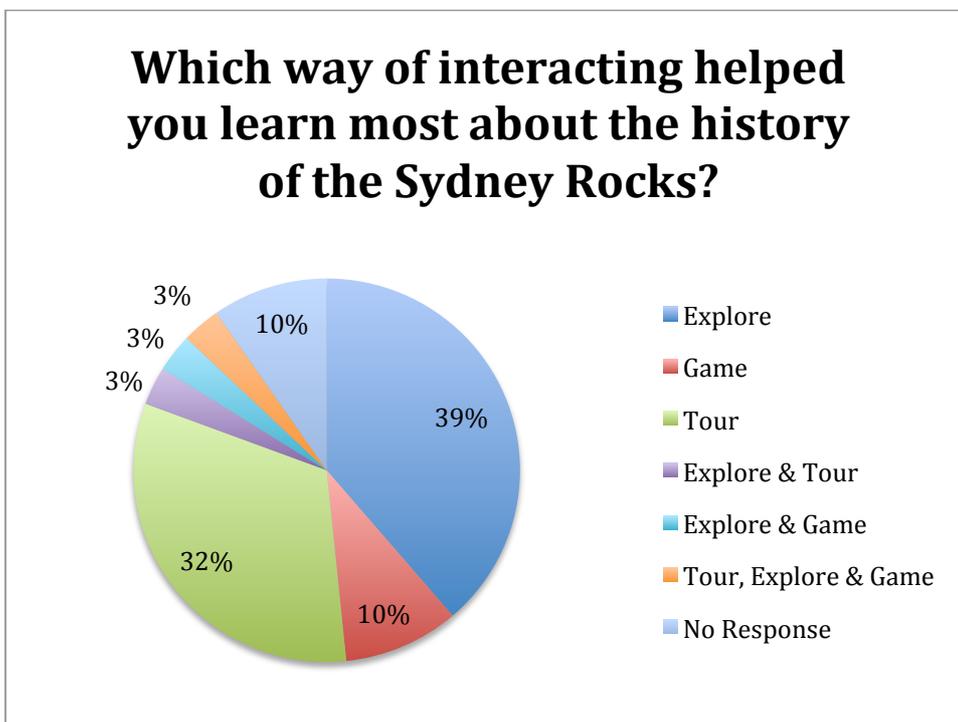


Figure 82 Responses to the question ‘Which way of interacting helped you learn most about the history of the Sydney Rocks?’ from the 31 respondents who tried all three modes of interaction

### 5.28 Why was Exploring the most effective interaction mode for helping you learn

### **some of the history of the Sydney Rocks?**

Exploring was the most effective mode for promoting learning for about a third of respondents who tried all three interaction modes. Respondents who chose Exploring were then asked to say why. The ability to access significant amounts of authoritative information and to travel in time were the two most common features mentioned. Respondent 14 said that in the Explore mode she was *'Able to see the whole building history. Shows me how Sydney Rocks has changed over the years & tells me the history with the links provided'*, Respondent 15 mentioned *'More time to look around and better access especially with the web links and other related sites.'* Similar comments include *'Clicking on various buildings to access further information'* from Respondent 36, *'Enabled me to set up & then follow time-lapse of developments (e.g. Argyle cutting) - once I knew to click on items e.g. buildings to obtain more info'* from Respondent 38 and *'I was able to focus on the things that were of interest. I liked being able to click onto buildings and call up their history'* from Respondent 40.

### **5.29 Why was taking the Tour the most effective interaction mode for helping you learn some of the history of the Sydney Rocks?**

As shown in Figure 82, taking the Tour was considered the most effective mode for promoting learning by a slightly smaller group than the people who chose Exploring (32% vs 39%). Respondents who chose the Tour were asked to say why. The main reason that the Tour was considered so effective at teaching the history of the Rocks was that the information was delivered in a structured way. Among the responses were *'The explanation is clear, you get to picture the scenario'* from Respondent 13, *'Listening to info is easier than reading (LAZY)'* from Respondent 30, *'The history was clearly and well explained to me'* from Respondent 33 and *'Narration gave information*

in a 'ready to consume' state' from Respondent 34.

### **5.30 Why was playing the Game the most effective interaction mode for helping you learn some of the history of the Sydney Rocks?**

Only 10% of respondents chose the Game as the most effective interaction mode for learning but when they were asked to say why they said that the game promoted engagement and therefore learning. Respondent 17 said '*Because there was more purpose to the learning - you have goals to achieve which leads to learning*', Respondent 20 said '*Probably the game because I feel this way of interacting & learning about history is more affective for remembering & actually "learning" the history. But if you spend more time in the virtual world exploring & clicking in to all the links available - there is such a huge database of information to be explored*' and Respondent 46 said '*getting involved helps learning*'.

Several people chose two modes equally. Respondent 12 said '*I like both game & explore, they helps me to have a better understanding of the history*'. Respondent 29 said '*I think the Tour and Explore as you can get additional information from the guidebook on the right by clicking on various things & also from the voice-over on the Tour.*'

### **5.31 Summary – Which way of interacting helped you learn most about the history of the Sydney Rocks?**

There was an overwhelmingly positive response from respondents with regard to giving users '*learning some of the history of the Rocks*'. This positive response applies to all three modes of Tour, Game and Explore and across both the subgroup of 31 users who tried all three modes and the full group of all 58 respondents. The interaction modes of

Tour (39%) and Explore (32%) were seen as the stronger modes with the Game mode only garnering 10% support as the best mode for learning. This is an interesting finding given the current enthusiasm for Serious Games. It may be the case that the game was not very good and that a better game might produce a different outcome. As will be seen later, improving the game is one of the key suggestions from respondents for the VSR. The main finding here is that there is not one particular interaction mode that works best with all users and the revised VSR should retain the three different modes. This should be of interest to other developers of virtual heritage.

### **5.32 Seeing how the Sydney Rocks has changed over time**

The last four questions in this section on Place, Presence and Learning are concerned with learning in a time-based virtual heritage world. Respondents were asked to indicate how much they had learned about how Sydney had changed over time in the three different modes of Tour, Game and Explore. They were then asked to indicate which interaction mode was most effective at showing how the Sydney Rocks had changed over time and invited to say why.

Respondents were asked to respond to the statement *'I saw how the Sydney Rocks has changed over time'* when using the different modes. A six point Likert scale was used where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree and 6 = strongly agree. As discussed in Chapter 4, Section 4.26 the author decided to use a six point Likert scale because it forced testers to indicate either a negative or a positive response to the question. Respondents were then asked *'Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time?'* and *'Why?'* The responses from all 58 respondents are summarised in Figures

83-85 along with those of the 31 respondents who tried all three modes<sup>38</sup>.

### 5.33 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks Tour’.

For the Tour, just over a fifth of respondents (22%) agreed, and exactly a half (50%), strongly agreed with the statement ‘I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks Tour’. Together this gives a combined positive feedback of 72% from all 58 respondents. A similar endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. One in six agreed (16%), and nearly two thirds strongly agreed (61%) receiving a combined positive feedback of 77%.

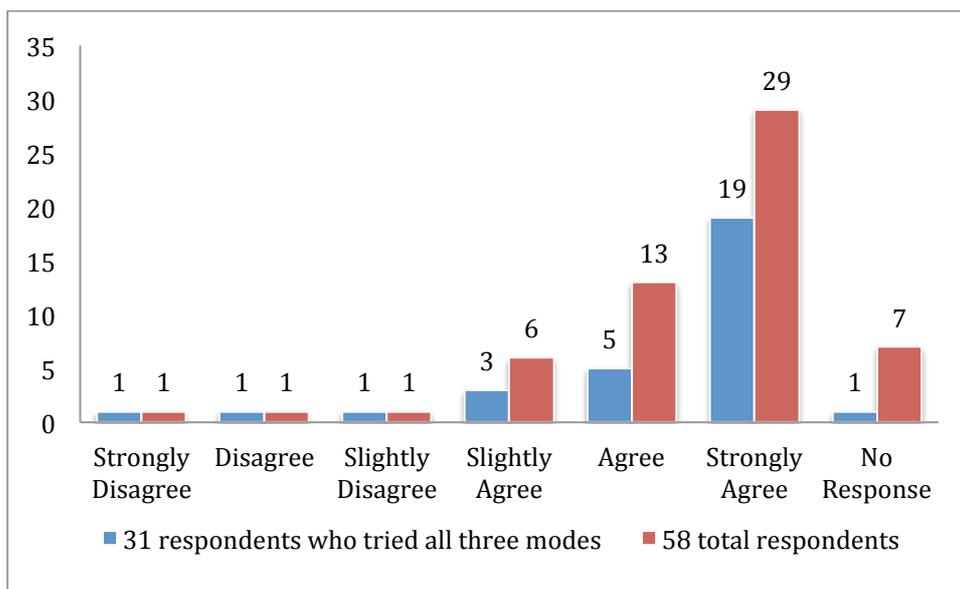


Figure 83 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks Tour.’

<sup>38</sup> See Appendix 1d for the complete transcript of the responses to the questionnaire.

**I saw how the Sydney Rocks has changed over time by taking the VSR Tour - responses from all 58 respondents**

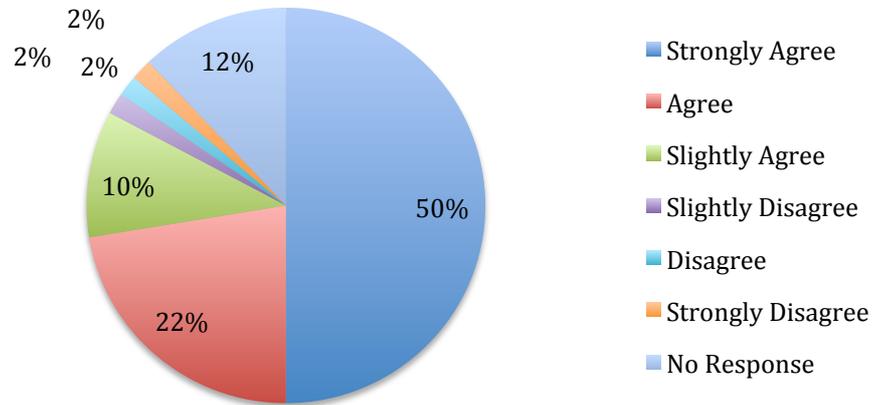


Figure 84

**I saw how the Sydney Rocks has changed over time by taking the VSR Tour - responses from the 31 respondents who tried all three modes**

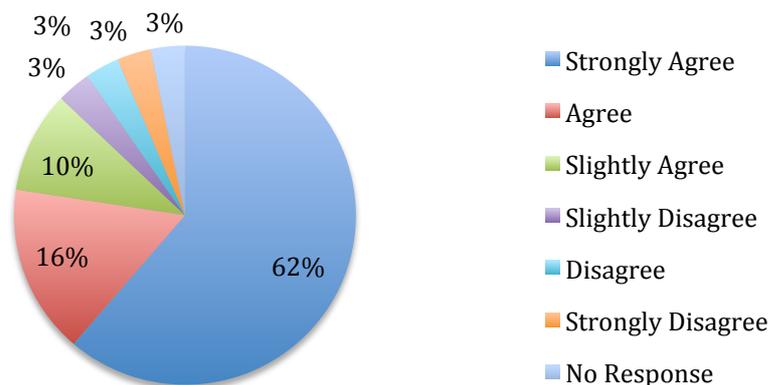


Figure 85

### **5.34 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks Game’.**

For the Game, just over a quarter (26%) of respondents agreed, and one in ten (10%) strongly agreed, with the statement *‘I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks Game’*. This gives a combined positive feedback of only 36% of all respondents. The question is only relevant to people who have played the game and the game was the least tried of the three modes. If the 18 respondents who gave no response to this question are excluded the result is quite different. The percentage who agree with the statement rises to 38% (15 of 40 responses not 15 of 58 responses) and strongly agreeing rises to 15% (6 of 40 responses not 6 of 58 responses) giving a combined positive response of 53%.

A slightly stronger endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. As shown in Figures 86-88, just under a third agreed (32%), and one in six (16%), strongly agreed giving a combined positive feedback of 48%. The time travel part of the game involves a period of about 20 years and the main change to the built environment is the addition of some stables behind the Cribb’s properties on Gloucester Street. The change in the Sydney Rocks over time is not very noticeable during the course of the game so a lower positive response was expected when compared with seeing how the Sydney Rocks had changed over time in the other two modes of Tour and Explore.

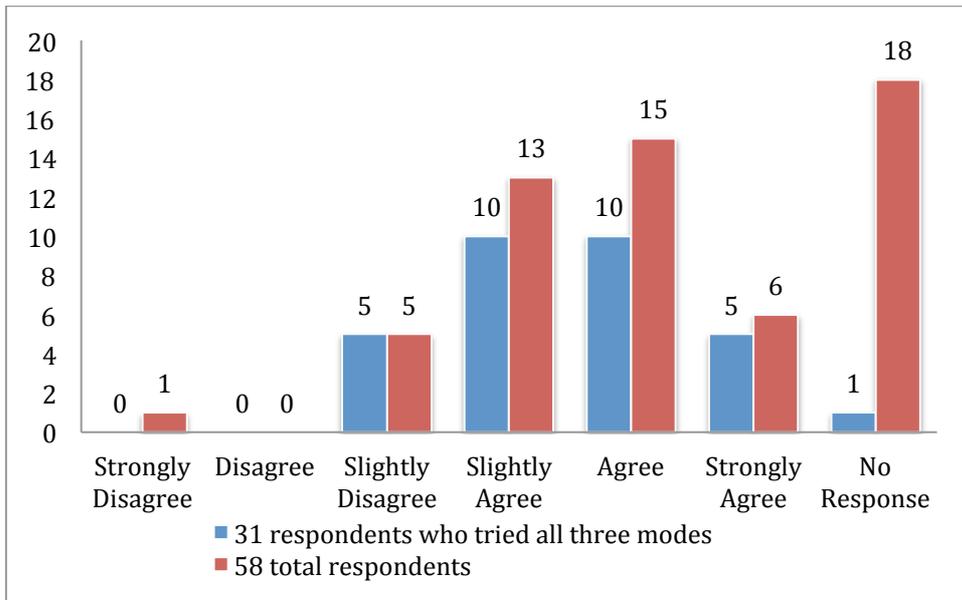


Figure 86 Responses to the statement 'I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks Game.'

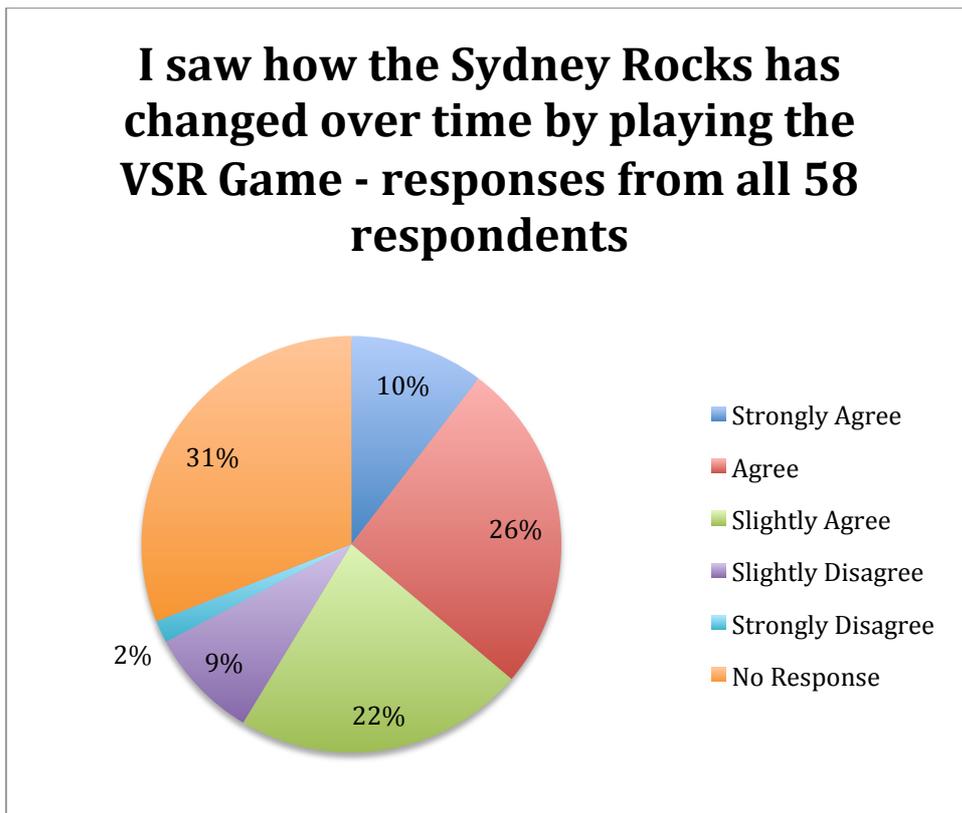


Figure 87

**I saw how the Sydney Rocks has changed over time by playing the VSR Game - responses from the 31 respondents who tried all three modes**

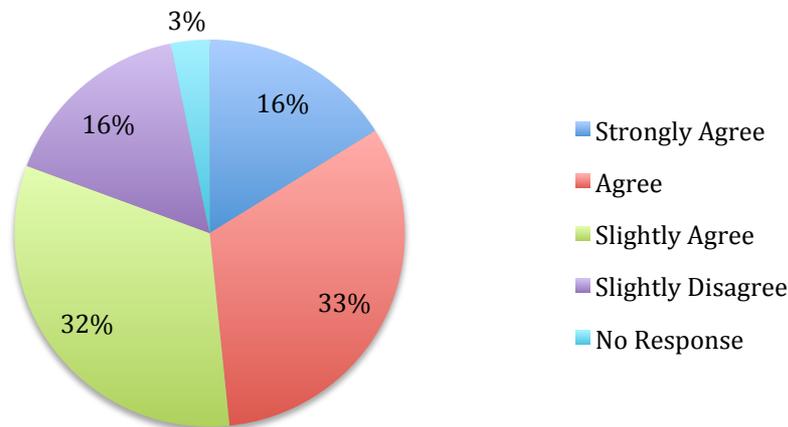


Figure 88

**5.35 Responses to the statement ‘I saw how the Sydney Rocks has changed over time by Exploring the Virtual Sydney Rocks’.**

Just under a quarter of respondents (24%) agreed, and just over half (52%) strongly agreed, with the statement ‘*I saw how the Sydney Rocks has changed over time by Exploring the Virtual Sydney Rocks*’. This gives a combined positive feedback from 76% of all respondents. An even stronger endorsement emerges when looking at the responses from the 31 respondents who tried all three modes. Just under a fifth (19%) agreed, and nearly two thirds (61%) strongly agreed giving a combined positive response from 80% of respondents (See Figures 89-91).

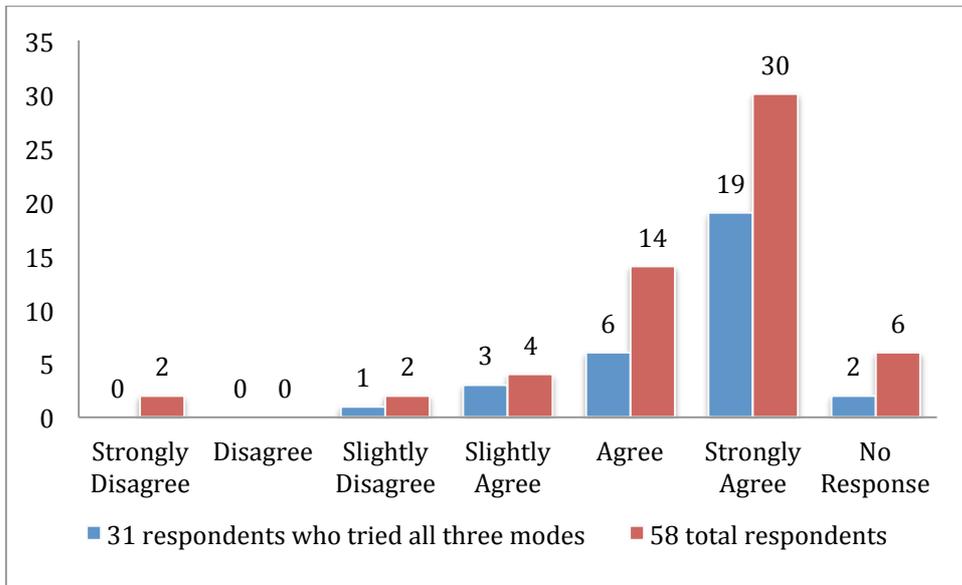


Figure 89 Responses to the statement 'I saw how the Sydney Rocks has changed over time by Exploring the Virtual Sydney Rocks.'

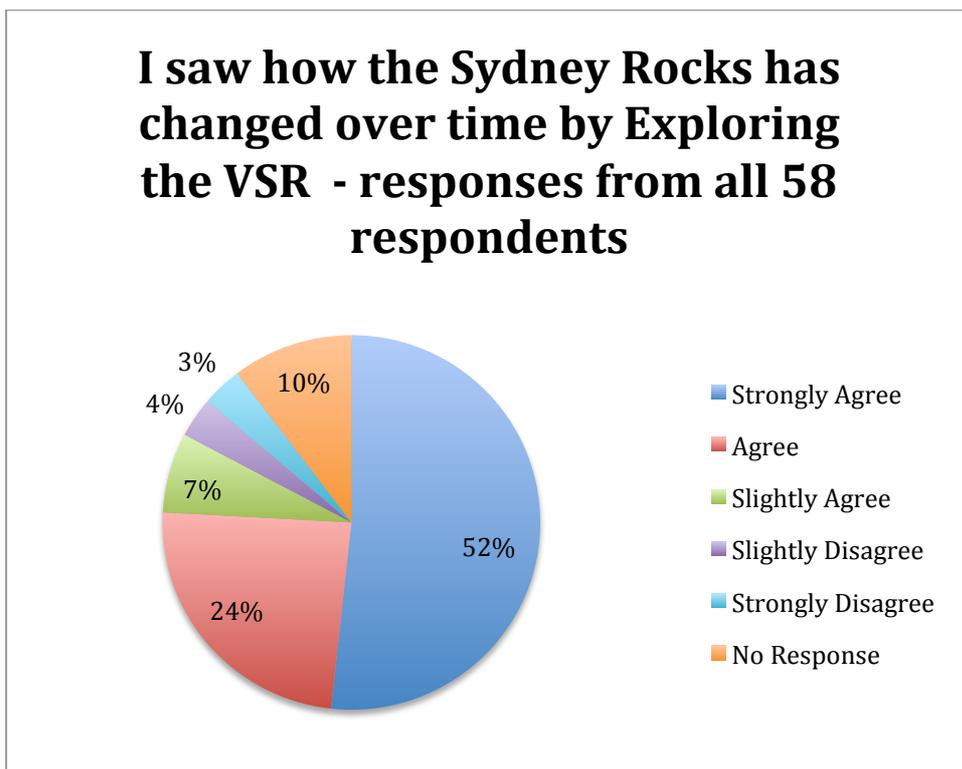
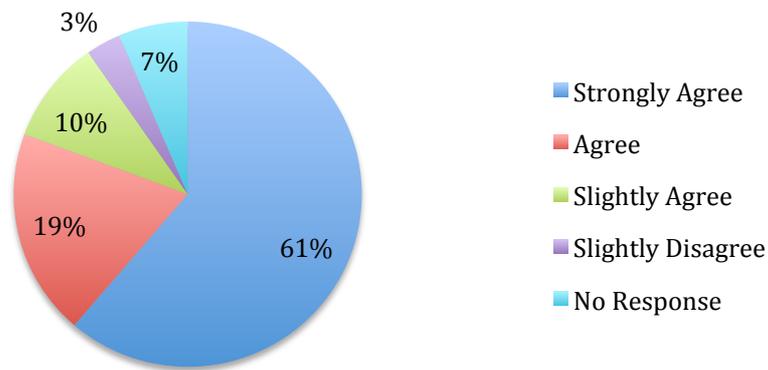


Figure 90

**I saw how the Sydney Rocks has changed over time by Exploring the VSR - responses from the 31 respondents who tried all three modes**



**Figure 91**

**5.36 Responses to the questions ‘Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time and why?’**

As this question asks respondents to compare the three different interaction modes this analysis is restricted to the 31 respondents who completed all three modes. Nearly three in five respondents (58%) chose the Explore mode, which offered respondents the ability to explore at will in space and time, as the most effective at showing how the Sydney Rocks has changed over time. And just over a quarter (26%) chose the Tour mode as the most effective at showing how the Sydney Rocks has changed over time (See Figure 92). The next section examines some of the reasons given by individual respondents.

## Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time?

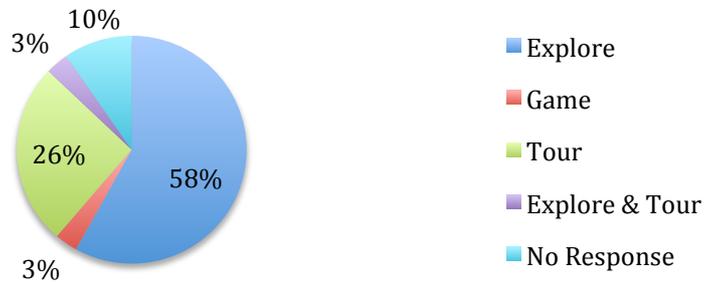


Figure 92

### 5.37 Why was Exploring the most effective interaction mode for showing you how the Sydney Rocks has changed over time?

Nearly 60% of respondents who tried all three modes reported that Exploring was the most effective interaction mode for showing change over time. The most common reason given was that they could make full use of the time-lapse functionality. Responses include *‘The fact that you can see it year by year and the fact that you can see the overview by putting the speed to 7 shows the whole Sydney Rocks that changed over time’* from Respondent 14, *‘Exploring allowed you to pause & see the gradual building and demolishing at any chosen point in the virtual world’* from Respondent 20, *‘Being able to choose different years and see the changes was BRILLIANT’* from Respondent 24, *‘changing the times back and forward’* from Respondent 33, *‘Allows (you) to see the increase in buildings and population over a lengthy period of time. Especially on the time-lapse elements’* from Respondent 34, *‘Choosing a year and watching the changing site - progression/populating the area’* from Respondent 36, *‘Could pick and choose times and place’* from Respondent 44 and, from Respondent 53, *‘Great seeing how buildings changed. Would be great to be able to go back so you*

*could find an area that you know and see how it's changed*'. Respondent 17 remarked that she thought that she paid more attention to her surroundings in the Explore mode than the Game mode because she was *'More focused in looking at the environment than the goals of the game'*.

### **5.38 Why was taking the Tour the most effective interaction mode for showing you how the Sydney Rocks has changed over time?**

Just over a quarter of users who tried all three modes nominated the Tour as being the most effective mode for showing how the Sydney Rocks had changed over time. This is not surprising as, after telling the story of George Cribb, the Tour concludes with a time-lapse of the period from 1788 to 2010 viewed from a fixed camera looking across the Rocks and Sydney Cove to Bennelong Point. The Tour was designed to tell both the story of George Cribb and also to showcase the time-lapse feature in the VSR and this is reflected in the comments from respondents. Among these were *'Most obvious because of the time-lapse function'* (Respondent 1), *'Watching the tour loop & particular buildings disappear over time gave a sense of how things are changing over time and our personal perspective is limited'* (Respondent 21), *'Time-lapse of area was great!'* (Respondent 23), *'Because it takes you through the time periods, and it tells you that this is what it's doing'* (Respondent 40) and *'Covers a good overview. Shows me a larger area over time with narration. I found this very informative'* (Respondent 15).

### **5.39 Why was playing the Game the most effective interaction mode for showing you how the Sydney Rocks has changed over time?**

Only Respondent 58 chose the Game as the most effective interaction mode for showing how the Sydney Rocks has changed over time and he commented that *'It gave more scope to explore inside the buildings'*. Respondent 29 nominated both the Tour and

Explore modes as the most effective interaction modes for showing how the Sydney Rocks has changed over time and said *‘I think both the Tour and Explore illustrated the changes that have taken place over time from the beginnings of Rocks as both show how it started before white settlement through to present day with the massive changes along the way’*.

#### **5.40 Summary – Which way of interacting was most effective at showing how the Sydney Rocks has changed over time?**

For users who tried all three modes, the Explore mode was the clear favourite, with nearly 60% of users nominating it as the best mode at showing change over time. This may be because in the Explore mode, unlike the Tour mode, the time-lapse is under the user’s control. The Tour mode still managed to be nominated the most effective by just over a quarter of users. It is unsurprising that the Game attracted such little attention as the time travel needed in the Game is only over a relatively short timespan during which there are few obvious changes beyond the building of some stables on the Big Dig site. A different game that featured time travel to a greater degree might produce quite different results.

The last three purely qualitative questions were meant to find out as much as possible about the VSR from the user’s perspective without prompting them for answers. The questions asked users to say what they did and did not like about the existing VSR and then they were asked to suggest improvements.

#### **5.41 Things Most Liked in the Virtual Sydney Rocks**

Testers were asked to ‘Write down the two things you liked most about the Virtual Sydney Rocks’ and the following recurring themes were identified in the responses:

*navigable time (including time-lapse), navigable space and interactivity, content quality and quantity, game, connection of the game items with the real items in the museum, interactivity, weather, soundtrack and human stories*<sup>39</sup>. Figure 93 shows a graph of the results of the grading of each response and it can be clearly seen that the content quantity and quality was the most liked feature of the VSR. The second and third most liked features were the affordances of navigable time and navigable space. Some of the individual responses are examined in detail below.

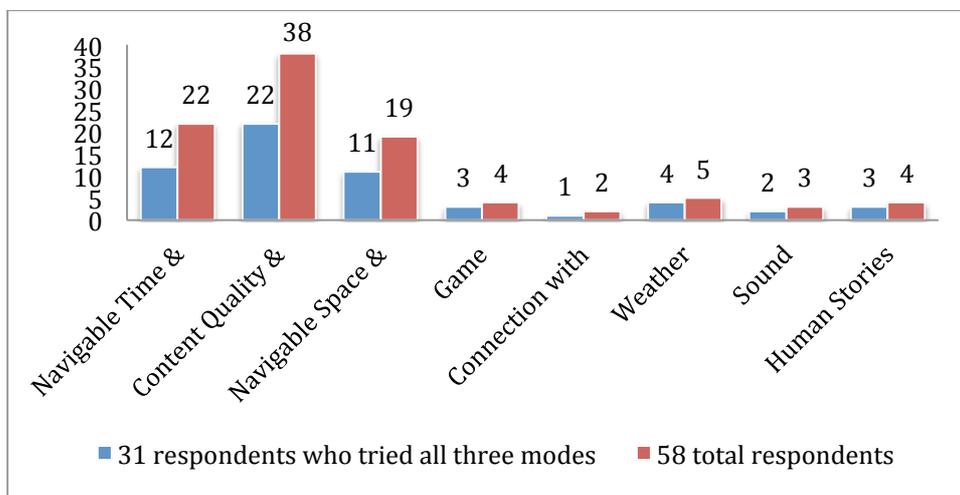


Figure 93 Write down the two things you liked most about the Virtual Sydney Rocks.

For all 58 respondents the most popular feature was the quantity and quality of the data that they had access to. Many respondents commented upon the depth and authority of the information they could access and which had informed the creation of the digital model. Comments include ‘*Depth of Information*’ (Respondent 1), ‘*The accuracy of the history*’ (Respondent 17), ‘*Access to information, images etc*’ (Respondent 23), ‘*Information about the history is great!*’ (Respondent 30), ‘*The info given when clicking on things*’ (Respondent 33), ‘*The information available through the program*’ (Respondent 34), ‘*Accuracy of model*’ (Respondent 43), ‘*Comprehensiveness and*

<sup>39</sup> See Appendix 1e for a full transcript of all the responses to this question and for the grading of each response with regard to the themes just mentioned.

*detail* (Respondent 44), *Links to websites* (Respondent 46) and *The ability to zoom around & easily link to snippets/background of history* (Respondent 38).

Navigable time and navigable space were the second and third most popular things mentioned by respondents. Navigable time was mentioned by twelve respondents and navigable space by 11. Comments included *The time shifting* (Respondent 4), *The build up from start to end in speed 7* (Respondent 14), *Being able to travel in time* (Respondent 15), *I loved seeing the developments of the city's landscape by year - time travel YES!* (Respondent 26), *Control of timing functionality* (Respondent 31), *Seeing change over time* (Respondent 39) and *Watching how it developed over time* (Respondent 46). The comments relating to navigable space included *Sense of movement* (Respondent 19), *I like the interactivity - being able to open doors, walk up steps etc* (Respondent 20), *Being able to navigate around and go inside buildings* (Respondent 24), *Exploring the laneways in the game* (Respondent 36), *Entering the house of G. Cribbs* (Respondent 36) and *Exploring areas* (Respondent 39). Two Respondents conflated the two and simply said *Being able to move around in space and time* (Respondent 17) and *Go to anywhere at any time* (Respondent 37).

Weather was specifically mentioned five times *Being able to see the weather for a specific day was awesome* (Respondent 20), *Weather* (Respondent 35), *Weather conditions* (Respondent 53), *The weather and the early sounds* (Respondent 40) and *Very cool stormy skies!* (Respondent 38).

Other responses mentioned the game and the connection between the game objects and the real objects in the same room. *George's personal story illustrated with his properties was really interesting and entertaining & enjoyed interacting with the game*

*& then actually seeing artefacts in the museum'* (Respondent 29). *'The example of the butcher, his life & the relationship to the 3 pieces in the museum room in the game'* (Respondent 38. One response noted the different interaction modes and declared one of the two best things about the VSR was *'The way you could both explore and play a game'* (Respondent 7).

#### **5.42 Summary - Things Most Liked in the Virtual Sydney Rocks**

The recognition by respondents of the depth, quality and quantity of the information available within the VSR was personally gratifying to the author as a lot of effort had gone into the creation of the resource. More interestingly it is an aspect of the VSR that was clearly very important to users and one that was not prompted by any particular questions in the questionnaire. This should be of critical interest to creators of virtual heritage.

Navigable time, or user controlled time travel, is a key affordance of the VSR and this was clearly appreciated by users. Two of the earlier sets of questions mentioned time, the first asked if the user had a feeling of being in the Rocks at different times and the second set of questions asked if the user had seen how the Sydney Rocks had changed over time. So it is likely that users were thinking about the time aspect of the VSR prior to answering this question. However, navigable space got almost as many mentions as navigable time despite there being no questions that touched on navigable space.

The author, as well being interested in the more popular responses by users, was also interested in all the other things mentioned by respondents. User feedback of this nature is invaluable to designers of virtual worlds. The sound and weather were singled out by a handful of people. This was personally gratifying to the author as a great deal of

thought and effort had been put into both. Neither was mentioned in the questionnaire to keep the size of it, and therefore the time to complete it, down. A handful of people mentioned the importance of human stories to help people connect with the historical data and also noted was the powerful affect of discovering that the game objects actually existed and were on display in the museum.

### 5.43 Things Least Liked in the Virtual Sydney Rocks

Testers were asked to ‘Write down the two things you liked least about the Virtual Sydney Rocks’ and the following themes were identified in the responses: *visual quality, controls, lack of people and activity, game quality, interface, technical issues*<sup>40</sup>. Fig. 94 shows a graph of the results of the grading of each response and it can be clearly seen that the visual quality was the least liked feature of the VSR. Also mentioned was the lack of people and activity. The quality of the game was also an issue and the other least liked features were concerned with the interface, the controls and technical issues.

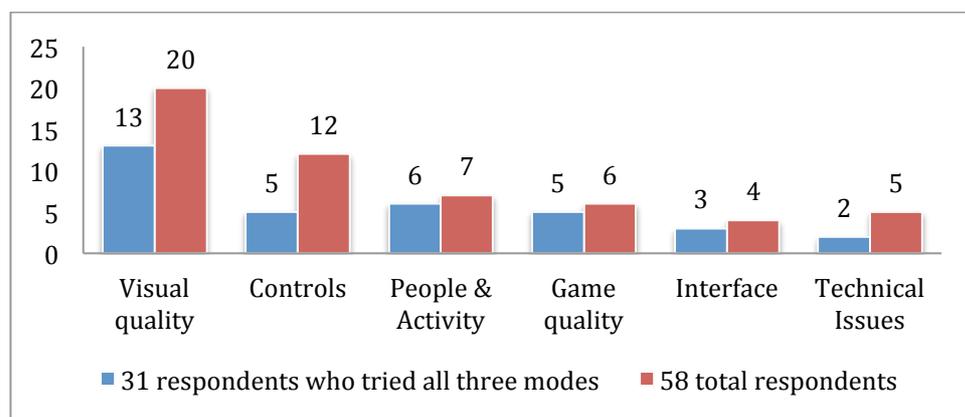


Figure 94 Write down the two things you liked least about the Virtual Sydney Rocks

The least popular feature was the overall visual quality of the virtual world. The lack of detail inside the buildings along with the ‘deliberate mistake’ of the wallpaper in 95

<sup>40</sup> See Appendix 1f for a full transcript of all the responses to this question and for the grading of each response with regard to the themes just mentioned.

Gloucester Street discussed in Chapter 4, were singled out for comment. Respondents 33 and 34 both put *'The wallpaper'* as their first 'least liked' thing about the Virtual Sydney Rocks. The textures and visual quality generally were mentioned as least liked by other respondents with comments such as *'The lack of sophistication of the buildings and surface texture'* (Respondent 40), *'Textures'* (Respondent 39), *'Should be extended to make more visual detail'* (Respondent 44), *'Needs more detail in houses/display design etc'* (Respondent 23), *'needs beautification'* (Respondent 17) and *'lack of textures inside buildings'* (Respondent 20).

Another least liked aspect of the VSR was the absence of people and animation. Comments include *'Lack of people and animals'* (Respondent 20), *'I know this would take a LOT more work but the absence of people and activity going on in the town'* (Respondent 24), *'Lack of on screen animation and movement'* (Respondent 31) and *'Needs people moving'* (Respondent 45).

One of the biggest causes of complaint was to do with the movement controls. There were twelve comments from all 58 respondents including five comments from among the 31 respondents who tried all three modes. Comments include *'Hard to navigate'* (Respondent 14), *'The joystick method of navigation is a bit awkward, but wouldn't know what else you could do!'* (Respondent 21), *'Controlling was hard'* (Respondent 33), *'Controls difficult'* (Respondent 39) and *'Not a fan of the joystick. Prefer mouse + WASD interface'* (Respondent 43).

Several people found the interface confusing. Respondent 40 commented that the *'Control panel could be cleaner'* and Respondent 53 said that it *'Has the potential to be complicated'*. Respondent 1 said *'Format a little confusing'* and *'Needs a human to*

*fully explain the benefits of the game*' as her two least liked things about the VSR.

Three people mentioned the game. Respondent 14 thought it was too short and Respondent 17 commented that it *'Needs more game elements, needs to be on the ipad'*. Two respondents mentioned the technical problems relating to collision detection. This allowed users to run through walls easily and sometimes caused them to fall through the ground. When declaring what they liked least, Respondent 4 mentioned *'Walking through walls accidentally'* and Respondent 37 mentioned *'Fall through bottom of world'*.

#### **5.44 Summary - Things Least Liked in the Virtual Sydney Rocks**

When it came to the least liked things in the VSR, first and foremost for respondents was the visual quality, but the lack of people and activity and the quality of the game were also mentioned. The interface, the controls and technical issues were singled out as well, but by less people. Given that the public knowledge of what virtual reality technology can deliver in terms of inhabited and richly detailed worlds is in part based on state-of-the-art game franchises like *GTA* and *Assassins Creed*, then the unpopulated VSR with its low-resolution textures, unfinished principle buildings, tricky controls and occasionally buggy behaviour is disappointing by comparison. None of the least liked things concern the underlying design and functionality of the VSR and fixing some of them opens up new areas for research. For example, the joystick interface was explicitly mentioned as a negative by several respondents. During testing the author noticed that the joystick marked the computer out as 'different' to visitors and for some it was a point of attraction while to others it was a point of repulsion. The revised VSR will experiment with different interface controls to find a set that works well with most users. Similarly, setting the time and date is currently done using forward and backward

arrows to step forward to backward through the different possible year, month, date, hour and minute settings while the revised VSR will be used to test other interface elements such as dropdown options and sliders.

### 5.45 Suggested Improvements

The final question asked of respondents was to ‘Write down any ways that you think the Virtual Sydney Rocks could be improved.’ The following themes have been identified in the responses: *improve realism and content, improve game, improve interface and improve navigation*<sup>41</sup>. Figure 95 shows a graph of the graded results of each response and it can be clearly seen that the majority of suggested improvements concerned the look and feel of the VSR, further developing the game and adding extra content.

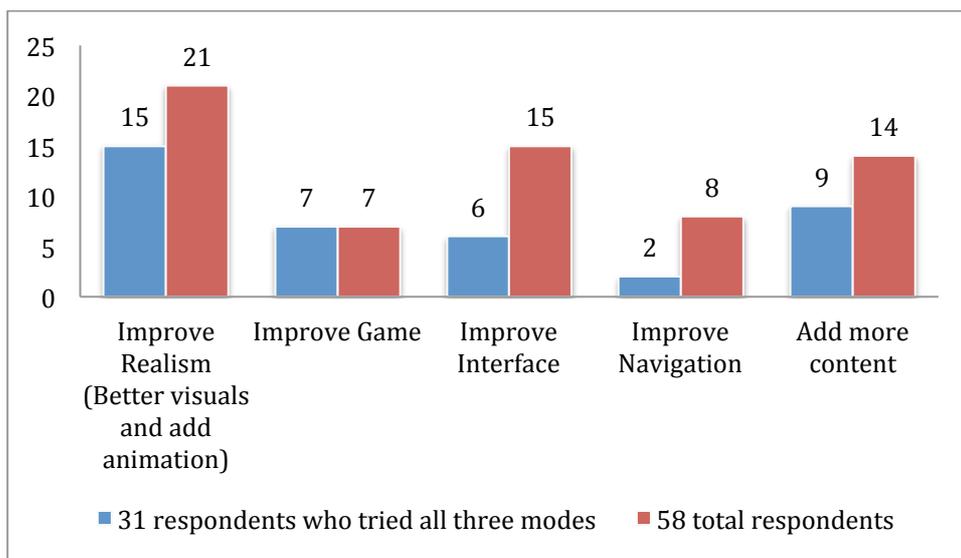


Figure 95 Write down any ways that you think the Virtual Sydney Rocks could be improved

Most responses suggested improving the visual quality of the model and expanding the VSR by populating and animating it. Respondent 4 wrote ‘*Funding! Texture maps, more missions, more animation, voice-overs (characters)*’ while Respondent 20 wrote

<sup>41</sup> See Appendix 1g for a full transcript of all the responses to this question and for the grading of each response with regard to the themes just mentioned.

*'I can't wait to see the texture dressing of rooms & maybe even people walking about Sydney doing their daily tasks. Dropping the ice, building woodblock roads, hanging washing etc'. Respondent 24 wanted 'Incidental animations to interact with' and Respondent 30 wanted 'More photos on the virtual page e.g. Click on the image (say a building) and the historical photo(s) pop up (on the same screen) with useful info. Have higher definition images. Have people in the buildings - click on the people & they talk to you'.*

Several respondents suggested making the game longer and exploring game-based interactions. Suggestions include *'Better games - incorporating icons - Sydney Opera House'* (Respondent 14), *'The game would span over a larger period so that the player can observe change over a greater period in time ie more drastic changes'* (Respondent 15), *'I enjoyed the game and could have kept playing so longer game please'* (Respondent 29). And one respondent remarked that *'The trees and the landscape need to look nicer'* and that the VSR was *'Missing lots of potential game ideas'* (Respondent 17).

Suggestions to improve the interface included the following detailed response from Respondent 40. *'I think it could become too complex and perhaps the interactive choices should be simplified or grouped more efficiently. Perhaps there are two aspects -> the overview history covering how the physical world changed (building & environment) - > the social/details history. Maybe both these aspects might not be required for all historic sites. Maybe the interface could be grouped so you can choose one type of history or the other. For example: if I don't have much time I might want to just see how the environment had changed. But as a people person I might want to "get to know" the residents.'*

Respondent 44 suggested that the VSR should *'be extended to make more visual detail'* and then noted *'this is an enormously interesting project with great potential. It deserves to be extended and enhanced. It serves so many interests. Architectural/historical - Educational - Tourism - promoting Australian heritage - excellent and visionary use of technology'* (Respondent 44). Respondent 34 suggested a web version and added *'I think this is a very good program and idea.'*

#### **5.46 Summary – Suggested improvement for the Virtual Sydney Rocks**

Unsurprisingly the suggested improvements dovetail well with the least liked features. The low visual quality was the least liked thing and top of the improvement list were calls to improve the realism and content. Improving the game was suggested by seven respondents. Changes to the interface and to movement within the VSR were also suggested and these are all being addressed in the revised VSR.

#### **5.47 Analysis of testers who did not play the game**

This section examines the responses from testers who tried both the tour and explore options and who also completed the questionnaire but chose not to play the game. This group was 14 in number with four of them in their 20s, two in their 30s, five in their 40s, two in their 50s, with one supplied no age data. Nine of this group were female and five were male. All of them reported using computers daily while seven played games at least once a month and seven did not play games. The author believes that this sample size is too small to draw any firm conclusions but the disinterest in the game is worthy of further study and will be explored with the revised VSR.

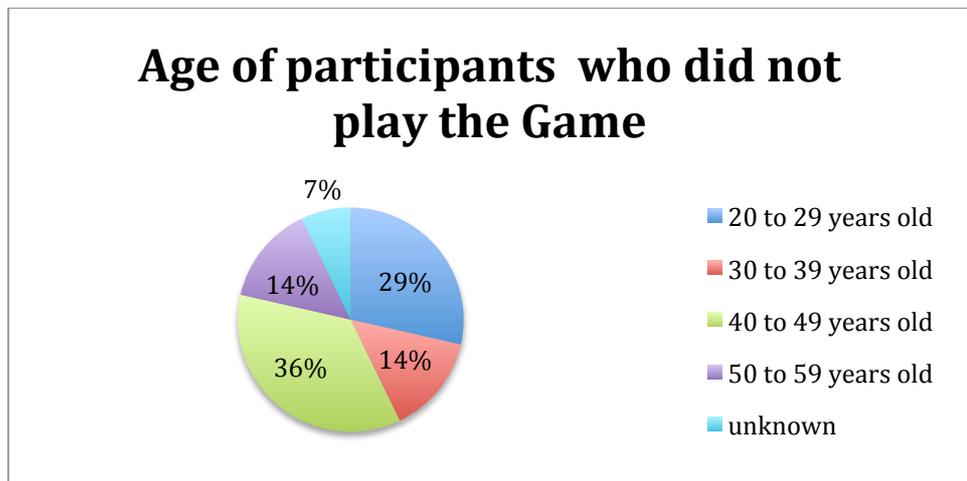


Figure 96

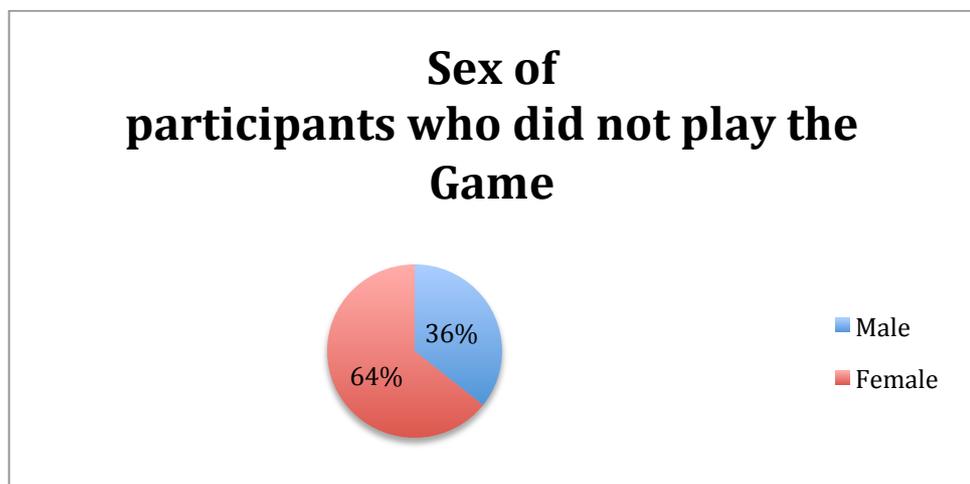


Figure 97

#### 5.48 Report Summary

Although the questions were very general in the nature, the overall picture that the data clearly reveal is that museum visitors like to engage with virtual heritage in a variety of ways. These engagement modalities include top-down didactic lectures where users passively watch and listen to a recorded video, goal-driven interactions such as games where users engage in task-solving activity and individually directed explorations where users have complete freedom to roam through time and space at will. While individual users had clear preferences there was no single individual mode of interaction that was the preferred choice of a clear majority of users. Rather, the data show that sizeable minorities of users liked each of the three modes best (See Figure 61). In addition, most

users tried at least two of the three available modes (See Figure 59) and, in the main, reported positive experiences with all of the modes that they tried.

All three interaction modes were considered educational and the ability to see a time-lapsed view was considered particularly useful for showing change over time. No particular mode was singled out as the best for learning the history of the Sydney Rocks with both the Tour and Explore modes being nominated by a sizeable minority of respondents (See Figure 82). When respondents were asked which mode was the best at showing change over time the results were less evenly spread between the three modes (See Figure 92). This is most likely because time-lapse was not featured in the Game but it was featured in both the Tour and in the short training video that gave users instruction on using the VSR controls. A revised game that covers a greater span of time and also features time-lapse may well produce a different response from users.

While the evidence is clear that users will try several of the available modes of interaction, it is also clear that the Game was the option that was the least popular of the three on offer (See Figure 58). Nearly one in three respondents never even bothered to find out if the game was good or bad, opting instead not to play it at all. This is an interesting finding given the current interest in Serious Games and indicates that virtual heritage that is solely game-based may not appeal to a large minority of the typical museum audience. However, given the small sample size, and the positive feedback from respondents who did play the Game, further research is clearly indicated.

Individual user factors are recognised as key factors for engagement and presence (Herrera, Jordan, and Vera 2006, Howe and Sharkey 1998, IJsselsteijn et al. 2000, Jurnet, Beciu, and Maldonado 2005, Lombard and Ditton 1997, Nunez 2004a, Schubert,

Friedmann, and Regenbrecht 2001). Unsurprisingly, agency is a key contributor to presence. If a user's actions in the virtual world can affect objects or events, this will support their engagement with the virtual world and promote a sense of presence (Lombard and Ditton 1997). Agency is fundamental to the ideas of *navigable* space and *navigable* time. Given the general public knowledge about virtual technologies, navigable space is not a new idea. Navigable time, however, with its different modes of destination-focused and journey-focused time travel, was recognised by respondents as a key affordance of the VSR. Both the instantaneous insertion into a particular time and the journey-focused mode of time-lapse proved to be popular, engaging and educational. Navigable space is mentioned almost as often as navigable time and together the two enable an unprecedented level of agency to users who are able to explore at will in both space *and* time!

With regard to what respondents liked about the VSR, the key feature was the quality and the quantity of the data that they could access. This was an unanticipated finding given that the VSR was intended to investigate time-based virtual heritage and user preference for various activities within virtual heritage. The author, cognisant of the need for cultural immersion in an unpopulated world, took great pains to provide a wealth of related information supporting prolonged engagement and spatial interaction for users, leading to their active participation with the making of meaning. The combination of the virtual model with the database could be compared to an iceberg where the portion above the surface is the virtual model and the much larger bulk below the surface is the database of related material. The virtual model acts as an interface to the Guidebook which in turn is a portal to a wealth of immediately relevant information hosted by reputable websites such as the Dictionary of Sydney, the Heritage and Conservation Register of NSW, the State Library of New South Wales and the

Australian Dictionary of Biography. This finding reveals the central importance of authenticity to museum audiences and the advantages of supporting prolonged engagement for users as this allows them to be actively engaged in the making of meaning.

The second most liked feature was the ability to move at will through time in two different ways. Users were able to jump instantaneously to a particular time and date and rejoin the normal flow of time or they could travel through time at different speeds ranging from one second of real time being equal to an hour in the VSR to one second of real time being equal to ten years in the VSR. If users chose a speed greater than real-time (ie one second of real time equals one second in the VSR) then the VSR would cycle through the years 1788 to 2012 using the interval specified by the speed of time and starting on the set date.

The least liked features and the suggestions for improvements were primarily to do with the look of the VSR, the lack of inhabitants, inadequacies with the game, and problems with the controls and the interface. Despite these issues, time-based enhanced virtual heritage worlds clearly deliver engaging and educational experiences to museum audiences. In addition, offering a variety of different interaction modes allows users to select the modes they prefer, thus enhancing their experience, increasing their engagement and fostering learning opportunities within the VSR.

#### **5.49 Time-based virtual heritage**

We live *in* time. Indeed, for those educated in western epistemologies, time is fundamental to the way that we make sense of the world (Hoffman 2009, Ozeki 2013). The unidirectional flow of time is at the heart of the notion of causality and, from our

early interactions, it is central to how we interact with, learn about and understand the physical world. Remove the unidirectional flow of time and the most basic mechanism by which meaning is constructed vanishes.

As discussed in Chapter 1 time and place are inseparably linked. A place is a location imbued with human meaning and it is therefore dynamic. A particular place is a location in space *and* time. The experience of place is a mixture of sensory and cultural, both of which are directly related to time. The day and the hour, the season and the phase of moon partly determine the sensory affect of a place as well as the activities of its inhabitants. Time is crucial to both the sensory and the cultural experience of place.

As discussed in Chapter 2, the nature of time remains a mystery and hence the focus of much philosophical and scientific enquiry. In terms of the lived life, we are all time travellers, moving inexorably into the future at the rate of one second per second. This may be time travel of a sort but it certainly is not navigable time. There is no agency or control. We are completely unable to stop or reverse our course. We can, by using our most advanced technologies, very slightly alter the speed of time for an individual. Living in orbit will slow time for someone relative to the people on Earth. For every year in orbit they will be about 0.1 milliseconds younger than if they had remained on the Earth. So a hundred years in orbit will make a person 0.1 second younger than if they had remained on the Earth (Jamieson 2011). Time travel in this way and at this speed is of scientific, and possibly philosophical, interest but of little practical import for heritage educators.

Despite our almost complete impotence with regard to real time travel, the 'now' that exists in the eternal present of our consciousness is able to contain and effortlessly

intermingle thoughts of past, present and future. (Curiously this ‘now’ is an illusion. It takes a finite time for our brains to process sensory input, so the ‘now’ our consciousness experiences is really 80 milliseconds behind the times (Eagleman and Sejnowski 2000).) Our stream of consciousness holds many interwoven thoughts that move between present, past and future in an order dictated by the peculiar workings of each particular mind. We can make sense of these temporally displaced events precisely because they are date-stamped. Time gives us a way to order our thoughts, to follow a tune or an argument and, fundamentally, to make sense of the world (Hoffman 2009, Ozeki 2013).

Despite the lived experience, the human imagination refuses to be bounded by the inability to physically travel in time. As discussed in detail in Chapter 2, time travel is a popular trope in literature and on screen and an established part of the human imaginary. Navigable time proved to be an extremely popular affordance of the Virtual Sydney Rocks. It was explicitly mentioned in numerous responses to five different questions, most of which did not directly ask about the ability of users to move at will through time. A small selection of the responses will be examined here<sup>42</sup>.

When users were asked which interaction mode they liked the most and why, Respondent 20 said she preferred the Explore mode because *‘Exploring the Rocks & being able to see the different buildings at different times in history was fascinating. I really feel it helps to bring to life the landscape & build an understanding of how the use of the land has changed over time.’* In answer to the question of which interaction mode gave them a feeling of being in the Rocks at different times, Respondent 28 said he preferred the Explore mode because it gave him *‘The freedom to explore, let me*

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<sup>42</sup> The full set of responses are available in Appendix 1d.

*change the time to whenever I wanted. I could see a life in a different time through exploring. It is one thing to read info but it is another to watch it all unfold*'. Users were asked which interaction mode helped them learn the most about the history of the Sydney Rocks and again navigable time was explicitly mentioned, with Respondent 14 saying that he preferred the Explore mode because he was *'Able to see the whole building history. Shows me how Sydney Rocks has changed over the years & tells me the history with the links provided'*.

Users were asked which interaction mode was most effective at showing them how the Sydney Rocks had changed over time. This question was intended to get users to consider the educational role of the time-lapse facility in the VSR which was demonstrated in the training video and was also featured at the end of the Tour. The Game featured some time travel but only over a few years and not in a time-lapse mode so very little change would have been seen. Unsurprisingly, the Tour and Explore modes were both considered very effective at showing change over time while the Game was not. A different game that involved time travel between more widely separated dates could well produce a different result. This was one of the improvements suggested by Respondent 15 who said *'The game would span over a larger period so that the player can observe change over a greater period in time ie more drastic changes'*. She believed that the Tour was currently the best for showing change over time because it *'Covers a good overview. Shows me a larger area over time with narration. I found this very informative.'* However, Respondent 25 thought that the Explore mode was best for showing change over time because *'Playing with time setting and using "fast forward" lets you see the development very quickly.'* The revised version of the VSR will be used to explore short and long engagement games as

vehicles for creating the kind of immersion that leads to understanding, insight and learning.

When users were asked to nominate their two most liked features of the VSR, navigable time was the second most mentioned feature. (The first was the quantity and quality of information to which users had access and this will be discussed later in this chapter.) As can be seen from the responses quoted above, navigable time made a strong impression on many users.

The contribution of agency to presence in virtual environments is well known (Lombard and Ditton 1997). The very term navigable space implies an ability to move at will through the virtual world. A user's controlled movement through, and interaction with, a virtual world creates important feedback loops that reinforce their sense of presence. Being able to walk around and interact with objects is key to creating the illusion that users are present and active in the virtual world (Barfield and Hendrix 1995). In a likewise fashion and quite apart from the educational potential of the destination and journey focused modes, navigable time promotes engagement by virtue of the agency it gives users. This is reflected in their comments with Respondent 17 saying '*Being able to move around in space and time*' and Respondent 37 saying '*Go to anywhere at any time*' in answer to the question asking them to nominate two most liked things in the VSR. The terms navigable space and navigable time both pre-suppose certain levels of agency in virtual worlds. Given the general public knowledge about virtual worlds in general and about mainstream commercial games in particular, the concept of navigable space is familiar to most members of the museum audience and the freedom to travel was positively mentioned by many respondents. Navigable time, with its different modes of destination-focused and journey-focused time travel, was new to users and it

was repeatedly mentioned by respondents as a key affordance of the VSR. Both the destination-focused and the journey-focused modes of time-lapse proved to be popular, engaging and educational. In the responses to the questionnaire navigable space is mentioned almost as often as navigable time. When combined, the two give users an unprecedented level of agency to travel in both space *and* time.

### **5.50 Findings for navigable time**

Time is fundamental to the human experience and particularly pertinent to heritage, which is directly concerned with tangible and intangible culture particular to and situated within particular places and times, and in the evolution and transmission through time of those cultures. But time is so central, so taken for granted, in the lived life that it risks becoming invisible. The VSR, by giving users control over time, forces them to consider time explicitly. One concern with giving people the ability to travel through time at will is the possibility that visiting a series of out of sequence dates could be confusing. No users reported any confusion though a number did mentioned that they liked the way that the Tour gave them a condensed history of the Rocks and others noted that the time-lapse provided a narrative of change. This indicates the important interplay between the different modes of Tour and Explore and illustrates the Constructivist process of learning occurring as the information from different modes is integrated into a coherent whole by the user. The interplay between the various interaction modes will be explored in more detail in the next section when user preference for particular interaction modes and the user experience of the VSR is examined but, for now, it should be noted that the Tour and the time-lapse facility can help to counteract possible temporal confusion in users.

The potential downsides of navigable time would therefore appear to be negligible while the upsides are significant. Time-based virtual environments enable time of day and weather to be made part of the virtual world. As discussed in Chapter 1, these are important contributors to the ambience of real places and are equally important contributors to the mood and feeling of virtual places. Just as with navigable time, the very act of including them brings them to the attention of users. Weather, like time, is often ignored in virtual heritage. Seeing the tents of the First Fleet on the shores of Sydney Cove is one thing, but seeing them under dark skies with flashes of lightning and claps of thunder might make people think about what it was actually like to be stuck in a tent for days in heavy rain. For users who asked the author about the weather finding out that the weather in the VSR for 1788 was based on historical data brought a level of veracity to the virtual world that had enough of an impact that it was mentioned in some of the responses.

The power of time-lapsed footage to show change over time is undeniable. As discussed in Chapter 2, Section 2.7, literally *seeing* a glacier flow has a unique phenomenological affect on the viewer. This affect is different to presence but no less powerful in its own way. It is an ‘ah-ha’ moment when seeing brings deep understanding. Time-lapsed virtual heritage provides a new way of experiencing heritage, a way of literally seeing change over time-spans outside the range of normal human experience. While the focus of this thesis is on the more practical use of time-lapse as a tool to understanding changes in a city over hundreds of years, the author notes that the human mind and human culture are not fixed but co-evolve over time in response to each other (Manovich 2001). Navigable time, even if only virtual, offers a new way of experiencing heritage that raises new questions and provokes new ways of thinking about heritage for both heritage professionals and the general public.

The data from testing strongly indicate that navigable time holds great potential as a way of creating memorable and educational experiences for museum audiences. However, this finding, though exciting, is a preliminary finding from the testing of a limited prototype. For example, during testing one of the testers remarked to the author that she would like to be able to see a backwards time-lapse as well as a forwards one. Certain time speeds worked better than others for a variety of reasons. At a rate of one second equaling a minute there was very little obvious change. At the rate of one second equaling an hour the movement of the sun across the sky was apparent and the corresponding change in lighting. At the rate of one second equaling a day the changing position of the sun in the sky over a year was apparent and, for 1788 only, the arrival and dispersal of the First Fleet and the establishment of the initial buildings. In other respects little change would be detected as it would take 365 seconds or just over six minutes to view a single year. At the rate of one second equaling four weeks again change would be detected, other than the changing position of the sun, as it would take just over a minute and a half to view a single year. The speeds best suited to seeing the development of the built environment of the VSR over a two hundred year time span were

- one second being equal to a year which resulted in an animation of three minutes twenty seconds
- one second being equal to five years which resulted in an animation of one minute ten seconds and twenty seconds
- one second being equal to ten years which resulted in an animation of twenty seconds.

Additional content that animates over daily, weekly and monthly schedules (for example buses, trams, ferries, shipping) will be added to the revised VSR and further research into navigable time will be conducted, including into backwards and well as forwards time-lapse at different time-lapse rates.

### **5.51 User activity preference**

When people visit real heritage places they do so in all manner of ways, influenced no doubt by budget, but primarily decided by individual inclination. They usually have a choice of accommodation and food, they can take a variety of tours, attend cultural events, seek out particular places or wander serendipitously. Individual preference for particular activities can be very deeply ingrained. For example, some people prefer to explore in their own time and in their own way rather than taking tours while others prefer to take the tour. When designing the VSR the author decided that restricting the activities in it to just one mode, be it Game, Tour or Exploring, ran the very real risk of only appealing to a sub-section of the intended audience.

The author was uncertain about what, if anything, would be discovered about user preference and the three different interaction modes of Game, Tour and Explore. She wondered if one mode in particular would stand out as either the most popular or the least popular and, if it did so, to what extent. This turned out not to be the case. While individual users had clear preferences, there was no particular interaction mode that was the preferred choice of a clear majority. Rather, the data show that, of the users who tried all three modes, sizeable minorities preferred each of the three modes, with the Tour preferred by 23%, the Game by 32% and Exploring by 39% (See Figure 61). It is therefore clear that providing only one interaction mode will fail to satisfy the majority

of users and it is strongly recommended to virtual heritage developers to provide a range of activities if possible.

As described in Chapter 4, Section 4.9, it is a common practice in heritage education to use individual narratives to connect people to the past. The author therefore decided to use the story of George Cribb, a colourful character who at one time had owned much of the Big Dig site, in both the Tour and the Game. In addition, by keeping much of the subject matter the same, it was hoped that meaningful comparisons between the two could be made.

The Tour received positive comments, often with reference to the personal narrative of George Cribb or to the overview of the history of the Rocks, showing the power and appeal of a strong linear narrative. Respondent 26 preferred the Tour for both these reasons, saying that she *'Enjoyed the guidance and the added information about Mr Cribb – (because it) 'made it more personal and engaging'*.

While the Tour was well received with no negative comments, the reaction to the Game was more mixed. Some people really loved it but one in five of respondents, when asked to suggest improvements to the VSR, nominated the Game. This may be because the familiarity of users with the high quality and sophistication of commercial games may have made what was a simple treasure hunt a little boring. Respondent 17, when asked about improving the VSR, suggested that it was *'Missing lots of potential game ideas'*. Interestingly there was a strong positive response from users when the objects from the game in the glass cabinet adjacent to the test computer were pointed out. Six testers mentioned this in their comments. For example, when asked to nominate the best things about the VSR, Respondent 29 wrote *'George's personal story illustrated with*

*his properties was really interesting and entertaining & enjoyed interacting with the game & then actually seeing artefacts in the museum.*' The strong connection people felt to the personal story of George Cribb, told in both the Tour and the Game, supports the decision to use the power of individual narratives to connect people with the past. The author notes that the George Cribb story was only one of many interesting and well-documented stories for the Rocks. In addition there are numerous other objects in the museums that can be linked to content in the VSR. So there is ample opportunity to use Gee's insights to develop interactive content designed to reward prolonged engagement in the revised VSR (Gee 2007).

The 'aura' of the 'real' thing is clearly alive and well, and, as in this case when directly linked with a virtual version, it can deliver an engaging and memorable learning experience. While Serious Games have much to offer (Michael and Chen 2005) it must be noted that the Game was the least tried of the three modes. Only 2 percent did not try Exploring and 12 percent skipped the Tour but 29 percent chose not to play the Game (See Figure 58, Chapter 5, Section 6). It was very interesting to find that nearly a third of users did not even bother to find out if the Game was good or bad despite obviously enjoying the other modes of the VSR. For example, respondent 28 wrote *'Having the freedom to wander where I liked and being able to change the time were so interesting. I really loved this virtual world. It was done so well'* when asked to nominate the best thing about the VSR but did not try the game. So it was not a case of blanket technophobia on the part of users but rather a strong dis-interest in game-styled interaction for a significant minority of them. All the results came from people who took the time to interact with the VSR and to stay long enough afterwards to fill in the comments sections of the questionnaire as well as the 'circle an answer' questions. For whatever reason people did not play the Game, a lack of time was not it. As discussed

earlier in Section 5.47, this seeming disinterest in the game is certainly something that deserves further research but on an immediate practical level, it is plain that offering users a variety of interaction modes both widens the appeal of virtual heritage and increases individual engagement.

For users who tried more than one mode, (and most of them did - with 29 percent trying two modes and 54 percent trying three modes) generally positive experiences were reported with all of the modes that they tried. From a Constructivist learning perspective, the interplay between the different modes will encourage users to make cross-connections and so assist them in the construction of meaning (Osguthorpe and Graham 2003). Users who did both the Tour and the Game actually received almost exactly the same information about George Cribb in both and the author wondered if users would pick up on this and, as a result, become bored when they got the same information the second time round. The lack of comment about this indicates that either users did not notice it or that they neither liked nor hated it enough to mention it.

It is highly probably that delivering the same information via the two modes helped to integrate and reinforce the information in the minds of users (Osguthorpe and Graham 2003). The answer to the question ‘which is the best mode for education?’ is not any one mode in particular but is actually all of them in combination, especially when the user has the power to choose which mode and in what order. As Respondent 38 noted ‘*Each had things I like (hard to nominate my favourite)*’ and elaborated that ‘*The tour was good to give a historic backdrop to where Sydney/European settlement began. The game was fun & really helped bring the life of the butcher to life! Could have mucked around with exploring a lot more (liked the different features that showed different weather, time of year)*’.

When it came to combining the different modes, again there was no clear favourite with 52 percent recommending new users to do the Tour first, followed by the Game and then Explore while 36 percent recommending new users to do the Tour first, followed by Exploring and then doing the Game last (See Figure 62). As reported in the previous chapter, respondents expressed preferences for particular orders to try the modes in, and gave good reasons for their (differing) choices. Again, the message to take away here was that there is no right answer to the question of what is the best order to do the modes in. As it comes down to individual user preference the best solution is to allow users to determine for themselves in what order they want to try each mode.

Agency refers to the capacity to act independently and to make choices. In the free choice, or informal, learning that takes place in museums it is important for users to have choice and control (Goins 2011). Within a time-based virtual world the terms ‘navigable space’ and ‘navigable time’ describe the agency over movement in space and time possessed by users. In addition, any other factor for which the user has a level of freedom reveals a new degree of agency. Therefore, having a choice of activities in a virtual world and over the order to do them in, if doing more than one, offers a further degree of agency to users. These multiple levels of control allow users to tailor the experience to their individual taste and hence to deepen their engagement and learning in a free choice Constructivist fashion.

Individual user factors are recognised as key factors for engagement and presence (Howe and Sharkey 1998, Herrera, Jordan, and Vera 2006, Jurnet, Beciu, and Maldonado 2005, Lombard and Ditton 1997, IJsselsteijn et al. 2000, Nunez 2004b, Schubert, Friedmann, and Regenbrecht 2001). When asked, users expressed clear preferences for particular engagement modes and gave considered and eminently

sensible reasons for their answers. For example, Respondent 15 chose the Explore mode as her preferred interaction mode because it *'Covers more of the area from first person perspective and gives more information about each specific part of the Rocks. Also lets me play with different time periods and observe the changes'*, Respondent 29 chose the Game because it *'it was fun & interactive & informative'* and Respondent 26 chose the Tour because she *'Enjoyed the guidance and the added information about Mr Cribb - Made it more personal and engaging.'* These respondents all gave very logical reasons for their (different) choices. Other responses, such as that from Respondent 40 who said *'the game was a good concept because it forces you to look closely at the details and interact with a time and a place. However I prefer freestyle exploring and asking questions about what I see'* indicate the primacy of innate personal preference.

A key consideration for heritage is the learning aspect of the experience, regardless of which mode is chosen. The findings show that all three interaction modes were considered educational. No particular mode was singled out as the best for learning the history of the Sydney Rocks with both the Tour (32 percent) and Explore (39 percent) modes being nominated by a sizeable minority of respondents (See Figure 82). When respondents were asked which mode was the best at showing change over time the results were less evenly spread between the three modes with Explore nominated by 58 percent the Tour by 26 percent and the Game by only 3 percent (See Figure 92). This is most likely because time-lapse was not featured in the Game but it was featured in both the Tour and in the short training video that gave users instruction on using the VSR controls to Explore freely in space and time. The Game only spanned a short period of time so there was very little noticeable change in the surrounding built environment. A revised game that features a larger timespan or includes a time-lapse is likely to produce a different response. Interestingly, respondent 15 suggested the following improvement

- *'The game would span over a larger period so that the player can observe change over a greater period in time ie more drastic changes'*.

### **5.52 Findings for user preference**

The focus of this research is on the creation of heritage resources using New Media technologies that encourage the kind of immersion that leads to historical understanding, insight and learning. The results from the VSR show that users had clear preferences with regard to which interaction mode they used and that there was no single activity that was the clear favourite among users. Supporting a range of interaction modes broadens the audience for virtual heritage and deepens their engagement. Choice increases engagement for users by enhancing their sense of agency and, for users in the Game or Explore modes, there are the additional freedoms of user-directed travel through space and through time. Active engagement lies at the centre of Constructivist learning. Constructivists argue that knowledge is actively created when an individual integrates new knowledge with their existing ideas. Based on the results from the VSR, when it comes to learning, people like a mixture of interaction modes and, while they may have a preference for one mode in particular, there is often an appreciation that each particular mode has something to offer. The best opportunities for learning experiences arise when there is maximum user engagement and this occurs when the different modes are used in a combination determined by the user.

### **5.53 Other findings**

This research into the user experience of time-based virtual heritage focused on both the educational affordances of navigable time and the user response to having a range of interaction modes. However, due to the general nature of the questions, the responses also revealed a number of other things that are worthy of comment. Navigable time was

the second ‘most liked’ thing in the VSR but the ‘most liked’ thing was the quality and quantity of information that was available to users. In creating the VSR the aim was to make the virtual model the starting point for a user’s engagement with the history of the Rocks. In real places many people choose to explore on foot and carry a guidebook (or they can directly access resources on the web via their phone or tablet) so that they can get more information if they want to, enhancing cultural immersion. Given the unpopulated nature of the prototype VSR, the author considered it to be extremely important to give users a similar ability to find out more, and so she found it very gratifying to discover that providing a significant amount of integrated and high quality content did not go unnoticed.

The combination of the virtual model with the database could be compared to an iceberg, where the section above the surface is the virtual model and the much larger bulk of the iceberg below the surface is the database of related material. The virtual model acts as an interface to the Guidebook which is, in turn, a portal to a considerable amount of pertinent information which has either been generated specifically for the VSR or is hosted by reputable websites such as the Dictionary of Sydney, the Heritage and Conservation Register of NSW, the State Library of New South Wales and the Australian Dictionary of Biography. It must be pointed out that there are costs as well as benefits to providing this level of information in this way. There is the initial cost of researching and then creating each individual web page for the Guidebook website. Then there are the costs involved in the ongoing maintenance of the website such as adding new content and fixing expired links on individual pages.

The story of George Cribb, featured in both the Tour and the Game proved to be memorable and engaging for many users. Among the responses were the following from

Respondent 29 who preferred the Tour because *'I think because I saw this first & I enjoyed the voice-over and historical information & I really enjoyed George's personal story'* and *'It was very user friendly and entertaining and you learn some cool things about George Cribb and his nephew'* from Respondent 49 who preferred the Game. These data confirm the power of human narrative to bridge time and space regardless of interaction mode and connect people with the past.

The author was particularly curious about user reaction to the weather and to the ambient sound. Although neither sound nor weather were mentioned in the questionnaire the weather was mentioned by six respondents and in each case positively such as in this response from Respondent 20 who said *'Being able to see the weather for a specific day was awesome'*. The sound was only mentioned by three respondents but again positively. Respondent 52 explained that he preferred the Explore mode because *'I felt as though I was walking the streets in my imagination. Background noises/soundtrack really assisted this too'*. The author argues that, as discussed in Chapter 1, Section 1.2, sound and weather added important environmental dimensions to the VSR, enhancing the phenomenological aspects of place and creating a richer sense of 'being there'. A new questionnaire will be developed for the evaluation of the revised VSR and will include questions designed to explore audience responses to weather and sound.

## **5.54 Conclusions**

This chapter analysed, discussed and summarised the findings from the testing of the VSR, a prototype time-based virtual heritage world. Test audiences reported that time-based virtual heritage supporting navigable time provides memorable and educational experiences for museum visitors. Destination and journey-focused time travel provide

complementary opportunities for audiences to engage with heritage by experiencing a specific moment in time and by seeing the evolution of that place over time. In addition it was found that heritage audiences have strong individual preferences for particular activities within a virtual heritage world. The following chapter summarises the author's conclusions from these findings.

## CHAPTER 6: Conclusions

This final chapter presents the author's conclusions based on the test findings and their contribution to the field of virtual heritage. It is argued that time is central to human experience and is particularly pertinent to heritage, which is directly concerned with the transmission and evolution of human culture over time and that time-based virtual heritage enables a richer experience of virtual place, phenomenologically and culturally. It is also contended that both the destination-focused and the journey-focused modes of navigable time are powerful tools for fostering understanding, insight and learning. Offering users a choice of different activities increases user engagement, supports different modes of interaction and, as users are actively engaged in the making of meaning, enables a Constructivist learning experience.

As shown in Chapter 1, Section 1.4, heritage places are places that have rich histories and deep cultural associations which, like all places, change over time and this change occurs over many time periods. The phenomenological dimension of place, its particular sights, sounds and smells, are significantly determined by the natural daily, lunar and annual cycles that dictate the position of the sun, the season of the year, the phase of the moon and regulate human, floral and faunal activity. As well as the regular cycles of activity and change imposed by the natural world there are also, for inhabited places, the changes over longer times scales of years and decades, driven by the dynamic nature of human culture and its expression in the built environment and the dress and behaviours of the inhabitants. For a heritage place, a particular time and date will determine the specific historical and cultural moment for that place, its inhabitants and their associated activities, many of which are shaped by daily, weekly and seasonal cycles that inform working hours and religious calendars. Heritage places, even ones

that are now physically uninhabited, are dynamic – phenomenologically, historically and culturally.

As has been noted, museums have a long history of using illustrations and dioramas to help audiences engage more deeply with heritage and foster historical understanding, insight and learning. Virtual heritage is part of this pedagogical tradition and, while virtual heritage places cannot match the physical and cultural immersion and affect of real heritage places they, like illustrations and dioramas, can engender insight, understanding and learning in museum audiences. The author argues that time-based virtual heritage enables a richer phenomenological and cultural re-creation of place while time-lapsed virtual heritage, by showing changes in the built environment over timescales outside of normal human experience, allows heritage audiences to gain insight and understanding of historical processes, opening up a dialogic engagement with heritage itself. In addition it is posited throughout this thesis that navigable time provides a degree of agency which users find engaging, contributing to immersion.

Finally the author argues that, given the importance of individual user preference to engagement in virtual worlds and the range of activity preference expressed by users of the VSR, then restricting user activity to game-styled interactions significantly reduces engagement for heritage audiences. Applying Constructivist learning theory to virtual heritage demands the crafting of a range of user-centred activities that support the active engagement of users and provide learning opportunities.

Audience experiences have always been central to the museum's relationship to the public and to the public's relation to the museum (Kenderdine 2006, Witcomb 2003). Capturing a visitor's attention with spectacle has been part and parcel of the museum

experience from the very earliest origins of museums in the cabinets of curiosities amassed by the wealthy and powerful (Noordegraaf 2004). The visitor experience is fundamental and, as Manovich reminds us in *The Language of New Media* when he discusses the installation art of Kabakov, ‘this focus on the viewer offers an important lesson for New Media designers, who often forget that what they are designing is not an object in itself but a viewer’s experience in time and space’ (Manovich 2001: 267).

As discussed in Chapter 1, Section 1.5, the ability of virtual environments to engender a sense of ‘being there’ makes them particularly well suited to heritage pertaining to the built environment. Place is of course much more than just a geographical setting. As this thesis has shown, place is a social construct, with multiple layers of human meanings and activities underlying and overlaying geography and architecture. Time-based virtual heritage, as well as supporting richer virtual place, phenomenologically and culturally, also extends the virtual re-creation of place to include place over time, in turn creating opportunities for deeper engagement with the past. Cities are particularly well suited to the potential of time-based virtual heritage as they usually exist for many hundreds, and sometimes thousands, of years. The story of each individual inhabitant of a city is limited to a single lifetime but the story of the city itself takes place over longer timescales than it is possible to experience directly. Journey-focused time travel in virtual heritage enables users to literally *see* this longer history unfold. This is phenomenologically powerful, creating affective and memorable learning experiences. Many cities have museums dedicated to their history and, as the costs of virtual heritage continue to fall, projects like the Virtual Sydney Rocks will become increasingly viable.

In summary, the two key findings from testing the VSR are that navigable time is

engaging and informative and that individual museum visitors have clear preferences when it comes to activities within a virtual heritage world. The overall picture that the data clearly reveal is that, as well as being engaging, users believe that a time-based virtual world provides educational opportunities. In addition, the responses indicate that museum visitors have strong individual preferences for different interaction modes when they engage with virtual heritage and, given the role that individual factors play in engagement, supporting a range of interaction modes will greatly broaden the appeal of virtual heritage to museum audiences. Additionally, agency is an important factor in informal learning and offering users choices increases their sense of agency and engagement. These findings are important contributions to knowledge that will be useful to future developers of heritage-based virtual worlds intended to deliver affective, memorable and educational heritage experiences to general audiences.

While these findings clearly show the potential of time-based virtual heritage, given the prototype nature of the VSR and the limited numbers of test users, further research into navigable time is indicated. The task ahead is to use the feedback from testers and analysis of the data to revise the VSR and devise further research that builds on the initial findings and continues to develop the educational potential of time-based virtual heritage. The least liked features and the suggestions for improvements reported by users were primarily to do with the look of the VSR, the lack of inhabitants and problems with the controls and the interface. This feedback shows the importance of social presence and image quality to users and reflects a public awareness of state-of-the-art commercial game worlds. The revised VSR is being implemented in Unity and will address a number of the identified shortcomings. The new interface will explore different options such as sliders, text boxes, drop down menus and experiment with using game controllers, keyboard keys and the mouse for movement and object

selection instead of a joystick. It will also feature a dynamic sun, moon and starfield system, a weather system and trees and grasses that are affected by the wind, creating a phenomenologically rich natural environment. However, while there is a wide range of content available in the Unity Asset Store such as dynamic weather systems, individual objects, plants, animals and human models, animations and crowd control systems, many Australian native plants and animals do not exist and they will need to be built from scratch. These include a range of human models, in correct period dress, of the many diverse inhabitants of the Rocks between 1788 and the present day including Indigenous people, convicts, soldiers, sailors and immigrants. Once these are created they will be animated using libraries from the Asset Store to create a populated virtual heritage world supporting social presence and creating deeper cultural immersion.

As stated in the Introduction, the author's main interest is in creating better virtual heritage worlds. Time-based virtual heritage is in its infancy and the revised VSR will be a powerful tool to continue the investigation of the educational potential of navigable time. It will be used to research the temporal contribution to the experience of place, culturally and phenomenologically. Additionally, given the disinterest in playing the game evidenced by a significant subset of testers, further research will be undertaken to explore public preferences for and the educational potential of, different activities and game genres. Role-playing games will be developed to encourage deeper engagement by users and additional content in the form of tours and games that go beyond simple narratives will be developed to support spatial and dialogic interactions.

The revised VSR is intended for public download as well as museum installation and will include content designed for repeated and prolonged engagement. Delivery of the revised version of the VSR to multiple platforms including desktop machines, tablets

and smart phones is being explored along with an AR version that would detect the location and orientation of a phone or pad device and display on the screen the appropriate view of a particular time and date set by the user. Users would then be able to use their device as a literal window into the past while walking the real physical streets of the Sydney Rocks. AR devices such as Google Glass herald a deepening engagement and melding of navigable space with everyday life and VR headsets such as the Oculus Rift profoundly deepen the immersive affect of virtual environments. The future is bright for the virtual past.

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## APPENDIX 1a: Big Dig buildings

Address	Type/Name	Dates	Web page
Big Dig site	Cribb's Slaughter-yard	c1817- c1824	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/Cribbs_SlaughterYard_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/Cribbs_SlaughterYard_BigDig.htm</a>
Big Dig site	Industrial Shed	1917- 1950s	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/Shed_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/Shed_BigDig.htm</a>
Big Dig site	Bus Park	1950's- 1972	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BusPark_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BusPark_BigDig.htm</a>
Big Dig site	SHFA storage area	1972- 1984	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/SHFA_StorageArea_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/SHFA_StorageArea_BigDig.htm</a>
Big Dig site/110 Cumberland Street	YHA Sydney Harbour	2010	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/YouthHostel_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/YouthHostel_BigDig.htm</a>
1/1-3 Carahers Lane	Terrace	c1845- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/1_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/1_CarahersLn_BigDig.htm</a>
3/1-3 Carahers Lane	Terrace	c1845- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/3_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/3_CarahersLn_BigDig.htm</a>
5/5-11 Carahers Lane	Terrace	c1845- 1903	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/5_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/5_CarahersLn_BigDig.htm</a>
7/5-11 Carahers Lane	Terrace	c1845- 1903	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/7_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/7_CarahersLn_BigDig.htm</a>
9/5-11 Carahers Lane	Terrace	c1845- 1903	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/9_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/9_CarahersLn_BigDig.htm</a>
11/5-11 Carahers Lane	Terrace	c1845- 1903	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/11_CarahersLn_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/11_CarahersLn_BigDig.htm</a>
Cnr Cumberland Street & Cribbs Lane	Byrne house Weather-board cottage	c1807- c1860	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/TheByrneHouse_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/TheByrneHouse_BigDig.htm</a>
Cumberland St	William Williams house	c1809-	
Cumberland St	Chanhell house	c1809-	
116 Cumberland St (corner Cumberland St and Cribbs Lane)	The Plymouth Arms Inn	1844- 1913	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/116_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/116_CumberlandSt_BigDig.htm</a>

118 Cumberland St (corner Cumberland St and Cribbs Lane)	Berry's Bakery/John Simpson's General Store	1844- c1900	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/118_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/118_CumberlandSt_BigDig.htm</a>
120 Cumberland St	Nicholas Rents	c1833- 1907	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/120_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/120_CumberlandSt_BigDig.htm</a>
122 Cumberland St	Nicholas Rents	c1833- 1891	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/122_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/122_CumberlandSt_BigDig.htm</a>
124 Cumberland St	Nicholas Rents	c1833- 1907	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/124_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/124_CumberlandSt_BigDig.htm</a>
126 Cumberland St	Nicholas Rents	c1833- 1907	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/126_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/126_CumberlandSt_BigDig.htm</a>
128 Cumberland St	Nicholas Rents	c1833- c1900	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/128_CumberlandSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/128_CumberlandSt_BigDig.htm</a>
79/79-81 Gloucester Street	Fenelley Terraces		<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/79_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/79_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
81/79-81 Gloucester Street	Fenelley Terraces		<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/81_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/81_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
83/83-87 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/83_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/83_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
85/83-87 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/85_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/85_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
87/83-87 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/87_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/87_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
89/89-93 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/89_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/89_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
91 Gloucester Street	The Arm and Legg House	C1795- 1891	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/91_GloucesterSt_ArmLeggHouse_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/91_GloucesterSt_ArmLeggHouse_BigDig.htm</a>
91/89-93 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/91_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/91_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
93/89-93 Gloucester Street	Fenelley Terraces	1889- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/93_GloucesterSt_FenelleyTerraces_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/93_GloucesterSt_FenelleyTerraces_BigDig.htm</a>
95 Gloucester St	Row hut	c 1790	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm</a>
95 Gloucester Street	Cribb's House	c1823	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/95_GloucesterSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/95_GloucesterSt_BigDig.htm</a>
95 Gloucester Street	St. Patrick's Inn/The Whalers Arms	1830- 1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/95_GloucesterSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/95_GloucesterSt_BigDig.htm</a>
97 Gloucester St	Row hut	c 1790	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm</a>

97 Gloucester Street	Cribb's Butchers Shop	c1817-1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/97_GloucesterSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/97_GloucesterSt_BigDig.htm</a>
99 Gloucester St	Row hut	c 1790	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/BarkHut_BigDig.htm</a>
99 Gloucester Street	The Turk's Head/The Bird in Hand	c1817-1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/99_GloucesterSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/99_GloucesterSt_BigDig.htm</a>
101 Gloucester Street	The King House	c1817-1902	<a href="http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/101_GloucesterSt_BigDig.htm">http://virtualsydneyrocks.com/GuideBook/Pages/theBigDig/BigDig_Buildings/101_GloucesterSt_BigDig.htm</a>

## APPENDIX 1b: Surrounding buildings

Address	Name	Heritage Listing	Dates	Web page
1 Alfred Street	Goldfields House		1966	<a href="http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_1.htm">http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_1.htm</a>
31 Alfred Street	Customs House	Yes	1845	<a href="http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_31.htm">http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_31.htm</a>
33 Alfred Street	AMP Building		1962	<a href="http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_33.htm">http://virtualsydneyrocks.com/GuideBookPages/AlfredStreet/AlfredSt_33.htm</a>
Cnr Alfred Street & Loftus Street	Paragon Hotel		1868	<a href="http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_ParagonHotel.htm">http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_ParagonHotel.htm</a>
	Argyle Bridge		1868	
	The Argyle Cut	Yes	1843	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleCut.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleCut.htm</a>
12-20 Argyle Street	Argyle Stores	Yes	1826	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_12to20.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_12to20.htm</a>
39-43 Argyle Street	British Seamens' Hotel	Yes	1886	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_39to43.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_39to43.htm</a>
45-47 Argyle Street	Gannon House	Yes	1839	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_45to47.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_45to47.htm</a>
Cnr Argyle Street & Lower Fort Street	The Garrison Church & School	Yes	1840	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_GarrisonChurch.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_GarrisonChurch.htm</a>
1-7 Atherden Street	Playfair's Terrace	Yes	1880	<a href="http://virtualsydneyrocks.com/GuideBookPages/AtherdenStreet/AtherdenSt_1to7.htm">http://virtualsydneyrocks.com/GuideBookPages/AtherdenStreet/AtherdenSt_1to7.htm</a>
2-4 Atherden Street	Avery Terrace	Yes	1881	<a href="http://virtualsydneyrocks.com/GuideBookPages/AtherdenStreet/AtherdenSt_2to4.htm">http://virtualsydneyrocks.com/GuideBookPages/AtherdenStreet/AtherdenSt_2to4.htm</a>
Bennelong Point	Bennelong's House		1790-c1795	<a href="http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm</a>
Bennelong Point	Fort Macquarie		1817-1901	<a href="http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm</a>
Bennelong Point	Fort Macquarie Tram Depot		1901-1955	<a href="http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm</a>
Bennelong Point	Sydney Opera House		1957	<a href="http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/BennelongPoint/BennelongPoint.htm</a>
4 Bridge Street	Cliveden	Yes	1985	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_4.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_4.htm</a>

5-11 Bridge Street	Burns Philip Building	Yes	1899	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_5to11.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_5to11.htm</a>
6 Bridge Street	Northumberland Insurance Building	Yes	1884	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_6.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_6.htm</a>
10 Bridge Street	Exchange House		1960	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_10.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_10.htm</a>
13-15 Bridge Street	Pauls terrace		1836-1850's	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm</a>
13-15 Bridge Street	Royalt Chambers		1850's-1959	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm</a>
13-15 Bridge Street	Liner House	Yes	1959	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_13to15.htm</a>
16-30 Bridge Street	Australian Stock Exchange		1960	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_16to30.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_16to30.htm</a>
17-19 Bridge Street	Scottish House	Yes	1926	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_17to19.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_17to19.htm</a>
23-33 Bridge Street	Lands Department Building	Yes	1877	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_23to33.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_23to33.htm</a>
35-39 Bridge Street	Department of Education Building	Yes	1912	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_35to39.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_35to39.htm</a>
38-42 Bridge Street	Dalgety House		1966-1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_38to42.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_38to42.htm</a>
38-42 Bridge Street	Bridgeport		1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_38to42.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_38to42.htm</a>
44 Bridge Street	Booth House	Yes	1937	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_44.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_44.htm</a>
50 Bridge Street	AMP Tower		1976	<a href="http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_50.htm">http://virtualsydneyrocks.com/GuideBookPages/BridgeStreet/BridgeSt_50.htm</a>
65 Bridge Street	NSW Chief Secretary's Building (also 121 Macquarie Street and 44-50 Phillip Street)	Yes	1873-	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm</a>
2 Bulletin Place	Offices		1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_2.htm">http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_2.htm</a>
6-8 Bulletin Place	Warehouse	Yes	1880	<a href="http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_6to8.htm">http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_6to8.htm</a>
10-14 Bulletin Place	Warehouse	Yes	1880	<a href="http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_10to14.htm">http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_10to14.htm</a>
16-18 Bulletin Place	Mary Reiby Warehouse	Yes	1816	<a href="http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_16to18.htm">http://virtualsydneyrocks.com/GuideBookPages/BulletinPlace/BulletinPl_16to18.htm</a>

Caraher's Lane	Longs Lane Precinct	Yes	1807	<a href="http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=176">http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=176</a>
Circular Quay	Circular Quay Railway Station and Viaduct	Yes	1938	<a href="http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4801109">http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4801109</a>
3 Cumberland Street	King George V Recreational Centre		1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_3.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_3.htm</a>
14-36 Cumberland Street	Sirius Apartments		1979	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_14to36.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_14to36.htm</a>
88 Cumberland Street	Offices		1991	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_88.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_88.htm</a>
96-98 Cumberland Street	Glenmore Hotel	Yes	1921	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_96to98.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_96to98.htm</a>
100-104 Cumberland Street	Australian Hotel	Yes	1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_100to104.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_100to104.htm</a>
110 Cumberland Street	Sydney Youth Hostel		2010	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_110.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_110.htm</a>
132-134 Cumberland Street	Terraces	Yes	1891	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_132to134.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_132to134.htm</a>
136-138 Cumberland Street	Shops and Residences	Yes	1881	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_136to138.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_136to138.htm</a>
140-142 Cumberland Street	Tenements	Yes	1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_140to142.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_140to142.htm</a>
176 Cumberland Street	Lilyvale	Yes	1845	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_176.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_176.htm</a>
176 Cumberland Street	Shangri-La Hotel		1988	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_176_Shangri-La.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_176_Shangri-La.htm</a>
178-180 Cumberland Street	Butchery Buildings Shops and Residences	Yes	1890	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_178to180.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_178to180.htm</a>
182 Cumberland Street	Shop and Residence	Yes	1911	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_182.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_182.htm</a>
182.5-186 Cumberland Street	Terraces	Yes	1890	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_182.5to186.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_182.5to186.htm</a>
202-210 Cumberland Street	Reynell Building	Yes	1913	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_202to210.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_202to210.htm</a>

212-218 Cumberland Street	Lawson House	Yes	1924	<a href="http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_212to218.htm">http://virtualsydneyrocks.com/GuideBookPages/CumberlandStreet/CumberlandSt_212to218.htm</a>
8-14 Dalley Street	Electricity Substation		1968	<a href="http://virtualsydneyrocks.com/GuideBookPages/DalleyStreet/DalleySt_8to14.htm">http://virtualsydneyrocks.com/GuideBookPages/DalleyStreet/DalleySt_8to14.htm</a>
	Dawes Observatory		1788	<a href="http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm</a>
	Dawes Point Battery		1791-1819	<a href="http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm</a>
	Dawes Point Fort	Yes	1790-1813	<a href="http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm">http://virtualsydneyrocks.com/GuideBookPages/DawesPoint/DawesPoint.htm</a>
10-14 Essex Street	Harts Building	Yes	1890	<a href="http://virtualsydneyrocks.com/GuideBookPages/EssexStreet/EssexSt_10to14.htm">http://virtualsydneyrocks.com/GuideBookPages/EssexStreet/EssexSt_10to14.htm</a>
	Bethel Steps	Yes	1907	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_BethelSteps.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_BethelSteps.htm</a>
	First Fleet Park	Yes		<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_FirstFleetPark.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_FirstFleetPark.htm</a>
	George Street North Commercial Precinct	Yes		<a href="http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=167">http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=167</a>
	George Street North Metcalfe Heritage Precinct	Yes		<a href="http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=169">http://www.shfa.nsw.gov.au/sydney-About-us-Our-heritage-role-Heritage-and-Conservation-Register.htm&amp;objectid=169</a>
23 George Street	Ajax Building	Yes	1915	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_23.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_23.htm</a>
25-27 George Street	Mercantile Hotel	Yes	1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_25to27.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_25to27.htm</a>
29-31 George Street	Terraces	Yes	1866	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_29to31.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_29to31.htm</a>
33-41 George Street	Sergeant Majors Row	Yes	1881	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_33to41.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_33to41.htm</a>
36-64 George Street	(former) Mining Museum	Yes	1902	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_36to64.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_36to64.htm</a>
43-45 George Street	Merchants House	Yes	1848	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_43to45.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_43to45.htm</a>
47 George Street	(former) Union Bond Store	Yes	1841	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_47.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_47.htm</a>
53-55 George Street	Old Sydney Holiday Inn	Yes	1924	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_53to55.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_53to55.htm</a>

66-76 George Street	Metcalfe Bond Stores	Yes	1912	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_66to84.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_66to84.htm</a>
78-84 George Street	Metcalfe Bond Stores	Yes	1916	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_66to84.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_66to84.htm</a>
69 George Street	Observer Hotel	Yes	1908	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm</a>
69 George Street	Observer Tavern		1848- 1908	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm</a>
69 George Street	Watermans Arms		1844- 1848	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_69.htm</a>
71 George Street	Retail (R M Williams Shop)		unkno wn	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_71.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_71.htm</a>
73 George Street	(former) Ambulance Station	Yes	1842	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_73.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_73.htm</a>
75-75.5 George Street	Retail/Office	Yes	1883	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_75to75.5.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_75to75.5.htm</a>
77-85 George Street	Unwin's Stores	Yes	1843	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_77to85.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_77to85.htm</a>
86-88 George Street	(former) Bushells Warehouse	Yes	1886	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_86to88.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_86to88.htm</a>
87-89 George Street	Orient Hotel	Yes	1843	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_87to89.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_87to89.htm</a>
91-93 George Street	Assistant Surgeon's House		1788- 1815	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm</a>
91-93 George Street	Francis Greenway		1816- 1837	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm</a>
91 George Street	(former) ASN Building	Yes	1839	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_91.htm</a>
93 George Street	Retail (Restaurant)		unkno wn	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_93.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_93.htm</a>
95-99 George Street	Shops and Residences	Yes	1868	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_95to99.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_95to99.htm</a>
98-100 George Street	Mariners' Church	Yes	1856	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_98to100.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_98to100.htm</a>
101 George Street	Restaurant (Philips Foote)	Yes	1838	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_101.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_101.htm</a>
102-104 George Street	(former) Coroner's Court	Yes	1906	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_102to104.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_102to104.htm</a>
103 George Street	Shop and Residence	Yes	1856	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_103.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_103.htm</a>

105 George Street	Shop and Residence	Yes	1856	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_105.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_105.htm</a>
106 George Street	(former) Sailors Home	Yes	1864	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_106.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_106.htm</a>
107-109 George Street	Restaurant (Rockpool)	Yes	1860	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_107to109.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_107to109.htm</a>
110 George Street	Cadman's Cottage	Yes	1816	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_110.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_110.htm</a>
111-115 George Street	Captain Tench Arcade	Yes	1920	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_111to115.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_111to115.htm</a>
117-119 George Street	Julian Ashton Art School	Yes	1832	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_117to119.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_117to119.htm</a>
121 George Street	Shop and Residence	Yes	1880	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_121.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_121.htm</a>
123-125 George Street	Shops and Residences	Yes	1882	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_123to125.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_123to125.htm</a>
127-129 George Street	(former) Rocks Police Station	Yes	1882	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_127to129.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_127to129.htm</a>
131-135 George Street	(former) ES & AC Bank	Yes	1886	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_131to135.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_131to135.htm</a>
132-134 George Street	The Rocks Police Station		1923	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_132to134.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_132to134.htm</a>
136-140 George Street	Commissariat Stores		1809-1939	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_136to140.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_136to140.htm</a>
136-140 George Street	Museum of Contemporary Art		1904	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_136to140.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_136to140.htm</a>
137 George Street	Fortune of War Hotel	Yes	1922	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_137.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_137.htm</a>
139-141 George Street	Shops and Residences	Yes	1881	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_139to141.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_139to141.htm</a>
143-143A George Street	Samuel Terry Terrace		1820's	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_143to143A.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_143to143A.htm</a>
143-143A George Street	The Russell Hotel	Yes	1887	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_143to143A.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_143to143A.htm</a>
145 George Street	Shop and Residence	Yes	1892	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_145.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_145.htm</a>
147 George Street	Shop and Residence	Yes	1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_147.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_147.htm</a>
149-151 George Street	Shops and Residences	Yes	1913	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_149to151.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_149to151.htm</a>

153-155 George Street	(former) New York Hotel	Yes	1908	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_153to155.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_153to155.htm</a>
176 George Street	Jacksons on George Hotel		unknown	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_176.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_176.htm</a>
178-186 George Street	Commercial		unknown	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_178to186.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_178to186.htm</a>
190-200 George Street	Commercial		1988	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_190to200.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_190to200.htm</a>
199 George Street	Four Seasons Hotel		unknown	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_199.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_199.htm</a>
210 George Street	Lippo House		1990	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_210.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_210.htm</a>
220 George Street	Commercial		1972	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_220.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_220.htm</a>
225 George Street	Grosvenor Place		1988	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_225.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_225.htm</a>
229 George Street	Brooklyn Hotel	Yes	1912	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_229.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_229.htm</a>
231 George Street	Commercial	Yes	1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_231.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_231.htm</a>
233-235 George Street	Johnson's Building	Yes	1912	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_233to235.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_233to235.htm</a>
234-242 George Street	Commercial		unknown	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_234to242.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_234to242.htm</a>
244 George Street	Metropolitan Hotel	Yes	1834	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_244.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_244.htm</a>
255 George Street	NAB House		1985	<a href="http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_255.htm">http://virtualsydneyrocks.com/GuideBookPages/GeorgeStreet/GeorgeSt_255.htm</a>
2 Globe Street	(former) NSW Records Office		unknown	<a href="http://virtualsydneyrocks.com/GuideBookPages/GlobeStreet/GlobeSt_2.htm">http://virtualsydneyrocks.com/GuideBookPages/GlobeStreet/GlobeSt_2.htm</a>
26-30 Gloucester Street	View Terraces	Yes	1893	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_26to30.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_26to30.htm</a>
32-36 Gloucester Street	Terraces	Yes	1885	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_32to36.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_32to36.htm</a>
38-40 Gloucester Street	Terraces	Yes	1885	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_38to40.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_38to40.htm</a>
46-56 Gloucester Street	Tenements		1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_46to56.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_46to56.htm</a>
58-64 Gloucester Street	Susannah Place	Yes	1844	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_58to64.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_58to64.htm</a>

66-68 Gloucester Street	Baker's Terrace	Yes	1875	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_66to68.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_66to68.htm</a>
70-72 Gloucester Street	Baker's Terrace	Yes	1882	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_70to72.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_70to72.htm</a>
98-100 Gloucester Street	Quay West		1991	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_98to100.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_98to100.htm</a>
103-111 Gloucester Street	Jobbins Terrace	Yes	1855	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_103to111.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_103to111.htm</a>
113-115 Gloucester Street	Terrace	Yes	1881	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_113to115.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_113to115.htm</a>
117-117A Gloucester Street	Tenements	Yes	1912	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_117to117A.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_117to117A.htm</a>
120 Gloucester Street	Housing Board Building	Yes	1910	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_120.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_120.htm</a>
157-161 Gloucester Street	(former) Science House	Yes	1930	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_157to161.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_157to161.htm</a>
171-193 Gloucester Street	Reynell Terraces and Stamford Residences		2011	<a href="http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_171to193.htm">http://virtualsydneyrocks.com/GuideBookPages/GloucesterStreet/GloucesterSt_171to193.htm</a>
16-18 Grovesnor Street	(former) NSW Housing Board Building	Yes	1921	<a href="http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_16to18.htm">http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_16to18.htm</a>
20 Grovesnor Street	St. Patrick's Church		1840	<a href="http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_20.htm">http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_20.htm</a>
24-30 Grovesnor Street	Federation Hall	Yes	1891	<a href="http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_24to30.htm">http://virtualsydneyrocks.com/GuideBookPages/GrovesnorStreet/GrovesnorSt_24to30.htm</a>
	St. Patrick's Hall and School		1914	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_StPatricksHall.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_StPatricksHall.htm</a>
28-32 Harrington Street	Reynold's Cottages	Yes	1830	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_28to32.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_28to32.htm</a>
34-40 Harrington Street	Evans' Stores	Yes	1890	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_34to40.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_34to40.htm</a>
34-40 Harrington Street	Harbour Rocks Hotel	Yes	1980	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_34to40.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_34to40.htm</a>
35-53 Harrington Street	Clocktower		1988	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_35to53.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_35to53.htm</a>
42-52 Harrington Street	Terraces	Yes	1873	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_42to52.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_42to52.htm</a>
42-52 Harrington Street	Harbour Rocks Hotel	Yes	1980	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_42to52.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_42to52.htm</a>

55-59 Harrington Street	Stafford Terrace	Yes	1886	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_55to59.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_55to59.htm</a>
66 Harrington Street	SHFA Building		1977	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_66.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_66.htm</a>
67 Harrington Street	Terrace	Yes	1860	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_67.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_67.htm</a>
71 Harrington Street	House	Yes	1895	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_71.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_71.htm</a>
75 Harrington Street	Rendezvous Stafford Hotel		1986	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_75.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_75.htm</a>
117-119 Harrington Street	Accountants' House	Yes	1840	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_117to119.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_117to119.htm</a>
121-127 Harrington Street	Bushells Building	Yes	1924	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_121to127.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_121to127.htm</a>
129 Harrington Street	The Cove		1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_129.htm">http://virtualsydneyrocks.com/GuideBookPages/HarringtonStreet/HarringtonSt_129.htm</a>
1-5 Hickson Road/ 35-45 Circular Quay West	Australasian Steam Navigation Company Building (ASN Co)	Yes	1884	<a href="http://virtualsydneyrocks.com/GuideBookPages/HicksonRoad/HicksonRd_1to5.htm">http://virtualsydneyrocks.com/GuideBookPages/HicksonRoad/HicksonRd_1to5.htm</a>
7 Hickson Road	Park Hyatt Hotel		1990	<a href="http://virtualsydneyrocks.com/GuideBookPages/HicksonRoad/HicksonRd_7.htm">http://virtualsydneyrocks.com/GuideBookPages/HicksonRoad/HicksonRd_7.htm</a>
2-8 Kendall Lane	Coach House/McKeller Stores	Yes	1853	<a href="http://virtualsydneyrocks.com/GuideBookPages/KendallLane/KendallLn_2to8.htm">http://virtualsydneyrocks.com/GuideBookPages/KendallLane/KendallLn_2to8.htm</a>
2-8 Kendall Lane	Rocks Discovery Museum	Yes	2005	<a href="http://virtualsydneyrocks.com/GuideBookPages/KendallLane/KendallLn_2to8.htm">http://virtualsydneyrocks.com/GuideBookPages/KendallLane/KendallLn_2to8.htm</a>
Cnr Loftus Street & Alfred Street	Paragon Hotel		1868	<a href="http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_ParagonHotel.htm">http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_ParagonHotel.htm</a>
10 Loftus Street	Commercial		1984	<a href="http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_10.htm">http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_10.htm</a>
12-14 Loftus Street	Gallipoli Club		1876	<a href="http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_12to14.htm">http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_12to14.htm</a>
16-20 Loftus Street	Commercial		1974	<a href="http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_16to20.htm">http://virtualsydneyrocks.com/GuideBookPages/LoftusStreet/LoftusSt_16to20.htm</a>
Cnr Lower Fort Street & Argyle Street	The Garrison Church & School	Yes	1840	<a href="http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_GarrisonChurch.htm">http://virtualsydneyrocks.com/GuideBookPages/ArgyleStreet/ArgyleSt_GarrisonChurch.htm</a>
1 Macquarie Place	Gateway Plaza		1989	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_1.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_1.htm</a>

7 Macquarie Place	Commercial & Retail			<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_7.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_7.htm</a>
27-31 Macquarie Place	Kyle House		1931	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_27to31.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquariePlace/MacquariePl_27to31.htm</a>
1-7 Macquarie Street	Bennelong Apartments (The Toaster Building)		1998	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_1to7.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_1to7.htm</a>
89-91 Macquarie Street	Royal Automobile Club of Australia		1926	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_89to91.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_89to91.htm</a>
93 Macquarie Street	Sir Stamford Hotel		1850s	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_93.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_93.htm</a>
99-113 Macquarie Street	Transport House	Yes	1938	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_99to113.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_99to113.htm</a>
115-119 Macquarie Street	Intercontinental Hotel (former NSW Treasury Building)	Yes	1896	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_115to119.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_115to119.htm</a>
115-119 Macquarie Street	Intercontinental Hotel Tower		1984	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_115to119.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_115to119.htm</a>
121 Macquarie Street	NSW Chief Secretary's Building (also 65 Bridge Street and 44-50 Phillip Street)	Yes	1873	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm</a>
Observatory Hill	Observatory Hill			<a href="http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/ObservatoryHill.htm">http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/ObservatoryHill.htm</a>
Observatory Hill	Fort Phillip		1803	<a href="http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm">http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm</a>
Observatory Hill	Signal Station	Yes	1825	<a href="http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm">http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm</a>
Observatory Hill	Observatory	Yes	1857	<a href="http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm">http://virtualsydneyrocks.com/GuideBookPages/ObservatoryHill/Observatory.htm</a>
2 Phillip Street	The Quay		1984	<a href="http://virtualsydneyrocks.com/GuideBookPages/PhillipStreet/PhillipSt_2.htm">http://virtualsydneyrocks.com/GuideBookPages/PhillipStreet/PhillipSt_2.htm</a>
4-8 Phillip Street	Justice and Police Museum	Yes	1854	<a href="http://virtualsydneyrocks.com/GuideBookPages/PhillipStreet/PhillipSt_4to8.htm">http://virtualsydneyrocks.com/GuideBookPages/PhillipStreet/PhillipSt_4to8.htm</a>
44-50 Phillip Street	NSW Chief Secretary's Building (also 121 Macquarie Street and 65 Bridge Street)	Yes	1873	<a href="http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm">http://virtualsydneyrocks.com/GuideBookPages/MacquarieStreet/MacquarieSt_121.htm</a>

1 Pitt Street	Ship Inn		1905	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt1.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt1.htm</a>
19-31 Pitt Street	Fairfax House		1970	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt19to31.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt19to31.htm</a>
22 Pitt Street	Export House		unkno wn	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt22.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt22.htm</a>
30 Pitt Street	Sydney Harbour Marriott Hotel		unkno wn	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt30.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt30.htm</a>
33-35 Pitt Street	Atrium Building		1984	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt33to35.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt33to35.htm</a>
37-49 Pitt Street	Underwood House		1959	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt37to49.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt37to49.htm</a>
50 Pitt Street	Commercial		1974	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt50.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt50.htm</a>
51-57 Pitt Street	Commercial		1959	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt51to57.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt51to57.htm</a>
56 Pitt Street	Wool Exchange		1853	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt56.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt56.htm</a>
56 Pitt Street	Royal Exchange		1965	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt56.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt56.htm</a>
69-73 Pitt Street	Republic Hotel		1865	<a href="http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt69to73.htm">http://virtualsydneyrocks.com/GuideBookPages/PittStreet/PittSt69to73.htm</a>
6-8 Playfair Street	Westpac Museum		1986	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt6to8.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt6to8.htm</a>
13-15 Playfair Street	Argyle Terrace	Yes	1883	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt13to15.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt13to15.htm</a>
17-31 Playfair Street	Playfair Street Terraces	Yes	1875	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt17to31.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt17to31.htm</a>
22-26 Playfair Street	Stone stores		1844	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm</a>
22-26 Playfair Street	Playfair's Garage	Yes	1924	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm</a>
22-26 Playfair Street	Rocks Visitor Centre	Yes	1994	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt22to26.htm</a>
33 Playfair Street	Cleland Bond Store		1913	<a href="http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt33.htm">http://virtualsydneyrocks.com/GuideBookPages/PlayfairStreet/PlayfairSt33.htm</a>
Upper Fort Street	Military Hospital		1815	<a href="http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm">http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm</a>

Upper Fort Street	Fort Street School		1849-1975	<a href="http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm">http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm</a>
Upper Fort Street	The National Trust S.H. Ervin Gallery		1978	<a href="http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm">http://virtualsydneyrocks.com/GuideBookPages/UpperFortStreet/FortSt_School.htm</a>
1 York Street	The York		1982	<a href="http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_1.htm">http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_1.htm</a>
3 York Street	Wattle and daub church		1793-1798	<a href="http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm">http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm</a>
3 York Street	St. Philip's Church		1810	<a href="http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm">http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm</a>
3 York Street	St. Philip's Church		1856	<a href="http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm">http://virtualsydneyrocks.com/GuideBookPages/YorkStreet/YorkSt_3.htm</a>
5-7 Young Street	Oznam House and Marist Chapel		1860	<a href="http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_5to7.htm">http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_5to7.htm</a>
9-13 Young Street	Commercial		1970	<a href="http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_9to13.htm">http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_9to13.htm</a>
15-17 Young Street	Commercial		1971	<a href="http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_15to17.htm">http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_15to17.htm</a>
36-42 Young Street	Terraces	Yes	1875	<a href="http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_36to42.htm">http://virtualsydneyrocks.com/GuideBookPages/YoungStreet/YoungSt_36to42.htm</a>

## **APPENDIX 1c: Questionnaire**

### **Sydney Virtual Rocks Questionnaire June 2013**

#### **Introduction**

In 1788 the British established a penal colony at Sydney Cove. In just over 200 years the site has evolved from a collection of tents to the heart of a large city. The Virtual Sydney Rocks is a prototype interactive virtual world designed to teach people about the history and development of the area surrounding Sydney Cove. Your feedback is invaluable and very much appreciated.

Thank you

**Kit Devine**

**Phd candidate in the School of Design, College of Fine Arts, UNSW**

**Project Title: Testing Times**

**Virtual heritage, 'time travel' and the user experience of museum visitors: A case study of an experimental prototype.**

**Ethics Approval Number: 11 161 & 11 161 EXT.**

**Your consent is confirmed by the completion and return of this survey under the National Statement on Ethical Conduct in Research Guidelines, section 1.9**

**If you have any queries regarding either the research or the questionnaire, please contact:**

**Kit Devine via email at [kit@dlf.org.au](mailto:kit@dlf.org.au) or via telephone at 0414 695334**

**Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email [ethics.sec@unsw.edu.au](mailto:ethics.sec@unsw.edu.au)). Any complaint you make will be investigated promptly and you will be informed out the outcome.**

# Sydney Virtual Rocks Questionnaire November 2011

## Questions

### Demographic \*\*\*\*\*

Age -  
Male/Female -  
Occupation -

### Pre-knowledge and Learning \*\*\*\*\*

Have you visited the Sydney Rocks?  
Yes/No (circle one)

Have you visited any virtual museums or virtual heritage sites?  
Yes/No (circle one)

### Computer and Electronic Game Knowledge \*\*\*\*\*

#### Do you use computers?

(Please circle to indicate your choice)

1. never
2. once a month
3. once a week
4. two to three times a week
5. at least once a day

#### Do you play electronic games?

(Please circle to indicate your choice)

1. never
2. once a month
3. once a week
4. two to three times a week
5. at least once a day

#### If you play games, do you play

On console? Yes/No (circle one)  
On a computer? Yes/No (circle one)  
On a phone? Yes/No (circle one)

**Interaction Strategy Questions \*\*\*\*\***

Did you

- 1) Take the virtual tour?      Yes/No (circle one)
- 2) Play the game?              Yes/No (circle one)
- 3) Explore?                      Yes/No (circle one)

If you did more than one of the above

Which did you do first?      Tour    Game    Explore (circle one)

Which did you do second?    Tour    Game    Explore (circle one)

Which did you do third?      Tour    Game    Explore (circle one)

Which did you like the most? \_\_\_\_\_

Why? \_\_\_\_\_

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Would you advise someone to

- 4) Take the virtual tour?      First    Second    Third (circle one)
- 5) Play the game?              First    Second    Third (circle one)
- 6) Explore?                      First    Second    Third (circle one)

Why? \_\_\_\_\_

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**Place, Presence, History and Culture Questions \*\*\*\*\***

On a scale of 1 to 6 where

- 1. Strongly disagree
- 2. Disagree
- 3. Slightly disagree
- 4. Slightly agree
- 5. Agree
- 6. Strongly agree

1) The Virtual Sydney Rocks **Tour** gave me a feeling of what it was like to be in the Rocks at different times.

(circle one)

1      2      3      4      5      6

2) The Virtual Sydney Rocks **Game** gave me a feeling of what it was like to be in the Rocks at different times.

(circle one)

1      2      3      4      5      6

**3) Exploring** the Virtual Sydney Rocks gave me a feeling of what it was like to be in the Rocks at different times.

(circle one)

1      2      3      4      5      6

4) Which way of interacting was most effective at making you feel like you were actually there?

(circle one)

Tour    Game    Explore

Why?

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On a scale of 1 to 6 where

- 1. Strongly disagree
- 2. Disagree
- 3. Slightly disagree
- 4. Slightly agree
- 5. Agree
- 6. Strongly agree

5) I learned some of the history of the Sydney Rocks by taking the Virtual Sydney Rocks **Tour**.  
(circle one)

1      2      3      4      5      6

6) I learned some of the history of the Sydney Rocks by playing the Virtual Sydney Rocks **Game**.  
(circle one)

1      2      3      4      5      6

7) I learned some of the history of the Sydney Rocks while **Exploring** the Virtual Sydney Rocks.  
(circle one)

1      2      3      4      5      6

8) Which way of interacting helped you learn most about the history of the Sydney Rocks?  
(circle one)

Tour    Game    Explore

Why?

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On a scale of 1 to 6 where

- 1. Strongly disagree
- 2. Disagree
- 3. Slightly disagree
- 4. Slightly agree
- 5. Agree
- 6. Strongly agree

9) I saw how the Sydney Rocks has changed over time by taking the Virtual Sydney Rocks **Tour**.  
(circle one)

1      2      3      4      5      6

10) I saw how the Sydney Rocks has changed over time by playing the Virtual Sydney Rocks **Game**.  
(circle one)

1      2      3      4      5      6

11) I saw how the Sydney Rocks has changed over time by **Exploring** the Virtual Sydney Rocks.  
(circle one)

1      2      3      4      5      6

12) Which way of interacting was most effective at showing you how the Sydney Rocks has changed over time?  
(circle one)

Tour    Game    Explore

Why?

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**Design Feedback**

13) Write down the two things you liked most about the Virtual Sydney Rocks.

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14) Write down the two things you liked least about the Virtual Sydney Rocks.

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15) Write down any ways that you think the Virtual Sydney Rocks could be improved.

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## **APPENDIX 1d: Questionnaire data**

The results from the 31 respondents who tried all the modes are shown on a grey background and the results from the other 27 respondents are shown on a white background.

Respondent	Age	Sex	Occupation	Visited Rocks	Visited VH	Use Computers	Games	Console	Computer	Phone
1	34	F	Researcher	Y	N	5	1			Y
2	59	F	Teacher	N	N	5	1			
3		F	Media Producer	Y	Y	5	5	Y	Y	Y
4		F	Director	Y	Y	5	5	Y	Y	Y
5	43	F	Museum Host	Y	N	5	1	n/a	n/a	n/a
6	36	F	Engineer	Y	N	5	4	N	N	Y
7	14	F	Student	N	N	5	3	N	Y	N
8	25	F	Student	Y	N	5	1			
9	25	F	Student	Y	N	5	1			
10	26	F	Student	N	N	5	1			
11	20	M	student/traveller	Y	N	5	3	N	Y	N
12	22	F	Student	N	N	4	2	N	Y	Y

Respondent	Age	Sex	Occupation	Visited Rocks	Visited VH	Use Computers	Games	Console	Computer	Phone
13	24	F	Digital producer	Y	N	5	4	Y	N	Y
14	24	F	Student	Y	N	5	1	N	Y	N
15	28	F	3D artist	Y	N	5	5	N	Y	Y
16	35	F	Employee	Y	Y	5	3	Y	Y	Y
17	41	F	Ipad developer	Y	N	5	3	N	Y	Y
18	48	M	Process technician	Y	Y	5	5			Y
19	52	F	Horticultural Field Officer	Y	Y	5	5		Y (tablet)	
20	28	F	Tour guide/education officer	Y	Y	5	1 (rarely)	Y		
21	34	M	Designer	Y	Y	5	2		Y	Y
22	50	F	Admin	Y	Y	5	1			
23	49	F	Archaeologist	Y	Y	5	2		Y	Y

Respondent	Age	Sex	Occupation	Visited Rocks	Visited VH	Use Computers	Games	Console	Computer	Phone
24										
25	32	M	Account manager	Y	N	5	4	N	Y	Y
26	40	F	Performer	Y	N	1	1			
27	23	M	Public Servant	N	N	5	3	Y	Y	Y
28	16	M		N	N	5	4	Y		
29	48	F	Video editor	Y	N	4	2			Y
30	30	F	Lecturer/student	Y	N	5	5	Y	Y	Y
31	35	M	Media Production	Y	N	5	1			
32	16	F		Y	N	5	2	N	Y	Y
33	18	M	Student	Y	N	4	2	Y		
34	18	M	Student	Y	N	5	3	Y	Y	Y
35	50	M	vfx	Y	Y	5	1			

Respondent	Age	Sex	Occupation	Visited Rocks	Visited VH	Use Computers	Games	Console	Computer	Phone
36	47	F	museum sector	Y	Y	5	2 - less			Y
37	48		investor	N	N	5	3	Y	Y	Y
38	46	F	Marketing	Y	Y	5	1 (rarely)			
39	25	M	unemployed	Y	N	5	5	Y	Y	Y
40	50	F	Illustrator	Y	N	5	once or twice a year	N	Y	N
41	20	F	Student	Y	Y	5	2	N	N	Y
42	20	F	High School	Y	N	5	2	N	N	Y
43	41	M	IT	Y	N	5	4	Y	Y	Y
44	42	F	Writer	Y	N	5	1			
45	10	M	Awesomeness	Y	Y	4	4	Y	Y	Y
46	50	M	Payroll manager	Y	N	5	5	Y	Y	Y

Respon- dent	Age	Sex	Occupation	Visited Rocks	Visited VH	Use Computers	Games	Console	Computer	Phone
47	33	M	Scientist	N	N	5	1			
48	27	M	Phd student	Y	N	5	4	N	N	Y
49	15	M	Student	Y	Y	5	4	Y	Y	Y
50	46	M	Retail	Y	N	5	1			
51	54	M	Lawyer	Y	N	5	1			
52	48	M	Administra tor	Y	N	5	1			
53	30	F	TV Producer	Y	Y	5	2		Y	Y
54	55	M	Self- employed	Y	N	5	2	N	Y	N
55	40	F	Police officer	N	N	5	3	Y	Y	Y
56	10	M	Student	N	N		4	Y	Y	Y
57	8	M	Student	N	N		4	Y	Y	Y
58	56	M	Teacher	Y	N	5	1			

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
1	Y	Y	Y	Tour	Explore	Game	Explore	Multiple types of historical information - very interesting. Would probably enjoy game if I had more experience of virtual gaming
2	Y	N	Y	Tour	Explore		Undecided	Tour was interesting re overview but the explore gave most detail
3	Y	N	Y	Explore	Tour		exploring	Free-form discovery and learning. Making own decisions
4	Y	Y	Y	Game	Tour	Explore	Explore	Open ended play and exploration. Let me go at my own pace
5	Y	N	Y	Tour	Explore	n/a	Explore	I had an interest in the history of the Rocks so enjoyed seeing what facts were available
6	Y	Y	Y	Tour	Game	Tour	Tour	Very interactive and informative
7	N	Y	Y	Game	Explore	n/a	Explore	I could learn about what buildings were here and which are here now, the detail was awesome
8	N	N	Y	Explore			just did the explore	
9	Y	N	Y	Explore	Tour		Explore	More independent feels good to go wherever you want and explore whatever you want, more interactive
10	Y		Y	Explore	Tour		Tour	To get a short overview. If you have seen the big differences, I think it's easier to explore and search for buildings of your interest
11	N	Y	Y		Explore	Game	Game	

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
12	Y	Y	Y	Explore	Game	Tour	Game & Explore	you get to interact and have a better understanding of the history, I like hands-on stuff than the long theory
13	Y	Y	Y	Game	Explore	Tour	Tour	very well informed, easy to understand
14	Y	Y	Y	Explore	Game	Tour	Explore	Able to go through the whole history year by year. Each building has a link to it which further elaborates on the history
15	Y	Y	Y	Explore	Game	Tour	Exploring	covers more of the area from first person perspective and gives more information about each specific part of the Rocks. Also lets me play with different time periods and observe the changes
16	Y	N	Y	Tour	Explore		Explore	you can see the difference in the ages
17	Y	Y	Y	Tour	Game	Explore	Game	Having a goal to find things and learn is the most entertaining
18	Y	N	Y	Tour	Explore		Explore	Liked seeing the view change at snapshot
19	Y	Y	Y	Tour	Explore	Game	Explore	Discover bearings
20	Y	Y	Y	Tour	Explore	Game	Explore	Exploring the Rocks & being able to see the different buildings at different times in history was fascinating. I really feel it helps to bring to life the landscape & build an understanding of how the use of the land has changed over time.

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
21	Y	Y	Y	Tour	Game	Explore	Game	The articles (objects) in the game were behind me sitting in a cabinet
22	Y		Y	Explore	Game	Tour		The history lesson + wallpaper + wander into houses + WEATHER
23	Y	Y	Y	Tour	Game	Explore	Tour	information presentation
24	Y	Y	Y	Tour	Game	Explore	Explore	it is probably closest to actually being there
25	N	Y	Y	Explore	Game		Game	Little challenge and gives a starting point for exploring the city at a specific time
26	Y	Y	Y	Tour	Game	Explore	Tour	Enjoyed the guidance and the added information about Mr Cribb - Made it more personal and engaging
27	N	Y	Y	Explore	Game		Game	Detective skills and exploration skills were required
28	N	N	Y	Explore	Game	Tour	Explore	Being able to see the detail of the city in different years and then changing the year and watching the difference interests me greatly. Watching how the city progressed through time.
29	Y	Y	Y	Tour	Game	Explore	Game	it was fun & interactive & informative

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
30	Y	Y	Y	Game	Explore	Tour	Tour	Interesting facts about Sydney - evolution of the city & convict history
31	Y	Y	Y	Tour	Explore	Game	Explore	free world felt more control
32	N	N	Y					
33	Y	Y	Y	Explore	Game	Tour	Game	was interesting finding the historic items that are held in the museum
34	Y	Y	Y	Explore	Game	Tour	Game	very interactive and allowed for central exploration. The items to be found in the museum adds extra appeal
35	Y	N	Y	Tour	Explore		Tour & Explore	Both were interesting to me
36	Y	Y	Y	Tour	Game	Explore	Game	being able to move joy stick + explore the space
37	Y	Y	Y	Explore	Game	Tour	Explore	most interesting, game was great as well, link to cabinet

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
38	Y	Y	Y	Tour	Game	Explore	Each had things I like (hard to nominate my favourite)	The tour was good to give a historic backdrop to where Sydney/European settlement began. The game was fun & really helped bring the life of the butcher to life! Could have mucked around with exploring a lot more (liked the different features that showed different weather, time of year)
39	Y	Y	Y	Tour	Game	Explore	Game	Interactive
40	Y	Y	Y	Tour	Game	Explore	Explore	Because it was fun. However the tour was necessary so as to get an idea what was going on.
41	Y	N	Y	Explore	Tour		Explore	it was interesting to be able to see it from a street view
42	Y	N	Y	Explore	Tour		Explore	
43	Y	Y	Y	Tour	Explore	Game	Explore in time	
44	Y	Y	Y	Tour	Explore	Game	Tour	
45	Y	Y	Y	Tour	Explore	Game	Game it's cool	it's awesome
46	Y	Y	Y	Tour	Game	Explore	Tour	gaining knowledge about the history

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
47	Y	N	Y	Explore	Tour		Explore	Nice elaborate background provided
48	Y	N	N					
49	Y	Y	Y	Explore	Tour	Game	Game	I really enjoyed the game. It was very user friendly and entertaining and you learn some cool things about George Cribb and his nephew. I would definitely recommend this game.
50	Y	Y	Y	Game	Tour	Explore	Explore	more interactive
51	Y	N	Y	Tour	Game	Explore	Tour	provided an interesting potted history of earliest settlement
52	Y		Y	Explore	Tour		Explore	very interactive, game me a real sense of the layout of historic Sydney
53	Y	Y	Y	Tour	Explore	Game	Game	I think it was a great way to link real world items and then place in history. That said I also loved how you saw the architecture change.
54	Y	N	Y	Explore	Tour		Explore	
55	Y	N	Y	Explore	Game	Explore		

Respondent	Tour	Game	Explore	First	Second	Third	Preferred	Why
56	Y	Y	Y	Explore	Game	Explore	Game	
57	Y	Y	Y	Explore	Game	Explore	Explore	
58	Y	Y	Y	Tour	Game	Explore	Tour	

Respondent	First mode	Second mode	Third mode	Why
1	Tour	Explore	Game	just to get some background on the story
2	Tour	Explore	Game	
3	Tour	Explore		I liked the free-form exploring best but if you wanted to orient yourself first (didn't know the Sydney Rocks) then I'd recommend tour first
4	Tour	Explore	Game	Really hard to say as gamers may get interface immediately whereas non-gamers struggle. For mainstream user would suggest this order - eg giving prompt for game after 2 mins of exploration
5	Tour	Explore	Game	
6	Tour	Game	Explore	To have a tour to have an overview first. Play the Game then finally explore.
7	Tour	Game	Explore	Because the tour is an intro, the game lets you learn about the town and controls, and then you can explore on your own
8				
9	Tour	Explore	Game	Tour is good for getting an impression of the tool and info on Sydney in general. Then you can start from these and explore yourself in more detail
10	Tour	Explore	Game	1. Overview 2. Specific search 3. more fun
11				

Respondent	First mode	Second mode	Third mode	Why
12	Explore	Tour	Game	good to start with a min-explore of the history and then tour, especially they will guide and educate you. If you ever missed out something then game time
13	Tour	Game	Explore	Touring first to understand the concept and the story, game to better understand the tour, then explore to discover new sights
14	Tour	Explore	Game	Have an overview of the tour then follow through by exploring yourself before ending it by playing the game seeing if you remember the places
15	Tour	Explore	Game	Virtual tour gives an overview of the project the exploring then allows one to familiarise themselves with the rocks, which then makes the game play more familiar in terms of navigating around & finding the right places
16	Explore	Tour		
17	Tour	Game	Explore	you need background info to understand the game and you need the game to understand what you are exploring
18	Tour	Explore	Game	
19	Tour	Explore	Game	Best way to figure how it all works
20	Tour	Game	Explore	virtual tour first to give an understanding of how the landscape can come alive especially when thinking about the real people that lived here in the Rocks. Second the Game - a great way to interact with the virtual world. Third - exploring (especially for someone who knows the area well) is just amazing. great to be able to click links and discover further.

Respondent	First mode	Second mode	Third mode	Why
21	Tour	Game	Explore	Tour is a general intro, game engages in a guided way, exploring could then go on for ages
22	Tour	Game	Explore	
23	Tour	Game	Explore	Tour gives background, game gives detail, explore gives overview
24	Tour	Explore	Game	I like the notion of learning by accident. Serendipity. Surprise. Discovery.
25	Explore			A lot to discover!
26	Tour	Game	Explore	seems like the natural progression
27				
28	Explore	Game	Tour	Just having the freedom to wander around and then change the year to look at the difference is incredible. So detailed and so fleshed out.
29	Tour	Game	Explore	Because I think it's good to do the tour first to get the background info. So you can play the game properly & you know George's story
30	Tour	Explore	Game	Overall intro to Sydney - better able to understand what you are searching for in the game. History first!

	First mode	Second mode	Third mode	Why
31	Tour	Explore	Third	logic as above
32				
33	Explore	Tour	Game	exploring you get to know your way. The tour helps fill you in on what you are exploring. Taking the game last you are now knowledgeable on it
34	Tour	Game	Explore	it allows to see the central component of the program to be done first then the more interactive components
35	Tour	Explore	Game	Didn't play the game so would suggest this order to prepare for the game experience
36	Tour	Game	Explore	The tour gave a good overview of George Cribb to get the player into the world of George. The game was fun and explore allowed you to make choices about the year and to watch the Rocks site change. Tour - provides an overview. Game - entertaining. Explore - more instructive and educational
37	Explore	Game	Tour	Tour is the most informative and fun
38	Tour	Game	Explore	If they don't know the history prior, suggest tour is best intro; then the game with sense of animals in backyard
39	Tour	Game	Explore	logical order

Respondent	First mode	Second mode	Third mode	Why
40	Tour	Game or Explore	Game or Explore	suggestion: Perhaps the tour could be more self conscious ... in that it should explain the virtual world and what it does rather than just giving a history lesson. For example : 1/ this is a virtual re-creation of Sydney Cove 1788 ... 2/ "let's look at one of the early residents Cribb the butcher" ... his story and the fact that his belongings are in the <u>museum</u>
41	Explore	Tour	Game	
42	Explore	Tour		
43	Tour	Game	Explore	Logical order, training
44	Tour	Game	Explore	Tour gives you an overview Game takes you through the space in planned way which then makes your exploration an informed experience
45	Tour	Game	Explore	Because
46	Tour	Explore	Game	need to know the history before the game
47	Tour	Explore		

Respondent	First mode	Second mode	Third mode	Why
48	Tour			
49	Tour	Explore	Game	The tour first because you should start learning about the settlements and some people and new things evolved. Then you can play the game for fun and to learn George Cribb's convictions and then you can explore or free roam for fun as well.
50	Tour	Game	Explore	good order
51	Tour	Game	Explore	most appropriate progression
52	Explore			Found it to be the most engaging and informative activity
53	Tour	Explore	Game	I think the controls were not completely instinctual especially the speed function so I think tour is important
54	Tour	Explore	Game	
55	Explore	Game		
56				
57				good to explore + learn different things before the game

Respon- dent	First mode	Second mode	Third mode	Why
58	Tour	Game	Explore	it gives you a greater sense of background and setting

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
1	5	5	5	Game	More detailed and closer view of artefacts and buildings
2	6	n/a	6	Explore	
3	5	n/a	5		Tour was faster. Exploring was slower (for me running into walls) so to get a feel faster/overview of more stuff -> tour
4	5	3	5	Explore	story/game mission did not grab me but historical research did
5	4	n/a	5	Explore	you have a level of control
6	6	4	6	Tour	The explanations helped the understanding
7	n/a	1	1	Explore	Because I got to see every aspect at my own speed
8			3	Explore	
9	2		5	Explore	Because I got more detailed information about people living there and some of their life stories (info from links on the internet)
10	6		5	Explore	It's like walking through the streets
11	n/a	5	5	Game	

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
12	5	5	5	Explore	you get to go to different places as you want & check out what is in the building also the years have different seetiy (?), ast (?) feel like we were in there
13	5	5	5	Explore	You get to see how the building structures are first hand. Makes it easier to comprehend
14	6	5	6	Tour	Good to have the 4 minute video showing the building and with a speaker explaining (some) of the background
15	6	4	6	Game	having to search for items that then relate to main figures in history gave it a more immersive feeling. Exploring is also really good but the game adds another level to the experience.
16	5		5	Explore	you can move everywhere you like in an easy way
17	6	5	6	Explore	because there was more places to go - when the game is more developed the game will probably be better
18	5	n/a	5	Explore	
19	5	5	5	Explore	Make your own way
20	5	6	6	Explore	probably because I know the area well it was easy to imagine walking down the very same streets 100 or 150 or 180 years ago!
21	4	5	5	Explore	Exploring through time in particular, wandering around

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
22	5	5	5	Tour	History v/o (voice over) + 5 yr time frame
23	5	4	5	Explore	exploring allows us to wander around like walking/living the streets etc
24	6	6	6	Explore	I found myself not thinking about the creator's intention so much. It is in a sense the least directed and there is more self determination. The tour is great but narration gives it more historical rather than experiential feel.
25	4	5	4	Game	Tells a personal story of a single person with name and details of that person
26	5	5	5	Game	The game enforced a goal-based direction
27	5	4	5	Explore	Can go anywhere to see past times, houses, important locations.
28	5	5	5	Explore	The freedom to explore let me change the time whenever I wanted. I could see a life in a different time through exploring. It is one thing to read info but it is another to watch it all unfold.
29	6	6	5	Tour	I think because I saw this first & I enjoyed the voice over and historical information & I really enjoyed George's personal story.

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
30	3	2	3	Tour	More info given - quicker coverage of info
31	3	4	5	Explore	speed functionality made it possible to see change visually
32	5	6		Game	
33	5	6	6	Explore	being able to jump through different times and the graphics of exploring
34	5	6	6	Explore	Allowed for freedom to explore different areas and times more freely. As well as giving information on the different buildings and aspects.
35	5	n/a	5	Explore	didn't play the game it may have been better
36	5	5	5	Game	moving through the laneways, up & into George's house, the animals in the backyard - priceless!
37	2	1	1	Explore	
38	4	5	6	Game & Explore close to dead heat	Not just about frontage/street level with ability to be enhanced if the project was funded to enable fleshing out details

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
39	5	6	5	Explore	see different areas, change dates
40	5	5	6	Explore	The game was a good concept because it forces you to look closely at the details and interact with a time and a place. However I prefer freestyle exploring and asking questions about what I see.
41	5	n/a	5	Explore	
42	5		6	Explore	
43	5	4	6	Explore	freedom of movement
44	6	6	6	Tour	It was nice to have such a great overview without having to navigate
45	5	5	6	Game	Because
46	5	5	5	Explore	being explained what it was like
47	5		6	Explore	Every building or other presence can be explored at different times

Respondent	Tour Feel	Game Feel	Explore Feel	Preferred	Why
48	6				
49					
50	6	6	6	Game & Explore	Defined points
51	5	5	5	Tour	most straightforward way of the 3
52		n/a	2	Explore	Felt as though I was walking the streets in my imagination. Background noises/soundtrack really assisted this too
53	6	6	6	Game	Gave you insight into yr. daily life and get you off the main path
54	5		5	Explore	To feel like one was <u>there</u> one needs more <u>personal</u> information
55	n/a	6	5	Game	
56					Actually had to time travel to find things
57					
58	5	6	5	Game	you could relate to the historical objects

Respondent	Tour Learn	Game Learn	Explore Learn	Preferred	Why
1	6	6	6	Tour	more information available. Format takes some time to get used to for me
2	6	n/a	6	Explore	More detail
3	6	n/a	6	Tour	Faster than exploring, so more info quicker
4	6	4	6	Explore	Got to explore scale of environment
5	5	n/a	5	Explore	
6	5	4	5	Tour	Very educational and fun
7		1	1	Explore	See other (last) page - ie previous entry which was 'Because I got to see every aspect at my own speed'
8			5	Explore	
9	5		6	Explore	
10	6		6	Explore	The attached information about the buildings are very informative!
11	n/a	2	2	Game	

Respondent	Tour Learn	Game Learn	Explore Learn	Preferred	Why
12	5	5	6	Game & Explore	I like both game & explore, they helps me to have a better understanding of the history. It would be great if the game is set in a MCO (?) of some quest
13	6	6	5	Tour	The explanation is clear, you get to picture the scenario
14	5	5	5	Explore	Able to see the whole building history. Shows me how Sydney Rocks has changed over the years & tells me the history with the links provided
15	6	6	6	Explore	more time to look around and better access especially with the web links and other related sites.
16	4		5	Explore	You can click and discover info on the web
17	6	6	6	Game	because there was more purpose to the learning - you have goals to achieve which leads to learning
18	5	n/a	5	Explore	
19	6	6	6	All good	

Respon- dent	Tour Learn	Game Learn	Explore Learn	Preferred	Why
20	6	6	6		Probably the game because I feel this way of interacting & learning about history is more affective for remembering & actually "learning" the history. But if you spend more time in the virtual world exploring & clicking in to all the links available - there is such a huge database of information to be explored
21	5	5	6	Explore	Exploring through time, seeing the artefacts in game & in real life
22	6	5	6	Tour	Quick immediate history lesson
23	5	5	5	Tour	Access to detail info - just the manner in which we explored. Probably all three allow the same detail to be told
24	6	5	6	Explore	I already know well the Cribb story which is featured in the game we played though I think it's brilliant having a game where you discover & learn as you progress through it. I learnt more exploring because of existing knowledge and questions that I had. It gave me a desire to SEE things or experience things I had only read about.
25	5	6	5		
26	6	6	6	Tour	The verbal information was great

Respon- dent	Tour Learn	Game Learn	Explore Learn	Preferred	Why
27	4	5	5	Game	Because of the pop-ups of information when progressing through the items
28	6	5	6	Game	Through the game, at first I was just collecting items. But then I found out that all these items told a story. A story of life in an older time.
29	6	6	6	Tour & Explore	I think the Tour and Explore as you can get additional information from the guidebook on the right by clicking on various things & also from the voice over on the Tour.
30	5	2	4	Tour	Listening to info is easier than reading (LAZY)
31	5	5	5	Explore	as in last page
32	5	6			
33	6	5	5	Tour	The history was clearly and well explained to me
34	6	6	5	Tour	Narration gave information in a 'ready to consume' state
35	6	n/a	5	Explore	

Respondent5	Tour Learn	Game Learn	Explore Learn	Preferred	Why
36	6	6	6	Explore	clicking on various buildings to access further information
37	2	2		Explore	
38	5	5	6	Explore	Enabled me to set up & then follow timelapse of developments (eg Argyle cuttings) - once I knew to click on items eg buildings to obtain more info
39	6	5	5	Tour	voice over explaining notable changes
40	5	5	6	Explore	I was able to focus in on the things that were of interest. I liked being able to click onto buildings and call up their history
41	6	n/a	6	Explore	
42	5		6	Explore	
43	6	6	6		
44	6	6	4	Tour	well explained and amusing story

Respon- dent5	Tour Learn	Game Learn	Explore Learn	Preferred	Why
45	5	7 really strongly agree		Game	Because
46	6	6	6	Game	getting involved helps learning
47	5		5	Tour	Good summary
48	6				
49					
50	6	6	6	Explore	Good help from staff
51	4	4	4	Game	the objects provided a deeper insight than the tour
52	4	n/a	2	Explore	saw some feature or building and click of a mouse could put an actual photo to the location. Helped form a picture in your mind of what Rocks/Sydney was like at a particular time.
53	6	6	6	Explore	Great to see how it developed.
54	4		5	Explore	
55	n/a	6	6		

Respon- dent5	Tour Learn	Game Learn	Explore Learn	Preferred	Why
56				Game	
57				Explore	
58	6	6	6	Tour	It was more visual

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
1	5	5	5	Tour	Most obvious because of the timelapse function
2	6	n/a	6		Both Tour and Explore
3	4	n/a	6	Explore	
4	4	3	6	Explore	This is the mode we stayed in the longest
5	5	n/a	5	Explore	
6	6	4	6	Explore	The change over time allows me to see the changes to the landscape and activities at the harbour
7	n/a	1	1	Explore	Because I could change the time as often as I wanted
8			4		
9	6		3	Tour	Most visual change. Was easier compared to exploring, because you only see one area and you don't have to change the time layers yourself
10	6		5	Tour	better overview of the changes from time to time
11	n/a	5	5	Explore	

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
12	5	4	5		I would say is the Tour, it shows how Sydney Rocks changed over a minarely (?)
13	6	4	4	Explore	can really see the harbour taking shape
14	5	3	6	Explore	the fact that you can see it year by year and the fact that you can see the overview by putting the speed to 7 shows the whole Sydney Rocks that changed over time
15	6	5	6	Tour	Covers a good overview. Shows me a larger area over time with narration. I found this very informative.
16	5		5	Explore	you can go over ages very quickly
17	6	6	6	Explore	as you were more focused in looking at the environment than the goals of the game
18	5	n/a	5	Explore	
19	6	5	6	Tour	

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
20	6	4	6	Explore	Exploring allowed you to pause & see the gradual building and demolishing at any chosen point in the virtual world
21	6	4	5	Tour	watching the tour loop & particular buildings disappear over time gave a sense of how things are changing over time and our personal perspective is limited
22	6	5	6	Explore	
23	1	4	4	Tour	time lapse of area was great!
24	6	6	6	Explore	Being able to choose different years and see the changes was BRILLIANT
25	5	5	6	Explore	Playing with time setting and using "fast forward" lets you see the development very quickly
26	5	3	6	Explore	Free range!
27	5	4	6	Explore	You could see buildings disappear and appear in a fast speed setting

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
28	6	4	6	Explore	Standing in one spot, changing time 100 years in distance (?) and seeing the difference was incredible. You could see how different it all was.
29	6	5	6	Tour & Explore	I think both the Tour and Explore illustrated the changes that have taken place over time from the beginnings of Rocks as both show how it started before white settlement through to present day with the massive changes along the way
30	4	4	4	Explore	shows the progression
31	5	5	6	Explore	
32	5	6			
33	6	5	6	Explore	changing the times back and forward

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
34	6	5	6	Explore	Allows to see the increase in buildings and population over a lengthy period of time. Especially on the time lapse elements.
35	5	n/a	6	Explore	again didn't play the game which could have been better
36	6	5		Explore	choosing a year and watching the changing site - progression/populating the area
37	2	3	3	Explore	
38	3	3	6	Explore	By focusing on one view/aspect/building I could then click on the link to the museum & source information - great! And interesting way to learn
39	6	6	5	Tour	Time lapse
40	6	4	5	Tour	Because it takes you through the time periods, and it tells you that this is what it's doing
41	6	n/a	6	Tour	

Respon- dent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
42	6		5		
43	6	4	6	Explore	
44	6	6	6	Explore	Could pick and choose times and place
45	6	5	7	Tour	Because
46	6	5	6		
47	5		5	Tour	Summary time lapse gives good impression
48	6				
49					
50	6	6	6	Explore	Good staff
51	4	5	6	Explore	the change over time was most apparent
52	4		1	Explore	

Respondent	Tour Time Change	Game Time Change	Explore Time Change	Preferred	Why
53	4	4	6	Explore	Great seeing how buildings changed. Would be great to be able to go back so you could find an area that you know and see how it's changed
54	6		5	Tour	If only here a very short time
55	n/a	5	6	Explore	got to see how it changed over time
56					
57					
58	6	4	5	Game	it gave more scope to explore inside the buildings

Respondent	One Best	Two Best
1	Depth of Information	use of virtual technology to animate static displays
2	The visual representation made it easier to identify with things	
3	the bird's eye view	seeing buildings/geo features that are still there today. clicking on things to get more web resources
4	The time shifting	the links to websites
5	links to building history	ability to navigate to a specific year
6	Easy to navigate and educational	
7	The detail	The way you could both explore and play a game
8	noises	explanation/information about
9	very visual + free (you're independent)	nice to do something interactive in a museum
10	fast overview about the changes	virtual interaction
11	Interactive	

Respon- dent	One Best	Two Best
12	I like the game & explore, helps me to travel to places at any year & times, especially when there is another monitor telling you the history, not very dry, interesting interaction	
13	It is interesting with real life examples and stories	
14	the history links	the buildings -> like the build up from start to end in speed 7
15	Being able to travel in time	Navigating around the entire area & discovering the history & the stories behind all these sites
16	you can move easily	you can see good images
17	the accuracy of the history	Being able to move around in space and time
18	the time change, snapshots	links to other web sites
19	sense of movement	Sounds
20	I like the interactivity - being able to open doors, walk up steps etc	Being able to see the weather for a specific day was awesome
21	The virtual engagement combined with actually being in the physical is powerful & The physical objects	And most especially the time travel aspect & the hot linking to the web database

Respondent	One Best	Two Best
22		
23	access to information, images etc	
24	Being able to navigate around and go inside buildings.	Loved all the links. Also gave me a great sense of the space and layout
25	strong focus on details and information	possibility to set the time and see changes over the years
26	I enjoyed hearing about people's lives	I loved seeing the developments of the city's landscape by year - time travel YES!
27	The detail in these few buildings	The ability to click on buildings with their links
28	Having the freedom to wander where I liked and being able to change the time were so interesting. I really loved this virtual world. It was done so well.	
29	George's personal story illustrated with his properties was really interesting and entertaining & enjoyed interacting with the game & then actually seeing artefacts in the museum	

Respondent	One Best	Two Best
30	information about the history is great!	
31	Control of timing functionality	Game
32	ability to click on object + find out info about it	watch quickly how the area evolved over time
33	I liked the well designed graphics of it	the info given when clicking on things
34	the interactive nature of the program	the information available through the program
35	weather	time lapse of the years
36	exploring the laneways in the game	entering the house of G. Cribbs
37	go to anywhere at any time	
38	The ability to zoom around & easily link to snippets/background of history	The example of the butcher, his life & the relationship to the 3 pieces in the museum room in the game. (And a 3rd: very cool stormy skies!)
39	exploring areas	seeing change over time
40	The weather and the early sounds	It was cool to see building represented virtually that are still visible today

Respon- dent	One Best	Two Best
41	The time lapse	personal stories from the convicts
42	learning personal stories of the first convicts	seeing how it changed over the years
43	accuracy of model	number of buildings
44	comprehensiveness and detail	
45	it was cool	the game
46	Watching how it developed over time	links to websites
47	Time lapse	Info on individual items
48	The ability to visualise the original appearance of the area	The links to historical information
49		
50	interactive	Good help
51	the aesthetic pleasure of the VSR	the easy to comprehend growth of the Rocks

Respondent	One Best	Two Best
52	Vivid way of showing what rocks was like at a particular time - got a real sense of 3D "being there"	
53	weather conditions	Scale
54	the detail of research presented	
55		
56	I like how you moved around + when you clicked on things you found out information	
57	fun to play around with + learn	
58	How you could vary the visual speeds	

Respon- dent	One Worst	Two Worst
1	format a little confusing	needs a human to fully explain the benefits of the game
2	n/a	
3	slow navigation	would like the ability to zoom up to bird's eye at any era and place
4	the textures	walking through walls accidentally
5	not being a gamer I found navigation a little difficult	some of the graphics
6	may be difficult to navigate for kids	
7	You couldn't get into the houses	
8	design of houses	information (shorter)
9	some links did not work	
10	for explore you need some background knowledge. Better for people who have some knowledge about Sydney's buildings	
11	navigation through the game	

Respondent	One Worst	Two Worst
12	perhaps the game, I find that it can be better if there are more engagement and questions	
13	I like how I show the construction of Sydney taking place over the years and also the stories of the people living here in the past (think this is meant to be second good thing)	short games
14	hard to navigate	
15		
16	you fall under the graphic	
17	needs beautification	needs more game elements, needs to be on the ipad
18	n/a	
19		
20	lack of textures inside buildings	lack of people and animals
21	the joystick method of navigation is a bit awkward, but wouldn't know what else you could do!	
22		

Respondent	One Worst	Two Worst
23	needs more detail in houses/display design etc	
24	I know this would take a LOT more work but the absence of people and activity going on in the town	
25	graphics	
26	I wanted to know more and see more detail	
27	Not enough detail on all the buildings (understandable though considering all the buildings)	
28	There wasn't anything I didn't like but of course more detail would make everything look stunning. Of course limitations with time and various engines taken into account, this is no problem	
29		
30	Tour is a bit quick	
31	level of models	lack of on screen animation and movement

Respondent	One Worst	Two Worst
32		
33	the wall paper	controlling was hard
34	the wall paper	
35	cannot move up and down	lack of textures + details
36		
37	people were not filled in (?)	fall through bottom of world
38	sometimes difficult to visualise the streetscape (recognise the project being funded would sort this out)	limitation of game functionality
39	controls difficult	textures
40	The lack of sophistication of the buildings and surface texture	Has the potential to be complicated
41	graphics not vivid	a little tricky to operate
42		

Respondent	One Worst	Two Worst
43	not a fan of the joystick. Prefer mouse+ WASD interface	
44	should be extended to make more visual detail	
45	not a lot of details	needs people moving
46		
47	n/a	
48	The joystick	
49		
50	none	
51		
52	not used to using joystick but got the hang of it with help	
53	Game needs human face even without characters ie picture of Cribb	control panel could be cleaner

Respon- dent	One Worst	Two Worst
54		
55		
56	didn't have a least	
57		
58	n/a	

Respondent	Improve1	Improve2	Improve3
1	more instructions	more time to play it	
2	when changing dates to be able to type the numbers not scroll		
3	slow navigation	would like the ability to zoom up to bird's eye at any era and place	
4	Funding! Texture maps, more emissions, more animation, voice overs (characters)		
5	more buildings histories to be available	better graphics	audio of special histories included eg green bans. The Rocks push gangs
6	simple games for kids		
7	insides of more houses		
8	maybe the design of the houses could be better	short information to every house (not a whole website)	
9	Have some words on the houses to make it easier to recognize them		
10	perhaps some numbers/signs for very important historical buildings		
11	more objects to interact with	using standard gaming navigation and movement keyboard keys and mouse	
12	pretty much similar to previous answer - overall is good		

Respondent	Improve1	Improve2	Improve3
13	navigation can be improved but it was good enough		
14	easier navigation tool	better games - incorporating icons - Sydney Opera House	
15	the game would span over a larger period so that the player can observe change over a greater period in time ie more drastic changes		
16	possibility to jump over the water to move from the bridge to the opera house for example		
17	the trees and the landscape need to look nicer, missing lots of potential game ideas		
18	a few bugs to be corrected	when money and time permit more detail	
19			
20	I can't wait to see the texture dressing of rooms & maybe even people walking about Sydney doing their daily tasks. Dropping the ice, building woodblock roads, hanging washing etc		

Respondent	Improve1	Improve2	Improve3
21	An 'oculus rift'? or a google glass virtual tour?		
22	the console and the integration of web based text into the vision/gaze of the graphic		
23			
24	incidental animations to interact with		
25	graphics could be improved	public availability on the web	
26	I would really love to see this project develop so the landscape is more "life-like" and the information we receive is more populated. learning about the people is just as interesting to me as the city's buildings + development. Also I think it would be great to add more game options in different time. Great Job!		

Respondent	Improve1	Improve2	Improve3
27	Pop-ups with the external links - Easy way to see if there is additional info on buildings/sites		
28	Like I said, if more detail was in this it would look incredible. But the current display is very cool already!!		
29	I enjoyed the game and could have kept playing so longer game please.		
30	More photos on the virtual page eg. Click on the image (say a building) and the historical photo(s) pop up (on the same screen) with useful info. Have higher definition images. Have people in the buildings - click on the people & they talk to you		
31	HQ designs, people & a		
32	hast(?) per period		
33			

Respon- dent	Improve1	Improve2	Improve3
34	when done on a web format it will be used in a range of areas. I think this is a very good program and idea. Good Luck :)		
35	improvements for the navigation, the gui and the textures (looks and feel issues) The fundamental underpinning materials are excellent!		
36	More detail in the virtual view ie the Cumberland/Gloucester site/George Cribb's empire		
37			
38	if possible, more on-screen instructions (eg when setting the explore functions) more realistic		
39		easier instructions so verbal explanation is not needed - more intuitive	

Respondent	Improve1	Improve2	Improve3
40	<p>I think it could become too complex and perhaps the interactive choices should be simplified or grouped more efficiently. Perhaps there are two aspects -&gt; the overview history covering how the physical world changed (building &amp; environment) -&gt; the social/details history. Maybe both these aspects might not be required for all historic sites. Maybe the interface could be grouped so you can choose one type of history or the other. For example: if I don't have much time I might want to just see hoe the environment had changed. But as a people person I might want to "get to know" the residents.</p>		
41			

Respon- dent	Improve1	Improve2	Improve3
42			
43	fix clipping issues, more textures		
44	as above. This is an enormously nitustp (?) project with great potential. It deserves to be extended and enhanced. It serves so many interests. Architectural/historical - Educational - Tourism - promoting Australian heritage - excellent and visionary use of technology		
45	more details	moving vehicles, moving animals and moving people	
46			
47			
48	More realistic graphics		
49			

Respondent	Improve1	Improve2	Improve3
50	more suggested key points in time to view		
51			
52	pretty good as it is - thanks		
53	obviously with a budget and resources to allow texture mapping		
54	not enough time spent have to say, but ... maybe more "personal" type info - like the info about George Cribb		
55	using the VSR made the stuff in the museum more interesting		
56	maybe move about as a person - get on boats, walk about		
57			
58	As more historical information is uncovered it needs to added to the program		

## **APPENDIX 1e: Questionnaire data, Two Most Liked**

Categories for best liked things about the VSR

1 = Navigable time & Time-lapse

2 = Content quality & quantity

3 = Navigable space and interactivity

4 = Game

5 = Juxtaposition with the real

6 = Weather

7 = Soundtrack

8 = Human stories

Respondent	Best 1	Best 2	1	2	3	4	5	6	7	8
1	depth of Information	use of virtual technology to animate static displays		x						
2	the visual representation made it easier to identify with things									
3	the bird's eye view	seeing buildings/geo features that are still there today. clicking on things to get more web resources		x			x			
4	The time shifting	the links to websites	x	x						
5	links to building history	ability to navigate to a specific year	x	x						
6	Easy to navigate and educational			x	x					
7	The detail	the way you could both explore and play a game		x	x	x				
8	noises	explanation/information about		x					x	
9	very visual + free (you're independent)	nice to do something interactive in a museum			x					
10	fast overview about the changes	virtual interaction	x		x					

Respon- dent	Best 1	Best 2	1	2	3	4	5	6	7	8
11	Interactive		x	x	x					
12	I like the game & explore, helps me to travel to places at any year & times, especially when there is another monitor telling you the history, not very dry, interesting interaction		x	x						
13	It is interesting with real life examples and stories			x						
14	the history links	the buildings -> like the build up from start to end in speed 7	x	x						
15	Being able to travel in time	Navigating around the entire area & discovering the history & the stories behind all these sites	x	x	x					
16	you can move easily	you can see good images			x					
17	the accuracy of the history	Being able to move around in space and time	x	x	x					
18	the time change, snapshots	links to other web sites	x	x						
19	sense of movement	sounds			x				x	
20	I like the interactivity - being able to open doors, walk up steps etc	Being able to see the weather for a specific day was awesome		x	x			x		

Resp on- dent	Best 1	Best 2	1	2	3	4	5	6	7	8
21	The virtual engagement combined with actually being in the physical is powerful & The physical objects	And most especially the time travel aspect & the hot linking to the web database	x	x	x					
22										
23	access to information, images etc			x						
24	Being able to navigate around and go inside buildings.	Loved all the links. Also gave me a great sense of the space and layout		x	x					
25	strong focus on details and information	possibility to set the time and see changes over the years	x	x						
26	I enjoyed hearing about people's lives	I loved seeing the developments of the city's landscape by year - time travel YES!	x	x						x
27	The detail in these few buildings	The ability to click on buildings with their links		x						
28	Having the freedom to wander where I liked and being able to change the time were so interesting. I really loved this virtual world. It was done so well.		x		x					

Resp on- dent	Best 1	Best 2	1	2	3	4	5	6	7	8
29	George's personal story illustrated with his properties was really interesting and entertaining & enjoyed interacting with the game & then actually seeing artefacts in the museum			x			x			x
30	information about the history is great!			x						
31	Control of timing functionality	game	x			x				
32	ability to click on object + find out info about it	watch quickly how the area evolved over time	x	x						
33	I liked the well designed graphics of it	the info given when clicking on things		x						
34	the interactive nature of the program	the information available through the program		x	x					
35	weather	time lapse of the years	x					x		
36	exploring the laneways in the game	entering the house of G. Cribbs			x	x				
37	go to anywhere at any time		x							
38	The ability to zoom around & easily link to snippets/background of history	The example of the butcher, his life & the relationship to the 3 pieces in the museum room in the game. (And a 3rd: very cool stormy skies!)		x	x			x		x

Resp on- dent	Best 1	Best 2	1	2	3	4	5	6	7	8
39	exploring areas	seeing change over time	x		x			x	x	
40	The weather and the early sounds	It was cool to see building represented virtually that are still visible today		x						
41	The time lapse	personal stories from the convicts	x	x						x
42	learning personal stories of the first convicts	seeing how it changed over the years		x						
43	accuracy of model	number of buildings		x						
44	comprehensiveness and detail			x						
45	it was cool	the game				x				
46	Watching how it developed over time	links to websites	x	x						
47	Time lapse	Info on individual items	x	x						
48	The ability to visualise the original appearance of the area	The links to historical information		x						
49										
50	interactive	Good help			x					

Resp on-ident	Best 1	Best 2	1	2	3	4	5	6	7	8
51	the aesthetic pleasure of the VSR	the easy to comprehend growth of the Rocks								
52	Vivid way of showing what rocks was like at a particular time - got a real sense of 3D "being there"									
53	weather conditions	scale		x				x		
54	the detail of research presented			x						
55										
56	I like how you moved around + when you clicked on things you found out information			x	x					
57	fun to play around with + learn									
58	How you could vary the visual speeds		x							

## **APPENDIX 1f: Questionnaire data, Two Least Liked**

Categories for least liked things about the VSR

1 = Visual quality

2 = Controls

3 = People and activity

4 = Interface

5 = Technical issues

6 = Game quality

Respondent	1st Worst	2 <sup>nd</sup> Worst	1	2	3	4	5	6
1	format a little confusing	needs a human to fully explain the benefits of the game				x		x
2	n/a							
3	slow navigation	would like the ability to zoom up to bird's eye at any era and place		x		x	x	
4	the textures	walking through walls accidentally	x				x	
5	not being a gamer I found navigation a little difficult	some of the graphics	x	x				
6	may be difficult to navigate for kids			x				
7	You couldn't get into the houses		x		x			
8	design of houses	information (shorter)	x					
9	some links did not work						x	
10	for explore you need some background knowledge. Better for people who have some knowledge about Sydney's buildings	for explore you need some background knowledge. Better for people who have some knowledge about Sydney's buildings						
11	navigation through the game			x				x
12	perhaps the game, I find that if can be better if there are more engagement at(and?) questions							x

Respon- dent	1st Worst	2 <sup>nd</sup> Worst	1	2	3	4	5	6
13	I like how I show the construction of Sydney taking place over the years and also the stories of the people living here in the past (think this is meant to be second good thing) <i>(this answer was evaluated as a response to the previous question - 2 most liked things.)</i>							
14	hard to navigate	short games		x				x
15								
16	you fall under the graphic						x	
17	needs beautification	needs more game elements, needs to be on the ipad	x			x		x
18	n/a							
19								
20	lack of textures inside buildings	lack of people and animals	x		x			
21	the joystick method of navigation is a bit awkward, but wouldn't know what else you could do!			x				
22								

Respondent	1st Worst	2 <sup>nd</sup> Worst	1	2	3	4	5	6
23	needs more detail in houses/display design etc		x					
24	I know this would take a LOT more work but the absence of people and activity going on in the town				x			
25	graphics		x					
26	I wanted to know more and see more detail		x					
27	Not enough detail on all the buildings (understandable though considering all the buildings)		x					
28	There wasn't anything I didn't like but of course more detail would make everything look stunning. Of course limitations with time and various engines taken into account, this is no problem		x					
29								
30	Tour is a bit quick							
31	level of models	lack of on screen animation and movement	x		x			
32								

Respondent	1st Worst	2nd Worst	1	2	3	4	5	6
33	the wall paper	controlling was hard	x	x				
34	the wall paper		x					
35	cannot move up and down	lack of textures + details						
36								
37	people were not filled in (?)	fall through bottom of world			x		x	
38	sometimes difficult to visualise the streetscape (recognise the project being funded would sort this out)	limitation of game functionality	x					x
39	controls difficult	textures	x	x				
40	The lack of sophistication of the buildings and surface texture	Has the potential to be complicated	x					
41	graphics not vivid	a little tricky to operate	x	x				
42								
43	not a fan of the joystick. Prefer mouse+WASD interface			x				
44	should be extended to make more visual detail		x					

Respondent	1st Worst	2nd Worst	1	2	3	4	5	6
45	not a lot of details	needs people moving	x		x			
46								
47	n/a							
48	The joystick			x				
49								
50	none							
51								
52	not used to using joystick but got the hang of it with help			x				
53	Game needs human face even without characters ie picture of Cribb	control panel could be cleaner			x	x		
54								
55								
56	didn't have a least							
57								
58	n/a							

**APPENDIX 1g:**  
**Questionnaire data, Suggested Improvements**

Categories for improvements for the VSR

1 = Realism – look & content,

2 = Game

3 = Interface

4 = Interface

5 = Navigation

6 = More Content

Respondent	Improvement 1	Improvement 2	1	2	3	4	5
1	more instructions	more time to play it			x		
2	when changing dates to be able to type the numbers not scroll				x		
3	slow navigation	would like the ability to zoom up to bird's eye at any era and place			x	x	
4	Funding! Texture maps, more missions, more animation, voice overs (characters)		x	x			x
5	more buildings histories to be available	better graphics	x				x
5 cont.	Improvement 3 - audio of special histories included eg green bans. The Rocks push gangs						x
6	simple games for kids						x
7	insides of more houses		x				x
8	maybe the design of the houses could be better	short information to every house (not a whole website)			x		
9	Have some words on the houses to make it easier to recognize them				x		
10	perhaps some numbers/signs for very important historical buildings				x		
11	more objects to interact with	using standard gaming navigation and movement keyboard keys and mouse				x	x

Respon- dent	Improvement 1	Improvement 2	1	2	3	4	5
12	pretty much similar to previous answer - overall is good - <b>previous answer was perhaps the game, I find that if can be better if there are more engagement at(and?) questions</b>			x			
13	navigation can be improved but it was good enough					x	
14	easier navigation tool	better games - incorporating icons - Sydney Opera House		x		x	x
15	the game would span over a larger period so that the player can observe change over a greater period in time ie more drastic changes			x			
16	possibility to jump over the water to move from the bridge to the opera house for example					x	
17	the trees and the landscape need to look nicer, missing lots of potential game ideas		x	x			
18	a few bugs to be corrected	when money and time permit more detail	x			x	
19							

Respondent	Improvement 1	Improvement 2	1	2	3	4	5
20	I can't wait to see the texture dressing of rooms & maybe even people walking about Sydney doing their daily tasks. Dropping the ice, building woodblock roads, hanging washing etc		x				
21	An 'oculus rift'? or a google glass virtual tour?				x		
22	the console and the integration of web based text into the vision/gaze of the graphic				x		
23							
24	incidental animations to interact with		x				
25	graphics could be improved	public availability on the web	x		x		
26	I would really love to see this project develop so the landscape is more "life-like" and the information we receive is more populated. learning about the people is just as interesting to me as the city's buildings + development. Also I think it would be great to add more game options in different time. Great Job!		x	x			x

Respon- dent	Improvement 1	Improvement 2	1	2	3	4	5
27	Pop-ups with the external links - Easy way to see if there is additional info on buildings/sites				x		
28	Like I said, if more detail was in this it would look incredible. But the current display is very cool already!!		x				
29	I enjoyed the game and could have kept playing so longer game please.			x			
30	More photos on the virtual page eg. Click on the image (say a building) and the historical photo(s) pop up (on the same screen) with useful info. Have higher definition images. Have people in the buildings - click on the people & they talk to you		x				x
31	HQ designs, people & a hast(?) per period		x				
32							
33							
34	when done on a web format it will be used in a range of areas. I think this is a very good program and idea. Good Luck :)				x		

Respon- dent	Improvement 1	Improvement 2	1	2	3	4	5
35	improvements for the navigation, the gui and the textures (looks and feel issues) The fundamental underpinning materials are excellent!		x		x	x	
36	More detail in the virtual view ie the Cumberland/Gloucestre site/George Cribb's empire		x				x
37							
38	if possible, more on-screen instructions (eg when setting the explore functions)				x		
39	more realistic	easier instructions so verbal explanation is not needed - more intuitive	x		x		

Respon- dent	Improvement 1	Improvement 2	1	2	3	4	5
40	I think it could become too complex and perhaps the interactive choices should be simplified or grouped more efficiently. Perhaps there are two aspects -> the overview history covering how the physical world changed (building & environment) - > the social/details history. Maybe both these aspects might not be required for all historic sites. Maybe the interface could be grouped so you can choose one type of history or the other. For example: if I don't have much time I might want to just see hoe the environment had changed. But as a people person I might want to "get to know" the residents.			X			
41							
42							
43	fix clipping issues, more textures	X					X

Respondent	Improvement 1	Improvement 2	1	2	3	4	5
44	as above. This is an enormously interesting project with great potential. It deserves to be extended and enhanced. It serves so many interests. Architectural/historical - Educational - Tourism - promoting Australian heritage - excellent and visionary use of technology - <b>previous answer was should be extended to make more visual detail</b>		x				x
45	more details	moving vehicles, moving animals and moving people	x				x
46							
47							
48	More realistic graphics		x				
49							
50	more suggested key points in time to view						x
51							
52	pretty good as it is - thanks						
53	obviously with a budget and resources to allow texture mapping		x				

Respon- dent	Improvement 1	Improvement 2	1	2	3	4	5
54	not enough time spent have to say, but ... maybe more "personal" type info - like the info about George Cribb						x
55	using the VSR made the stuff in the museum more interesting						
56	maybe move about as a person - get on boats, walk about		x			x	
57							
58	As more historical information is uncovered it needs to added to the program						x