Interactive Digital Technologies and the User Experience of Time and Place

Jerry Fishenden

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FACULTY OF HUMANITIES
DE MONTFORT UNIVERSITY
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Supervisors: Professor A. Hugill (IOCT)
Professor S. Emmerson (MTI)

ABSTRACT

This research examines the relationship between the development of a portfolio[1] of interactive digital techniques and compositions, and its impact on user experiences of time and place. It is designed to answer two research questions:

- What are some effective methods and techniques for evoking an enhanced awareness of past time and place using interactive digital technologies (IDTs)?
- How can users play a role in improving the development and impact of interfaces made with IDTs?

The principal creative and thematic element of the portfolio is the concept of the palimpsest, and its artistic potential to reveal visual and aural layers that lie behind the landscapes and soundscapes around us. This research thus contributes to an evolving cadre of creative interest in palimpsests, developing techniques and compositions in the context of testing, collating user experience feedback, and improving the ways in which IDTs enable an artistic exploration and realisation of hidden layers, both aural and visual, of the past of place.

An iterative theory-composition-testing methodology is developed and applied to optimise techniques for enabling users to navigate multiple layers of content, as well as in finding methods that evoke an increased emotional connection with the past of place. This iterative realisation cycle comprises four stages – of content origination, pre-processing, mapping and user interaction.

The user interaction stage of this cycle forms an integral element of the research methodology, involving the techniques being subjected to formalised user experience testing, both to assist with their further refinement and to assess their value in evoking an increased awareness of time and place. Online usability testing gathered 5,451 responses over three years of iterative cycles of composition development and refinement, with more detailed usability labs conducted involving eighteen participants. Usability lab response categories span efficiency, accuracy, recall and emotional response.

The portfolio includes a variety of interactive techniques developed and improved during its testing and refinement. User experience feedback data plays an essential role in influencing the development and direction of the portfolio, helping refine techniques to evoke an enhanced awareness of the past of place by identifying those that worked most,

[1] The portfolio is online at http://fishenden.com/research/research.html

and least, effectively for users. This includes an analysis of the role of synthetic and authentic content on user perception of various digital techniques and compositions.

The contributions of this research include:

- the composition portfolio and the associated IDT techniques originated, developed, tested and refined in its research and creation
- the research methodology developed and applied, utilising iterative development of aspects of the portfolio informed by user feedback obtained both online and in usability labs
- the findings from user experience testing, in particular the extent to which various visual and aural techniques help evoke a heightened sense of the past of place
- an exploration of the extent to which the usability testing substantiates that user responses to the compositions have the potential to establish an evocative connection that communicates a sense close to that of Barthes' *punctum* (something that pierces the viewer) rather than solely that of the *studium*
- the role of synthetic and authentic content on user perception and appreciation of the techniques and compositions
- the emergence of an analytical framework with the potential for wider application to the development, analysis and design of IDT compositions

Keywords: creative computing; interactive digital technologies; creative technologies; palimpsests; composition; rich internet applications; usability testing

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Various works in the portfolio include images taken from the book *Lost London 1870-1945* (Davies, 2009), provided courtesy of English Heritage London Region and the City of London, London Metropolitan Archives. Moving images of Piccadilly Circus and Trafalgar Square from the 1920's are provided courtesy of Getty Images. Other images are taken from original postcards in the researcher's personal collection and from the three volume work *Wonderful London* from 1926. All other images are the work of the researcher.

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INTRODUCTION

This research concerns an investigation of the relationship between the development of a portfolio[2] of works using interactive digital technologies (IDTs) themed on the concept of palimpsests of time and place, and the nature of its impact on the user experience. It aims to answer two research questions:

- What are some effective methods and techniques for evoking an enhanced awareness of past time and place using interactive digital technologies (IDTs)?
- How can users play a role in improving the development and impact of interfaces made with IDTs?

The research explores the role that users can play in helping to improve the development and impact of interactive digital technologies, and in the identification of those techniques and methods that achieve this most effectively.

As Ernest Edmonds (2010) observes:

> A significant feature of the increasing role of research has been the need for artists to try their works out with the public before completion. Because an interactive work is not complete without participants and because the nature of the interactive experience may depend significantly on context, an artist cannot finish the work alone in a studio. (p. 3)

The research is thus a combination of practice-based (in terms of its development of the composition portfolio), and practice-led (in terms of investigating new understandings about the practice and development of interactive digital technology compositions).

The word *composition* is used in this research in the wider sense that Mark Canter envisages, namely as combining:

> ... all forms of media, orchestrating fragments of graphics, animation, and text, in juxtaposition with sound and musical passages, into a single artwork. (Canter, 2001) reprinted in (Packer & Jordan, 2001, p. 180)

The composition portfolio was developed using IDTs, drawing extensively upon Microsoft Silverlight (Nathan, 2008; Moroney, 2008; Rader, Beres, Ambrose Little, & Hinkson, 2008; Dayley & DaNae Dayley, 2008; MacDonald, 2009; Paries, 2009; Ghoda & Scanlon, 2009) as the technical environment for the design of interactive audio-visual content. Microsoft Silverlight is described as:

[2] The portfolio is online at http://fishenden.com/research/research.html

> … a powerful development tool for creating engaging, interactive user experiences for Web and mobile applications. Silverlight is a free plug-in, powered by the .NET framework and compatible with multiple browsers, devices and operating systems, bringing a new level of interactivity wherever the Web works.[3]

Silverlight was selected for this research for two principal reasons: it provided a suitable platform for rapid prototyping and development of interactive works; and the researcher was already familiar with its capabilities as a development environment. Whilst other development environments, from Adobe Flash to MAX/MSP, were available, the focus of this research was the rapid and iterative development of the portfolio and the exploration of the user experience. The use of Silverlight enabled the researcher to maintain this focus rather than being distracted by acquiring the skills necessary to use an entirely new technical environment. Towards the end of the research, as the open HTML5 standard began to mature, some of the techniques developed during this research were successfully ported from the proprietary Silverlight environment to open-standards based HTML5, Javascript and Cascading Style Sheets (CSS). This formed an important element in ensuring that the technical aspects of the research are independent of the means achieved to realise them, and that they possess durability and viability outside of the Silverlight environment.

The principal creative and thematic element of the portfolio is the concept of the palimpsest, and its artistic potential to reveal visual and aural layers that lie behind the landscapes and soundscapes around us. IDTs are thus used not so much as media of illusion, but as media of revelation: revealing hidden, composer-originated perspectives of time and place. Whilst this research is about place, it is not site-specific in the sense of locative media: the role of place is a thematic element of the composition portfolio. This research focus on compositions to be experienced in dislocated place is thus distinct from the practice and theory of locative media, with its close association with specific geo-physical location and situational experiences.

IDTs such as Silverlight are still in their relatively early, embryonic years, a stage likely to prove formative in evolving domain-specific techniques, if the same developmental chronology is repeated that has been experienced before with new media:

> Today the language of cultural interfaces is in its early stage, as was the language of cinema a hundred years ago … We are witnessing the emergence of a new cultural metalanguage, something that will be at least as significant as the printed word and cinema before it. (Manovich, 2001, p. 93)

[3] Source: http://www.microsoft.com/silverlight/. Retrieved 01.01.2012.

Whilst we now inhabit a far more pervasive digital age than that which existed just twelve years ago, when Manovich's work was first published, the broader context of the maturity of the creative use of interactive digital technologies still remains in a relatively embryonic era – what Roger Malina referred to as 'the stone age of the digital arts' (Malina, 2002). This is a stage, potentially analogous to the early days of film, when generic techniques and vocabulary (and their familiarity with an audience) had yet to be established[4]. So too the vocabulary and methods for interactive arts critical analysis and design have also yet to be formalised. The BFI collection *Early Cinema: Primitives and Pioneers*[5] illustrates this in terms of the development of techniques associated with film making, where the maturing of film techniques happened in the period before 1910, in the silent era that pre-dated the arrival of sound films in 1927:

> ... many of today's film devices such as the close-up, the cut-away and editing were first invented by film makers such as George Melies, GA Smith and the Hepworth Manufacturing Company.[6]

This research thus aims to make a contribution to the development and refinement of IDT techniques through its investigation of their impact upon users. To do so, the portfolio was informed by a methodology that incorporated user experience testing conducted both online over the internet, and in the Institute of Creative Technologies' (IOCT) usability lab. The iterative, participatory methodology utilised, and the resulting findings and analyses of the various stages of usability testing, provide insight into the way that users experience and respond to the techniques and compositions. In pursuit of the two research questions, the application of the methodology focused upon both the role of users in the development of techniques and compositions that best evoke an enhanced awareness of the past of place; and the identification and refinement of those techniques that achieved this most effectively. Online usability testing gathered 5,451 responses over three years of iterative cycles of composition development and refinement, with more detailed usability labs conducted over four days (two days in each of May 2010 and October 2011) involving a total of eighteen participants.

The research also considered the concepts that Roland Barthes narrates in *Camera Lucida* (Barthes, 1981, originally published 1980). Barthes distinguishes between the mix of general symbolism inherent in a photo: that which anyone would see (which he termed

[4] See for example the BFI DVD Video. "Early Cinema : Primitives and Pioneers", BFIVD643.
[5] BFI DVD Video. "Early Cinema : Primitives and Pioneers", BFIVD643.
[6] Cover leaflet text, BFI DVD Video. "Early Cinema : Primitives and Pioneers", BFIVD643.

the *studium*), and that which was profoundly personal and intimate (which he termed the *punctum*):

> … this element which rises from the scene, shoots out of it like an arrow, and pierces me … a photograph's *punctum* is that accident which pricks me (but also bruises me, is poignant to me). (Barthes, 1981 originally published 1980. pp. 26-27)

This research explored the potential of IDTs to find an effective means of conveying the sensation encapsulated in the punctum to others: the extent to which it might prove possible to convey something that pierces the viewer to another who had no direct link or association with the subject or place portrayed. User experience testing therefore sought to acquire feedback regarding the techniques developed during the course of this research that most impacted and engaged users emotionally. As William Gibson comments:

> Multimedia, in my view, is not an invention but an ongoing discovery of how the mind and the universes it imagines (or vice versa, depending) fit together and interact. (Packer & Jordan, 2001, p. xii)

The research further aimed to understand the comparative impact of authentic and synthetic elements on user perception, inspired by Barry Truax's assertion that:

> The idealization of sound in the listener's memory is a practical fact ... One doesn't have to recreate the exact sound or environment for it to be evocative. Generally a tape recording of an actual sound is less effective than a skilful simulation that simplifies and idealizes it. (Truax, 2001, p. 30)

The research tested this assertion through the deliberative inclusion and contrast of authentic and synthetic elements (both visual and aural) in compositions and techniques, with subsequent assessments of their impact on users.

Chapter 1 is a discussion of conceptual and theoretical ideas underpinning the research. It explores various influences including the artistic conceptualisation of the palimpsest (hidden visual and aural layers of the past that exist around us in the present); the role of authentic and synthetic elements, including impulse responses; representational and conceptual models of time; individual and collective memory; theories of space and place; sound, and its role in terms of influencing our understanding of place; locative media, and in particular this research's focus on the disintermediated space of the internet as both performance medium and space, *not* requiring the specific geolocation of users in order to experience works; interactivity and randomness; the inheritance and tradition of IDT-based composition; and the role of contextualisation on the interpretation and understanding of interactive digital artworks.

Chapter 2 discusses the methodology utilised in this project. It details the four-part iterative model comprising (a) content origination (b) content pre-processing (c) content mapping and (d) content interaction. Stage (d), content interaction, of the research's methodology forms the basis for systematic usability testing and feedback, conducted both online and in the IOCT's usability lab, which in turn provides further inputs into stages (a), (b) and (c). The Chapter also discusses the categorisation and taxonomy developed to assess user responses across four key areas: efficiency (the time taken to complete, and ease with which participants completed, relevant tasks); accuracy (whether participants interacted in the expected way or deviated); recall (how well the participant was able to recall content or elements of the composition afterwards, and to identify those elements, ideas – both visual and aural – or techniques that were most, or least, significant for them); and emotional response (how the participant felt about the compositions, with specific reference to whether they felt they evoked a sense of the past of place). User experience testing was an integral analytical and developmental influence throughout the research: its findings both inform the final portfolio as well as providing an approach with potential wider application to the analysis of users' experiential interactions with IDTs.

Chapter 3 details the approach to the design and development of the portfolio, discussing the conceptual *n*-tier navigation model developed for both aural and visual content. It explores initial navigation controls spanning slider and lens techniques together with aural spatial experimentation, including the role of both authentic (field sourced) and synthetic (studio created) impulse responses and their role in the development of soundscapes focused on evocations of the past of place through their subsequent application using convolution reverb. It discusses how various ideas and techniques were designed and developed. It focuses on selected works and techniques in the portfolio, highlighting how they were informed by the methodology and how refinements were later incorporated into other works. It also discusses issues encountered relating to technical efficiency and optimisation.

Chapter 4 explores the user experience, detailing the role of usability testing in the development and refinement of the portfolio, including the usability lab assessment of key aspects such as efficiency, accuracy, recall and emotional response. The usability lab approach and configuration is detailed, including feedback collection methods spanning observation, formal feedback, informal feedback, user oralisation and automated instrument data collection. Details of the initial stages of online usability testing and the first usability lab are discussed. Data are presented relating to findings from usability

feedback, and those techniques and ideas that were most, and least, evocative are discussed. Subsequent refinements and the impact of these findings on the development of the portfolio are detailed, including the development and prototyping of custom hardware interfaces. Details of additional stages of online usability testing, and the second full usability lab, are also presented and analysed, with particular reference to how the findings support the underlying objectives of this research and the fundamental role of the data in addressing the research questions. A set of nineteen accompanying DVDs contains the primary research data[7].

Chapter 5 details the compositions in the portfolio, indicating linkages between earlier ideas, user feedback and later realisations. The portfolio is available online at the research website[8]. An accompanying DVD contains source code program listings for the compositions including their audio and visual content.

Chapter 6 presents the conclusions from the research based upon findings related to the interplay of IDT composition development and user experience testing and feedback. It highlights key findings and analyses, drawing conclusions that demonstrate the research's two questions are answered by the methodology developed and the data provided, as well as extrapolating the wider potential of the underlying methodological approach and its application to the analysis and understanding of how users may experience and influence the development of IDT-based compositions.

The contributions of this research include:

- the composition portfolio and the associated IDT techniques originated, developed, tested and refined in its research and creation;
- the realisation methodology, with its four-element model, utilising iterative development of aspects of the portfolio informed by user feedback obtained both online and in usability labs;
- the findings from user experience testing, both online and in usability labs, in particular the extent to which various visual and aural techniques help evoke a heightened sense of the past of place;
- the extent to which the usability testing substantiates that user responses to the compositions have the potential to establish an evocative connection that

[7] In compliance with the agreed ethical approach for this research, which guaranteed user anonymity, the resources containing video and audio footage of usability lab sessions are protected by De Montfort University under restricted access.
[8] See http://fishenden.com/research/research.html

communicates a sense close to that of Barthes' *punctum* rather than solely that of the *studium;*

- the role of synthetic and authentic content on user perception and appreciation of the techniques and compositions;
- the emergence of an analytical framework with the potential for wider application to the development, analysis and design of IDT compositions.

During the course of this research two papers were published and presented at conferences by the researcher. The first of these was *Palimpsests of Time and Place* (Fishenden & Hugill, 2011), presented at COMPSAC 2011, the IEEE Signature Conference on Computer Software and Applications held in Munich, Germany. The second was a paper and accompanying A1 poster, *Interactive Computer Visualisations of Time and Place* (Fishenden, 2011), presented at the Eurographics Association Ninth Theory and Practice of Computer Graphics 2011 Conference (TP.CG.11), held in Warwick, UK.

A mobile phone application, *sonic London*, based on aural and visual techniques developed and refined during this research, was released on the Windows Phone 7 platform in July 2011. To date it has been rated with 5 stars by those users who have downloaded and provided feedback, and has been downloaded 398 times[9]. Aspects of this research are also currently being used by the DMU Square Mile community-outreach project[10]. Together with an online site using HTML5 versions of the palimpsest slider and palimpsest lens techniques, a prototype application running on a high definition Android tablet has also been developed.

Three short, illustrative videos were produced during the course of this research, and hosted on YouTube: "palimpsests of time and place"[11], "more palimpsests of time and place"[12] and "palimpsests of time and place – prototype interfaces"[13]. They provide a record of the research at various stages of development.

[9] As of 16.02.2013
[10] http://voetek.com/palimpsests/dmusquaremile/index.html. Retrieved 27.01.2012
[11] http://www.youtube.com/watch?v=pydi0KGPMek. 137 views. Retrieved 27.01.2012
[12] http://www.youtube.com/watch?v=-fNmuSfb2hU. 97 views. Retrieved 27.01.2012
[13] http://www.youtube.com/watch?v=m9ft3_H6ZY8. 73 views. Retrieved 27.01.2012

CHAPTER 1: THEORETICAL FRAMEWORK

Influences on the design, development and refinement of the portfolio are explored in this Chapter.

PALIMPSESTS

The notion of the palimpsest has been defined as "... an overwritten manuscript; a manuscript written over a partly erased older manuscript in such a way that the old words can be read beneath the new."[14] But the concept also has a broader definition: Peter Ackroyd (2001) for example creates an evocation of London through the centuries, of a city whose topography is a palimpsest within which all the most magnificent or monstrous cities of the world can be discerned. He also observes a sense of hidden layers of the past of place: that there are people to whom or through the past of place can speak (Hugill B. , 1994). Ackroyd further hints at extra dimensions in the way that some people experience London: that its streets are filled with laughter already heard before, a tearful face already seen before, a street which seems unknown and yet also familiar (Ackroyd, 2001).

Physical palimpsests also exist, in the form of geological layers, the accretion of sediments that represent earlier life forms and events on Earth, such as the material evidence of Bodica's burning of Roman London, and the fossilised evidence of the evolution of the planet itself. Residues of a city such as London are not only to be sensed or imagined but can manifest as tactile reality too: as Ackroyd observes, "... the skeletons of sharks, the skull of a wolf ... and crocodiles... " provide tangible evidence of physical layers that lie beneath the city; and "Hippopotami and elephants lay beneath Trafalgar Square, lions at Charing Cross, and buffaloes beside St Martin-in-the-Fields." (Ackroyd, 2001).

There are also architectural palimpsests, hinting at the built environment that was once around us, from ghostly imprinted outlines of vanished buildings on walls, to faded vintage advertisements from another age, to the odd survival of a rogue old building trapped between the modern.

[14] Palimpsest. Microsoft Encarta Reference Library, 2007

FIGURE 1: AN ARCHITECTURAL PALIMPSEST – AN IMAGE OF WHAT ONCE WAS

Other palimpsests of the past have been revealed through hyperspectral imaging, complementing related techniques such as aerial photography to identify long-forgotten archaeological sites by revealing the outline imprints they have left on our planet. Eviatar Zerubavel (2004) suggests another dimension to the concept of the palimpsest in his conceptualisation of our sense of the present as largely a cumulative, multi-layered collage of past residues continually deposited through a cultural equivalent of the geological process of sedimentation.

Science, too, appears to be embracing similar ideas of hidden dimensions. Proof that there are invisible layers around us is taken from experiments such as those on photon behaviour, which David Deutsch (1998) argues ultimately demonstrate that reality is much bigger than it seems, and most of it invisible: that the objects and events that we and our instruments can observe around us are but the tip of an iceberg. Lawrence Krauss (2005) describes how when, in 1998, cosmological observations led to the discovery that the energy of empty space is not precisely zero there was an explosion of interest in accessible extra dimensions that might be hiding behind the looking-glass or on the other side of the wardrobe. And two may not be enough dimensions, with Deutsch commenting that in reality there are vast numbers of parallel universes. As Kraus counsels, however, perhaps our continuing intellectual fascination with the existence of extra dimensions may tell us more about our own human nature than it does about the universe itself.

The idea that past and present might exist in multiple dimensions of the same place is an important one for this research, which aims to enable both past and present to be revealed and explored through user interaction. This wider understanding of the palimpsest (with a scope that embraces hidden layers that influence our perception and understanding of

place) is a predominant thematic compositional element: in particular, the use of IDT techniques that help to reveal layers that lie latent beneath the present, both in vision and in sound.

This research thus provides a supplementary contribution to an existing creative interest in palimpsests. The British film director Patrick Keiller, for example, has blended architectural photography with fictional narratives. His film *London* adopted an essay format and audio-visual mix, described on the BFI's *ScreenOnline* Website thus:

> London was shot silently: ambient sound, narration and music were added subsequently, giving the film a layered quality: sound, images and music play off each other, in both harmony and contradiction.[15]

This "layered quality" is palimpsestic. Whilst London has continued to regenerate and recreate itself, rather than to decline in the way anticipated in the film, we can discover a London that might have been, had events assumed a different course.

The Palimpsest System (Codognet, 2008) applies the concept of the palimpsest to combine one photograph with another on a pixel-by-pixel basis, and to apply cellular automata rules to mix, in real-time, the images together. The approach is that of a slide-show, with the transitions between images automated through the pixel by pixel application of the cellular automata. This system is a more traditional author-led work that the user is left to experience as it develops, rather than interacting with and influencing it. It shares similarities with this research in its use of computer-based techniques to achieve its effects, notably with the custom pixel shader techniques applied in this research to provide a novel means of revealing, and hiding, underlying layers of place.

Whilst not explicitly designed as palimpsest-inspired work, John Maeda (2004) describes the work of one of his students (*See the past, present and future simultaneously*, Casey Reas, 2000) that has palimpsest-like qualities in its exploration of layers of time. It creates a visual map of a form in motion by stacking the shape's visual past, present and future in a single adjustable viewing frame – with each slice of time able to be further interpreted by adjusting its transparency and level of spatial displacement in the horizontal and vertical dimensions. This two dimensional visualisation of time is similar to the three dimensional aspects explored in this research, some of which likewise enable both past and present to be seen simultaneously (such as the effects achieved with the palimpsest slider, described later in this thesis).

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[15] Source: http://www.screenonline.org.uk/film/id/497617/index.html. Retrieved on 13.03.2009.

Brian DeLevie's *Remembered, Digital Palimpsests* is a visual exploration of recorded history and subjective memory. It uses the palimpsest as a basis for exploration, with each canvas presenting layers of imagery and video to represent mixed memory, helping merge historical and personal perspectives, and whose partial erasure and rediscovery recedes and re-emerges (DeLevie, 2007). Whilst as presented online[16] this does not include audio, some small scale digital interaction is possible (such as close examination of the image detail). However, this is limited in scope and the piece is largely presented as a visual artwork rather than an IDT composition.

Re-remembered; video palimpsests[17], also by Brian DeLevie, provides a visual exploration of recorded history and subjective memory:

> Using the palimpsest as a model for this exploration, each layering of imagery and video represents mixed memory, a merging of historical and personal perspectives whose partial erasure and rediscovery recedes and remerges within a media-saturated environment.
>
> Each day, an array of meaningful and arbitrary images are constructed and deconstructed within our minds and all around us. These works act to question the stability of what we call history and memory, what is remembered and re-remembered, fleeting and enduring, troubling and endearing, written and re-written.
>
> The original material manipulated in each piece is a combination of historical and personal footage and photographs. Digital artifacts and effects represent time, obstacles and our inability to erase what has taken place. The overall landscape of re-remembrances depicts our ability to re-present ourselves and the world with our notion of what is actual.

Whilst this work by DeLevie draws on the author-led audio-visual tradition rather than that of IDTs, some of its underlying creative intent (the exploration of the layering of imagery; the use of both historical and personal photographs) shares similarities with aspects of this research, which also uses both contemporary and historic imagery in the creation of various compositions.

The choreographer and performance artist Erica Mott has also explored the theme of the palimpsest. Her work *The Palimpsest Project*[18] is an integrated arts-based investigation of the relationship between personal and collective memory, undertaken in collaboration with dressmaker and visual artist Kristin Mariani. At the time of writing this is undergoing community co-research and seeks to work across design platforms to manifest the idea of

[16] Via http://www.briandelevie.com/. Retrieved 29.03.2011
[17] Retrieved from http://vimeo.com/6435318 on 29.03.2011
[18] See http://www.ericamott.com/the-palimpsest-project/. Retrieved 08.01.2011

creating an *environmental palimpsest*. This takes the form of a live performance installation rather than an IDT composition.

Audio Palimpsest by Anis Haron[19] is an interactive sound-based installation that explores applications of indeterminacy and randomness in an interactive platform. Based on a reconfigured cassette recorder, this installation allows multi-point interaction by synthesizing data inputs collectively. *Audio Palimpsest* is intended to be experienced in a gallery where it will start recording ambient sounds in the space and playing them back simultaneously. Over time, and after multiple interactions, the content of the magnetic tape builds up, layering previous recordings into a palimpsest of overlaid sounds. In a sense, this is an alternative realisation of the Babbage observation to the effect that every sound ever made is still out there (discussed in the section on Sound later in this Chapter) – capturing as it does the sounds made in the installation space and gradually layering them one upon another.

Multimedia producer and educator Ivy Roberts explores ideas of the palimpsest in her work *Version Control*[20]. In these – notably *Version Control (2) Palimpsest* and *Version Control (2.1) Palimpsest* – she explores the nature of time and space as they relate to digital media, pitting fixed form and linearity against layered space and experience of place and time. Whilst the works as presented are videos rather than interactive media, Roberts comments that hypertext and interactive technology can be utilised to counteract the fixed nature of digital media – a utilisation exploited in this research through the development of techniques that aim to ensure fixed digital media (such as old photos) interact with users in new and evocative ways.

This research similarly takes as its starting point the concept of the palimpsest and hidden dimensions, but does so within the reference domain of IDTs. It thus differs in its realisation from some of the works referenced above whilst complementing the wider artistic genre relating to palimpsests. It hence contributes to an evolving cadre of works and creative interest in palimpsests by developing techniques and compositions in the context of testing, collating user experience feedback and improving the ways in which IDTs enable an artistic exploration and realisation of hidden layers, both aural and visual, of the past of place.

[19] Retrieved from http://vimeo.com/13817251 on 08.01.2012
[20] See http://www.postmodernpalimpsest.com/?p=235. Retrieved 08.01.2012

AUTHENTIC/SYNTHETIC

A consideration in this research was the extent to which sounds and images used in the compositions needed to be those that genuinely existed in the past, or ones that succeeded in evoking or recreating a sensation of the past: of sounding and looking as people *imagine* the past to be.

Synthetic sound is often deployed as a device to lend visual images legitimacy but not necessarily authenticity: a punch or a fall in real life rarely creates much sound, unlike their customary representation on the cinema screen. Whilst not authentic, the use of sound in such situations helps to legitimise the image, to fulfil our psychological expectations:

> What we hear is what we haven't had time to see. (Chion, 1994, p. 61)

Jonah Lehrer (2008) highlights how Cézanne came to the realisation that reality only exists in the mind, that our impressions require interpretations, that to look is to create what we see: that reality is not waiting to be witnessed, but is created by the mind. In this sense, it is the effect of the visual or aural content that is of importance – whether it creates the intended effect in those experiencing the work – rather than whether the content is based on original or synthetic sources. Guy Debord, whose Situationist perspective analysed issues in terms of their political and ideological significance, highlights the powerful ability of abstracted or representational objects to in effect become real, commenting that when the real world is transformed into mere images, mere images become real beings (Debord, 1992).

This research explores how images and sounds of past and present can be composed in ways that make more evocative a creative interpretation of layers of the past that lie behind the present. It intentionally draws upon a mix of authentic and synthetic images and sounds (including authentic and synthetic impulse responses), and employs the feedback mechanisms of the internet and usability labs to test Truax's hypothesis (cf. p. 18) to better understand the impact of authentic and synthetic images and sounds on users.

PUNCTUM/STUDIUM

In *Camera Lucida* (Barthes, 1981, originally published 1980), as Barthes begins his exploration of the meaning that a picture of his late mother as a child holds for him, he considers the mix of general symbolism inherent in the photo (that which anyone would see, which he termed the *studium*), and that which was profoundly personal and intimate

(which he termed the *punctum*). His concern was how to find some means of conveying the sensation encapsulated in the *punctum* to others: how might it be possible to convey something that pierces the viewer to another who had no such direct link to the subject portrayed? As Andrey Tarkovsky observed, an artist may create a life-like effect, but that is not the same as examining life beneath the surface – that unless there is an organic link between the subjective impressions of the author and his representation of reality, he will fail to achieve authenticity and inner truth (Tarkovsky, 2006).

Barthes came to recognise that any photo is a representation of something that no longer exists: it lives in the past, not the present. In this sense, it acts as a reminder of the contrasting reality of a world in constant change. His emotions when considering a photo are hence purely a personal, subjective matter that is not encoded in the photo itself, but rather by the way in which it acts as a trigger to his own intimate memories and their associated emotions. This raises questions about how to achieve the *punctum* (the effect of being moved and rendered speechless – in Barthes' definition). Whilst to its creator a composition might provide a *punctum*, the same impact may not be experienced by an audience (for whom the personal relevance of the composition may seem less immediate, since it is not inherently encoded in the piece itself). We may intend to provoke a particular reaction, but yield another unless we understand the nature of the medium and the way in which individuals and collective audiences experience it. As Andrew Hugill observes (in the context of music composition):

> You may know what it is to feel anger, but what you want to do is to create some music that evokes that feeling. (Hugill A. , 2008, p. 102)

And similarly Orhan Pamuk notes:

> ...the primary aim of a landscape painter is to awaken in the viewer the same feelings that the landscape evoked in the artist himself. (Pamuk, 2005, pp. 83-84)

In considering the photograph of his late mother, Barthes is transported to another time and place – one where and when his mother was alive. The result is a discussion of the contradictions of time in photography – evidence that whilst some views of time are that we are always in the present, the photograph contradicts this and shows us something that quite clearly can only have come *from the past* even while it exists as an artefact *in the present*. As John Berger observes, an image is a sight which has been recreated or reproduced, detached from the place and time in which it first made its appearance: it offers a direct testimony about the world which surrounded other people at other times, and in this respect, can be more precise and richer than literature (Berger, 1972).

Through the development of interactive techniques, informed by the application of usability testing, this research explores the extent to which IDTs are able to achieve a *punctum* (by which is meant an impactful emotional response) rather than solely a *studium*. The usability testing adopted in order to assess the user experience, and the resulting data acquired, demonstrate that some elements of the portfolio have proved capable of establishing a strong, evocative emotional response in users – evidenced in the feedback discussed in "Chapter 4: User Experience."

TIME

The Western representation of time is based on the Gregorian calendar and the clock, inherited from a mix of natural physical phenomenon (the rotation of the earth over periodic cycles, such as the twenty-four hours of day and night) and cultural. It is however possible to distinguish between at least two separate ideas of time: our mental conception of time (our internal perception and representation of time), and the external measurement of time. As creative-oriented research, our inner model of time (how we perceive and interact with it – and its impact on our senses and emotions) is more central to this research than a scientific definition of time.

Marcel Proust's belief that time is in constant flux, with moments of the past and the present having equal reality (Proust, 2009, originally published 1919), captures the artistic intent applied during this research – that the palimpsests of place over time are all real, all waiting to be discovered, and that various techniques can be developed that enable us to explore and interact with these layers. In the digital domain, Maeda (2000) has observed that the creation of something as simple as an on-screen trail of digital ink is not only a record of a path through space, but also through time: that it possesses sculptural, space-time qualities.

Whilst philosophers of time remain deeply divided regarding ontological differences of the present, past and future (Dowden, 2007), the block universe theory suggests there are in fact no significant differences. As Deutsch elaborates, the block universe theory represents the whole of physical reality, past, present and future, as frozen in a single four-dimensional block. Nothing ever moves and what we generally refer to as moments of time are but slices through space-time: when the contents of these slices differ from one another, we call it change or motion through space (Deutsch, 1998).

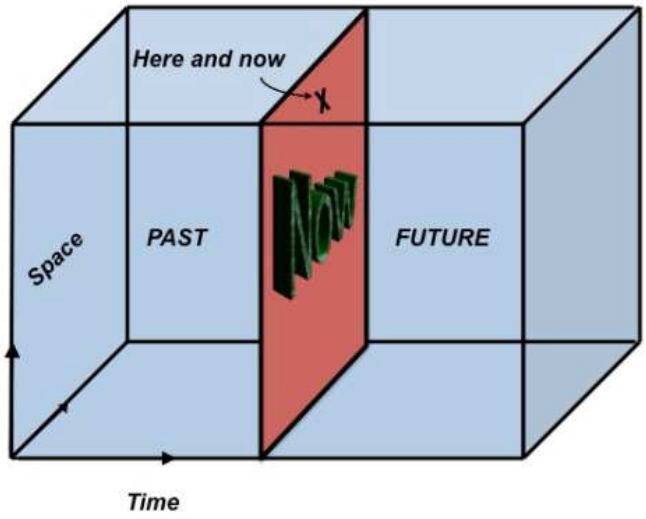


FIGURE 2: THE BLOCK UNIVERSE
(SOURCE: PROFESSOR JIM AL-KHALILI'S OFFICIAL WEBSITE[21])

This is an important concept and inspiration in this research, with a parallel between slices through the block universe and layers of time (palimpsests) in the *n*-tier navigation model (see "*n*-Tier Navigation" in "Chapter 3: Design and Development").

Zerubavel (2004) considers how language has freed human memory from personal isolation, with people able to share their experiences with others through oral and written communication, in turn enabling them to become preserved as disembodied impersonal recollections that effectively can travel through time, out-living their originator. This research explores how IDTs might provide an additional means of such sharing of experiences. It considers various representational models of time (including linear and cyclic) and their impact on user experience through the application of an iterative cycle of composition, usability testing and refinement. Earlier exploratory models – of linear, cyclic, rotational representations – were later evolved as a consequence of user feedback, better encapsulating the idea of the palimpsest by representing time as an accretion of layers built one upon another: in a work such as *Palimpsest Navigator* all time thus exists in multiple layers of the same space, using the idea of the block universe as an underlying conceptual model for the *n*-tier layered navigation techniques.

INDIVIDUAL AND COLLECTIVE MEMORY

Social networking facilities such as Twitter and Facebook and the growing use of mobile phones with in-built cameras offer a more pervasive and ubiquitous potential to capture and communicate the everyday reality of our contemporary lives. Such developments may,

[21] Retrieved from http://www.jimal-khalili.com/wordpress/wp-content/uploads/2010/09/Slide03.jpg on 10.02.2012

over time, act to counter Guy Debord's observation that our individual experience of daily life remains without a language, without critical access to its own past: that it is not communicated and is hence forgotten (Debord, 1973). More universally captured experiences of our everyday lives could enable future generations to connect better with our present. So too they might enable us to evoke and better appreciate the past that lies embedded around us in the fabric of our environment, in our current sense of space and place: to better communicate an understanding of the way in which a particular moment in time in a particular place looked and sounded to those who once inhabited it.

Patrick Keiller explored the communicative role of images in his work *The City of the Future* [22]. In his programme for the exhibition, Keiller quotes Henri Bergson (originally writing in 1896):

> Here I am in the presence of images, in the vaguest sense of the word, images perceived when my senses are opened to them, unperceived when they are closed. All these images act and react upon one another in all their elementary parts according to constant laws which I call laws of nature, and, as a perfect knowledge of these laws would probably allow us to calculate and foresee what will happen in each of these images, the future of the images must be contained in their present ... (Bergson, 1991, p. 17)

The title *City of the Future* echoes earlier work from the 1950's by Morton Heilig, notably his idea of the cinema of the future (one that would immerse the audience with reproductions of the world so convincing that they would feel they had entered another domain).

> Such a cinema, he wrote, 'would faithfully reproduce man's outer world as perceived in his consciousness, it will eventually learn to create totally new sense materials for each of the senses ... [that] they have never known before, and to arrange them into forms of consciousness never before experienced by man in his contact with the outer world.' (Packer & Jordan, 2001, p. xxii)

Walter Benjamin suggests that the true picture of the past flits by, that the past exists only as an image which flashes up at the instant when it can be recognised and is never seen again (Benjamin, 1999, originally published 1968). Although it often seems it is the true picture – and sound – of the present that flits by. As Marcel Proust observes, it is a contradiction to search in reality for memory's pictures, which never have the charm that comes from memory itself (Proust, 2003, originally published 1913). And those memories are not a fixed and dependable record of what once happened at a particular place or time – memories are constantly changing internal constructions, and often we fail to remember

[22] Keiller, P. "The City of the Future". 23 November 2007 to 3 February 2008 at the BFI Southbank Gallery, London.

accurately (Blackmore, 2000). Lehrer observes, following Proust, that our memories do not directly represent reality but are imperfect copies of what happened: that when memory is prevented from changing it ceases to exist (Lehrer, 2008).

Our own memories of place and the events that happened in them can be either highly individual (unique to us) or collective (involving two or more people in a shared experience). But there are also wider associative memories. Zerubavel cites the Polynesian use of the first-person pronoun when narrating one's ancestral history as well as in statements such as "I smelted iron in Nubia" or "I built Timbucto" to express a Barbadian poet's distinctly African memories (Zerubavel, 2004). These become what Zerubavel refers to as *mnemonic communities*: that by establishing such contrived connections we manage to provide both past and present events with historical meaning.

In his reference to Hampaté Ba's dictum (that in Africa an old person dying is a "library on fire"), Marc Augé (2008) suggests that what this tells us is less about the past than what we know or think about the past. This is reminiscent of Proust's ideas about memory comprising not only the act of recall, but also the way that the very act of recollection alters that which is being recollected. Each memory access or recall becomes a memory modification, moving us ever further away from the actuality of the past and increasingly into our perception of the past.

Maurice Halbwachs (1992) believed that our conceptions of the past are affected by the mental images we use in resolving issues in the present, that our collective memory is effectively a reconstruction of the past in the light of the present. Our memory thus relies upon constant attention from external sources in order to stimulate and reinforce our recollections of times past, with the greatest number of memories coming back to us when parents, friends or other persons recall them to us. What we might believe to be a simple act of memory as factual recall, as if we are merely replaying a film of actuality footage for example, is in fact more subtle, with the past being reconstructed on the basis of the present. He also suggests a complex interplay between actual events, our memories, our dreams and the images we associate with them. Walter Benjamin (1999b, originally published 1929-1934) emphasises that it is the relationship between memory and perception that is often most important, that it is life as remembered – not life as actually experienced – that is recalled. It is not so much the act of remembering but the weaving of memory itself that matters.

Ackroyd (2001) suggests that over time people of a city will say the same things or use the same gestures upon the same streets: that certain activities belong to certain areas, as if place is influenced by some unknown power. In this, Ackroyd implies a similar associative type of memory by *place* as Zerubavel explicates by *group*. And that such associations of place persist beyond the experience and memory of an individual as if the very place itself retained and reflected its own sense of memory.

IDTs, with their potential to utilise and stimulate a number of our senses, may offer the ability to better communicate our memories; to convey a better sense of our own experiences (and collective experiences, including of place) than has been possible through single medium approaches such as the written word (and the traditional literary biography or autobiography). This research explores how the portfolio's techniques and compositions impact a user's awareness of the past of place, of a *sense* of *memory* of what once happened (such as the hangings at Tyburn Tree), influenced particularly by Ackroyd's idea that places can retain and reflect their own sense of memory.

SPACE/PLACE

Modern maps portray our world with increasingly high fidelity and precision. When we examine historic maps there is therefore a sense in which we may regard them as an adult might view their own drawings as a child – as naive or out-dated, an approach at a moment in time that has passed but is now no longer appropriate.

FIGURE 3: MAP OF GREAT BRITAIN 1250-1259 (SOURCE: BRITISH LIBRARY)

Yet we could also consider earlier cartographers' sense of place to be as valid as our own: in judging the past through the lens of the present we may miss an important *human* sense of how place impacted man at those earlier moments in time. Those earlier maps provide insight into the knowledge, perceptions and beliefs of those who constructed them. It is

this idea of a *sense* of the past of place that is important to this research, in particular the ability of IDTs to evoke just such a sense in a user.

Some places are able to evoke strong memories, not just personally for us as individuals but at a collective or societal level too, with Zerubavel (2004) observing that constancy of place helps establish a strong sense of sameness: that despite the changes we undergo as individuals, our physical surroundings often remain relatively stable and hence provide a reliable locus of memories both for us and for wider groups. In addition, this constancy of place provides us with an ability almost to "see" the people who once occupied the same space that we do now:

> Walking down the streets of an old city, we can 'make contact with previous generations' by literally walking in their footsteps and looking at the 'vistas that greeted their eyes'. (Zerubavel, 2004, p. 42)

And Zerubavel also maintains that it may well not just be place itself that enables us to see the past like this, but also objects that have passed through time to exist with us in the current day: relics and memorabilia that provide us with a vivid, tangible contact with the past. Augé (2008) however points out the difference in perception between those who originally inhabited a place and others who come later, such as ethnologists who seek to interpret the purpose of place.

Tarkovsky (2006) observes a significant difference between the way we remember the house in which we were born, and which we have not seen for years, and the actual sight of the house after a prolonged absence. He notes that the poetry of the memory is destroyed by confrontation with its origin: something the researcher found resonant on re-visiting childhood homes during field research. This sense in which the spaces we have inhabited have a heightened significance beyond the physical is also reflected in Gaston Bachelard's comment that inhabited space transcends geometrical space (Bachelard, 1994, originally published 1958).

Augé's (2008) suggestion that an individual is able to live in an intellectual, musical or visual environment wholly independent of his immediate physical surroundings is particularly relevant to this research's objective of enabling a user to experience a sense of place independent of their physical location. Barry Blesser and Linda-Ruth Salter (2007) also assert that whilst artistic space may not be "real space", only the experience of space is itself real. These ideas are important in the context of IDT compositions that aim to establish a sense of the past of place for a user independent of their actual geophysical location, to create an environment independent of a user's immediate surroundings.

Bachelard posits the primary influence of the house in our psyche, suggesting that it is one of the greatest powers of integration for the thoughts, memories and dreams of mankind. He refers to the way in which we experience resonances, sentimental repercussions, reminders of our past, in particular spaces and places. In our own lives we often carry the memories of those places we once inhabited with us, and we may well return to them in our night dreams: there exists for each of us an oneiric house – a house of dream-memory lost in the shadow of the past. Such places from our individual lives continue to have importance to us, even when we are no longer near them (either in time or place): they continue to survive inside us in order to live again (Bachelard, 1994, originally published 1958). Images of earlier homes in which the researcher once lived are used in several works in the portfolio, part of an exploration of content that has meaning to the researcher but not to the user.

Alongside the key role of the house, Debord recognises the importance of the city in our sense of time and place, that the city is the focal point of human history, combining both social power and a consciousness of the past (Debord, 1992). The city – in particular, London – helps provide a recurrent visual and aural element in the works developed during this research.

The creative interest of this research lies not only in the potential reverberation of our own past and experiences, but to evoke in others a sense of what a place has experienced – or, more specifically, a sense imbued to it by a composer. To heighten a connection with place based on a greater empathy with its nature at various moments in time. In his installation, Keiller's *The City of the Future* (hosted at the British Film Institute's Gallery, London, in January 2008) provided an exploration of urban landscape at the turn of the twentieth century. It comprised an assembly of sixty-eight early actuality films arranged in the Gallery space on a network of maps from the period, providing an immersive psycho-geographical experience of modern places in the city enhanced with black and white footage co-located in the same place but not at the same time – evoking an emotionally connective experience of place through time.

So too this research aims to evoke and assess the potential for IDTs to communicate an emotional or artistic sense of place, particularly the past of place, effectively to others. When Susan Blackmore (2000) considers the question "Where am I?" it is in the sense of where "I" am located in my own brain – where my personality, identity, individuality resides. But "Where am I?" in relation to this work is more concerned with how the "I" (the personal experience of place) can be communicated to others by more impactful means

than the prevalent written and oral traditions. And of how our perceptions of image (street scenes from the past for example) transform depending on other associated elements, such as aural influences. The Scottish philosopher David Hume reached the conclusion that the self comprised nothing more than a "Bundle of Perceptions" (Hume, 1739-40).

This research explores different creative representations and interpretations of place, and how the past of place might be revealed through new navigational techniques, to better understand which methods have most impact on a user in terms of the communication of an evocation of a particular sense of the past of place. The *n*-tiered palimpsest navigation model, and associated techniques such as the slider and lens, and how they enable users to interact with and experience space and place over time, are discussed in "Chapter 3: Design and Development" and "Chapter 4: User Experience", and their realisation in various works detailed in "Chapter 5: Compositions".

SOUND

Charles Babbage believed that:

> The air itself is one vast library, on whose pages are for ever written all that man has ever said or woman whispered. There, in their mutable but unerring characters, mixed with the earliest, as well as with the latest sighs of mortality, stand for ever recorded, vows unredeemed, promises unfulfilled, perpetuating in the united movements of each particle, the testimony of man's changeful will. (Babbage, 1838, 2nd edition)

This is a key concept for this research, which explores through works such as *TimeRadio* the ability to tune into previous soundscapes. The aural aspects of IDT compositions are as important as the visual: indeed, Blesser and Salter comment that, in comparison with our vision, hearing is far more sensitive to temporal changes – that in a sense, sound is time (Blesser & Salter, 2007). Yet it is only comparatively recently that it has been physically possible to preserve sound. As Hugill observes, Emile Berliner is usually credited with the invention of the first true microphone in 1877 (Hugill A. , 2008), with the microphone itself first described in 1827 by Charles Wheatstone (Wheatstone, 1827). Whilst the visual landscape has been captured for millennia, the aural soundscape is less well served:

> However thoroughly a modern guidebook may describe the history and architecture of a town, it rarely mentions the town's soundscape, except perhaps as a curiosity. (Blesser & Salter, 2007, p. 69)

From earlier times we have sketches, drawings and paintings (including cave paintings), and books, both factual and fiction, that provide some insight into what previous times

may have looked like for those who lived through them. In terms of the soundscapes of the past, we have formalised musical notation systems that enable us to attempt to re-perform works from some previous ages together with instruments from the past that we can learn to play. But the actual soundscapes of the past are lost: and we cannot re-create the aural experience of the original listeners since we still hear acoustic environments as modern listeners, with the spatial experience of our ancestors forever lost (Blesser & Salter, 2007).

Whilst modern sounds such as those of the car have changed and continue to change as engine and other automotive technology matures, the background aural layers of the natural planet (rivers in motion, the wind, seas, earthquakes, volcanic eruptions) and species (bird song, the howl of wolves) are more persistent over time. We might therefore theorise a layered model of aural longevity (relative permanence) and aural transience (see Figure 4).

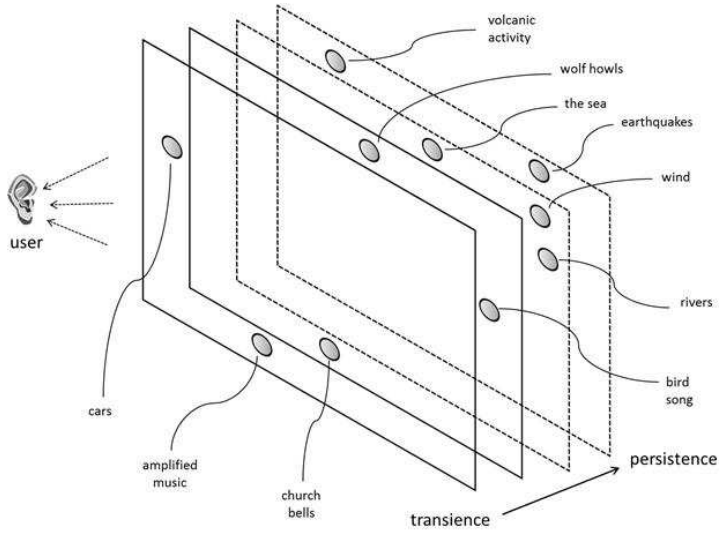


FIGURE 4: THE PERSISTENCE AND TRANSIENCE OF LAYERS OF THE AURAL SOUNDSCAPE

Those older, more persistent sounds that form the backdrop to our aural environment are often masked by the transient sounds of our age: these background aural palimpsests are as present as they have ever been, yet it becomes ever more difficult for us to perceive them since they are often overwhelmed by the higher volume and prominence of contemporary sounds.

Echoing Babbage's belief, in a sense sounds from the big bang are audible to us today: Arno Penzias and Robert Wilson, of the Bell Telephone Laboratories, were cited in an article (Dicke, Peebles, Roll, & Wilkinson)[23] in 1965 as having identified background

[23] Retrieved from http://adsabs.harvard.edu/full/1965ApJ...142..414D on 20.08.2012.

radiation of an unknown origin at a wavelength of 7.3cm. This background radiation was to later become known as cosmic microwave background radiation – cosmic static emanating from the big bang. In a sense, it is the oldest element of the soundscape.

Raymond Murray Schafer asserts however that water "is the fundamental of the original soundscape" (Schafer, 1994), although this cannot be taken literally given the evidence from radiometric dating that implies an age of around 4.5 billion years for our planet and that it would have emerged from the big bang. Water – and the rivers and seas as we know them today – would only have been part of a later soundscape. Before that, if there had been anything or anyone to hear them, there would have existed more fundamental noises associated with the early formation of the planet. These may have been similar in nature to the sounds around volcanoes and hence the soundscapes encountered in places such as Iceland.

Sounds that we might assume to have been present in the past may also have differed, one illustration of this being church bells. For example, two bells were cast for Westminster Abbey by Robert Mot at the Whitechapel bell foundry in 1583 and 1589 and are still in use as service bells at the Abbey to this day. But whilst those bells may sound now as they did over four hundred years ago, the patterns of bell ringing may have differed[24]. So whilst we may hear sounds from the past in our contemporary soundscapes, perhaps they are not as they would have sounded at the time, nor may they convey the meaning they once did to earlier listeners. Truax suggests that the romance associated with a past sound arises from nostalgia, and that the sound appears romantic because it not only evokes the past context but also idealises it (Truax, 2001).

Our ideas about soundscapes from the past are likely to be wrong if we think that the past was a less noisy, less intrusive soundscape than today. William Hogarth's *The Enraged Musician*, painted in 1741, portrays the bawdiness and cacophony that filled the streets of London (Brooke & Brandon, 2005). A report from 1891 comments upon how noisy areas next to the Thames had become, with the incessant clang of hammers disturbing the peace of the stream in west London (Bonney, 1891). This categorisation of sound as noise and nuisance has a long track record, with Truax observing that during the 1890s popular journals in England and North America carried articles and editorials on noise as one of the perils of the modern world, and with the Oxford English Dictionary referring to unwanted sounds in entries that date back to 1225 (Truax, 2001).

[24] Sourced from original materials held at the Whitechapel Bell Foundry, London. Personal research.

Schafer raises concerns that we are losing, forever, some of the soundscapes that have long existed on Earth. He writes about how our perceptions of place are being altered by the way we treat the environment, that as silence disappears from the world so too powerful myths depart (Schafer, 1994). An illustration of this is provided by a report in the *Independent* newspaper that the last native speaker of Eyak has died in Alaska (Shields, 2008). No longer will the sounds of that language be heard: part of our collective cultural soundscape has been silenced. How many times has this happened before – and what sounds would we hear that are now extinct if only we possessed some means of tuning in to hear them?

The memory of the acoustic nature of an environment is as important for some people and communities as memory of the images of a place may be for others, with memories of older people about the sounds of the past remaining vivid even after decades have passed (Truax, 2001). Such associations with sounds are not necessarily a granular, sound-by-sound recognition in memory. Through endless repetition, sounds and associated contexts build up patterns that Truax refers to as "sound symbolisms", which he compares with Jung's largely visual archetypes, since such symbolisms provide aural sources of great suggestive power, with strong emotional connections and associations (Truax, 2001). Blesser and Salter observe that our awareness of space is not simply a matter of the way in which it changes sound, but that it includes the more emotional and behavioural experiences of those spaces too (Blesser & Salter, 2007). Bachelard suggests that it is possible to recover both the timbre of lost voices, "the inflections of beloved voices now silent", and the resonance characteristics of each room of a house in which those voices were once heard (Bachelard, 1994, originally published 1958).

The use of sound can also be exploited as a deliberately manipulative, emotional phenomenon – the movement of the audience's perception "into the gap" as Michel Chion describes it (Chion, 1994). Truax observes that musical meaning can be analogous between composer and listener, with an emotion or image created by a particular set of acoustic relationships (Truax, 2001). He also observes that there are individual patterns of association based on personal experience, sounds that remind us of pleasant or unpleasant memories and therefore evoke a conditioned response. Sounds and their original context he believes are stored in memory as patterns and that recalling the context can revive a memory of the sound: and that the sound, when heard again, can bring the entire context back to life. Maeda comments that we expect most of our actions to result in reactions that are not only visual but aural: that without sound we are distanced from the reaction, making it more abstract but that once a sound is made we receive confirmation that the

event is not imagined – it is real (Maeda, 2000). Truax asserts that modern electroacoustic forms of sound production provide us with new potentialities – new patterns of communication that can bridge space and time, and hence create new relationships between people and their environments (Truax, 2001).

Sound can also be considered at both the macro and micro levels: as Curtis Roads notes, in the 1940s physicist Dennis Gabor proposed that any sound can be decomposed into acoustical quanta bounded by discrete units of time and frequency (Roads, 2004). In the twentieth century the manipulation of sound and vision predominantly referred to strips of tape or film being cut, assembled, and moved around at will (Hagen, 1971; Chion, 1994). But now content is predominantly digital, transformed into binary bits and manipulated using computers. Audio, video, communications, essays, books, photos, money – all have become binary bits, abstracted from their actuality and which, once in digital form, bear little resemblance to their original meaning or purpose. As elements such as sound have moved into the digital domain, improved analysis and understanding has enabled us to examine them in new ways, allowing us to view and manipulate the microsonic layers from which all acoustic phenomena emerge (Roads, 2004).

The portfolio explores various aspects of sound, including the use of impulse responses (discussed in "Chapter 3: Design and Development") from historic interiors, synthetic impulse responses, and the idea of street sounds that persist in the background from previous eras (after Babbage) in "Chapter 5: Compositions". User experience of sounds, and related techniques, were explored as part of the iterative process of user interaction and feedback (discussed in "Chapter 3: Design and Development" and "Chapter 4: User Experience").

Locative Media

This research is about place, but is not site-specific in the sense of locative media. The role of place is a thematic element of the composition portfolio, which is in part about the evocation of the experience of place. The research focus on compositions to be experienced in dislocated place is thus distinct from the practice and theory of locative media, with its close association with specific geo-physical location and situational guides and experiences. Utilising mobile devices and GPS-enabled functionality, locative media enables content related to a specific location to be delivered, experienced and interacted with in *a particular place*, providing experiences such as sound walks or augmented reality interactions. Locative media enhancements may range from the historically informative

(details for example of a battle, or other event that occurred in a specific place) or more artistic interpretations, such as how a place may have looked or sounded in the past, or indeed an entirely imaginary creation.

Some illustrative examples of the practice of locative media include:

- Uncle Roy All Around You[25], a game played online in a virtual city and on the streets of an actual city
- Murmur[26], a documentary oral history project that records stories and memories told about specific geographic locations
- Urban Tapestries[27], which is "adopting and adapting new and emerging technologies for creating and sharing everyday knowledge and experience; building up organic, collective memories that trace and embellish different kinds of relationships across places, time and communities."
- Inter-Urban[28], which provides an interactive narrative as people wander through the streets of a city

Whilst locative media can combine visual and aural elements to enhance a specific geophysical location, the IDT compositions of this project are not intended to be tied to location. The research interest is focused on the evocation of a sense of the past of place without requiring the recipient of that intent to be physically geolocated in a specific place. The composition portfolio utilises IDTs to liberate the user from being tied to a particular physical place. Its underlying intent is for the researcher's compositions to evoke a sense of what a particular place, or memory of place, or imagined memory, or impression of place, means to the composer. This desire to develop, and test, the effectiveness of the compositions is distinct from the in-situ physical requirements of locative media.

Drew Hemment comments that:

> The exploratory movements of locative media lead to a convergence of geographical and data space, reversing the trend towards digital content being viewed as placeless, only encountered in the amorphous and other space of the internet. (Hemment, 2004, p. 1)

For the purpose of the composition portfolio, locative media is thus a less desirable realisation environment. Indeed, for some of the compositions to attempt to require audience convergence on geographical space would be problematic: some of the places on which the compositions are focused are oneiric, related to a *memory* or *sense* of what a place once sounded and looked like and meant to the composer. For others, whilst the

[25] http://www.blasttheory.co.uk/bt/work_uncleroy.html (retrieved on 13.3.09)
[26] http://murmurtoronto.ca/ (retrieved on 13.3.09)
[27] http://urbantapestries.net/ (retrieved on 13.3.09)
[28] http://interurban.34n118w.net/ (retrieved on 13.3.09)

place may physically exist (such as an early home of the researcher), it is not the place as it was at the time, nor the place that the researcher once experienced. To require an audience to visit such a location when it no longer conveys the experience that the composer wishes to convey, and when the experience of that place today bears no relation to that which the composer experienced at that place at that time, could make it more difficult to evoke the very response in an audience that the composer was seeking. An audience would become aware of the physical realities and characteristics of that place as it exists now, not the experience or sense of the place (what it once meant) that the composer seeks to share, which can better be contextualised through a composition designed for a neutral, displaced performance space. As Trevor Wishart has observed (Milani & Placidi, 2009), modern compositions do not require us to be in a particular venue in order to experience them, and that divorcing music from the immediacy of a concert stage allows us to explore imaginary worlds, conjured in sound, beyond the social conventions of the concert hall. The works developed in this research do not require a user or audience to be in a particular venue or location to experience them: for most of the works, the internet *is* the performance space.

INTERACTIVITY

Interactivity has been defined as:

> … the set of processes, dialogues, and actions through which a human user employs and interacts with a computer. (Baecker & Buxton, 1987, p. 40)

The principle of interactivity refers to the ability of users to provide input that influences the behaviour of computer software.

> In interactive art ... a computer is frequently used as the controller of the interactive process, the definition of that process being specified by the software that is an integral part of the artwork ... interaction challenges the audience to move from being mere viewers to being active participants. (Candy & Edmonds, 2011, pp. 3-4)

One of the key figures in computational development, Alan Kay, observed that user interface design first came about as computer designers began to appreciate that a better understanding of users' minds would fundamentally improve the paradigm of interaction (Kay, 1990). Linda Candy and Ernest Edmonds (2002) comment that the

> … nature of [a] work is embodied not just in how it looks or what images are used, but in the way that it behaves when people interact with it. The problem of working with and defining interaction is a key one. (p. 29)

In terms of how a composition might best interact and engage with a user, John Dewey (2005) quotes William Coleridge's observations from *Biographia Literaria*:

> The reader should be carried forward, not merely or chiefly by the mechanical impulse of curiosity, not by a restless desire to arrive at the final solution, but by the pleasurable activity of the journey itself. (pp. 3-4)

However, this quotation excises a key element from Coleridge's original, which appears in *Biographia Literaria* as:

> The reader should be carried forward, not merely or chiefly by the mechanical impulse of curiosity, or by a restless desire to arrive at the final solution; but by the pleasurable activity *of mind excited by the attractions* of the journey itself. (Coleridge, 1817)[29] [Researcher's emphasis]

Coleridge's emphasis on the "activity of mind excited by the attractions" of the journey itself better emphasises the nature of the way experience and reality are a creation of the *mind*. And, in terms of this research, the objective then becomes better expressed as:

> The user of interactive digital technologies should be carried forward, not merely or chiefly by the mechanical impulse of curiosity, or by a restless desire to arrive at the final solution; but by the pleasurable activity of mind excited by the attractions of the journey itself.

Such an objective is shared with other artists: Brigid Costello for example states that she wants her participants to engage with and explore her artworks – since, if they do not, they will not produce the experiences and opportunities that she has intended (Costello, 2007). As Edmonds (2010) observes, the "interactive experience … is a key element in the aesthetics of the art" and that

> In interactive digital art, the artist is concerned with how the artwork behaves, how the audience interacts with it (and possibly with one another through it) and, ultimately, in participant experience and their degree of engagement. (p. 1)

Richard Guedj et al (1980) have defined interactivity as "a style of control and interactive systems that exhibit that style". Lev Manovich (2001) defines "open interactivity" as activities such as computer programming and the development of media systems, in contrast with "closed interactivity", where only the elements of access are determined by the user. Spiro Kiousis (2002) observes that the impact of interactivity partially resides in users' perceptions, and Byron Reeves and Clifford Nass (1996) observe that perceptions are often far more influential than reality in terms of individuals' interactions with computer-based works. Maeda (2000) comments that the purpose of reactive graphics is to go beyond the communicative level of interactive graphics in order to engage the

[29] See http://www.online-literature.com/coleridge/biographia-literaria/14/. Retrieved 04.11.2011

human sensory system at the instinctual level, and to create a resulting diversity of user reactions.

Interactivity has a long pedigree in the creative arts, being explored early on by artists such as Marcel Duchamp and Laszlo Moholy-Nagy in relation to objects and their effects (Paul, 2003; Candy & Edmonds, 2011). Randomness too has provided a key element in creative works:

> The element of a 'controlled randomness' that emerges in Dada, OULIPO and the works of Duchamp and Cage points to one of the basic principles and most common paradigms of the digital medium: the concept of random access as a basis for processing and assembling information. American digital artist Grahame Weinbren has stated that 'the digital revolution is a revolution of random access' – a revolution based on the possibilities of instant access to media elements that can be reshuffled in seemingly infinite combinations. (Paul, 2003, p. 15)

Engagement and exploration are equally essential to this research: the role of the methodology and its integral user experience testing are designed to understand the ways in which users engage with and explore the compositions – and the nature of the experiences created for those users. As Edmonds et al (2009) observe:

> …despite the fact that interactive art is a form that privileges experience over static objects, there is little empirical or in-situ research on the audience experience of this art form. (pp. 141-142)

Brigid Costello's exploration of the nature of play as a method of achieving engagement and exploration involved the development of practical strategies for examining in detail the experiential qualities of play. This approach parallels the development in this research of the methodology of iterative development and feedback through usability testing: the results of which (as detailed later in "Chapter 4: User Experience") demonstrate the extent to which IDT compositions create an evocative and personal experience for a user.

IDT Composition

The concepts of installation and personal interaction exist in some of mankind's earliest art works, such as the Palaeolithic art produced in the form of cave paintings from about 32,000 to some 11,000 years ago (alongside portable art, artistic expression that found its form in objects and artefacts rather than in a specific place). And perhaps cave paintings were not as static as we might imagine, animated by the flickering light from a fire, making the images move. Interestingly:

> ... researchers have found that the most richly decorated panels appear in caves with especially good acoustics, suggesting that sound played an important part in any ceremonies that might have accompanied the making of cave art. (Encarta)

Which suggests that mankind was doing then what it does now: creating works for public and private performance, combining a mix of aural and visual elements. What has changed over the years is not therefore the underlying intent, but the nature of the media in which we can now work and the ways in which we disseminate performance. As Oliver Grau (2003) establishes, artists have deployed a wide variety of techniques to immerse audiences within their works for millennia. This research has intentionally chosen the medium of the internet and the World Wide Web as its primary installation space, enabling works to be exposed widely and enabling feedback to be gathered on the user experience of encountering the compositions.

Marshall McLuhan's view was that:

> After more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. Rapidly, we approach the final phase of the extensions of man – the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media. (McLuhan, 1964, p. 3)

Whilst IDTs have not yet fulfilled that vision, there are parallels with this research's intent: namely, to enable compositions to evoke an artistic sense of a meaning or sense of place to a user, for the composer to be able to share a creative sense of the past of place.

Each medium has its own qualities: Gotthold Ephraim Lessing (2005, originally published 1766), for example, theorised that each artistic medium is unique and possesses qualities innate to that medium and which can only be realised in that medium. Some of the arts – such as painting and sculpture – he categorised as spatial arts, whereas poetry he regarded as a medium of temporal succession. After comprehending the significance of McLuhan's "the medium is the message", Alan Kay came to the realisation that the personal computer would involve a new renaissance by taking us beyond static representations to dynamic interactions: and that this would alter the very nature of thought as it would enable us to connect not just to a single point of view, but to all points of view drawn from across all eras (Kay, 1990).

In our current interactive digital age, the key force that arguably empowered the reformation, and the scientific rationale of our modern society, may itself be altered – given that the printing press did not cause this transformation merely by making printed books more readily accessible, it also altered the thought patterns of readers (Kay, 1990). The implication is that new media will alter the way we think (and therefore the kinds of

thoughts and conclusions we may reach). Kay's thinking and research was to lead to the Dynabook, "a dynamic medium for creative thought" which proved itself able to synthesise all media, across images, sounds, text and animation as it became embodied in the form of the personal computer (Packer & Jordan, 2001). It thus realised the earlier ideas of Vannevar Bush, Douglas Engelbart and Ted Nelson, and impacted on the design of the Xerox Alto computer and later derivatives, such as the Apple and Microsoft Windows operating systems. Yet the interactivity of new media continues to challenge our traditional ideas of how we understand and respond:

> ... architectural forms built in cyberspace can respond to the viewer, encouraging provocative and illuminating interactions. In cyberspace, architecture becomes a form of poetry. (Packer & Jordan, 2001, p. xxiv)

This raises the issue of how an audience experiences new media, when often both the medium and the space in which they are presented are novel. In the early days of cinema, whilst moving film was itself new, the auditoria in which films were exhibited (what became the cinema as we know it now) were familiar from theatre and music hall. But as Luis Buñuel recalls in his autobiography, in the early days of cinema the audience could not understand or decipher what was happening on screen: the language of film was unknown. He narrates how the audience were terrified by witnessing their first on-screen camera zoom, which appeared to them merely as a head coming closer and closer and growing larger and larger: they understood not that the camera was moving closer to the person, but that the head was coming towards them, swelling grotesquely. In those early days, film required an explicador, or narrator, to stand alongside the screen and explain what was happening to the audience (Buñuel, 1985). In reflecting on how cinema found its vocabulary in that silent era, Antonio Negri (Negri & Hardt, 2000) identifies a potential primacy of the visual over the verbal, supporting the belief that images may be a more natural and more effective form of communication than language, with Walter Benjamin quoting Paul Valéry's assertion that innovations can help transform both the technique and notion of art itself (Benjamin, 1999, originally published 1968, p. 211).

The label "virtual reality" is often used to describe the way in which digital media can be used to create experiences that exist only in the digital domain, not in the traditional physical world around us. This label appears misleading: to consider this from an orthogonal perspective, *everything* we experience might as well be considered virtual reality. As Deutsch describes the situation, all of our reasoning and thinking, and all our external experiences, are but forms of virtual reality (Deutsch, 1998). Thus the virtual reality rendering of our world *is* our world. So the way in which we might re-contextualise

and reinterpret time and place and their sensory impact upon us through IDTs is as meaningful and as real as the way in which we interpret time and place on a daily basis. As Manovich (2001) observes, computer-generated imagery is not an inferior representation of reality, but instead provides a realistic representation of a different reality.

It is likely that at some stage we shall become incapable of distinguishing between what we have traditionally regarded as the "real" world and the "synthetic" world that artists create in the digital domain.

> Virtual reality is not just a technology in which computers simulate the behaviour of physical environments. The fact that virtual reality is possible is an important fact about the fabric of reality. It is the basis not only of computation, but of human imagination and external experience, science and mathematics, art and fiction. (Deutsch, 1998, p. 122)

Whilst this research intentionally evaluates some aural-only and visual-only techniques, it is the combination and interplay of sound and imagery with which this research primarily concerns itself rather than either alone, building upon the concept of what Chion terms "audio-vision", which he defines as the spontaneous and irresistible mental fusion, completely free of any logic, that happens between a sound and a visual when these occur at exactly the same time (Chion, 1994). This research has aimed to develop a composition portfolio that explores the integration of visual and aural elements in pursuit of an "expressive power" (cf. Wagner), particularly as related to our sense of time and place.

The engagement of an audience in interacting with and influencing a creative work is not new, with Benjamin writing, in 1936, that the distinction between author and public was already about to lose its basic character and that at any moment the reader would also turn into a writer (Benjamin, 1999, originally published 1968). In the theories and compositions of composers such as John Cage and Allan Kaprow, we see Benjamin's observation made manifest – notably in Kaprow's desire that the line between art and life should be kept as fluid as possible (Kaprow, 1996), which built on the idea of the audience being increasingly participative. Likewise Benjamin was concerned with how the dominant new(ish) media of his age were challenging traditional notions of art, observing that much futile thought was being spent on the question of whether photography was an art – and that later the same misguided question was asked of film (Benjamin, 1999, originally published 1968).

IDTs offer the potential for capturing and preserving aspects of the everyday lives of people. If adopted more widely as part of the prosumer (the consumer as producer) age, they could enable a broadening of the discourse of our future history. An improved

understanding of the milieux of our own and future ages becomes possible through the degree by which we can now, should we wish either individually or collectively, build connective and associative stores of just about everything we experience (to paraphrase Bell[30]). It is in the way we might better communicate our individualistic, iconoclastic experiences of place, might find a better connection between each other's sensory experiences than has been possible through purely literary or oral tradition, that new IDTs may provide their greatest potential. In images and sounds of the past, it is perhaps where the public and the private lives of individuals and communities meet that we can most easily sense a better recollection of the impact of place through the use of new media: anywhere that people of one particular time already share a place and an experience with those of another time. We hence share not only in the sense of those around us in our particular moment of time, but with those who previously experienced those places at an earlier moment. Adapting the ideas that Nelson presents in *Computer Lib/Dream Machines* (Packer & Jordan, 2001) enables us to consider alternative ways in which associative human recall and navigation might be modelled and supported through the application of new techniques. Traversal of recollections (visual and aural) can, for example, take multiple non-linear routes. This would extend the ideas that Nelson outlined, which in turn drew upon the ideas and work of Vannevar Bush and Doug Engelbart.

This research has utilised IDTs as a form of hypermedia that enable users to navigate spatially, textually, aurally, visually through content with the intention of emulating the way we can freely navigate internally our own sensory memories. New methods of interaction that transcend the keyboard/mouse/screen interfaces that have predominated so far in our digital era are also becoming increasingly important. From multi-touch interactive surfaces to sensory environments (sensory in terms of both detecting and responding to our presence, but also enabling us to sense and experience IDTs in new ways), new potentialities built on such associative models may eventually provide:

> ... the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society. (McLuhan, 1964, p. 3)

CONTEXTUALISATION

This research takes account of the context in which IDTs exist, be they internet based or in a usability lab. In the former, the experiential environment is not within any meaningful degree of control of the researcher, with the user potentially existing in a variety of

[30] See "MyLifeBits", Gordon Bell. http://research.microsoft.com/en-us/projects/mylifebits/. Retrieved 20.01.2012

contexts, from a cyber café in the high street, to a noisy pub to a home PC with a large screen and high fidelity surround sound. Thus a large part of the experience is established by a context outwith the direct control of the researcher. The same internet delivered works will therefore acquire different contextually-dependent meanings and experiences. By contrast, in the environment of a usability lab a higher degree of control over the context in which the compositions are experienced becomes possible.

Issues of contextualisation and re-contextualisation have formed part of the creative approach of various artists, from those of Marcel Duchamp and Samuel Beckett, to Damien Hirst and Tracey Emin. As Duchamp commented:

> The creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds his contribution to the creative act. (Duchamp, 1957)

In his consideration of the impact of context, Barthes observed that a photograph can change meaning dependent upon its context, including the "point of reception" (Barthes, 1977). The nature of different contexts has implications for the way in which IDT composers should consider their works. A work conceived of being delivered in a very specific way in a very specific context, such as that of an installation in an art gallery, will acquire a potentially highly different meaning when delivered through the more randomised channel of the internet. As Tim Stephenson (2006) comments with regard to the later re-contextualisation of Edgar Varèse's *Poème électronique* in the form of a new performance:

> Poème électronique was originally created as part of a site-specific collaborative multi-media project and yet in reproduction it is presented as an individual work of art devoid of context. (p. 55)

Stephenson's experience raises a number of questions concerning both authenticity and reproduction. In analysing why the performance of *Poème électronique* given in City Hall Birmingham disappointed him, a key reason provided was the loss of context – its performance in a space other than that for which it was originally intended.

There are implications arising from such concerns for the design of an IDT composition delivered in a specific installation rather than over the internet. The implication for feedback received over the relatively uncontrolled channel of the internet is that the context in which users experience the work is an unknown (complicating consistency of interpretation), whereas in the controlled environment of the usability lab a greater consistency is achievable. This does not render internet-based feedback less relevant but its interpretation is less predictable due to the potentially arbitrary re-contextualisation of

the works experienced: issues a composer must bear in mind if their artistic intent is to be successfully realised.

CHAPTER 2: METHODOLOGY

The focus of this research spans both the development of the portfolio and the nature of users' experiential interactions with IDT techniques and compositions as they were developed and evolved, with specific reference to the two research questions. It draws upon the reflective practice ideas of Donald Schön (1991), including the symbiotic role of both technical knowledge and artistry in achieving professional excellence, and in particular the importance of feedback in this process. The research combines this with empirical study, thus combining both internal and external reflection. To structure this interplay of compositional development and user interaction and experience, the methodology utilises an iterative cycle of composition, testing, analysis and refinement. As Candy comments:

> Direct observation of an art system in action, interacting with people, is the only way to understand what actually takes place and whether or not it is 'successful' from the artist's point of view. (Candy & Edmonds, 2011, p. 39)

To achieve the objective of acquiring user experience feedback to inform the development of the portfolio, the testing included volunteers participating online over the internet and in the Institute of Creative Technologies' (IOCT) usability lab. The collection of user feedback on techniques and works iteratively influenced the development and content of the composition portfolio.

REALISATION

A multi-stage methodological model for compositional realisation, drawing upon that of Riccardo Mazza, was developed and adopted for this research. Mazza (2009) identifies three key phases in the creation of a digital visual artefact, namely those of pre-processing and data transformation; visual mapping; and view creation. These phases provide a useful formal model, but their focus is (by both intent and design) on more traditional data visualisation, less on the use of visualisation as part of an overall creative composition process: that is, the *realisation* of an overall interactive audio-visual work. This research applies an adapted model, comprising four iterative elements of:

- **Content Origination**: the content draws on original source material re-used with permission from archives such as Getty Images and English Heritage (encompassing both still and moving images) as well as researcher originated and synthesised materials from practical field and studio work, together with third party source materials gathered by the researcher (such as old postcards, and the

use of the Freesound[31] online collaborative database of Creative Commons licensed sounds). These source materials provide the basis of the works contained in the composition portfolio.

- **Content Pre-processing**: images and sounds may require manipulation to prepare them prior to their inclusion within the audio-visual environment – for example, rendering contemporary photos in sepia tint to make them appear older; or applying an impulse response from an historic location to a sound; or the alignment of older and newer images, still and moving, so that they can be seamlessly morphed between; or for sounds to be processed to create greater spatiality, such as through the application of binaural and transaural techniques. Such pre-processing forms part of this stage.
- **Content Mapping**: the source material originated in the preceding stage may contain an existing logical and physical structure – such as within a single JPEG image comprising a shot of a particular part of a city at a particular moment in time. However, its relationship to other elements being used in the composition is initially ambiguous and not inherently structured. Various ways of mapping and representing compositions on-screen (and in terms of their sound design, including their relative spatialisation) were explored during this research as part of the development and refinement of this stage of the iterative methodology. The composition process considered the way in which visuals are structured on-screen, including design elements such as their Cartesian disposition (along x, y and z axes, or planes), their methods of navigation and opacity, movement, colour, texture, and shape. The interplay of artistic intent, technical methods, tools and interfaces is a key element at this stage in the methodology.
- **Content Interaction:** the compositions allow for user interaction, both structured and unstructured, randomisation, and author-led models (and combinatorial techniques). They also encompass physical interaction, using mouse and keyboard interfaces, as well as prototypes of dedicated custom interfaces such as the sonar sensor utilised for distance-based user interactivity. Usability testing was utilised extensively during the content interaction stage to identify the most effective and least effective techniques in terms of the second research question, together with providing the basis for their potential improvement based on user feedback. This feedback formed an essential part of the overall methodology, providing the basis for iterative refinement to the techniques applied.

[31] See http://www.freesound.org/. Retrieved 13.01.2012

These four elements, and their iterative/cyclic nature in the overall process of the realisation of interactive digital compositions, are illustrated in overview in Figure 5.

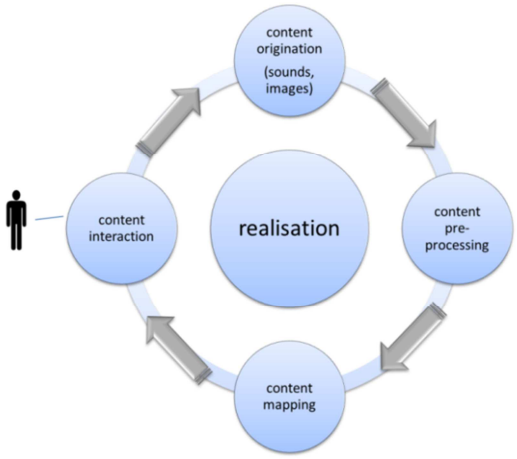


FIGURE 5: THE REALISATION PROCESS

This iterative realisation model is also analogous to Schön's observations about how a designer engages in a process of "seeing-drawing-seeing", establishing the art of design as a reflective and iterative process (Schön, 1991).

TESTING AND FEEDBACK

Candy and Edmonds observe that:

> Making artworks or 'art systems' to meet the expectations of this age of interaction demands a new kind of research that, whilst acknowledging the legacy of tried-and-tested methodologies, is driven by the special needs of this continually evolving field. (Candy & Edmonds, 2011, p. 9)

Jeffries et al (Jeffries, Miller, Wharton, & Uyeda, 1991) identify several methods of testing:

> ... results show that guidelines and cognitive walkthroughs can be used by software engineers to identify some important usability problems when UI specialists are not available. However, heuristic evaluation and usability testing have advantages over those techniques. Many of the most severe problems found in the study simply could not be identified by guidelines or cognitive walkthroughs. (p. 11)

Usability testing is a technique widely used in subject domains such as computer software engineering to evaluate a product by testing it with users during development. It measures the usability[32], or ease of use, of a target interaction, interface or product and was selected as part of the iterative methodology utilised by this research, with specific reference to the assessment of the impact of the compositions and techniques on users during the content

[32] "Usability" is defined by the International Standards Organisation (ISO) as "… the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." Defined in ISO 9241-11. Retrieved from http://usabilitynet.net/tools/r_international.htm#9241-11. 13.06.2008.

interaction stage. In its use of observation, contemporaneous notes, structured and free-text evaluations, and audio-video recording for later analysis, usability testing inherits elements of other qualitative research methods. The researcher's own experience of usability testing in projects scaling to millions of users of online services had proven its ability to inform and improve the development of complex, internet-based interactions and the user experience, substantiating its suitability for compositions whose primary performance space was the internet.

"Usability" as scoped within this research embraces the entire user experience – their reactions, thoughts, ideas and emotions. As Candy et al (2006) observe:

> At the heart of the field research process, is the drive to base claims and actions upon evidence from the real world ... data that are gathered aim to provide as accurate a picture of events as can be obtained. (p. 210)

Assessing and measuring the user experience helps determine how well the composition or technique under evaluation performs in terms of achieving the composer's intent (within the context of the two research questions), and in identifying potential improvements.

> We are not so concerned with task analysis, error prevention or task completion times, however, as with issues such as pleasure, play and long term engagement. (Edmonds, 2010, p. 1)

The methodology developed aims to identify those aspects that users find most or least evocative, or technically efficient or frustrating. Usability testing was thus assessed as being better suited to the portfolio's creative and artistic intent than other assessment techniques such as usability evaluations. The latter typically encompass methods such as questionnaires, observational evaluations, guideline based checks, expert reviews, and heuristic evaluations. Whilst some use was made of questionnaires in the course of this research, this was within the context of practical usability testing of techniques and compositions involving volunteer participants: formal usability evaluations typically do not use test participants. Candy et al (2006) comment that

> … researchers have to keep in mind that it is necessary to conduct observation first because eliciting 'reflections on a process' [via questionnaires and interviews] may affect the process itself. (p. 214)

The practical experience of users interacting with the techniques and compositions was the focus, rather than a more theoretical approach. For similar reasons, heuristic techniques were considered a less compatible or suitable method given their more formal evaluation of interfaces through an assessment of compliance with usability principles: in

the context of the development and refinement of the portfolio, there were no "correct" heuristics of the type developed by, for example, Rolf Molich and Jakob Nielsen (1990), Nielsen (1994) or Jill Gerhardt-Powals (1996).

Tom Tullis and Bill Albert (2008) identify three common characteristics of usability testing:

- A *user* is involved
- That user is *doing* something
- That user is doing something with a *product, system or other thing*

They also observe that resulting usability metrics are not an end in themselves, but a means of reaching an informed understanding of how users experience and respond to works. The purpose of the systematic usability testing undertaken during the *content interaction* stage of the process was also to inform the development of the composition portfolio by gathering feedback on various techniques and the extent to which they evoked a *sense* of the past in an audience, together with an exploration of the *punctum* and the role of synthetic and authentic elements. The testing enabled the capture and assessment of user responses and feedback based on interactions with various IDT techniques, both visual and aural, with specific application to palimpsests (the artistic evocation of hidden layers of place over time). The objective of the testing and the feedback gathered was both to improve the composition portfolio and to assess the underlying hypothesis, in particular the extent to which IDT compositions could connect emotionally with users to evoke a sense of the past of place, and which of the techniques accomplished this most effectively. The results of this feedback were subsequently used to inform the development of the portfolio and to ascertain the extent to which its artistic objectives had been realised.

Usability testing was iteratively applied during the development of the composition portfolio, both in the controlled environment of a usability lab as well as online over the internet. Usability lab studies utilised in the course of this research enabled systematic observation (under controlled conditions in the IOCT usability lab) of users to assess how well they interact with and respond to compositional techniques, including alternative approaches to interacting with layers of images and sounds. These studies were complemented by online feedback mechanisms for internet users interacting with compositional elements and techniques over the web. Whilst online techniques lack the systematic observation under controlled conditions achievable in the usability lab, they do provide insight into the effectiveness of the compositional techniques and examples for a

random, self-selecting sample of remote users encountering them on the internet. The usability lab, however, provides a more detailed data-gathering and analysis process better able to help determine *why* certain responses are being made. The use of both environments was important, however, since many of the works were intended for internet performance, therefore assessing online responses was of equal importance as the lab-based research.

SCALE AND NATURE OF PARTICIPATION

Tullis and Albert (2008) comment that just three or four participants are required where only major usability issues are to be identified, whilst according to Nielson, "...usability testing with five people can uncover 80 percent of ... problems." (Nielson, 2000). In earlier research with Thomas Landauer (Nielson & Landauer, 1993), Nielson determined that:

> ...the number of usability problems found in a usability test with n users is N(1-(1-L)n) where N is the total number of usability problems in the design and L is the proportion of usability problems discovered while testing a single user. The typical value of L is 31%, averaged across a large number of projects we studied.

Plotting the curve for L=31% produces the result shown in the following graph.

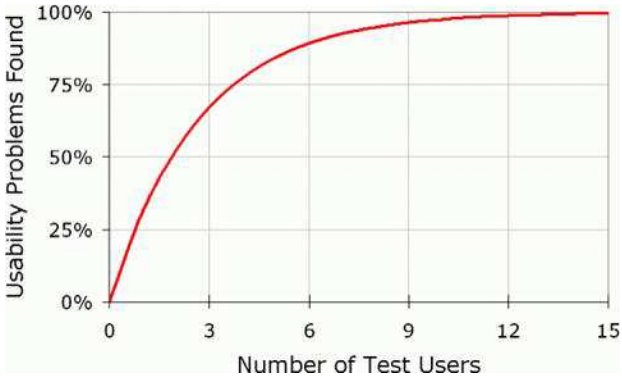


FIGURE 6: NIELSEN & LANDAUER'S MATHEMATICAL MODEL OF USABILITY PROBLEMS

Nielson proposes an iterative approach, stating that a set of three iterated tests with five users apiece will achieve more than a single test with fifteen users. However, the claim that five users are sufficient in usability testing has been challenged, notably by Jared Spool and Will Schroeder (2001). They do not identify a specific alternative number. Instead, their paper confirms that the overall "formula can be usefully applied", but that a different value of L needs to be found. More specifically, Laura Faulkner (2003) found that:

> It is widely assumed that 5 participants suffice for usability testing. In this study, 60 users were tested and random sets of 5 or more were sampled from the whole, to demonstrate the risks of using only 5 participants and the benefits of using more. Some of the randomly selected sets of 5 participants found 99% of the problems;

> other sets found only 55%. With 10 users, the lowest percentage of problems revealed by any one set was increased to 80%, and with 20 users, to 95%.

A target of between 8 and 12 participants was established for each iteration of formalised usability lab testing as part of this research, based on precedent and literature reviews (which suggest that a minimum of 80% of "problems" users might experience with the compositions would be identified by such a sample size). A larger number was desired for online feedback, given the increased ambiguity of online testing (for example, the lack of insight into the environments in which users were interacting with compositional techniques and the experience on which their feedback assessments were based).

Online evaluation adopted random sampling (since anyone encountering the works online was able to participate without any constraints), whereas the usability lab adopted a sample of convenience and sought anyone willing to participate via a variety of communications media spanning university networks, Facebook and the Web.

USABILITY TESTING DESIGN

Usability testing design was framed within the context of spanning the two categories that Bill Buxton (2007) discusses: to explore both the essence of a single established trajectory (in terms of the intended design of a work), as well as helping establish the trajectory which the technique or composition should be on (such as comparisons between, for example, the lens and slider techniques discussed in "Chapter 3: Design and Development"). Thus, usability testing was used both for incrementally refining and improving a given technique or work in terms of its evocation for a user, as well as in determining which of several alternative techniques best achieved this – thus mirroring what Buxton categorises as "prototyping as iterative incremental refinement" and as "branching exploration and comparison" (pp. 387-389). In usability testing terms, this parallels the use of independent variables, such as the difference in behaviour between two different designs (for example, the palimpsest lens and slider), and dependent variables (outcome or response variables) such as overall user satisfaction with the technique or composition evaluated.

Usability testing draws upon usability metrics that are typically quantifiable. Such metrics in this research are derived in a variety of ways: from users self-scoring responses, through to an analysis of qualitative user responses that in turn leads to a quantitative assessment (such as x% of users stating that they find a work evocative of the past of place). All of the usability tests utilised in this research are based on first-hand user interactions with compositions and techniques.

USABILITY LAB PREPARATION

In preparing for the testing in the usability lab, a checklist was developed of key steps involved. This was intended to:

- ensure the researcher's personal familiarisation with the usability lab's equipment and environment through hands-on testing and evaluation
- consider the make-up of usability lab participants (e.g. whether to ensure distribution on basis of gender, age, computer experience, etc.) and, if required, to develop an appropriate screening questionnaire. No selection criteria were applied to the 18 volunteer participants. On a gender basis it was observed that the first usability lab group was 4 female, 5 male and covered a diverse range of age groups. For the second usability lab the gender breakdown was 6 female and 3 male. Overall, the balance across the two usability labs was thus 10 female and 8 male, providing no significant gender bias. Two participants engaged in both usability lab 1 and usability lab 2
- request volunteer participants via a variety of channels (internal university communications, Facebook, Web)
- prepare the intended target environment, compositions and techniques, together with the associated test and questionnaire tools
- ensure ethical principles, ethics forms, consent forms and other background documents were finalised and circulated to volunteer participants
- identify data to be collected, the collection method and storage
- check all lab equipment and the testing environment immediately prior to testing
- develop participant introductory and debrief materials
- welcome and brief the participant on arrival
- ensure the participant completed and signed the required consent/ethics form
- enable the researcher to relocate to the testing area and ensure instruments were collecting data throughout the duration of the tests
- run the tests, observing participant behaviour throughout via the live audio and video feeds
- ensure the participant completed the post-test questionnaire and undertook an oral debrief
- thank the participant and show them out
- prepare the lab for the next participant
- repeat the above steps as required

- transfer captured data to removable storage and take off-site for more detailed analysis at the end of the lab sessions
- analyse captured data (automated, participant volunteered, observed, etc.)
- compare usability lab results and analysis with earlier online results
- undertake modifications to existing compositional techniques and methods (where appropriate) or utilise the findings in the next iteration of composition as part of the four-stage realisation methodology developed

For the usability lab testing, several decisions were taken:

- to run each of the two usability lab tests with the selected participants over two consecutive days, ensuring that all the tests were conducted with the selected users within the same time span to assist with the efficiency and consistency of lab equipment preparation
- to limit the lab testing target time for each individual user to ideally no more than an hour (although a degree of flexibility was built into the schedule and some participants did run over the provisionally allocated time)
- to remind users that it is the compositional techniques and their responses to them that are being tested and evaluated, not the user

USABILITY LAB FEEDBACK AND OBSERVATIONAL METHODS

A variety of interrelated feedback collection and observational methods were utilised for the usability lab sessions, as detailed in Table 1.

Observation	The observer (researcher) observed the participant via video and audio links during their interaction with the compositions, also taking contemporaneous notes. The participant was left on their own throughout the session, with the observer removed from any contact in order not to influence either intentionally or unintentionally their contextual perception or behaviour at any time during the lab. The only exception to this isolation was during the second usability lab when the user was required to relocate to the second workstation where the prototype sonar sensor was installed: the observer entered the room at this stage to configure the sound and ensure the participant understood the need to use the anaglyphic glasses, explore the prototype HMI provided, and to approach and retreat from the large-screen HD projection
Formal feedback	On concluding their interactions with the compositions and techniques, the participants each completed an online feedback questionnaire
Informal feedback	On completing the lab session, the observer entered the lab to de-brief the participant and gather their informal impressions of the usability session
User oralisation	During the participant's interaction with the compositions, they were encouraged to speak aloud, oralising their feelings, emotions and responses (describing orally whatever they are looking at, thinking, doing, feeling) if they felt comfortable doing so
Automated instrument data collection	Throughout the session, video and audio recordings were captured, with one video stream focused on the PC screen and the participant's interactions with the compositional techniques, and the other focused on the participant and their responses, gestures and other actions. A microphone near the participant captured audio content

TABLE 1: FEEDBACK AND OBSERVATIONAL METHODS

In addition to the specific questions that this research aimed to answer, four generic usability areas were assessed in the usability lab stage of this research, detailed in Table 2.

Usability Area	Description
Efficiency	the time taken to complete, and ease with which participants completed, relevant tasks (such as interacting with palimpsestic content, using the various techniques)
Accuracy	whether participants interacted in the expected way or deviated (that is, behaved in ways the composer did not intend or anticipate), indicating that the composition's presentation, design and associated techniques may not be optimal for the composer's intended purpose
Recall	how well the participant was able to recall content or elements of the composition afterwards, and to identify those elements, ideas (visual and/or aural) or techniques that were most, or least, significant for them
Emotional Response	how the participant felt about the compositions, with specific reference to whether they felt they evoked a sense of the past of place

TABLE 2: USABILITY AREAS

SEQUENCING OF PORTFOLIO DEVELOPMENT AND USER EXPERIENCE TESTING

The research involved the iterative development of the composition portfolio with the active involvement of and feedback from users in its evaluation and refinement. The sequencing of this interplay between the development of the portfolio and user experience testing was as follows:

- an exploration of literature and background influences (commencing 2008 and revisited and updated periodically throughout the research)
- the development of ideas, initial techniques and prototypes during 2008; development of the first online feedback survey
- the first online usability stage (OU1), which ran from April 2009 to August 2009 with 30 completed responses relating to 18 works
- the refinement of existing techniques, prototypes and compositions, and composition of additional works; development of the online star rating feedback system; development of the second online feedback stage
- the second online usability stage (OU2), which ran from March 2010 to August 2010 with a total of 1,722 responses across 22 works and with a peak of 106 responses to the work or technique most responded to; development of the first usability lab
- the first usability lab (UL1), which ran over two days in May 2010, with 9 participants
- modifications and refinements to techniques; development of new compositions and ideas; development of the third online feedback stage

- the third online usability stage (OU3), which ran from August 2010 to February 2011 with a total of 1,443 responses across 21 works and with a peak of 104 responses to the work or technique most responded to
- further modifications and refinements; creation of more compositions and techniques; development of the second usability lab
- the second usability lab (UL2), which ran over two days in October 2011 with 9 participants; development of the fourth online feedback stage
- the fourth online usability stage (OU4), which ran from July to October 2011 with a total of 2,256 responses across 36 works and a peak of 76 responses to the work or technique most responded to

A summary of the four online usability feedback stages is shown in Table 3.

Online iteration	Total responses	Number of works	Highest response rate
1	30	18	n/a
2	1,722	22	106
3	1,443	21	104
4	2,256	36	76
	5,451	**97**	

TABLE 3: ONLINE USABILITY FEEDBACK SUMMARY

The application of the iterative methodology in the development of this project is illustrated in Figure 7. *OU1* through *OU4* indicates the online usability stages, and *UL1* and *UL2* indicate the usability lab stages. The "analysis, refinement and development" stages include the *Content Origination*, *Content Pre-Processing* and *Content Mapping* elements of the realisation process developed and applied during this research.

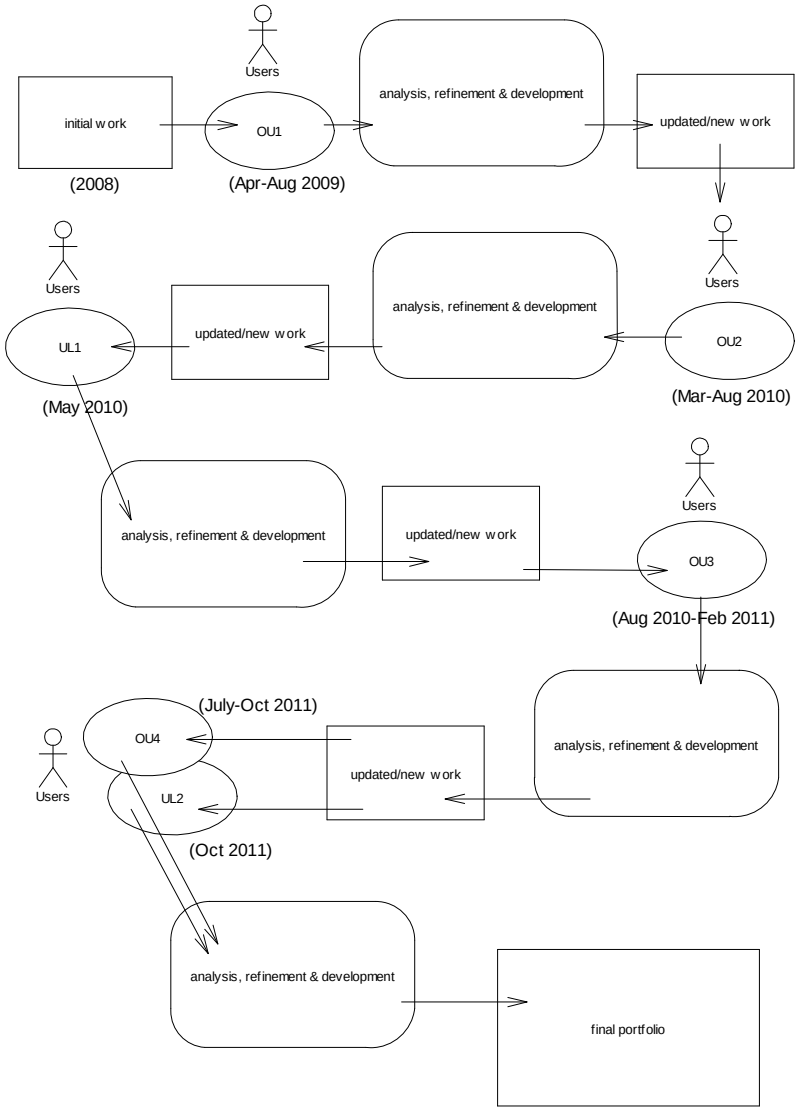


FIGURE 7: APPLICATION OF THE ITERATIVE METHODOLOGY

ONLINE USABILITY 1 (OU1)

The first stage in the acquisition of user experience feedback comprised the development of a set of questions for online visitors to the research website. The objective was to secure no less than five completed online responses, with a target range of ten to twenty. No attempt was made to constrain the make-up of online feedback participants. However, they were asked to self-identify how they would rate themselves in terms of PC experience. To recruit participants, various pages on the research web site highlighted the availability of the questionnaire. It was also mentioned on the researcher's blog and Facebook pages.

An initial online user feedback survey, entitled "feedback on fishenden.com research site", ran from April 2009 to August 2009 on the researcher's web site. During this period, a total of 30 completed responses to the user feedback survey were received. Links were

provided to the survey both from the fishenden.com landing page and the main site home page. In addition, details about the purpose of the survey and the ethical approach taken to the anonymous collection and use of data were available wherever a link to the survey was provided. The works and techniques evaluated during OU1 are shown in the following Figures.

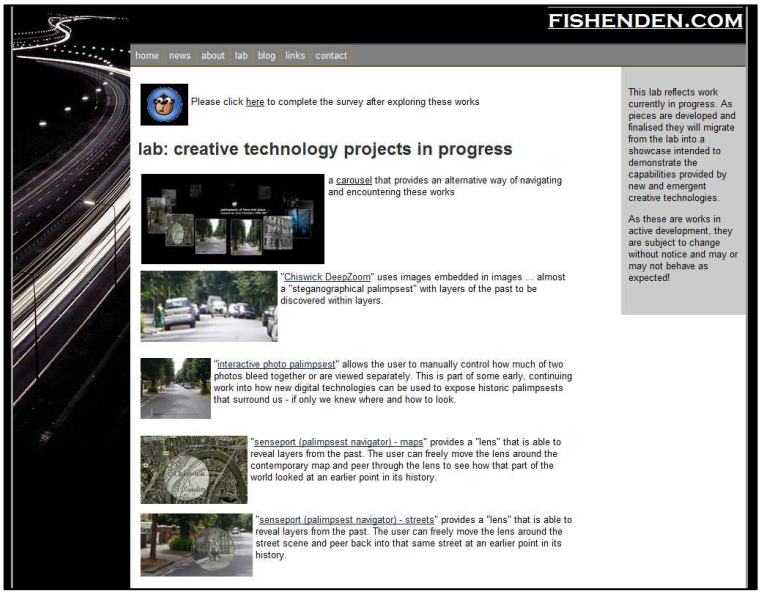


FIGURE 8: OU1 (1)

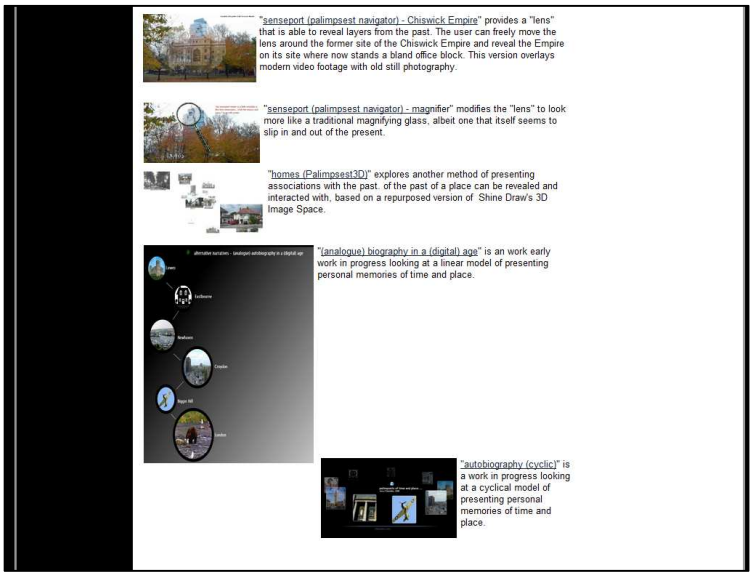


FIGURE 9: OU1 (2)

FIGURE 10: OU1 (3)

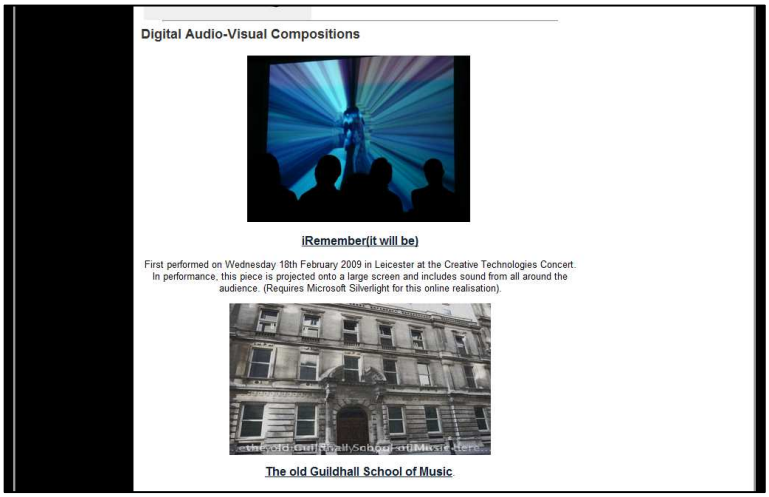


FIGURE 11: OU1 (4)

Nine questions were developed for the initial online form and SurveyMonkey[33] was used to develop and host the survey. The questions were a mix of closed (where the user could simply click on a button to indicate their selected answer) and open (with a free-form text box for the provision of comments). Questions 1, 2, 3 and 7 were categorised as closed and questions 4, 5, 6, 8 and 9 free-form. The questions and their nature (closed/open) are shown in Table 4. Users were free to choose not to answer any question.

[33] http://www.surveymonkey.com

Q1	How familiar would you rate yourself with using a PC, mouse, keyboard etc.? (on a scale from 1 to 10 where 1 is novice and 10 expert)	CLOSED
Q2	Did you find the compositions easy to use?	CLOSED
Q3	Was the way of navigating past and present images and sound evocative of the past?	CLOSED
Q4	How could the composition interfaces be improved?	FREE-FORM
Q5	What was your favourite composition - and what made it work well for you?	FREE-FORM
Q6	What was the composition that worked least well for you - and why did it not work?	FREE-FORM
Q7	What model of representing time worked best for you – cyclic or linear (or didn't care/no difference)?	CLOSED
Q8	Are there any particular sounds/images/pieces that really impacted you? If so, which ones? And why?	FREE-FORM
Q9	If you have any other comments about how you'd like to see this work develop please enter them here. And thank you for all your feedback.	FREE-FORM

TABLE 4: INITIAL SURVEY QUESTIONS AND THEIR CLOSED/FREE-FORM DESIGN

ONLINE USABILITY 2 (OU2)

After the conclusion of the initial feedback stage modifications were made to the research site to provide in-situ feedback mechanisms using a star rating system. Such star ratings are widely used on the internet, both for consumer feedback on e-commerce sites such as Amazon, as well as for ranking of blogs and other internet content by users. The intention was to provide a simple, immediate, familiar and convenient way for visitors to the research site to indicate which ideas and techniques worked well, or least well, for them rather than requiring them to visit an online form after interacting with the works. An interval based system was adopted that allowed users to rank from 1 star (least evocative) to 5 stars (most evocative). In accordance with the established ethical basis of this work, all feedback remained anonymous, although to minimise the potential for repeated voting by the same person, IP (Internet Protocol) addresses were temporarily retained in the database and used to prevent the same IP address from voting more than once. The table of IP addresses was deleted from the database at the conclusion of each stage of online feedback, in accordance with the approved ethical basis of the research that committed to ensuring anonymity[34].

This second stage of online feedback used a custom ASP (Active Server Pages) form designed and hosted on the researcher's website at http://fishenden.com. It used a star rating system, where 1 star was for users to indicate least effective and 5 stars most effective[35].

[34] Whilst IP addresses are not always related to a specific individual or computer, they can in some circumstances constitute personally identifiable information (PII), and their retention would thus have been in violation of the approved ethical basis of this research, which assured participant anonymity

[35] The star rating code draws on the ASP code made available by Chris Hardy. From http://chrishardy.co.uk/asp/scripts/accessible-star-ratings/. Retrieved on 04.06.2012.

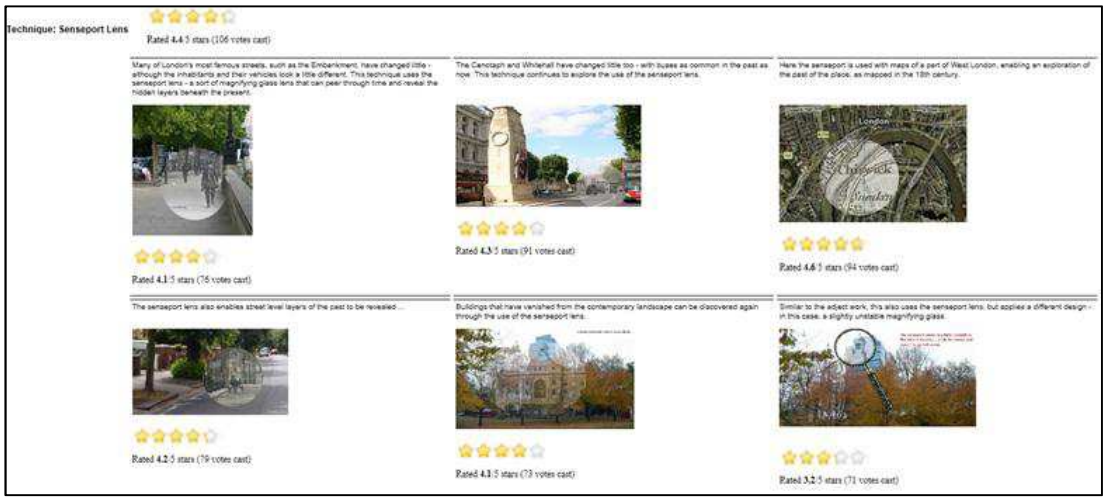


FIGURE 12: OU2 (1)

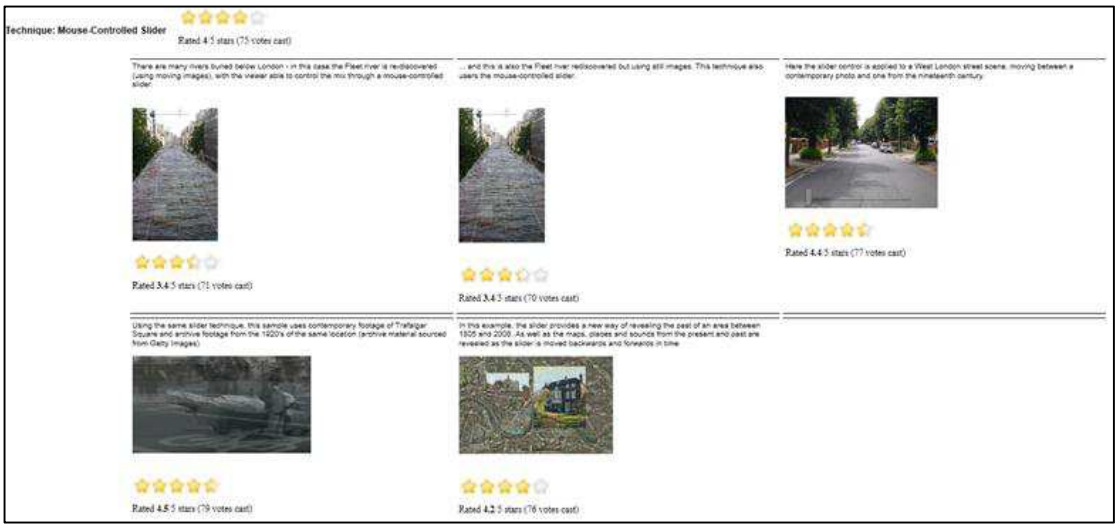


FIGURE 13: OU2 (2)

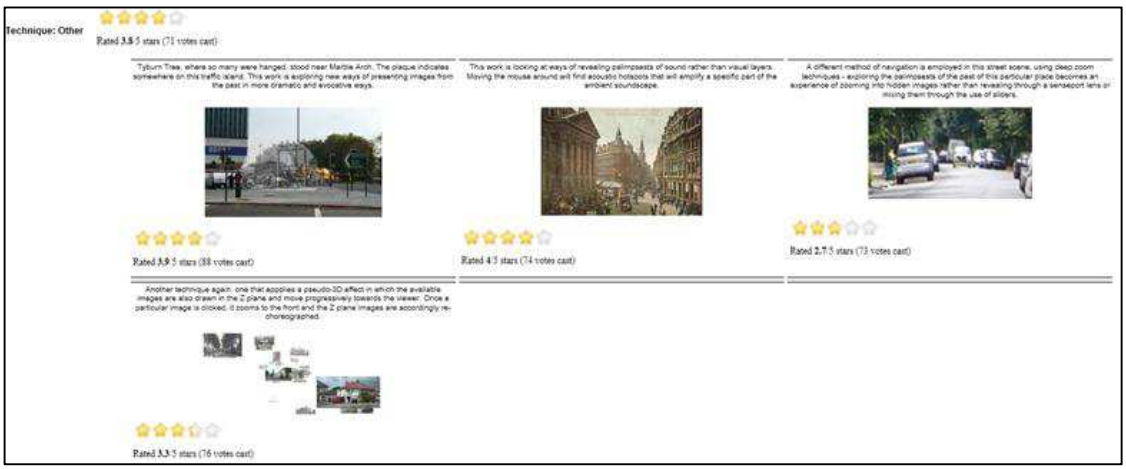


FIGURE 14: OU2 (3)

FIGURE 15: OU2 (4)

USABILITY LAB 1 (UL1)

The next stage involved evaluating the IDT compositional techniques in the IOCT's usability labs. This would allow for more detailed observation and analysis and potentially provide greater insight into *why* certain observations and comments were being made. It would also enable contemporaneous observation of how participants interacted with the techniques and examples provided. The first usability lab sessions were conducted over two consecutive days in May 2010 and involved nine volunteer participants.

LAB CONFIGURATION

The lab was based around the use of a laptop PC with separate Bluetooth mouse, aimed at emulating the environment a visitor to the site might be using at home. The laptop used wired Ethernet since the wireless signal in the lab proved unreliable and intermittent during preparatory testing. A separate large video monitor was used, not for the screen itself but to make use of its better audio speakers: the in-built laptop speakers lacked an adequate frequency response, failing to play some of the lower tones employed in various soundscapes. A microphone was placed next to the laptop to capture participants' comments. This configuration is shown in the photos below. Note that the freestanding speakers visible in the photo were not in use during the lab.

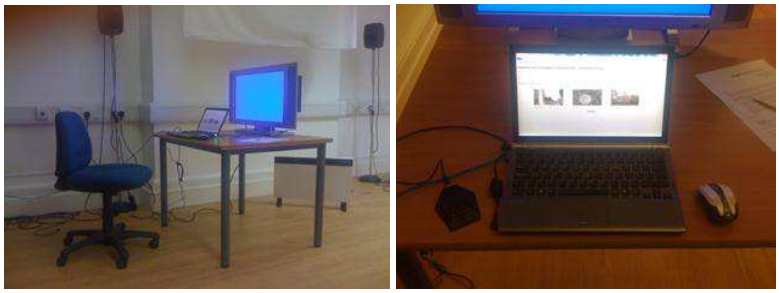


FIGURE 16: USABILITY LAB CONFIGURATION

The participant area was monitored through two cameras: one positioned behind the participant to capture the screen and the participant's interactions with it; the second, facing the user and the laptop setup to capture their overall interactions and reactions to the content. These cameras are shown below and were fully configurable from the control

room, enabling the observer (researcher) to zoom in/out and move the camera to cover diverse areas where required.

FIGURE 17: OBSERVATION CAMERAS BEHIND AND IN FRONT OF PARTICIPANTS

Example views from each of these cameras during an observation session are shown below.

FIGURE 18: THE "OVER THE SHOULDER" OBSERVATION VIEW

FIGURE 19: THE FRONTAL OBSERVATION VIEW[36]

In the control room, the observer configured the usability lab master PC to capture the two video feeds to disk as separate recordings, with both also configured to capture the audio from the microphone positioned by the laptop to record participants' oralisations. Thus two full video/audio streams were captured from each participant session in the lab. Contemporaneous hand-written notes were also taken. The photos below show the control room as configured during the two days of lab tests. The one-way viewing screen into the main lab area present during the first usability lab is not shown, but is situated behind the seats shown in this photograph.

[36] The volunteer's image has been redacted for privacy

FIGURE 20: THE USABILITY LAB OBSERVATION AREA

The usability lab sessions with the nine volunteers resulted in eleven hours of video/audio for later transcription and analysis, as well as the contemporaneous notes and formal end of lab session feedback form. The only technical problem encountered related to the recording of the participants' voices as they oralised their thoughts and responses, which occasionally became difficult to discern above the soundscape of various examples and techniques. A tie-clip microphone, closer to the participant's mouth, was identified as a means of avoiding this problem in future labs in place of the microphone placed next to the lab PC.

UL1 SURVEY

The UL1 survey used custom screens designed with a mix of HTML, Silverlight and ASP. All content was hosted on the researcher's website at http://fishenden.com.

CONTENT

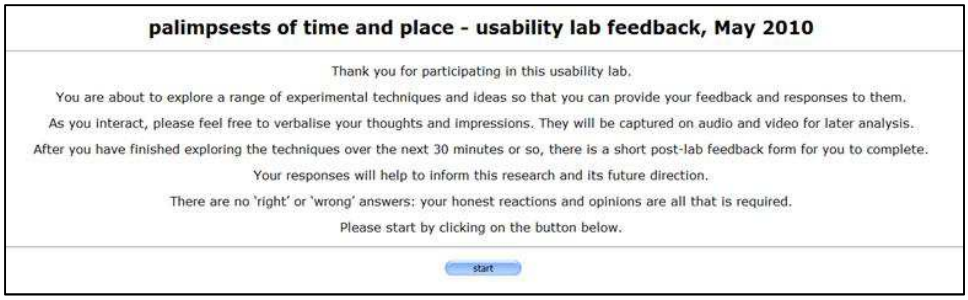


FIGURE 21: UL1 (1)

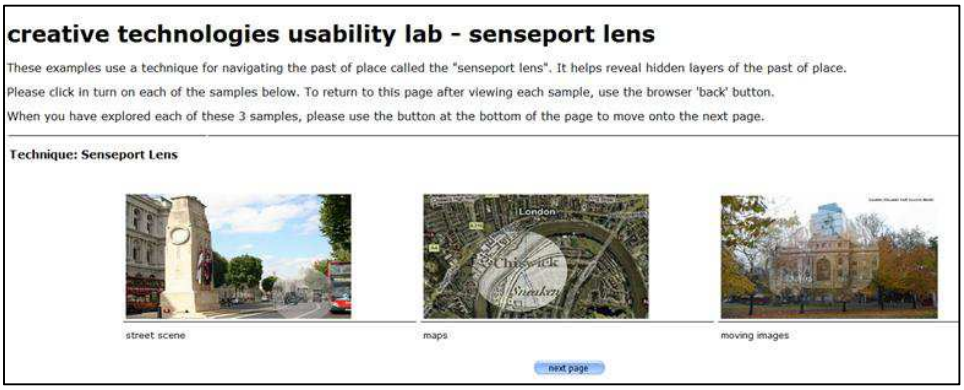


FIGURE 22: UL1 (2)

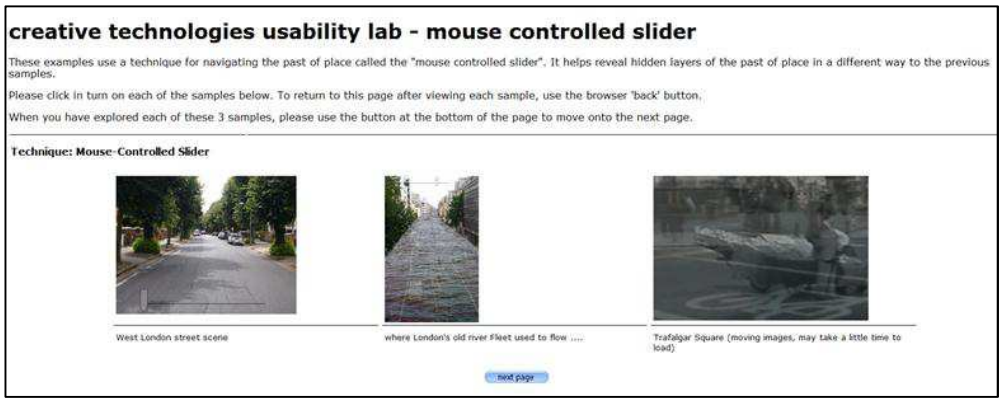


FIGURE 23: UL1 (3)

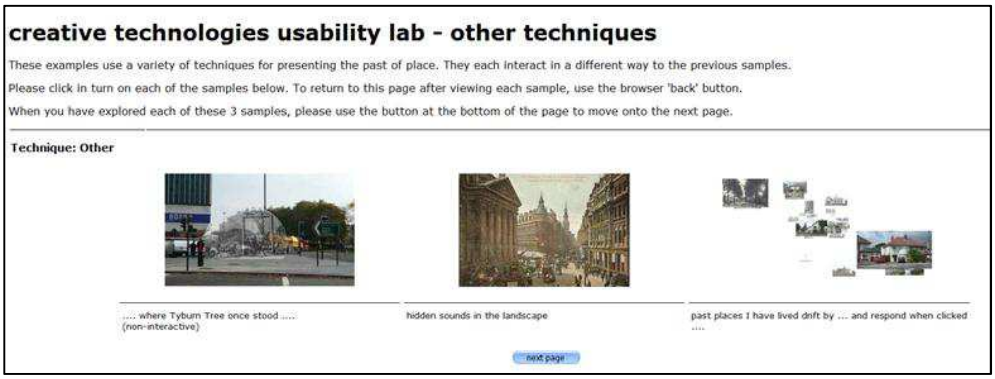


FIGURE 24: UL1 (4)

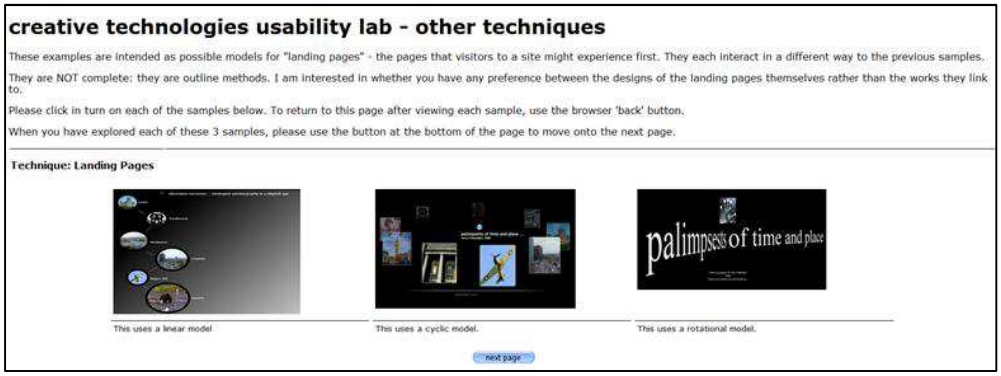


FIGURE 25: UL1 (5)

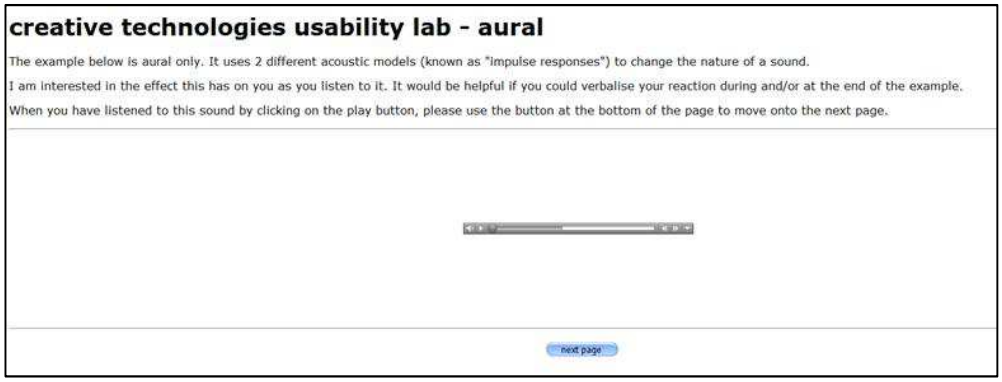


FIGURE 26: UL1 (6)

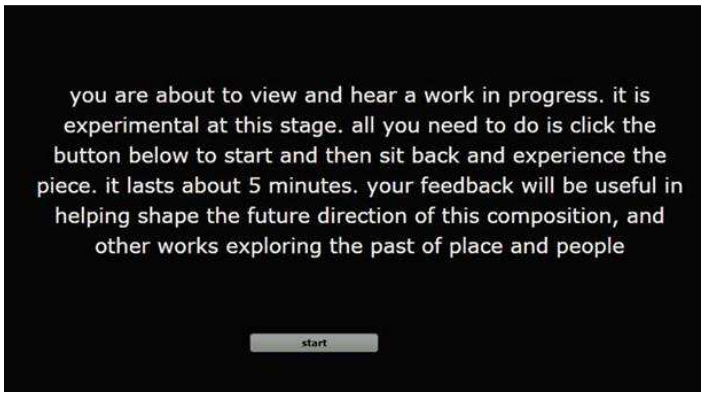


FIGURE 27: UL1 (7)

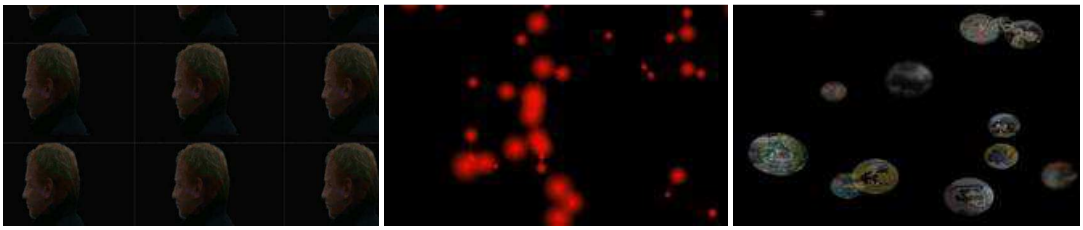


FIGURE 28: UL1 (8)

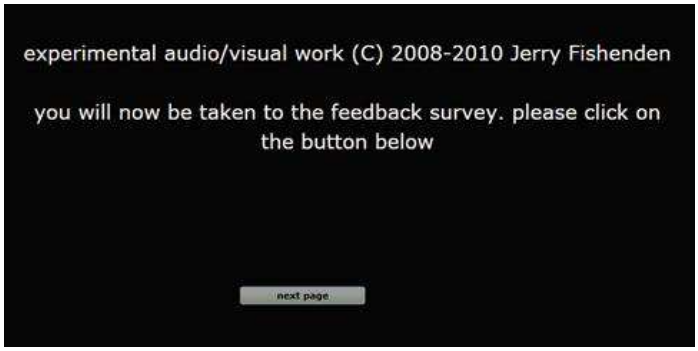


FIGURE 29: UL1 (9)

As with the online feedback form, nine questions were developed for the usability end of lab feedback form. A bespoke form was designed and deployed by the researcher on fishenden.com, enabling capture into a local research database. The questions remained a mix of closed and open and mirrored closely those of the previous internet feedback form. The questions and their nature (closed/open) are shown in Table 5.

Q1	How familiar would you rate yourself with using a PC, mouse, keyboard, etc.? (on a scale from 1 to 10 where 1 is novice and 10 expert)	CLOSED
Q2	Did you find the various techniques used to explore the past of place easy to use?	CLOSED
Q3	Were the ways of navigating past and present images and sound evocative of the past?	CLOSED
Q4	How could the interfaces be improved?	FREE-FORM
Q5	What was your favourite technique or example - and what made it work well for you?	FREE-FORM
Q6	What idea, example or technique worked least well for you - and why did it not work?	FREE-FORM
Q7	What model of representing time on the example "landing pages" worked best for you - cyclic or linear (or didn't care/no difference)?	CLOSED
Q8	Are there any particular sounds/images/pieces that really impacted you? If so, which ones? And why?	FREE-FORM
Q9	If you have any other comments about how you'd like to see this work develop, please enter them here. And thank you for all of your feedback.	FREE-FORM

TABLE 5: END OF LAB QUESTIONNAIRE

ONLINE USABILITY 3 (OU3)

In accordance with the iterative and cyclic nature of the methodology developed and applied to this research, work on refining the portfolio and developing new works continued in parallel with the usability testing, with feedback continuing to inform the development and refinement of the works. The third stage of online feedback commenced in August 2010 with additional techniques and examples added during the feedback period (shown with respective dates in the figures that follow). The feedback closed in February 2011. Its scope, data and analysis are shown below. The purpose of the usability testing was twofold:

- to evaluate updated techniques (such as the modified lens and slider) from earlier development, testing and feedback
- to evaluate new compositions in progress

The third stage of online feedback used custom forms designed and hosted on the researcher's website at http://fishenden.com. It used the same star rating system as OU2.

AUDIO-VISUAL TECHNIQUES

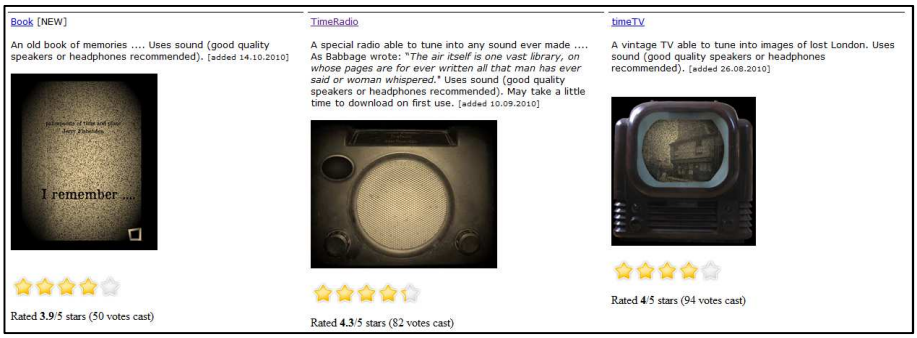


FIGURE 30: OU3 (1)

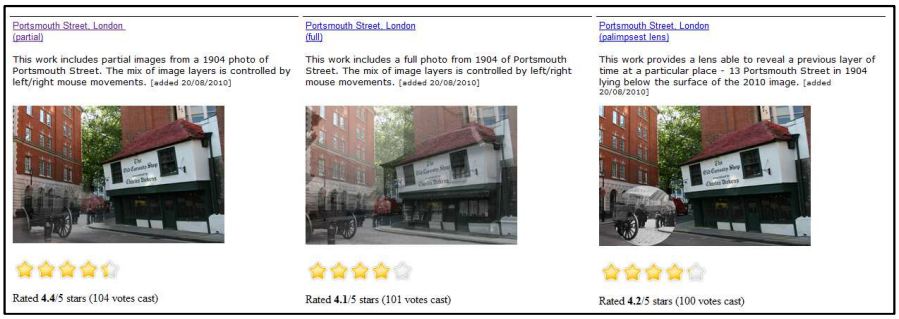


FIGURE 31: OU3 (2)

FIGURE 32: OU3 (3)

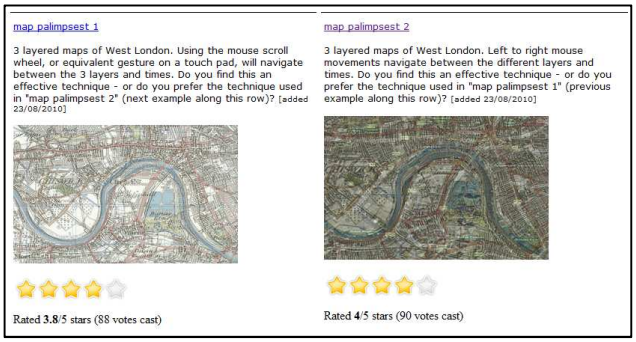


FIGURE 33: OU3 (4)

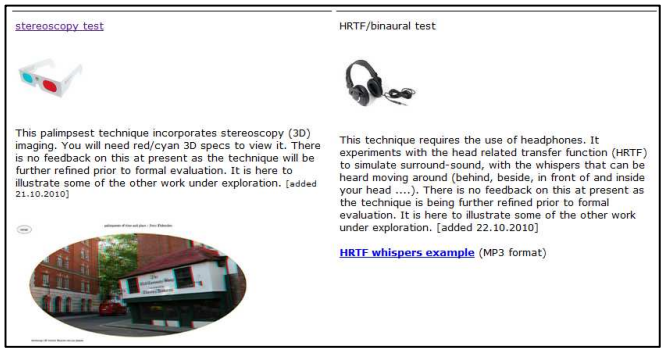


FIGURE 34: OU3 (5)

AURAL-ONLY TECHNIQUES

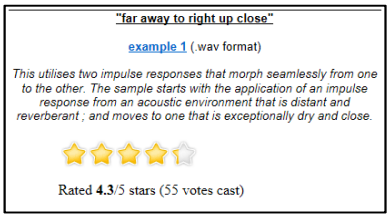


FIGURE 35: OU3 (6)

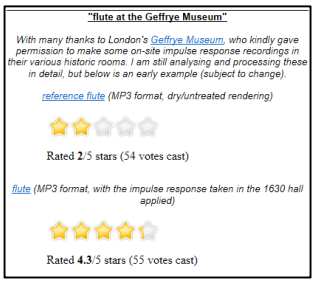


FIGURE 36: OU3 (7)

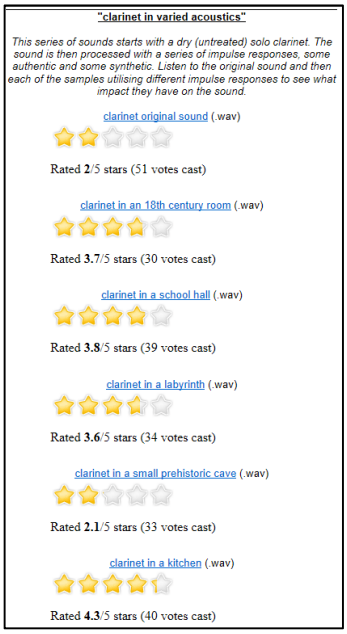


FIGURE 37: OU3 (8)

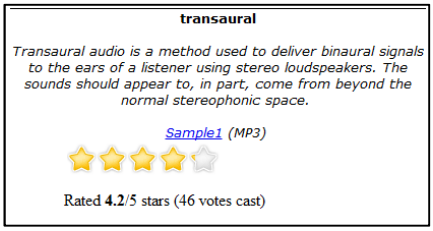


FIGURE 38: OU3 (9)

USABILITY LAB 2 (UL2)

The second usability lab took place over two days in October 2011, also in the IOCT's facility at Chantry House. Nine volunteers participated over the two days. The same overall preparation, approach and methodology detailed earlier with regards to UL1 were utilised for this second lab. The only difference in the physical disposition of the lab during these second tests was that the observation glass had been blocked-off with a blackout curtain, leaving all observation to be conducted through the visual displays from the cameras also being used to record the session. In practice, this had little impact since the

observation glass is situated behind the observer and therefore during the first usability lab the majority of real-time observation was conducted using the live camera feeds.

The intent of UL2 was both to evaluate revised techniques and examples based on earlier usability lab and online testing, and to test new works (such as *Palimpsest Navigator*). The lab content comprised modified palimpsest lens and slider examples, updated aural work (hidden soundscapes in the landscape) together with prototypes of physical control devices, namely the sonar sensor and the physical slider and knob to control the mixing of layers of images. In addition, these latter hardware-based prototypes were utilised in conjunction with large screen projection (using a 720p HD projector) and amplified stereoscopic sound. The configuration of UL2 thus utilised two workstations rather than the single workstation of UL1: the first workstation for principal testing of compositions and revised techniques; the second for the large screen projection and related hardware devices (see Figure 39).

FIGURE 39: THE TWO WORKSTATIONS OF USABILITY LAB 2

As part of the contextualisation of UL2, alternative lighting was used with the intent of creating a less clinical atmosphere in the lab environment (see Figure 40).

FIGURE 40: ALTERNATIVE LIGHTING IN USABILITY LAB 2

As a prototype, the configuration of the sonar sensor was not optimal, being placed side-by-side with the projection system. In an ideal configuration the screen would be reverse-projected, enabling users to be positioned centrally in front of the images and to be able to walk directly into the landscape, with the sonar sensor accordingly positioned centrally. The sound, however, was largely as intended, with high quality, wide frequency response

stereo speakers situated on both side of the projection surface. Whilst the image morphed into the older image the closer the user came to the screen, the audio also morphed between sounds suitable for the contemporary image (busy traffic noises) and those better suited to the historic image (horses hooves on a hard surface). A schematic of the configuration is shown in Figure 41 and can be seen as installed during the lab in the right-hand photo of Figure 40.

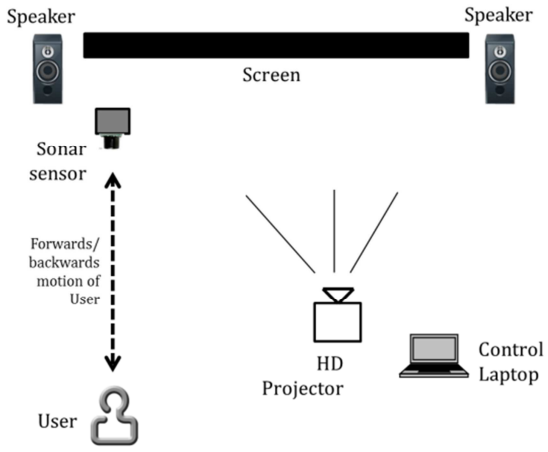


FIGURE 41: SONAR SENSOR HD PROJECTION LAB CONFIGURATION

UL2 adopted a slightly modified approach to the gathering of user responses, providing an in-place scoring mechanism for each work after it had been presented, as well as an optional open text box for comments. This was enhanced, as before, with a microphone (this time a lapel radio microphone to mitigate the occasional audio capture problems of UL1) to capture any oralisation of thoughts or responses made by users during their experience of the work. Whilst in general the lapel microphone worked better than the approach taken in UL1, some noise was caused by user clothing, including notably a scarf worn by one participant to counter the cool temperature of the lab.

The UL2 content and survey used custom screens designed with a mix of HTML, Silverlight and ASP. All content was hosted on the researcher's websites at http://fishenden.com and http://palimpsests.org.

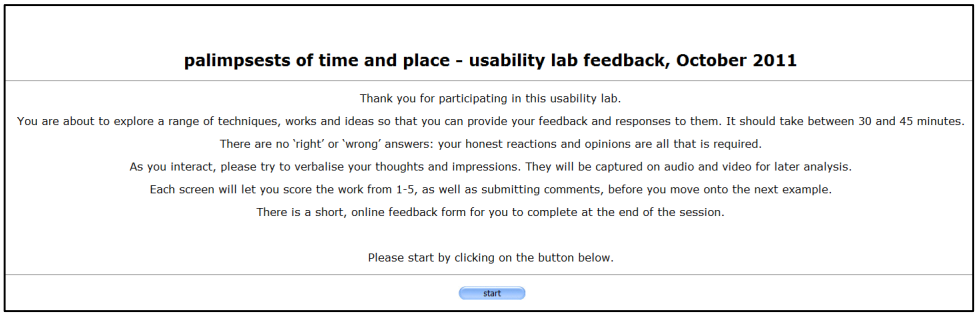


FIGURE 42: UL2 (1)

FIGURE 43: UL2 (2)

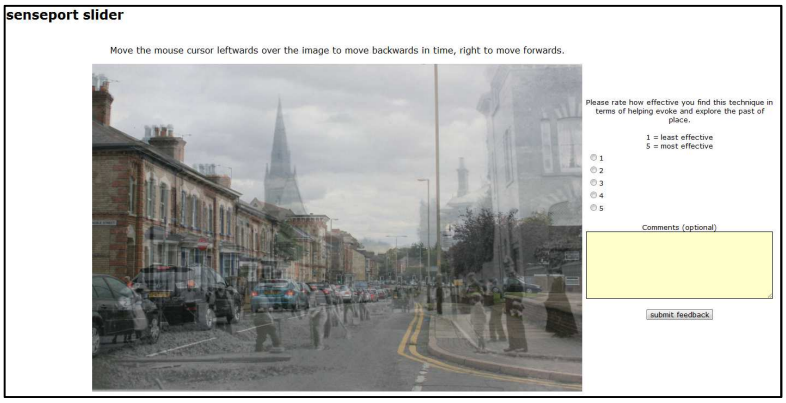


FIGURE 44:UL2 (3)

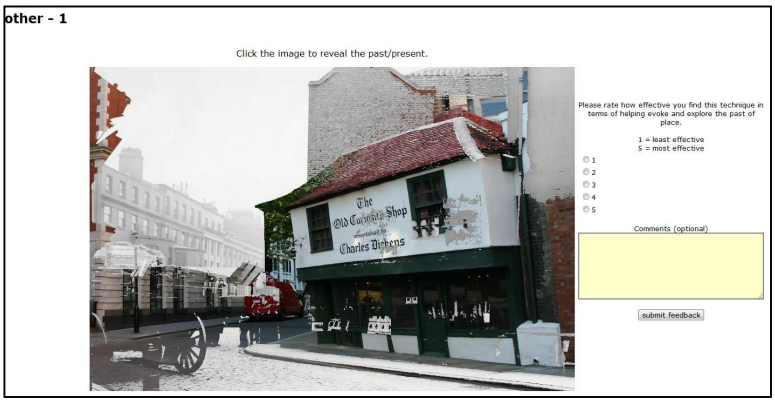


FIGURE 45: UL2 (4)

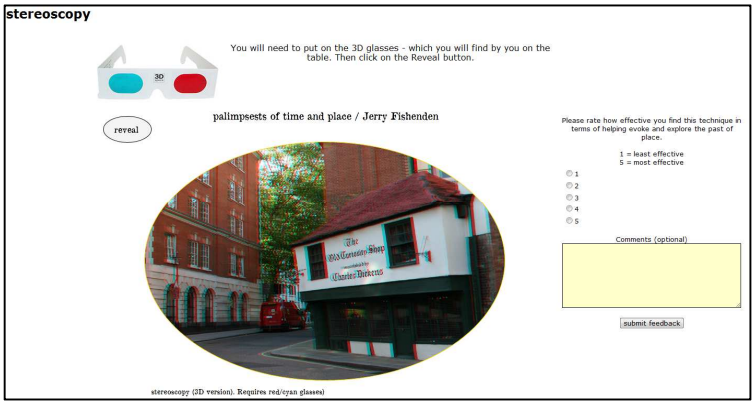


FIGURE 46: UL2 (5)

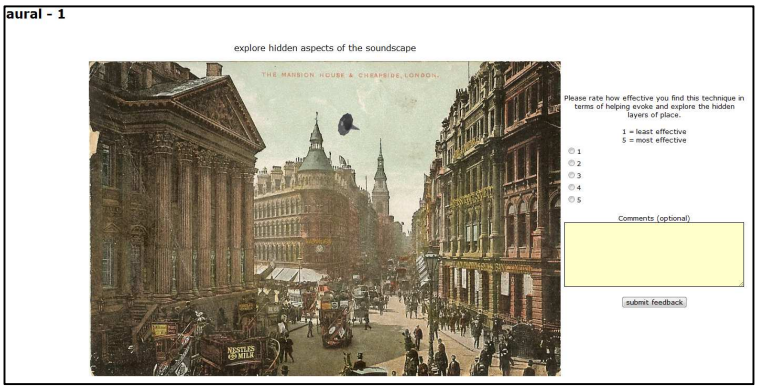


FIGURE 47: UL2 (6)

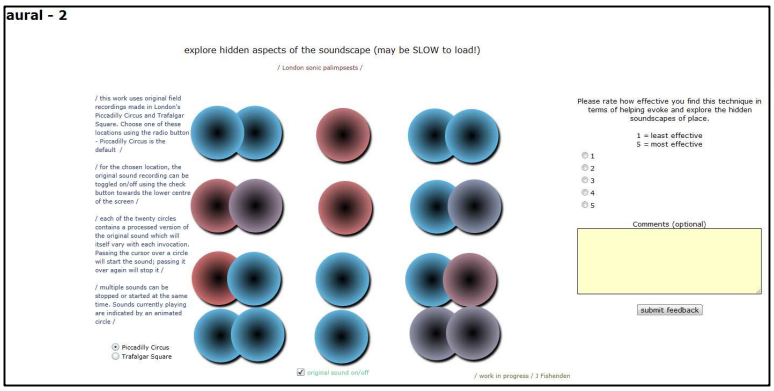


FIGURE 48: UL2 (7)

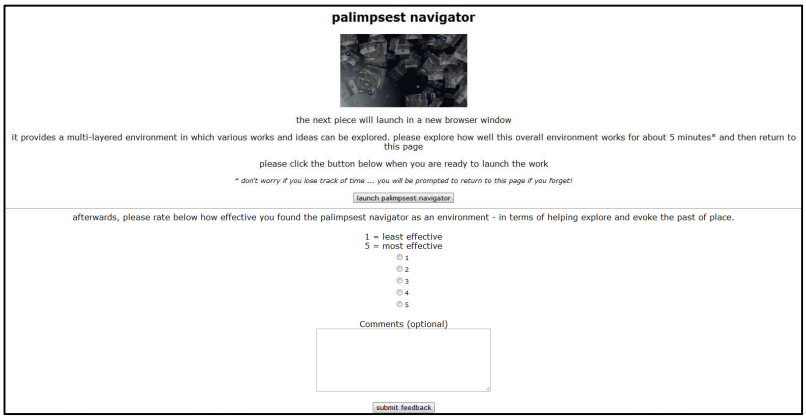


FIGURE 49: UL2 (8)

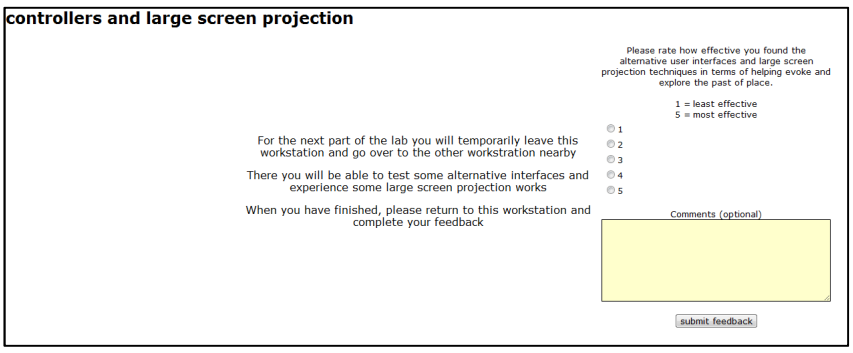


FIGURE 50: UL2 (9)

Nine questions were developed for the usability end of lab feedback form. A bespoke form was designed and deployed by the researcher on fishenden.com, enabling capture into a local research database. The questions remained a mix of closed and open and intentionally mirrored closely those of earlier feedback forms to ensure consistency. The questions and their nature (closed/open) are shown in Table 6.

Q1	How familiar would you rate yourself with using a PC, mouse, keyboard, etc.? (on a scale from 1 to 10 where 1 is novice and 10 expert)	CLOSED
Q2	Did you find the various techniques used to explore the past of place easy to use?	CLOSED
Q3	Were the ways of navigating past and present images and sound evocative of the past?	CLOSED
Q4	How could the techniques or interfaces be improved?	FREE-FORM
Q5	What was your favourite technique or example - and what made it work well for you?	FREE-FORM
Q6	What idea, example or technique worked least well for you - and why did it not work?	FREE-FORM
Q7	Please provide any additional thoughts and feedback on the prototype hardware interfaces and the use of larger screen projection techniques	FREE-FORM
Q8	Are there any particular sounds/images/pieces that really impacted you? If so, which ones? And why?	FREE-FORM
Q9	If you have any other comments about how you'd like to see this work develop, please enter them here. And thank you for all of your feedback.	FREE-FORM

TABLE 6: END OF LAB 2 QUESTIONNAIRE

ONLINE USABILITY 4 (OU4)

OU4 commenced on in July 2011 and closed in October 2011. Its scope, data and analysis are shown below. The purpose was twofold:

- to evaluate updated techniques (such as the modified lens and slider) from earlier development, testing and feedback
- to evaluate new compositions in progress

OU4 used custom forms designed and hosted on the researcher's website at http://fishenden.com. It used the same star rating system used in OU2 and OU3.

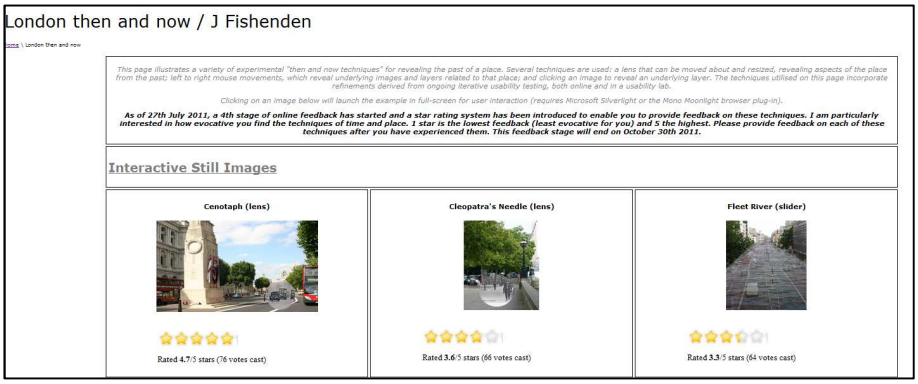


FIGURE 51: OU4 (1)

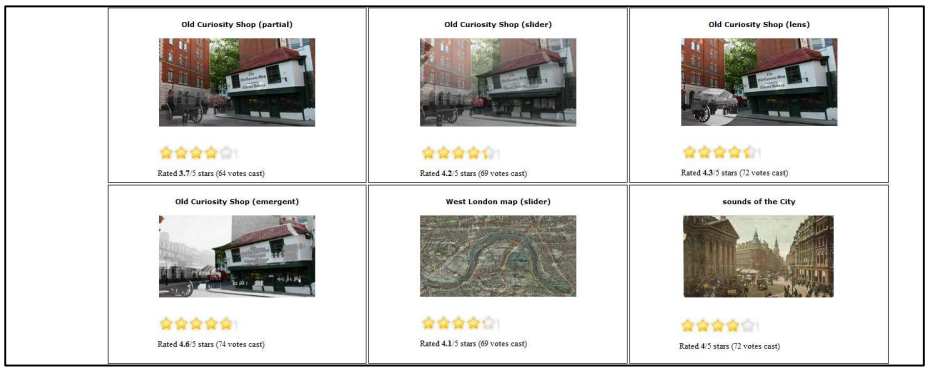


FIGURE 52: OU4 (2)

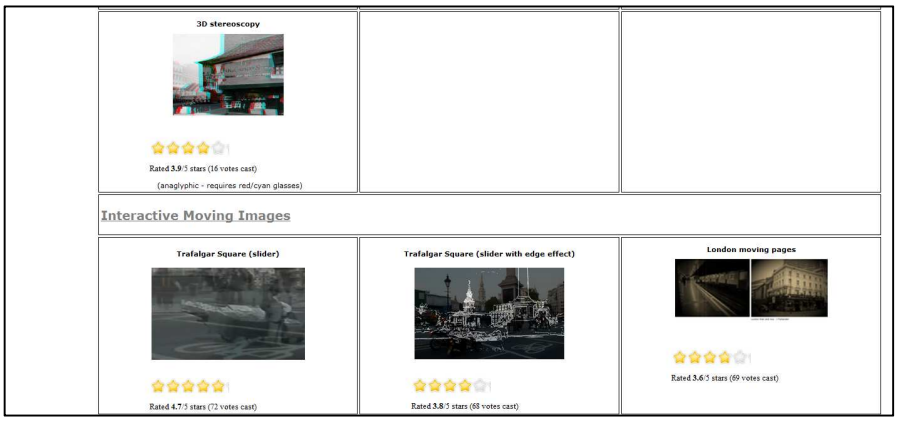


FIGURE 53: OU4 (3)

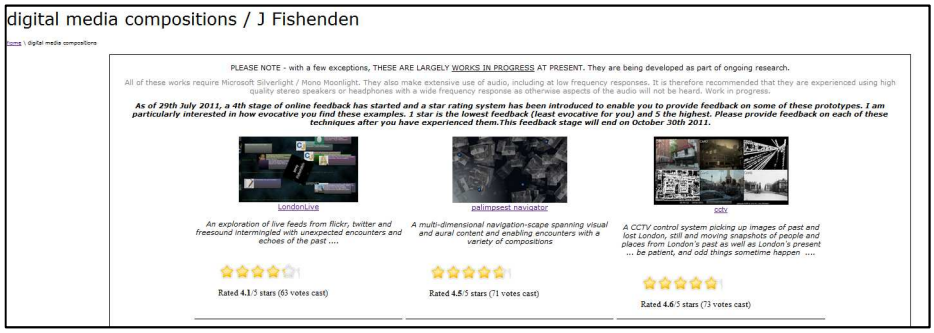


FIGURE 54: OU4 (5)

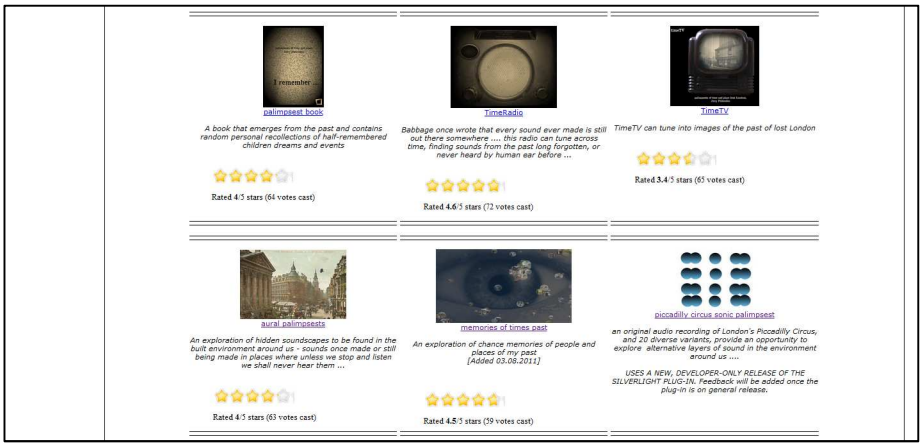


FIGURE 55: OU4 (6)

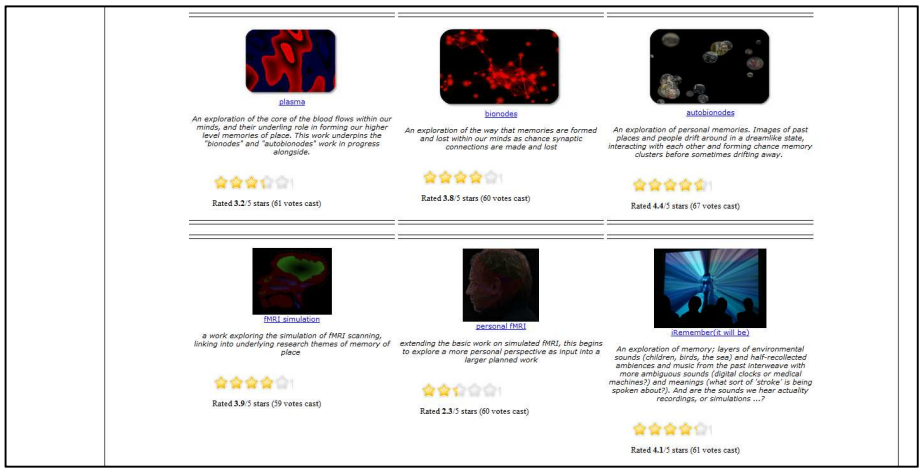


FIGURE 56: OU4 (7)

FIGURE 57: OU4 (8)

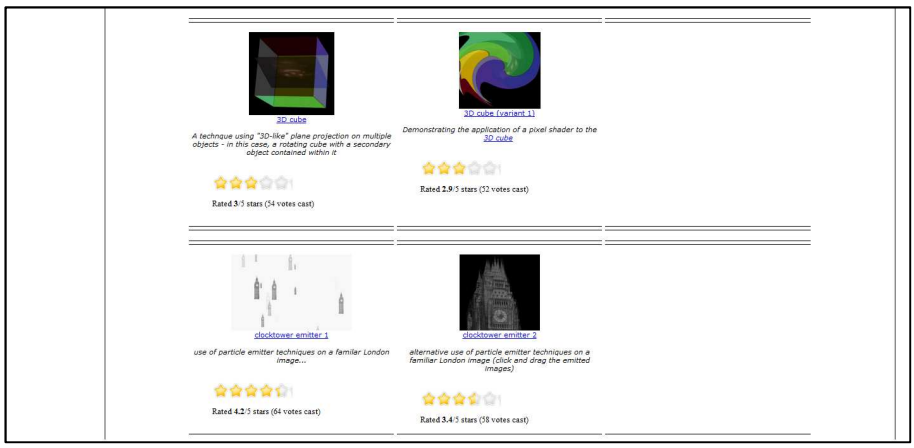


FIGURE 58: OU4 (9)

CHAPTER 3: DESIGN AND DEVELOPMENT

This Chapter details the approach to the creation of the portfolio, including the development and use of computer-based techniques for both presenting content and enabling user interaction. Such computer-based techniques possess a well-documented heritage as integral compositional elements in digital artworks (Paul, 2003; Popper, 2007; Mason, 2008). Alongside the digitisation of traditional creative works, such as photographs, and their utilisation in computer-based systems, original artistic practice has also produced new forms of computer-based art (Rush, 2005), including art developed for and based exclusively on the internet (Greene, 2004). A particular focus for this research has been the development of IDT techniques for interactive visual and aural content relating to the present and past of place, including images (still and moving) and sounds.

VISUAL CONTENT

The primary thematic basis for the development of visual content was the artistic conceptualisation of the palimpsest as layers of the past of place that lie below the present, and how such hidden layers can be revealed and experienced in novel, interactive and evocative ways. Contemporary computer systems provide a variety of means of displaying such content, including side-by-side *then* and *now* images that show how a place has changed over time. This might include, for example, images of a famous building or maps of a city both as it was in the past and how it is today. However, such an approach to visualisation differs little from static printed publications that have long utilised such side-by-side images to demonstrate how a place has changed over time. It also fails to realise the nature of a palimpsest, which is concerned with revealing layers *beneath the surface* rather than side-by-side comparisons. What was sought, therefore, was an improved method of visualising the changes to place over time that would allow users interactively to navigate and explore *then* and *now* in more effective, visually and aurally evocative ways through the use of interactive digital technologies.

N-TIER NAVIGATION

This research was particularly influenced by the block universe theory and the notion of the palimpsest, as discussed in Chapter 1. It sought to explore various techniques for utilising a web browser-based system to enable a user to discover and navigate multi-dimensional layers of interactive visual and aural content modelled on the concept of the block universe. The primary conceptual model used to realise an artistic construct of the palimpsests is structured around *n*-tiers of visual and aural content beneath the surface

level, illustrated in Figure 59, operating across the Cartesian co-ordinates for a three-dimensional space. Such content is typically related to visual images (still and moving) of the same place (such as a building) or other artefact (such as a map) over time and either authentic or synthetic sound. The research interest centred on developing and identifying intuitive ways for users to navigate and explore such multiple layers of content, as well as in finding methods that evoked stronger emotional connections with the past of place.

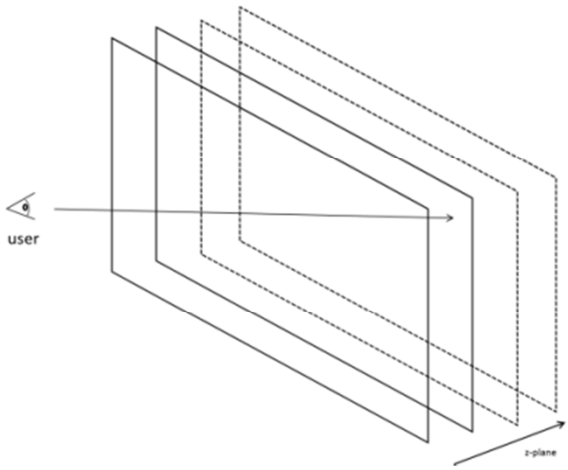


FIGURE 59: THE N-TIER LAYER CONCEPTUAL MODEL

INITIAL VISUAL NAVIGATION CONTROLS

LENS

The initial idea for a visualisation and interaction method for navigating the *n*-tiered model was that of a lens – a lens similar to a magnifying glass, but rather than magnifying content underneath the lens it would instead reveal how the particular place over which it moved had looked in the past (Figure 60).

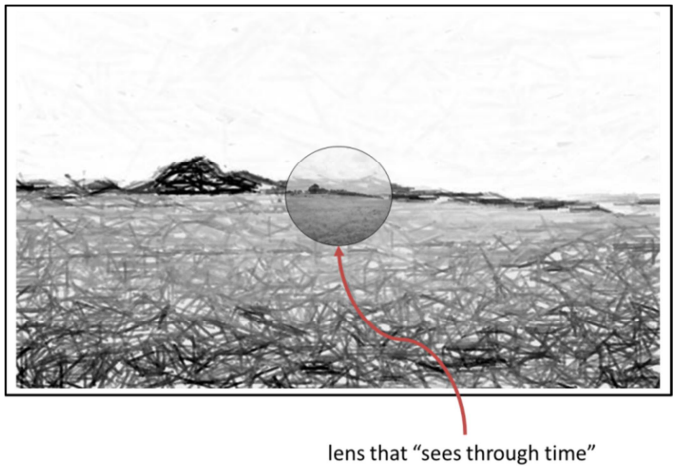


FIGURE 60: A LENS THAT CAN "SEE THROUGH TIME"

Figure 61 illustrates this initial conceptual model, where underlying *n*-layers (104-106) of visual content contained in the z-plane (or axis, 110) can be revealed through the use of a

circular aperture (or lens, 103) which the user (101) can freely position on the x and y axes through movements of a mouse. Wherever the lens moves in reaction to user mouse movements, it reveals the underlying visual content existent below a surface layer (102).

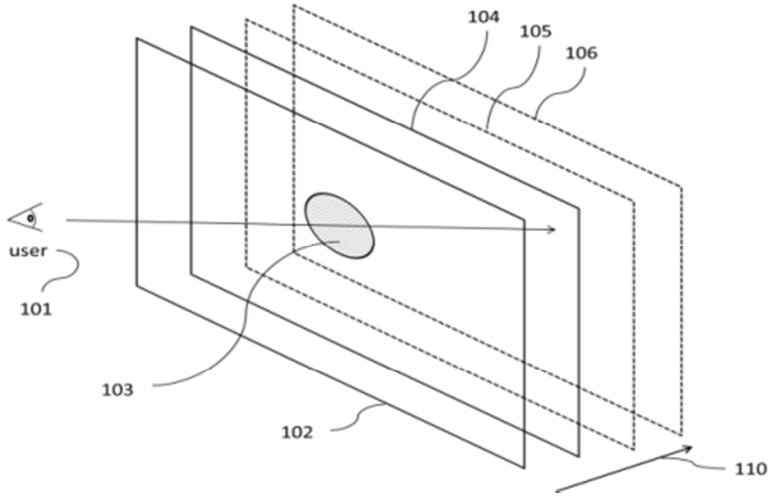


FIGURE 61: N-TIERED VISUAL CONTENT (LENS MODEL)

The technique is directed towards reacting to specific user action initiated by movement of a mouse (or another input control device, such as use of a finger on a touch screen) to navigate a circular aperture (lens) across visual content. The result is that the visualisation area over which the lens moves reveals underlying related visual content (layered in the z-axis). As the lens is moved by the user across the x and y axes of the surface layer, underlying *n* layers located in the z-plane are visualised in the area of the lens, revealing visual content related to those particular co-ordinates. Underlying visualisation control code tracks where the lens object is situated on-screen relative to the surface manifestation through visualisation display logic, which tracks the movements of the mouse and updates the corresponding x and y axes co-ordinates of the on-screen lens control. There are limits on these calculations so that the lens control does not wrap from one edge of the screen to the other, although such wrapping is feasible.

The initial realisation of the application of this technique was coded in Microsoft Silverlight 1.0, utilising the eXtensible Application Markup Language (XAML) for design elements and Javascript for code-behind. Silverlight's representation of Cartesian co-ordinates for a three-dimensional space is shown in Figure 62, providing a direct correlation between theoretical and physical models.

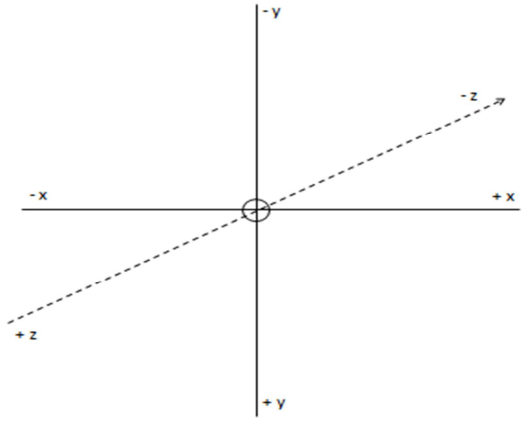


FIGURE 62: SILVERLIGHT'S 3-DIMENSIONAL CO-ORDINATES

An example early visualisation prototype is illustrated in Figure 63.

FIGURE 63: PALIMPSEST NAVIGATOR LENS (WITHOUT USER FOCUS)

When the user positions the cursor over the lens the underlying image becomes less opaque (Figure 64) and an associated sound is invoked to provide aural reinforcement that the lens has entered an interactive state.

FIGURE 64: PALIMPSEST NAVIGATOR LENS (WITH USER FOCUS)

When the mouse button is clicked and held down, the user is able to move the lens around the screen, revealing an additional visual layer within the locus of the lens of the same place at an earlier time. The user can choose to stop moving the lens around the screen by releasing the mouse button. The cursor then disengages from the lens and can be moved away, restoring the lens to its passive state.

SLIDER

A second complementary technique for navigating visual layers of place over time was developed utilising an on-screen slider control. This was programmed in the same environment as the lens, Silverlight 1.0, and is illustrated in Figure 65. Movement of the slider progressively reveals an additional (previous) layer of the same place at an earlier time.

FIGURE 65: PALIMPSEST SLIDER CONTROL

Unlike the lens control, the slider control affects the entire visual image displayed, also allowing fine-grained merging of the images so that the user can adjust the extent to which one or other images dominate the mix, or whether both are mixed equally (Figure 66).

FIGURE 66: PALIMPSEST SLIDER CONTROL (IMAGES MIXED)

In other applications of this technique more than two layers are manipulated, a model applied to maps of the same area over time (Figure 66).

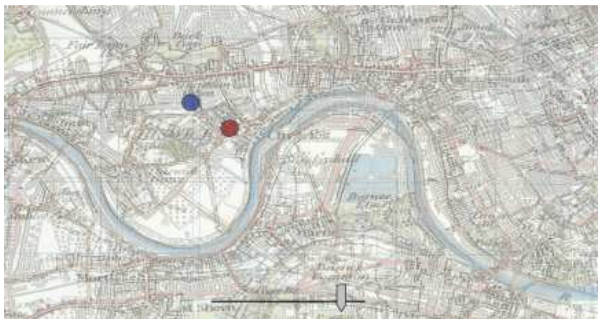


FIGURE 67: PALIMPSEST SLIDER CONTROL (MAPS - IMAGES MIXED)

AURAL CONTENT

In common with the visual elements, the primary thematic basis for the aural elements of compositions was the concept of the palimpsest. The aural dimension of the approach is well described by the quotation from Charles Babbage:

> The air itself is one vast library, on whose pages are for ever written all that man has ever said or woman whispered. (Babbage, 1838, 2nd edition)

The *n*-tiered model outlined in the previous section was also applied to aural content. Research in this area included exploring the role of impulse responses (the acquisition of the acoustic characteristics of particular spatial environments) and convolution reverb (recreating the acoustic reverberation characteristics of a physical or synthetic space based on an associated impulse response). Aural-related tests in the usability lab and online provided feedback on the impact of different impulse responses upon user perception and evocation.

In terms of evocations of the past of place, the creative interest related to how sound behaves in different buildings and structures – architectural and vibration acoustics. In particular, how impulse responses may differ over time: for example, between period rooms spanning the late 1600's to the late 1990s. The research involved the capturing of impulse responses in a range of period environments at London's Geffrye Museum in order to enable their subsequent application within the composition portfolio and the evaluation of their impact on users. Aural content for the portfolio was influenced by several elements: authentic impulse responses of available original locations; synthetic (or imaginary) impulse responses; and the subsequent use of both in convolution reverb tools.

The application of the *n*-tier model at an aural level is thus of the embedding of sounds (both authentic and synthetic) within a surface visual layer and, optionally, other layers below. Figure 68 illustrates multiple aural elements embedded across *n* layers. In such a case, the embedded audio content could utilise impulse responses gathered from historic

sources. For example, each *n* tier could relate to a particular time period and each audio element embedded within that tier could utilise an impulse response/convolution reverb appropriate to that tier. Thus the further back into the tiers the user navigates and listens, the earlier the related impulse response.

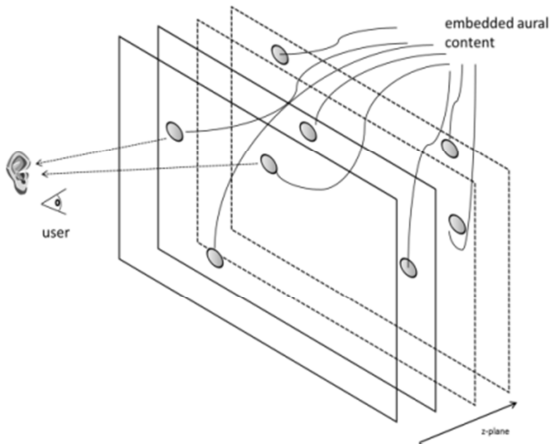


FIGURE 68: AURAL CONTENT EMBEDDED WITHIN N-TIER LAYERS

In one technique, multiple aural elements were embedded without any visual indication of their existence within a single surface layer, with all elements being continually audible, generating an overall background soundscape comprising multiple layered sources. When a user moves the cursor across one of these hidden aural elements, the cursor is modified to show a hand (a visual cue to reinforce that an aural element exists at that on-screen location) and the related aural element has its volume boosted to become more prominent than the others contained in the aural layer. When the user moves the cursor away from that aural element, the volume is reduced and the element returns to the general background mix. Figure 69 illustrates one of the examples used for prototyping and usability feedback (the second image visualises the location of aural elements purely for the purpose of illustration).

FIGURE 69: EMBEDDED, HIDDEN, AURAL ELEMENTS

AURAL SPATIAL EXPERIMENTATION

Initial aural work focused on the stereophonic domain. A desire to explore more spatially oriented alternatives, such as binaural and surround sound, was reinforced by feedback received during UL1. Unprompted, some of the participants articulated a desire to experience some of the compositional techniques using binaural or surround sound. Blesser and Salter have emphasised the relevance of the means of producing sound in their observation that:

> ... presenting sound with stereo headphones, binaural headphones, and transaural loudspeakers illustrates the high degree to which the spatial experience depends on the means for creating the sound field. (Blesser & Salter, 2007, p. 191)

A pair of Soundman in-ear stereo microphones were acquired as part of the field research element involving the capturing of binaural location recordings. Binaural recordings provide a more immersive aural experience since they exploit the head-related transfer function (HRTF) – the inference of the direction of sounds derived from the way sound arriving at the brain is interpreted after its diffraction and reflection due to intermediate elements such as our head, pinna, inner ear, torso etc. HRTF describes the filtering of a sound source before it is perceived at the left and right ears. An overview of HRTF is shown below.

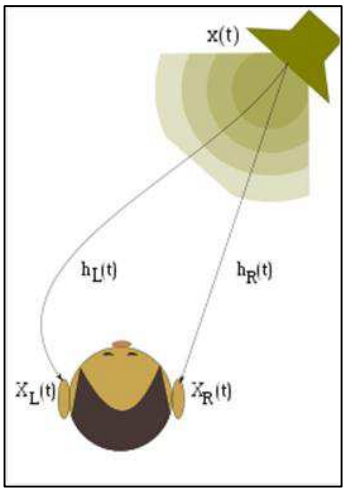


FIGURE 70: HRTF'S FOR LEFT AND RIGHT EAR (SOURCE: WIKIPEDIA)

Equally relevant is how the immersive characteristics caused by HRTF can be emulated in studio-originated works. Work therefore focused on experimenting with a variety of binaural/HRTF plug-ins for the composition environment. These enabled numerous characteristics of sounds, including simulated HRTF, to be manipulated to create a more immersive experience (still within the stereo domain). These can be either binaural (to be experienced through headphones), or transaural (to be experienced through stereo

speakers, yet creating sounds that appear to come from beyond the natural boundaries of normal stereo imaging).

Impulse Responses and Convolution Reverb

The portfolio aims to create a performance experience dislocated from a specific physical place, yet which evokes a *sense* of authenticity in an audience experiencing the composition. That desire for the invocation of a sense of authenticity is sought regardless of whether the composition concerns itself with synthetic and imaginary content created by the composer or content sourced from authentic materials. As Blesser and Salter have observed:

> Although we think of hearing primarily as how we sense such active sound sources as speech, sirens, or snapping twigs, it is also how we sense the passive acoustics of our environment. Walls and open doorways change active sounds in a perceptible way, as do enclosed spaces. If we listen carefully, we can sense a wall or an open doorway by the presence or absence of an echo, and the depth of a cave by its resonances. We can also hear how the acoustics of space, whether bathroom or concert hall, changes the way a voice or a violin sounds. (Blesser & Salter, 2007, p. 309)

Impulse responses and convolution reverb became an integral part of the composition design process. Two key elements were thus impulse response acquisition or modelling (authentic and synthetic) and its subsequent use within the convolution reverb tools of the composition software. In terms of evocations of the past of place, this included an artistic interest in how sound behaves in the environment around us, particularly buildings and structures – summarised in the concept of architectural and vibration acoustics. Of equal interest was how such acoustic behaviour might differ for different time periods – for example, how the acoustics of a sixteenth century room may differ from those of a contemporary room. Whilst there is much curational work in museums concerned with how the past looked, there is a much less evident focus on how it would have sounded. Research thus spanned obtaining recordings of the impulse responses of physical locations; synthetic (or imaginary) impulse responses (created by the composer in Voxengo's Impulse Modeler[37]); and the subsequent use of both in REVerence (the convolution reverb plug-in included in Steinberg's Cubase).

The Open Impulse Response Library[38] describes convolution as:

> … the process of applying the audio characteristics of an impulse response to another audio signal. The impulse response is 'convolved' with an incoming signal,

[37] See http://www.voxengo.com/product/imodeler. Retrieved 26.11.2011
[38] See http://irlibrary.org/index.php?page=7. Retrieved 13.3.2010.

> say a vocal or guitar track, creating the effect of playing the unprocessed audio in the same environment in which the impulse response was recorded.

And a precise mathematical definition is provided on Wolfram MathWorld[39]. Audio plug-ins such as REVerence provide a means of undertaking the convolution of an impulse response without requiring the direct involvement of a composer in the mathematical calculations, allowing time to be focused on the characteristics of the sound itself.

RECORDING APPROACH

A variety of techniques exist for obtaining impulse responses and exhibit diverse characteristics and acoustic accuracy. These range from digitally created audio sweep software, to hand claps, starter pistols and burst balloons. The techniques involving hand claps, starter pistols and balloons are sometimes referred to as *transient methods* (and the response is contained at the beginning of the recording in an impulse). The other technique, which involves playing an audio sine sweep into an acoustic space and recording both the sweep and space, is referred to as the *sine sweep method*. This method covers the entire audible frequency range, which can result in a broader-range, and higher-quality, impulse response.

The use of starter pistols in public spaces is problematic, given the nature of using what appears to be a firearm. This technique was therefore not considered further here. And handclaps were considered inadequate in terms of generating sufficient consistency in terms of initial energy and excitation. For a balance of convenience, ease of deployment and effectiveness, it was decided to apply the burst balloon method. Whilst audio sweeps provide the most systematic means of exciting the appropriate range of audible frequencies and energy, the balloon burst technique provides a more readily portable and easy to deploy alternative that could be used consistently for all field impulse response recordings.

Limitations of the balloon approach are, however, acknowledged:

> Balloons are, unfortunately far from perfect, they produce a good volume, but the frequency spectrum of the impulse they generate is far from flat – peaking at about 400 Hz and dropping by approx 6dB per octave above and below. This means that the recorded impulses needed corrective EQ'ing to restore a good frequency balance to the impulse responses.[40]

However, such limitations also need to be balanced by a key question: namely, what is an *historically authentic room* from an acoustic perspective? Is it possible to assert that an

[39] See http://mathworld.wolfram.com/Convolution.html . Retrieved 30.9.2009
[40] From http://noisevault.com/nv/index.php?option=com_content&task=view&id=23&Itemid=33. Retrieved 23/02/2010

impulse response recorded in a sixteenth century room is an accurate re-creation of the acoustic environment of the sixteenth century? Little evidence is to be found that curators of such historic environments currently pay attention to the acoustic authenticity of their recreations, focusing instead on the physical and visual authenticity of the past. Whilst that visual recreation may be assumed to include a degree of consequential recreation of the acoustic environment (which in part is derived from its fixtures, fittings, furnishings and spatial dimensions), it is not a specific intent of the curators. Also, there is likely to be a large degree of variability in any such environment: for example, one need only look at contemporary environments to determine that there is no such thing as a standard "twenty-first century" space. However, the impulse responses were intended for creative and artistic intent, rather than as historically authentic, exploring the sense of evocation of the past that differing impulse responses have upon sound and hence an audience as part of the creative intent and user experience. The balance of quality and usability of the burst balloon technique were therefore regarded by the researcher as appropriate for the purposes of the composition portfolio.

For the recording of field impulse responses, an Edirol R-09HR digital solid state recorder was utilised in its 24bit/44.1kHz linear PCM recording configuration, with sounds captured via the onboard electret condenser stereo microphone (which has a 20 Hz to 40 kHz frequency response). The R-09HR was placed in a stand and used with its wireless remote controller to avoid any handling noise during the recordings. Various initial test balloon bursts were made in a variety of trial locations to ensure the strongest possible signal was obtained by the Edirol. This involved substantial reductions in the standard input level to remove severe initial clipping of the input signal. The final, optimal input setting proved to be 30 (out of a possible 80), which still provided a strong digital to noise ratio (peaking at just under 0 decibels), whilst removing the clipping. All on-board Edirol effects and input controls (the limiter/automatic gain control and low cut filter) were disabled to ensure the raw sound was captured without interference and the microphone gain was set to low.

London's Geffrye Museum: Impulse Response Recordings

London's Geffrye Museum shows the changing style of the English domestic interior in a series of period rooms from 1600 to the present day. The researcher identified it as a useful location for obtaining impulse responses that sought to provide some indication of how historic rooms might have sounded, based upon an environment that seeks to preserve the authenticity of their fixtures, fittings and furnishings. The Geffrye Museum

curatorial team were supportive of the research and provided access on a day when the museum was closed to the public in order for the researcher to generate and record the impulse responses.

The majority of the Geffrye Museum's rooms are open on one side, allowing easy movement for visitors from one historic environment to the next. The acoustic materials of the open side are not in keeping with the remainder of each historic exhibit, as well as lending some inauthentic colouration to the sound by the nature of their open design. The building in which the museum is housed itself dates from 1715 and the open side remains largely in keeping with that period (comprising plain walls and windows, albeit with shutters over them), hence likely to be less acoustically authentic for those later periods where increased furnishings in the form of curtains and carpets are evident. To provide some correction for this, the recordings were made in a way that emphasised the area of the rooms that were not open: the recording device was placed within and angled towards the period exhibit and the balloon burst was made from well within the interior of the exhibit. It is recognised that the impulse responses gathered will contain a degree of additional reflection from the open side of the rooms than would have been the case had the entire environment been furnished to the same historically accurate level of detail. For the purposes of this research, this lack of complete acoustic authenticity is acknowledged but not deemed a significant issue for the subsequent utilisation in the creative design of soundscapes.

In each room the location of both the Edirol and the site for the balloon burst were determined by the researcher using his ears and experience from earlier trials to identify the optimal location. Account was also taken of the anticipated acoustic impact of the open side, as described above. Prior to starting the recording and bursting the balloon, the researcher ensured that there was complete silence in the environment. Some low level of background traffic noise could not be excluded given the museum's proximity to a busy East London road, but the low input level of the recording device meant that this was not captured by the recording. The recording of the impulse response was initiated with the remote control to avoid any handling noise of the recording unit itself. Both prior to and after the balloon burst the researcher observed complete silence.

	Description		**Description**
	1630 Hall		1870 Drawing Room

	Description		Description
	1695 Parlour		1890 Drawing Room
	1745 Parlour		Restored Alms House 1780
	1790 Parlour		Restored Alms House 1880 (door open)
	1830 Drawing Room		Restored Alms House 1880 (door closed)

Table 7: Geffrye Museum impulse response recordings

London's Geffrye Museum: Impulse Response Analysis, Editing and Evaluation

The researcher obtained 10 usable impulse responses from the Geffrye Museum, described in the table above. These were captured to an SDHC memory card which was then utilised in the researcher's home composition studio to retrieve the .WAV files. The raw recordings were preserved, with all subsequent edits and modifications made to digital copies. This was to ensure that the raw recordings remained available for subsequent work in the event that the copies did not produce the outcomes desired in terms of quality or effect for the composition portfolio.

An initial technique was subsequently developed using Steinberg's Wavelab. This involved making edits to the raw recordings:

- The pre-amble/run into the bursting of the balloon was removed, so that the WAV recordings started exactly on the burst. Any extraneous later noise (such as talking after the impulse decay and before the recording device had been halted) was also removed.
- The wave form was adjusted to peak at 0dB (although the recordings were such that little adjustment was actually required since most had been optimally recorded based on earlier tests)
- To compensate for the nature of the balloon burst method of creating impulse responses (which characteristically peak at about 400 Hz and drop by approx 6dB per octave above and below), corrective EQ was applied. Two corrective tests were applied and evaluated:
    - Three Wavelab presets were tested, applied sequentially to the source impulse response: "Mid Boost – Wide", "Treble Boost" and "Bass Boost".

The default "Mid Boost" started at 800Hz, "Treble Boost" at 2000Hz and Bass Boost below 200Hz.

- Manual correction was tested: to determine the approximate EQ correction required, based on the assertion that "a drop of 6dB takes place for each octave above and below 400Hz", the octave measurement needed to be re-expressed in terms of Hz. The ratio of frequencies of two notes an octave apart is 2:1 Thus, for a sound with a frequency of 400Hz the note an octave above it is at 800Hz, the note an octave below at 200Hz. Further octaves of a note will then occur at 2x, 4x, 8x, 16x of the original note and the reciprocal of the series. For example, 200Hz and 1600Hz are one and two octaves away from 400 Hz because they are ½ and 4 times the frequency respectively. Tabulating this centred on the frequency of 400Hz is shown below. Thus, for manual EQ, 6dB of boost was applied over these frequency ranges to compensate for the characteristics of the balloon burst impulse responses.

Octave	1	2	3	4	5	6	7	8	9	10
Frequency *(Hz)*	50	100	200	400	800	1600	3200	6400	12800	25600

TABLE 8: OCTAVE/FREQUENCY RELATIONSHIPS

The resulting modified impulse responses were then imported into Cubase's REVerence and tested with various sounds. On playback and aural comparison of the two, both had enhanced the original raw recording in slightly different ways. However, neither (to the researcher's ear) were of the quality and artistic effect that was desired: even a reverberant room, such as the 1630 Hall, sounded dry and slightly muddy in tone. It was therefore decided to model an alternative technique.

The second technique involved making initial edits to copies of the raw files as before, namely:

- The pre-amble/run into the bursting of the balloon was removed, together with any later extraneous noise
- The wave form was adjusted to peak at 0dB

However, no further edits or modifications were made in Wavelab. Instead, the resulting impulse response file was then imported into Cubase REVerence.

FIGURE 71: GEFFRYE MUSEUM IMPULSE RESPONSES USED IN CUBASE

Subjective aural analysis found this latter approach to provide more interesting results, with the sound less muddied and some subtle changes of acoustic characteristics between the rooms. The most notable differences were found in the extremes of period, between the 1630 hall and almshouses (both sparsely furnished with many bare surfaces) and those of the late 19th century rooms (which were more densely furnished, including carpets and curtains). As well as the recordings undertaken at the Geffrye Museum, a limited number of other original impulse responses were also gathered during this research, including from a Victorian school hall and from a contemporary kitchen utilising the same techniques detailed above.

SYNTHETIC IMPULSE RESPONSE RECORDINGS (VOXENGO)

Software such as Voxengo's Impulse Modeler (VIM) provides a range of additional creative options for a composer. Architectural elements such as walls can be inserted and moved around in the modelling environment, and the composition of those elements – such as concrete, carpets or glass amongst others – can be specified. Alongside a list of pre-defined construction elements it is possible to create and design new ones. It is also possible to control the acoustic medium – for example, whether air or water.

The creation of impulse responses within VIM involves the injection and placement of emitters within the completed on-screen design. These provide the sound triggers used for calculation of the impulse response. The emitters can be pointed in a specific direction and their dispersal characteristics can be user-defined. VIM can produce 8, 16, 24 and 32-bit output and 44.1, 48, 88.2, and 96 kHz output sampling rates. It also provides 8 frequency bands for precise material definition.

Whilst restricted to 2-dimensional space, VIM can produce results not achievable with actuality impulse response recordings: it can, for example, produce sounds from

imaginary spaces (ones that do not exist in the physical world), as well as other creative content (such as the recreation of remembered spaces and places, such as those from childhood). The researcher used VIM to recreate some environments recalled from earlier in his life, such as a childhood bedroom as well as imaginary environments. An illustrative model is shown in Figure 72, complete with three emitters.

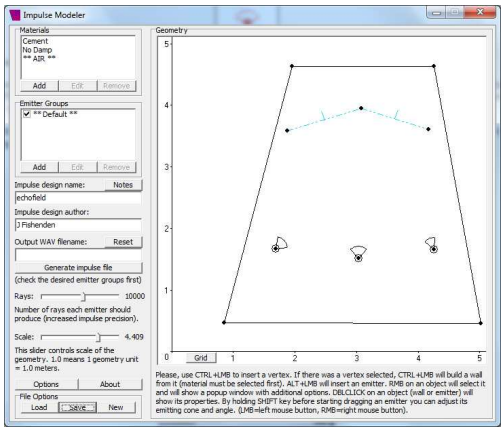


FIGURE 72: 3 EMITTER VOXENGO EXAMPLE

Unless recorded at the time, the sounds and acoustic characteristics of our own past exist now only in our imaginations. And sounds from earlier times beyond our direct experience are also largely imagined since no-one is alive who can remember and recall them first-hand, other than those sounds which it has been possible to record and preserve. Since what was sought in this research is the evocation of a *sense* of authenticity in an audience experiencing the composition, synthetic/imaginary impulse responses were a related area of exploration, with specific reference to testing the impact that such synthetic environment impulse responses have upon the perceptions of a listener versus authentic ones. Impulse Modeler was therefore used in the creation of a range of synthetic impulse responses subsequently applied to aspects of the sound design in the portfolio.

INITIAL EXPLORATIONS OF PLACE AND TIME

The ideation and methodology underpinning the composition portfolio is described in this section – the origin and development of ideas and the iterative approach used, informed by the usability testing discussed in Chapter 4. The influence of such earlier exploratory works and techniques can be found in later works and ideas contained in the portfolio. This section covers a representative sample of earlier works, their intent and development, in order to provide examples of how the portfolio was designed and developed.

The researcher's Web site was used for hosting of content. Important to this work was an exploration of how associations of "layers of reality" (a creative, impressionistic sense of what is, and once was, in a particular place at a particular time), layers of association (such as resonances with the concept of the oneiric house or more specific memories of a place and time), and technical layers (digital representations of aural and visual characteristics, past and present) can be interwoven in ways that provide new means of evocation and for a "bundle of sensations" to be communicated.

Writing of Russian film director Dziga Vertov's 1929 film *Man with a Movie Camera*, Manovich observes that it has:

> … particular relevance to new media. It proves that it is possible to turn 'effects' into a meaningful artistic language ... Vertov is able to achieve something that new media designers and artists still have to learn – how to merge database and narrative into a new form. (Manovich, 2001, p. xxviii)

The role of IDTs thus explored "effects", both aural (such as the application of impulse responses) and visual (such as the use of dynamic pixel shaders and other computer graphics techniques), and how they might help construct an evocative, artistic connection with an audience.

EXAMPLE: LONDON EVOCATIONS GALLERY

One of the initial compositions was the *London Evocations Gallery*.

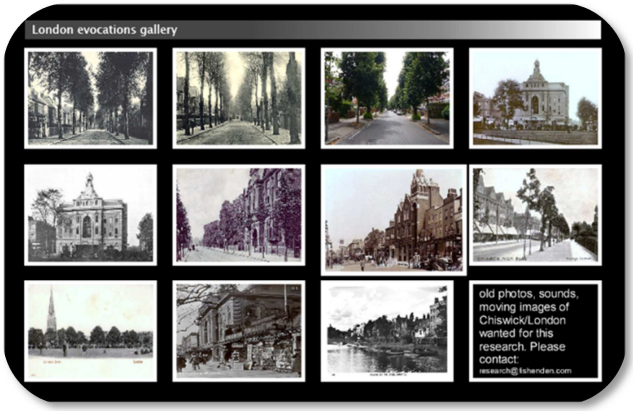


FIGURE 73: LONDON EVOCATIONS GALLERY

Taking the familiar metaphor of an art gallery, with walls presenting photos of past and present, the *London Evocations Gallery* provided a way of not only seeing photos of past and present of the same place side-by-side (see Figure 73), but also when the viewer moved the cursor over an image, it responded by enlarging slightly – and when clicked became both full size and incorporated linked aural material (see Figure 74).

FIGURE 74: LONDON EVOCATIONS GALLERY - SELECTED ITEM

Revealing the layers of a past place through interactive images of the same place at a previous time and incorporating sounds aimed to provide an alternative, and more immersive, way of understanding place than is typically experienced in traditional photographic exhibitions or galleries. This example aimed to connect the contemporary surface – what we see and hear today around us at a particular place at a particular time – with what would have been seen and heard in those places in previous times. Or at least, to evoke in an audience the sensation that they are experiencing the past of that place, even if, in actuality, the realisation uses synthetic means (such as artificially aged contemporary images, or synthetic sounds). The influence of elements of this early work can be seen in later examples in the composition portfolio, notably in a work such as CCTV, with its multiple interactive screens. Online at http://fishenden.com/research/portfolio/gallerysound/default.htm and evaluated in OU1.

EXAMPLE: MORPHING STREETS

To explore the concept of the palimpsest and its more formal realisation, another composition was developed that seamlessly morphed between two images of the same street scene taken over one hundred years apart. In *Morphing Streets* (see Figure 75), two photos gradually blend automatically in and out of each other. There are interesting visual effects whereby at times the ghostly image of the children on the right, for example, persists and becomes present in the contemporary image, enabling us to perceive in the contemporary image a layer from a time long passed. Although relatively simple to realise at a technical level, the slow speed of morphing between the images creates intermediate visual impressions that manifest layers of place below the surface of the present day. Intentionally, this composition used no aural effects: it was concerned with a rendering of

visual images that explored how visual layers of time for a particular place could be represented and manipulated through digital layers.

FIGURE 75: MORPHING STREETS

This particular work highlighted a recurrent issue: the problem of accurately registering or calibrating new and old images to exactly the same co-ordinates to enable the desired transitional effect of palimpsestic revelation to be achieved with maximum impact. Challenges in finding the identical location, the nature of the camera equipment used (lenses, focal distances, formats) and manipulation on-screen using digital imaging software made completely accurate overlay a time-consuming manual process. However, it also highlighted the importance of aiming to achieve alignment (with feedback provided on this specific issue in usability labs) and the need for a focus on detail and preparation at this stage in order to provide a more powerful experience in the final realisation of the work.

Some of the influences of this work persisted into the work on sliders and lenses – providing the user with control over the rate and nature of interaction, rather than automating the process. This user interaction became a key distinguishing feature of many of the works – and is a point of departure from broadcast works, such as film, where the user experiences a work precisely as constructed by its originator rather than having scope to interact with and influence their own experience of the work during its realisation. Evaluated in OU1 and OU2.

EXAMPLE: LAYERED LONDON

Layered London takes three images of the same place – two from the late nineteenth century and one taken in 2007 by the researcher – and employs an alternative interface built on "touch screen" model source code. The touch screen approach enabled users to manipulate images with their fingers through simple physical gestures and have no need

of interfaces such as mice and keyboards. The composition can also be realised on a more traditional PC using a mouse, as the internet version illustrated here shows.

FIGURE 76: LAYERED LONDON

In the topmost photo shown in Figure 76, the highlighted yellow areas provide a visual cue to the user about which photo is currently the focus of attention and where its control points are. So in this instance, the topmost photo is the focus: the photo itself can be repositioned by clicking on the central highlighted yellow square and then dragged to wherever desired. It can be resized by clicking on any of the corner highlighted squares and then dragging inwards or outwards to shrink or grow respectively. On a touch screen device this is more intuitively achieved through the simple use of finger taps and single or multi-touch gestures.

This approach enables the user to move the photos around, place them on top of each other, flick through them and generally compare the images of the same place over time. It makes the ideas of layers manifest and enables direct user manipulation of those layers in ways long familiar from our experiences with handling physical objects, such as paper, on a physical surface. The way in which it also supports the images being displayed side-by-side in any date order helps challenge the notion of linear or sequential time: these are all valid representations of place over time. How we choose to order them, and interact with them, is for us to decide. Evaluated in OU1.

Elements of this touch screen interaction model are found in later works, including a touch-screen tablet version of the lens and slider being prototyped for the De Montfort Square Mile project.

EXAMPLE: ROTATING PHOTO CUBE

The composition *Rotating Photo Cube* takes the same three images used in the preceding example, but explores new ways of presenting and interpreting them. In this work, the images were laid onto the faces of a 3-dimensional rotating cube.

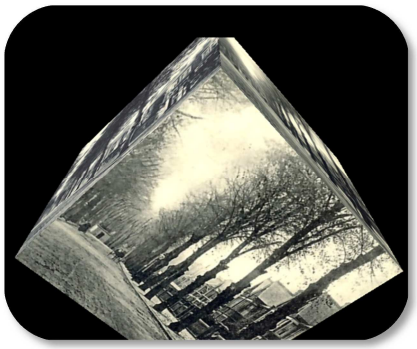


FIGURE 77: ROTATING PHOTO CUBE

This work was intended to explore a new way of considering place over time: that the same place and how we read it may as well be compared to the chance throw of a die as any traditional conceptual models of time, such as linear or cyclic. It is chance that the researcher was here, now, and could take one of these images. It is chance that the same street scene had been caught as images taken from a near identical point at earlier points in time. It is chance that those earlier images caught other people on them, locking them into a representation of place at a particular snapshot of time. And now it is chance that as we consider this particular place, our experience will vary on the random rotation of the cube as to which of the times we may experience this place.

Influences of this early work can be found in several later works in the portfolio which incorporate rotating cubes with dynamically generated and manipulated content, including *London Live* and the opening screen of *Palimpsest Navigator.* The original prototype of this was written in Windows Presentation Foundation (WPF) rather than Silverlight and was not evaluated online or in the usability labs, but provided the basis of the later works indicated.

EXAMPLE: INTERACTIVE PHOTO PALIMPSEST

The composition *Interactive Photo Palimpsest* takes the idea of the earlier *Morphing Streets* into the realm of the interactive, in which the user/audience plays an active part. In place of the animated morphing of the two images of *Morphing Streets*, in *Interactive Photo Palimpsest* the viewer is able to manually manipulate the two images and decide how much of the two bleed into each other, which should take dominance or subservience. This

is achieved through an on-screen slider control that progressively blends one image into the other.

FIGURE 78: INTERACTIVE PHOTO PALIMPSEST

Ghostly apparitions from the nineteenth century become a visible element in the present (see Figure 78). The viewer can control how the layers of the palimpsest combine and separate. It is they who are in control of the layers of time that exist at this particular street.

As described in the following Chapter on usability testing, user feedback enabled this work to be refined, with the onscreen slider replaced and the morphing of past and present layers achieved instead through left and right movements of the mouse. This control paradigm, made possible through the integrated role of usability testing and feedback, can be found in many of the later compositions in the portfolio. Online at http://fishenden.com/research/portfolio/Chiswick%20street/Default.html and evaluated in OU1 and UL1.

EXAMPLE: DEEP ZOOM CHISWICK

Deep Zoom Chiswick – Duke's Avenue (see Figure 79) utilises a different technique, that of zooming into and out of images, including images embedded inside other images. Rather than morphing between a past and present representation of the same place over time, deep zoom explored an alternative technique for navigation, enabling users to progressively zoom into a picture and uncover other layers within it from other times, a sort of "steganographical palimpsest" with layers of the past to be discovered embedded deep within layers.

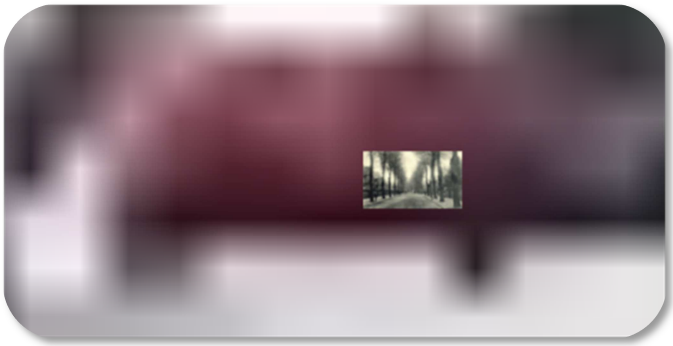


FIGURE 79: DEEP ZOOM CHISWICK - DUKE'S AVENUE

The influence of this early explorative work can be found in the portfolio in *Palimpsest Navigator*, which enables users to drill through different types of metacontent and different compositions within an overall multi-tiered navigation environment. Online at http://fishenden.com/research/portfolio/deepzoom/ and evaluated in OU1 and OU2.

EXAMPLE: INTERACTIVE PALIMPSEST OF WEST LONDON

Taking various ideas explored in earlier compositions outlined above, another early composition brought together various elements in *The Morphing Maps of West London* (see Figure 80). This work provided a new way of revealing the past of an area of West London between 1805 and 2008. As well as three maps, places and sounds from the present and past are invoked as the viewer moves backwards and forwards in time and various techniques of interactivity, including morphing, were brought into play.

FIGURE 80: THE MORPHING MAPS OF WEST LONDON

As the user passes through the era when the Chiswick Empire existed (1912-1959) they see it flicker on its site by Turnham Green – and if they stop the slider during that era or click the slider anytime in that era its image will grow to be viewed. Clicking on the Empire switches audio on/off. Dots on the map enable the viewer to interact with content, some of which only exists at particular moments in time and some of which is persistent throughout the three maps. For example, a red dot invokes Hogarth's House, which was

present at the time all three maps were produced. Clicking on the dot brings up a photo of the house. The viewer is able to leave the revealed photo while they move the slider back and forwards between the three maps. If invoked at an earlier time period, the sounds associated with the house are those of the countryside that Hogarth described from the time when he lived there. If invoked in contemporary times, the sounds are those of the busy, multi-lane A4 which now runs alongside the house. So whilst visually the house has persisted throughout, the aural layers have changed considerably over time, something which the user can experience with this work.

Another dot represents Duke's Avenue, the same street used in the previous composition that enabled the morphing of past and present. Clicking on that dot brings up the two photos that morph in and out of each other from the twentieth and nineteenth century, accompanied by (synthetic) sounds of children playing from the 19th century. This illustrates the way in which layered compositions can be built up which themselves comprise layers within layers (see Figure 81).

FIGURE 81: MORPHING MAPS OF WEST LONDON, EMBEDDED LAYERS

The idea of layers within layers and the influence of this early exploratory work can be seen in the composition portfolio in *Palimpsest Navigator*. Online at http://fishenden.com/research/portfolio/morphing-maps/Default.html and evaluated in OU1 and OU2.

EXAMPLE: TIMERADIO

The idea for *TimeRadio* originated with Babbage's observation to the effect that every sound ever made is still out there. What if it were possible to tune into and hear these sounds? With the right sensitivity of equipment, these aural palimpsests that still exist around us, yet go unheard, might be made audible again. In the same way as the most sensitive monitoring equipment is apparently able to detect the original 'big bang' (or at least the persistence of the associated cosmic radiation, processed to become audible to

the human ear), a time radio would be able to tune into any sound that has been made from that time until the present day.

Utilising the adapted Mazza model for realisation, and influenced by the work of Buxton (2007), an iterative process commenced to develop possible models for how *TimeRadio* might look and function. The rationale for the adoption of the analogy of a radio was its potential to offer a familiar device that anyone can understand and hence facilitate its use and acceptance (even as a purely digital artefact rendered only in two dimensions). In the researcher's notebook, an initial sketch was made of how this radio might appear in its simplest form. This sketch was subsequently scanned into a computer and added as a resource into Silverlight (see Figure 82).

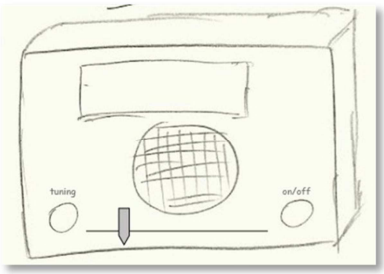


FIGURE 82: 'SKETCH' TIMERADIO IN SILVERLIGHT

Initial work included research into the way that the user interface (UI) layer could be separated from the underlying programmatic application code, yet linked through the use of the XML application mark-up language (XAML). Although the above Figure apparently manifests as a simple static cartoon, all of its UI elements are in fact programmatically addressable: the knobs on each side, the textual display panel, the speaker in the middle and even the casing itself. Each of these can be independently addressed by the underlying application code.

This initial prototype was sufficient to provide an on/off switch, a tuning dial and a 'time period' slider control, with the textual display (the blank white panel in the Figure) updating the user as to which period they have currently tuned into and a related commentary on the sound currently playing (see Figure 83). Sounds were originated and synthesised using the researcher's home composition studio.

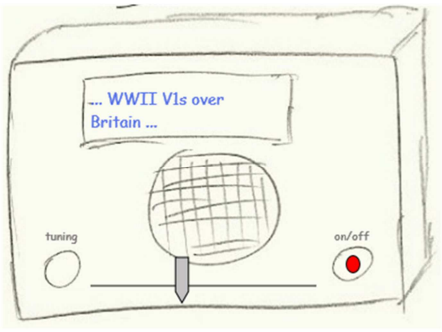


FIGURE 83: 'SKETCH' TIMERADIO IN OPERATION

Alternative representations of the radio were considered. As the researcher owned a vintage valve radio, the next stage involved its digitisation so that its visual representation could also be imported into and utilised in Silverlight. By separately digitising the elements of the vintage radio (such as the controls), these could also be rendered as programmatically accessible objects and independently controlled in the same way as they had been in the initial sketch radio.

FIGURE 84: VINTAGE TIMERADIO

One additional feature incorporated was the time period slider along the tuning display at the top of the vintage TimeRadio. This enabled users progressively to move forwards through time (or vice versa) and explore sounds detected by the radio.

The next iteration was a basic representation of a contemporary design *TimeRadio*, shown in the Figure below.

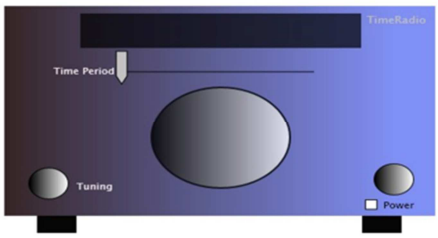


FIGURE 85: 'CONTEMPORARY' TIMERADIO

A later, more elaborate version of the contemporary *TimeRadio* was designed. This was developed entirely in Silverlight XAML, with the radio itself fading in from black as if it too had been tuned into and hence appeared at this particular moment in time, its display

screen shimmering and the magic tuning eye glowing across a range of colours (in homage to original valve radios), all accompanied by an ethereal, metallic sound to suggest the *TimeRadio* itself was as much able to travel through time as to tune into sounds across time.

FIGURE 86: LEICESTER TIMERADIO

This latter radio provided the platform for further development of a generic *TimeRadio* that would incorporate the various lessons learned during the development of the preceding prototypes. This incorporated the dynamic display panel, a full screen toggle (to enable the radio to go full screen), an animated power switch to turn the radio on/off and an animated tuning knob to locate and play sounds the radio was currently able to detect. When launched, the radio itself slowly appears, suggesting the radio itself is as temporally elusive as the sounds it aims to tune into. The magic valve tuning eye used in the preceding model was incorporated and in addition the radio casing itself was also updated to modify at various times (such as during instantiation and when the radio experiences stability problems in the current time dimension).

FIGURE 87: TIMERADIO

The sound palette was both expanded and randomised (rather than stepping through sounds in an approximately sequential/linear progression as with the earlier *TimeRadios*, sounds instead were plucked at random). Rather than the number and origin of sounds being hard-coded into the application code, the code was modified so that a separate file could be maintained listing the source sound files to be used, simplifying the addition of

sounds or other related alterations. Likewise, the display panel utilised random texts (randomised separately from the sounds, such that there was no association between the two). These display texts were added to the separate file in which the sound array was created to provide greater flexibility in terms of updating and modifying sources. As well as utilising a randomisation function that ensured each iteration of the *TimeRadio* would present the sounds in a new, unique order, a further function was added to occasionally select four random sounds from the available palette and play these simultaneously in a more complex overlay and interaction of sound. Earlier *TimeRadios* are online at http://fishenden.com/research/portfolio/TimeRadio/TimeRadio.htm and an early *TimeRadio* was evaluated in OU1, and later ones in OU3 and OU4.

A final, further modified version of *TimeRadio* is present in the portfolio (both in standalone and within the overall *Palimpsest Navigator* environment). It adopts the antique radio form rather than that of some of the examples above, and applies the learnings of the various iterations described above, modified with later techniques, such as pixel shaders, intended to provide the radio itself with an "other worldly" feel, as if it too, like the sounds it is able to locate, has only recently stabilised in this time and place.

Example: The Old Guildhall School of Music

During the mid-1970s the researcher travelled weekly for trumpet tuition to the old Guildhall School of Music and Drama in London's John Carpenter Street. The building was a microcosmic acoustic environment, uniquely its own. It has left forever memories of a building alive with the diverse, echoic, overlaying sounds of rehearsal from multiple rooms and corridors: from the human voice to the tuba. The composition *Old Guildhall School of Music* aims to syncretise a sense of what this building once meant to the researcher; to unlock an insight into its character; to peel away the current surface layer to reveal those beneath and make us sense in the twenty-first century what this particular place in this particular London street once meant.

The initial composition was designed as author-led. Photos of the building were taken by the researcher and adapted in various ways – including artificially ageing some of them, as well as isolating specific features of the building that could then be layered into the visual elements of the realisation. The composition itself involves multiple visual and aural layers. At the visual level, the work morphs between an old (or more accurately, synthetic old created from appropriate processing of contemporary imagery) and current view of the building, overlaid onto which are elements of its design (figureheads and decoration). At the aural level, four separate tracks of instruments (voice, trumpet, clarinet and French

horn) in rehearsal can be heard, in this case mixed down into a fixed final form. All were created as independent, autonomous layers, but all interweave as the sounds inside the old School often would, making chance, random compositions. Visually too we experience multiple layers: the transition between an old view of the building and the contemporary view, combined with features of the external architecture of the building which blend in and out of visibility.

This composition is non-interactive and a 'set piece' in the sense that it is identical each time it is experienced. However, there was clear potential to develop this work: either at the level of randomisation of the layers (so that each time they will interplay in different ways) or by enabling the visitor to interact directly, influencing both the visual and aural layers and how they are invoked and interweaved together. Both of these ideas were developed as this research progressed.

FIGURE 88: THE OLD GUILDHALL SCHOOL OF MUSIC, IN SILVERLIGHT REALISATION

The second version explored a less fixed, more random experience for the user, which perhaps better reflected the fact that the layers of sound to be experienced at the school were rarely, if ever, the same. The number of sounds was expanded to provide a richer aural palette to draw upon and a randomisation function was applied to select the particular sounds to be played on launching the composition. The four initial voices (of voice, trumpet, clarinet and French horn) were expanded to include a bass singer, guiro, harp, marimba, oboe, piano, tuba, vibes and viola. In addition, a layer of contemporary London traffic noises was also added as a constant background rather than a randomised variable. Although John Carpenter Street is now closed to traffic at the River Thames embankment end, during the mid-1970s it was a busy thoroughfare.

From this palette of thirteen possible rehearsal sounds, the composition was designed to select four on its invocation. On loading the thirteen sounds into the application, they were then cross-loaded into a second array in a random sequence, including a process to ensure

there was no duplication. The first four sounds of this second array were then used as the composition was instantiated. Thus, each time the composition is launched, the four sounds that play will be dependent upon the randomisation function. The composition is in this sense dynamic and created on the fly, albeit from elements that the composer has provided.

The idea of enabling greater user participation in the visual elements of a composition was explored in other examples earlier in this section. The locus in this particular development however was to enable the user to experiment with aural rather than visual layers. The key intent for the third version of this piece was therefore to let the user choose which of the available sounds they wished to listen to, or stop listening to. The first visualisation of the design (Figure 89) provided a series of buttons that enabled the user to toggle the available sounds on/off. One constant remained the background sound of traffic, as well as the animation of the building continuing rather than concluding as in the other, fixed-time pieces.

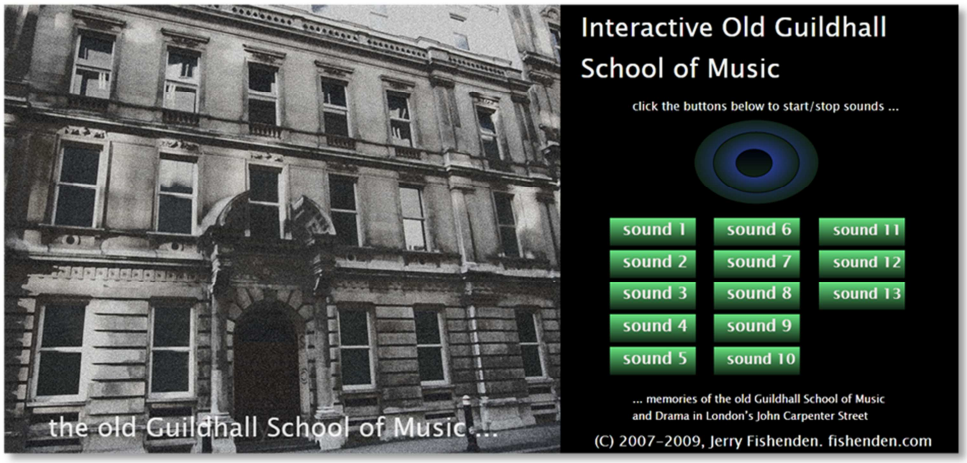


FIGURE 89: GUILDHALL SCHOOL OF MUSIC, INITIAL INTERACTIVE VERSION

The second iteration of this third version re-designed the visual appearance of the work, and was intended to provide the work with a greater sense of fluidity than the initial iteration above with its formal buttons. In this latter design, the buttons were replaced by bespoke gradient circles that pulsed once activated in a manner similar to that of the magic eye of *TimeRadio*.

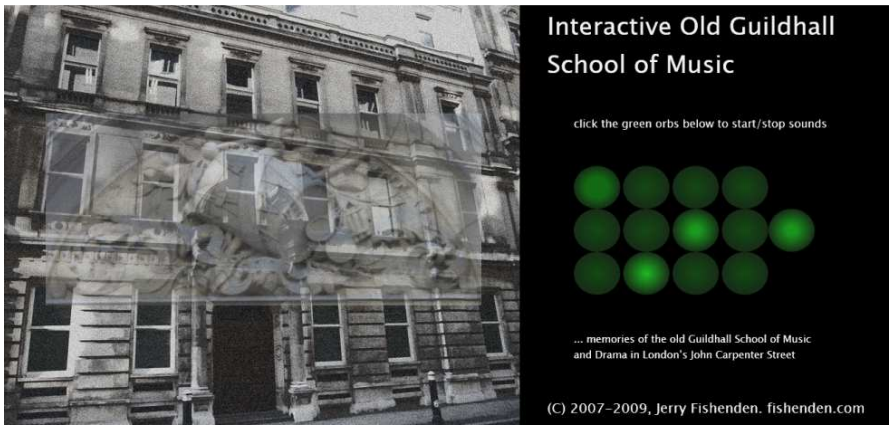


FIGURE 90: GUILDHALL SCHOOL OF MUSIC, SECOND ITERATION

All three of these works (author-led, random, and interactive) can be found in the final composition portfolio. The alternative, animated control model (used in place of buttons) can also be found in later works, including the *sonic London* app available in the Windows Phone 7 marketplace and in the online work *sonic Palimpsest.* Online at http://fishenden.com/research/portfolio/GSM/Default.html, http://fishenden.com/research/portfolio/GSM%20random/Default.html and http://fishenden.com/research/portfolio/GSM%20interactive/default.html. Evaluated in OU1 and OU4.

EXAMPLE: EXPLORATIONS WITH A LENS

The development of additional techniques explored how IDTs could be used to enable an improved ability to understand and navigate hidden layers of the past of place. One of these developments focused on maps, realised through a prototype known as *senseport (palimpsest navigator) – maps*. This work provided a "lens" able to reveal layers from the past. The user could freely move the lens around a contemporary map and peer through the lens to see how that part of the world looked at an earlier point in its history. The work used three West London maps from 2008, 1920 and c.1805 (see Figure 91). Online at http://fishenden.com/research/portfolio/senseport%20maps/Default.html and evaluated in OU1, OU2 and UL1.

FIGURE 91: SENSEPORT (PALIMPSEST NAVIGATOR) – MAPS

These same principles were then applied to a different target, namely views of the same street over time. *senseport (palimpsest navigator) – streets* instead provided a lens able to reveal layers with a different perspective from the past to that of the preceding maps example – the user being able to freely move the lens around the street scene and peer back into that same street at an earlier point in its history (see Figure 92). Online at http://fishenden.com/research/portfolio/senseport%20streets/Default.html and evaluated in OU1 and OU2.

FIGURE 92: SENSEPORT (PALIMPSEST NAVIGATOR) – STREETS

Progressing from this approach, the development incorporated moving images rather than only still images. For one such example, contemporary original video footage was taken of the location of the old Chiswick Empire. Old images of the Empire prior to its demolition were then digitised from postcards and integrated using the senseport lens technique previously used. This enabled the user to see behind the present day moving images of the location and to discover the presence of the Empire that had once stood there beneath. Online at

http://fishenden.com/research/portfolio/senseport%20Chiswick%20Empire/Default.html and evaluated in OU1, OU2 and UL1.

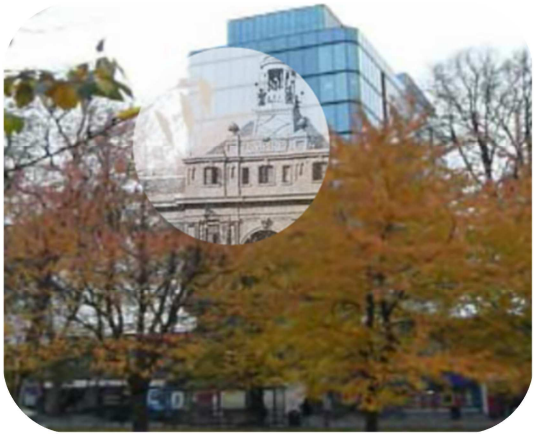


FIGURE 93: SENSEPORT AND MOVING IMAGES - CHISWICK EMPIRE

The technique of the lens able to see through time is a core element of many works in the portfolio, and has been demonstrated through usability testing to provide a strong and emotionally connective method for navigating the past of place. Usability testing has also facilitated the development of the lens technique, making it more intuitive and effective to use.

EXAMPLE: AUTOBIOGRAPHY – CYCLIC

One of the main threads of this research was the exploration of the concept of the *punctum*: the ability to convey effectively to others a particular emotion, feeling or memory using IDTs. Whilst some of the compositions concern place over time, what might be termed a more general biography of time and space, other works intentionally focus on the researcher's autobiography. Accordingly, various compositions were developed to explore this specific interest and to then evaluate the impact of these compositions through the structured feedback mechanisms employed in this research to determine how effectively they were perceived.

The first autobiographical composition adopted a cyclic representational interface (Figure 94). In developing this prototype, the researcher revisited a wide range of former homes and locations where he had previously lived in order to build a portfolio of original images and sounds that were then incorporated into the composition.

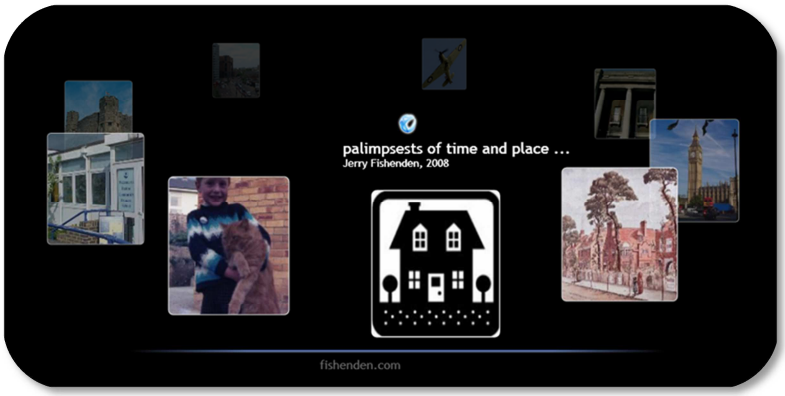


FIGURE 94: AUTOBIOGRAPHICAL PALIMPSESTS OF TIME AND PLACE (CYCLIC)

Clicking on a particular image in the carousel of images would bring it to the foreground (Figure 95).

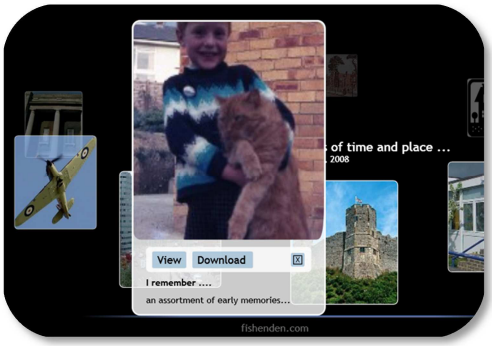


FIGURE 95: SELECTED CAROUSEL IMAGE

And then choosing to view that particular set of associations and memories would invoke an on-screen 'book' that the viewer could flip through. As seen in the screen capture, this book also supports multi-touch capabilities so that, with the appropriate equipment, the viewer could physically manipulate the 'book', resizing and repositioning it and turning the pages with their fingers or through use of a mouse (Figure 96 and Figure 97).

FIGURE 96: THE 'BOOK' OF MEMORIES (COVER PAGE)

FIGURE 97: THE 'BOOK' OF MEMORIES (INTERIOR PAGE)

Online at http://fishenden.com/research/portfolio/autobiography_cyclic/index.html and evaluated in OU1, OU2 and UL1.

Several elements of this earlier work can be found in later works in the portfolio. The *iRemember* book is based on these earlier techniques, enhanced by usability feedback and with the application of methods such as pixel shaders to give the book a more appropriate look and feel. The early exploration of differing representational models – linear, cyclic and rotational – developed into the final form seen in *Palimpsest Navigator,* where layers (in line with the theme of palimpsests) become the predominant modality for the representation and manipulation of time.

EXAMPLE: "PLASMA"

The desired effect was to develop a personal representation of the inner workings of the mind, initially at a pseudo-biological level and then progressively to move the audience into higher level functions, such as recollections of visual and aural memories. The intention was to create a colourful and immersive experience, one that could potentially be large screen projected rather than limited solely to the confines of a desktop PC screen.

For the initial representation, a fluid, dynamic and continually morphing effect was required, built around the concept of red and blues (representational of the flow of blood, with red the blood on the outward journey from the heart and blue that on its return journey). Various open source examples of Silverlight plasma effects were available on the Web from Silverlight community members and although they were not what was required in terms of the effect or visualisation, some of the underlying computational techniques provided a basis from which to develop the composition. One specific set of sample code,

Plasma, was downloaded[41] as a resource that could be stripped down and rebuilt to construct the intended effect.

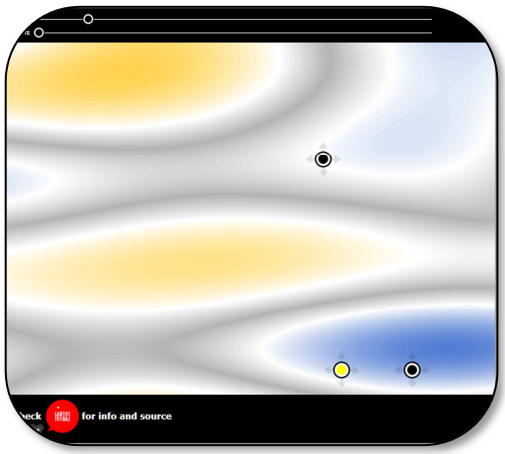


FIGURE 98: KRIS MEEUSEN'S PLASMA SAMPLE

The original code provided sliders and associated manual controls to manipulate the plasma and the various pastel shades of interpolating colours. The code was instructional as an educational tool, but required substantial reworking to achieve the intended artistic purpose. The intent was therefore to:

- Re-design the colour palette to blend in with an emergent work based around memory and internal synapses and connections
- Remove discrete control mechanisms in favour of either automated ones (responding to audio events) or those associated with macro-narratives (incorporating mouse movements and user- or author-initiated events)
- Automate the nature of the plasma and palettes based on audio events and narrative interaction events
- Re-design and constrain the range of underlying colour palettes and interpolations to reflect the narrative purpose
- Move to an automatic height/width scale based on filling the browser screen regardless of the actual dimensions of the user's screen
- Explore different time dimension iterations of the work, from those that could be embedded as part of a larger composition to those that could work standalone in an installation

The downloaded XAML, design-side elements were substantively removed since they related to the manual sliders and buttons. The associated code-behind these controls was also removed and replaced with new code that randomised a choice from the selection of available palettes and utilised event triggers based on embedded audio markers. The original sample palettes were progressively removed and replaced with ones more

[41] From http://www.lab101.be/2009/06/silverlight-3-writeable-bitmap-api-plasma/ on 21.11.2009). The full source code was published online by Kris Meeusen, but in part draws upon C# To ActionScript and Alchemy.

evocative and appropriate to the desired biological colour space (reds for example in place of yellows and with emergent patterns that were better suited to the narrative purpose).

Separately, audio was also composed and marked-up with event triggers to call the new code-behind, invoking changing plasma effects and palettes. The screens are generated in real time and are different each time the composition is experienced.

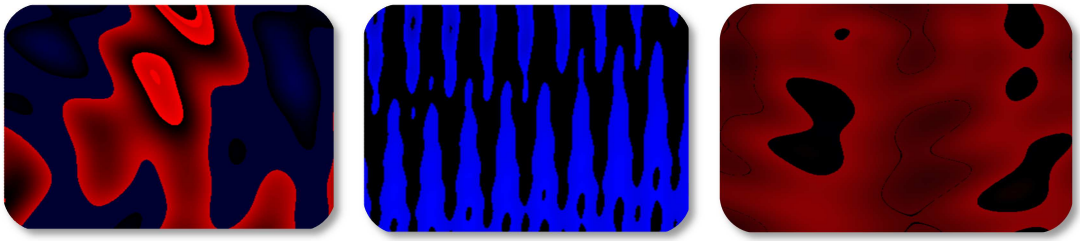


FIGURE 99: SAMPLED INITIAL RESULTS OF PLASMA BIOLOGICAL REPRESENTATION

Online at http://fishenden.com/research/portfolio/plasma/default.html and evaluated in OU4.

EXAMPLE: "BIONODES"

The next phase of work was a representation of the interaction of neural nodes and the development of neural networks sitting in the layer above the low level biological representation provided by the plasma composition. From Jeff Paries book (Paries, 2009), downloadable sample code, the *Node Garden*, provided the foundation for this work, consisting of a variety of blue nodes that moved at random around the screen, but interacted when they came closer together.

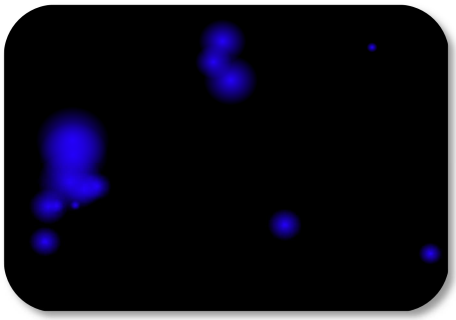


FIGURE 100: JEFF PARIES' NODE GARDEN

The code was reworked to change the colour selection (to red) and various parameters were modified to adapt the way in which the nodes behaved (speed, interaction, etc.), as well as to support a means of layering additional nodes over time (potentially triggered by other events, such as user interaction or markers in related audio content).

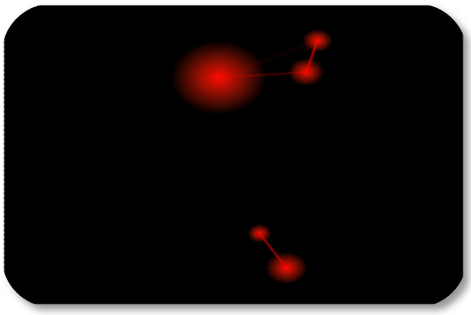


FIGURE 101: BIONODES, FIRST LAYER

While the initial screen was intentionally sparsely populated by nodes and the chance networking between them, the second layer (triggered by an audio marker), adds a significantly richer layer (more nodes, more interactions and connections).

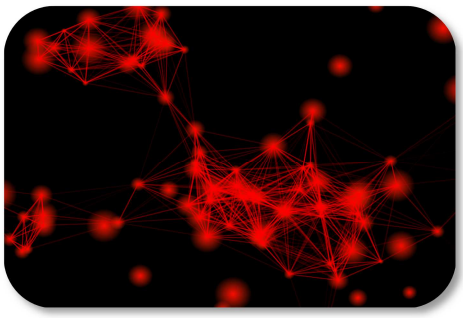


FIGURE 102: BIONODES, SECOND LAYER

Whilst the overall effect was close to that desired, this second layer caused performance issues and led to some stuttering and other undesirable visual artefacts (due to the underlying frame rate dropping significantly because of the computational resources involved). The same issues were experienced in other parts of the composition development and are dealt with in a later section of this Chapter that discusses some of the technical issues encountered during this research.

Online at http://fishenden.com/research/portfolio/bionodes/default.html and evaluated in OU4.

EXAMPLE: "AUTOBIONODES"

The next layer was envisioned as a personal, autobiographical instantiation of the *bionodes*, utilising personal family photographs and associated images representing places and periods of time in the researcher's life. These images would appear in place of the red neural nodes, and there would be additional layers over time, triggered by marker events encoded in the audio stream. These visual memories would be free to float around the screen, initially out of focus. When in sufficient proximity to another memory, they would connect and come into focus. Some groups would drift around together, whilst other

memories snapped away and linked up with others. Some memories would drift around unattached, and hence permanently out of focus. An array was developed to load and provide access to the required images.

FIGURE 103: AUTOBIONODES

Initial programming resulted in overly-complex code, with each layer requiring its own node generation, monitoring and movement routines. It also resulted in each additional layer of nodes remaining isolated from the others rather than interacting. A subsequent re-write enabled a more efficient re-use of common routines and removed around 80% of code. The coding incorporated the design intent of the visual memories (the image nodes, or *autobionodes*) being hazy or blurred when isolated, but moving into sharp focus once linked to and interacting with other memories (an artistic interpretation of the Proustian concept that memories are only created at their time of recall and that it's the act of recall and the interaction of memories that makes them manifest and gives them internal focus).

Online at http://fishenden.com/research/portfolio/autobionodes/default.html and evaluated in OU4. The influence of this, and the two preceding works (*plasma* and *bionodes*), can also be found in *memories of times past* included in the portfolio.

EXAMPLE: SLIVERS OF TIME MODEL

Other approaches to visualising and interacting with images and sounds of the past of place were considered, such as additive layers appearing sequentially on-screen. Charles Petzold published his open source random globules program to demonstrate some of the new features included with Silverlight 3. His code generated rapid random colour "globules" (Petzold's terminology) layered one on top of another.

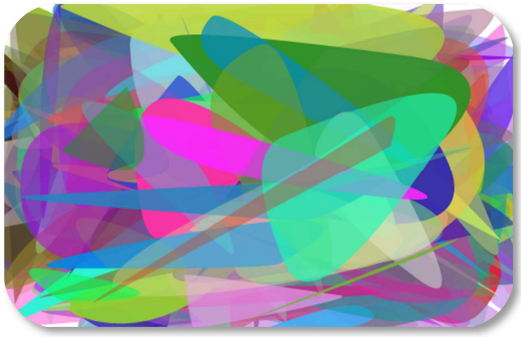


FIGURE 104: CHARLES PETZOLD'S RANDOM GLOBULES

The palimpsest nature (the overlaying of visual layers) was self-evident, but the researcher saw the basis for the layering of images rather than random colours: the underlying approach could be adapted as the basis for randomised image brush and video brush shapes. The source code was downloaded from Charles Petzold's blog[42] and reviewed and re-coded in line with the researcher's vision of a less ethereal, less dreamlike work than that of the bio-nodes, one intended to evoke a more edgy, uneasy atmosphere with images set against a dark background and tearing or ripping jagged holes in the fabric of time. The progressive layers, or tears (the "slivers"), are triggered by markers embedded in an associated audio stream. The randomisation module means that the size and shapes through which the images are seen is rendered differently on each instantiation of the composition.

One issue raised by this composition is the context of the performance: the random nature and size of the polygonal shapes means some are difficult to perceive on a small, desktop PC screen, with the work better suited to large screen projection. The autobiographical model developed the code to include images related to the researcher's own life. Online via http://fishenden.com/research/portfolio/composition2/default.html and evaluated within *Palimpsest Navigator* during UL2 and OU4.

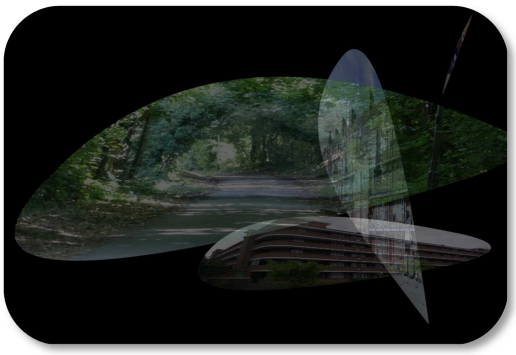


FIGURE 105: SLIVERS OF TIME – AUTOBIOGRAPHICAL

[42] http://www.charlespetzold.com/blog/2009/11/Random-Globules-This-Time.html. Downloaded on 8.11.2009

An alternative variant used biographical instead of autobiographical material – in this case, contemporary moving images of the site where once stood the old Chiswick Empire.

FIGURE 106: SLIVERS OF TIME - BIOGRAPHICAL

This was enhanced with original field recordings of a local resident recalling his memories of the Chiswick Empire in its heyday. Starting with moving images of the current site, the slivers slowly overlay, triggered by each memory, until the present day site has entirely vanished, overlaid with images and sounds of the Chiswick Empire as it once was. Original sound recordings made in the local resident's home were edited into discrete sound bites of specific recollections, each of which was used as an event marker to trigger the visual activities.

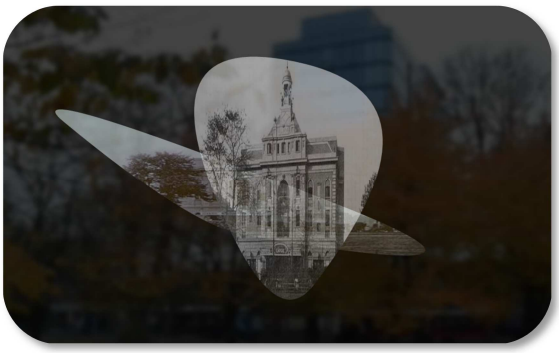


FIGURE 107: SLIVERS OF TIME – BIOGRAPHICAL

Online via http://fishenden.com/research/portfolio/composition2/default.html and evaluated within *Palimpsest Navigator* during UL2 and OU4.

EXAMPLE: FMRI IMAGES

Part of an intended visualisation for the plasma and internal memory representational models included the use of functional magnetic resonance imaging (fMRI) views of the brain. However, fMRI images found on the Web were the copyright of their respective originators. Since they were therefore not available for re-use, the researcher instead used their general appearance as the basis for the creation of a synthetic fMRI model. This approach also had the advantage that the elements of the synthetic fMRI image became programmatically accessible. The initial iteration thus enabled the core "brain" and several

other elements within the fMRI style visualisation to be independently animated and programmed. Online at http://fishenden.com/research/portfolio/mrisite/ and evaluated in OU4.

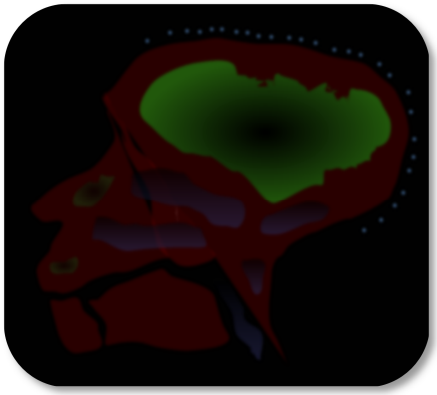


FIGURE 108: SYNTHETIC FMRI SCAN CREATED IN EXPRESSION DESIGN

Part of the design intent was to enable a narrative or interactive sequence to morph between external and internal images, transitioning between the various layers (from blood flow level to neural nodes and synapses to memories). A photo of the researcher in side profile was used (to match the previous fMRI representation developed) and then progressively adapted in Photoshop as a series of related images that could be used to enable programmatic movement between external and internal representation.

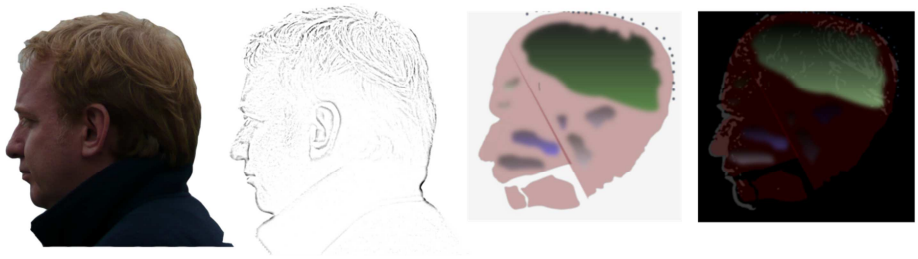


FIGURE 109: IMAGE MANIPULATION, FROM PHOTO TO FMRI

Online at http://fishenden.com/research/portfolio/personal%20fmri/ and evaluated in OU4.

TECHNICAL REALISATION OF THE LENS

The *n*-tier navigation model used several techniques throughout the research, one of these being the development of the lens able to "see" through layers of the same place over time. This section illustrates how the code for the lens was developed in and re-coded across several environments – early Silverlight with Javascript; later Silverlight with C#; and more recent work with HTML5 and Javascript – as well as its re-design based on user experience testing.

ORIGINAL JAVASCRIPT AND XAML CODE

The original code used an image clip combined with ellipse geometry to create the lens shape and to use that same image clip area to show the past image. Note that this first iteration requires the lens to be selected with the mouse and is active only as long as the left mouse button is held down.

```
<Canvas
xmlns="http://schemas.microsoft.com/client/2007"
xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
Width="1280" Height="720"
Background="White"
x:Name="Page">

<Canvas.RenderTransform>
<TransformGroup>
<ScaleTransform ScaleX="1.0" ScaleY="1.0" x:Name="PageScale"/>
</TransformGroup>
</Canvas.RenderTransform>

<MediaElement x:Name="soundport" Source="senseportenter.mp3" AutoPlay="False"/>
<Image Width="1280" Height="720" Source="chiswick3.jpg" Stretch="Fill"/>

<Canvas x:Name="palimpsest" Width="1280" Height="720" Opacity="0.7">

<Image x:Name="senseport" MouseEnter="handleMouseEnter"  MouseLeave="handleMouseLeave"
MouseLeftButtonDown="handleMouseDown" MouseMove="handleMouseMove" MouseLeftButtonUp="handleMouseUp"
Width="1280" Height="720" Source="chiswick1.JPG" Stretch="Fill" RenderTransformOrigin="0.54,0.57"
Canvas.Top="8" Opacity="0.6">

<Image.Clip>
<EllipseGeometry  x:Name="Ellipse" RadiusX="75" RadiusY="75" Center="300,150" />
</Image.Clip>
</Image>
</Canvas>

<TextBlock MouseLeftButtonDown="FSBClick" x:Name="FullScreenText" Text="Enable/Disable Full Screen Mode"
Foreground="White" Cursor="Hand" FontSize="14" FontWeight="Bold" Canvas.Left="875" Canvas.Top="8" Width="236"
Height="24" TextWrapping="Wrap"></TextBlock>
</Canvas>
```

FIGURE 110: PAGE.XAML PALIMPSEST LENS CODE

The page's Javascript, code-behind, is shown in the Figure below. Note that some of these scaling options are to accommodate the facility to switch back and forth between full screen mode.

```
if (!window.senseport_test_ideas)
          senseport_test_ideas = {};

senseport_test_ideas.Page = function()
{
}

senseport_test_ideas.Page.prototype =
{
          handleLoad: function(control, userContext, rootElement)
          {
                    this.control = control;


                    // following settings are for enabling full screen setting
                    m_root = rootElement.FindName("palimpsest");
                    control.content.onFullScreenChange = FullScreenChange;
          }
}

// Global variables below used to keep track of the
// mouse position and whether the object is captured
// by the mouse.

var isMouseCaptured;
var mouseVerticalPosition;
var mouseHorizontalPosition;

// global variables below to ensure
// scaling works effectively
// including the senseport lens

var scaleX = 1;
var scaleY = 1;

function handleMouseDown (sender, args)
{
  var item = sender;
  mouseVerticalPosition = args.getPosition(null).y;
  mouseHorizontalPosition = args.getPosition(null).x;
  isMouseCaptured = true;
  item.CaptureMouse();
}

function handleMouseMove (sender, args)
{
  var item = sender;
  if (isMouseCaptured)
  {
          if (sender.Name == "senseport")
          {
              // Calculate the current position of the object.
          var deltaV = args.getPosition(null).y - mouseVerticalPosition;
          var deltaH = args.getPosition(null).x - mouseHorizontalPosition;



              // Update position global variables.
          mouseVerticalPosition = args.getPosition(null).y;
          mouseHorizontalPosition = args.getPosition(null).x;

          //update image in senseport.
           mycenter = "" + (mouseHorizontalPosition/scaleX) + "," + (mouseVerticalPosition/scaleY) + "";
           sender.findName("Ellipse").Center=(mycenter);
          }
  }
}

function handleMouseUp (sender, args)
{
  var item = sender;
  isMouseCaptured = false;
  item.ReleaseMouseCapture();
  mouseVerticalPosition = -1;
  mouseHorizontalPosition = -1;

}

function handleMouseEnter (sender, args)
{
  sender.findName("senseport").Opacity="1.0";
  sender.findName("soundport").Play();
}

function handleMouseLeave (sender, args)
{
  sender.findName("senseport").Opacity="0.6";
  sender.findName("soundport").Stop();
}


// the following function handles a click on the Full Screen toggle button

function FSBClick(sender, args)
{
    // Toggle between embedded mode and full-screen mode.
   var silverlightPlugin = sender.getHost();
   silverlightPlugin.Content.FullScreen = !silverlightPlugin.Content.FullScreen;
}
```

```
function FullScreenChange(sender, eventArgs)
{
    control = m_root.getHost();
    width = control.content.ActualWidth;
    height = control.content.ActualHeight;

    scale = m_root.FindName("PageScale");

    scaleX = width / m_root.Width;
    scaleY = height / m_root.Height;
    scale.ScaleX = scaleX;
    scale.ScaleY = scaleY;

    // reset the senseport to std location and dimensions
    sender.FindName("Ellipse").RadiusX="75";
    sender.FindName("Ellipse").RadiusY="75";
    sender.FindName("Ellipse").Center="300,150";
}
```

FIGURE 111:PAGE.XAML.JS PALIMPSEST LENS CODE

C# AND XAML CODE

Following usability testing, and alongside continuing updates to the Silverlight development environment, the code was refreshed. This change took into account two key elements of user feedback including the problems encountered with users realising that the lens needed to be selected: for this modified version, the cursor became the lens without requiring any action on the user's behalf. In addition, the feedback that some users would prefer the lens to be re-sizeable was also incorporated into the redesign. This version uses a custom clip path to define the area of the lens.

```
<UserControl
xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
x:Class="Senseport__NET_generic_version.MainPage">

<Grid x:Name="LayoutRoot" Background="White" MouseMove="LayoutRoot_MouseMove" MouseWheel="LayoutRoot_MouseWheel"
Cursor="None">

<Image Source="/new.jpg" Stretch="Fill" Opacity="1" HorizontalAlignment="Center" VerticalAlignment="Center"  />

<Grid x:Name="bigScene" Opacity="0.9" Visibility="Collapsed" >
<Image Source="/old.jpg" Stretch="Fill" >
<Image.Clip>
<EllipseGeometry x:Name="Ellipse" RadiusX="115" RadiusY="115" Center="300,350" />
</Image.Clip>
</Image>
</Grid>

<Canvas x:Name="magGlass" Width="260" Height="395" Canvas.Left="-1" Canvas.Top="-1" />

<Path x:Name="magnifyArea" Fill="#00000000" Stretch="Fill" Canvas.Left="-1" Canvas.Top="-1" Data="M1.5202086,-
0.38218391 L-0.47718381,602.46073 302.12777,600.46456 324.01043,527.0249 476.98435,527.0249 499.86962,599.46648
800.47717,601.46264 800.47718,-0.38218391 z"/>

</Grid
>
</UserControl>
```

FIGURE 112: MAINPAGE.XAML PALIMPSEST LENS CODE

The related C# code for the page is as shown below. A mouse scrollwheel, or equivalent gestures on a touchpad, are used in this version to enable the user to dynamically re-size the lens, making it as large or as small as they like.

```
using System;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Ink;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Animation;
using System.Windows.Shapes;

namespace Senseport__NET_generic_version
{
          public partial class MainPage : UserControl
          {
                    public MainPage()
                    {
                              // Required to initialize variables
                              InitializeComponent();
                    }
                    private void LayoutRoot_MouseMove(object sender, MouseEventArgs e)
                    {
                              bigScene.Visibility=Visibility.Visible;

                              double x = e.GetPosition(null).X;
                              double y = e.GetPosition(null).Y;
                              Ellipse.Center= new Point(x, y);
                    }
                    private void LayoutRoot_MouseWheel(object sender, MouseWheelEventArgs e)
                    {
                    if (e.Delta > 0)
                              {
                                        Ellipse.RadiusX= Ellipse.RadiusX + 15;
                                        Ellipse.RadiusY= Ellipse.RadiusY + 15;
                              }
                              else
                              {
                                        Ellipse.RadiusX= Ellipse.RadiusX - 15;
                                        Ellipse.RadiusY= Ellipse.RadiusY - 15;
          }
          }
          }
}
```

FIGURE 113: MAINPAGE.XAML.CS PALIMPSEST LENS CODE

HTML5 AND JAVASCRIPT

The most recent developmental work on the palimpsest lens has been to port it to the emergent HTML5 environment to remove the need for a proprietary plug-in such as Silverlight. This has been successfully tested on a variety of operating systems and browsers, and is being piloted in the DMU Square Mile project in Leicester. This initial version does not currently support the re-sizeable lens of the C# Silverlight version, but does natively turn the cursor into the lens as it passes over the image area.

```
<!DOCTYPE html>
<html>
<head>
<title>palimpsest lens - Javascript prototype - Jerry Fishenden</title>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8">
<style type="text/css">
.imagePast
{
          width:715px;
          position:absolute;
          top:50px;
          left:8px;
          z-index:1;
}
.imagePresent
{
          width:715px;
          position:absolute;
          top:50px;
          left:8px;
          z-index:-100;
}
.detailsText
{
          width:715px;
          position:absolute;
          top:470px;
          left:8px;
          font-family: Verdana, Geneva, Tahoma, sans-serif;
          font-size: small;
          font-weight:bold;
}
.helpText
{
          width:715px;
          position:absolute;
          top:520px;
          left:8px;
          font-family: Verdana, Geneva, Tahoma, sans-serif;
          font-size: x-small;
          font-style:italic;
}
.aboutText
{
          width:715px;
          position:absolute;
          top:560px;
          left:8px;
          font-family: Verdana, Geneva, Tahoma, sans-serif;
          font-size: x-small;
}
.auto-style1 {
          font-family: Verdana, Geneva, Tahoma, sans-serif;
          font-size: large;
}
</style>
<script type='text/javascript'>
window.onload=function(){
          var canvas = document.getElementById('canvas')
          var ctx=canvas.getContext('2d')
          var mouse={x:300,y:300} // put the lens somewhere central to start until the user interacts
          canvas.onmousemove=function(e){mouse={x:e.pageX-this.offsetLeft,y:e.pageY-this.offsetTop};} //update
the mouse when the canvas is moved over
          canvas.style.cursor="none"
          var img=new Image()
          img.src="old.jpg"
          setInterval(render, 40)

function render(){
          canvas.width = canvas.width
          ctx.save()
          ctx.beginPath()
          ctx.arc(mouse.x,mouse.y,80,0,6.28,false)
          ctx.clip()
          ctx.drawImage(img,0,0)
          ctx.closePath()
          ctx.restore()
          }
}
</script>
</head>
<body>
<h1 class="auto-style1">Palimpsest Lens - Javascript prototype / Jerry Fishenden</h1>
<canvas id='canvas' class="imagePast"  width="715" height="417">Your browser does not support the HTML5 Canvas
element.</canvas>
<div class="imagePresent" ><img id="nowimage" src="new.jpg" height="417" width="715" ></div>
<p class="detailsText">Leicester - corner of Fosse Road North and Noble Street</p>
<p class="helpText">
<span >Move the mouse cursor over the image. It will turn into a lens that can see through time.</span></p>
<p class="aboutText" style="visibility: visible"><span >
<a href="javascript:alert('(C) Jerry Fishenden, 2007-2011\n\nWork in progress ')">About</a></span></p>
</body>
</html>
```

FIGURE 114: HTML5/JAVASCRIPT PALIMPSEST LENS CODE

USE OF PIXEL SHADERS

Another key programming technique used was that of pixel shaders, which enable dynamic effects to be applied to both moving and still images. These ranged from the slightly "unstable" realisation applied to *TimeRadio*, to the edge finding techniques of one of the Trafalgar Square palimpsest slider works. To illustrate how the pixel shaders were developed and applied in the design environment, this example uses the alpha filtration pixel shader utilised with the emergent model applied to Portsmouth Street in London (the Old Curiosity Shop). Both existing, modified and new pixel shaders were developed using the Shazzam pixel shader tool[43]

```
/// <class>ColorKeyAlphaEffect</class>
/// <description>An effect that makes pixels of a particular colour transparent </description>
//-----------------------------------------------------------------------------
// Shader constant register mappings (scalars - float, double, Point, Color, Point3D, etc.)
//-----------------------------------------------------------------------------
/// <summary>The color that becomes transparent.</summary>
/// <defaultValue>Green</defaultValue>
float4 ColorKey : register(C0);
/// <summary>The tolerance in color differences.</summary>
/// <minValue>0</minValue>
/// <maxValue>1</maxValue>
/// <defaultValue>0.3</defaultValue>
float Tolerance : register(C1);
//-----------------------------------------------------------------------------
// Sampler Inputs (Brushes, including Texture1)
//-----------------------------------------------------------------------------
sampler2D Texture1Sampler : register(S0);
//-----------------------------------------------------------------------------
// Pixel Shader
//-----------------------------------------------------------------------------
float4 main(float2 uv : TEXCOORD) : COLOR
{
   float4 color = tex2D( Texture1Sampler, uv );
   if (all(abs(color.rgb - ColorKey.rgb) < Tolerance)) {
      color.rgba = 0;
   }
   return color;
}
```

FIGURE 115: SHAZZAM / COLORKEYALPHA.FX

The resulting ColorKeyAlpha.ps (pixel shader) file was used along with the following C# class as part of the code for the emergent palimpsest technique.

[43] See http://shazzam-tool.com/. Requires Microsoft Silverlight. Retrieved 09.06.2012

```
using System;
using System.Windows;
using System.Windows.Media;
using System.Windows.Media.Effects;
using System.Windows.Media.Media3D;
namespace palimpsest_crystal_ball.Shader
{
public class ColorKeyAlphaEffect : ShaderEffect
    {
        public static readonly DependencyProperty InputProperty =
ShaderEffect.RegisterPixelShaderSamplerProperty("Input", typeof(ColorKeyAlphaEffect), 0);
        public static readonly DependencyProperty ColorKeyProperty =
DependencyProperty.Register("ColorKey", typeof(Color), typeof(ColorKeyAlphaEffect), new
PropertyMetadata(Color.FromArgb(255, 0, 128, 0), PixelShaderConstantCallback(0)));
        public static readonly DependencyProperty ToleranceProperty =
DependencyProperty.Register("Tolerance", typeof(double), typeof(ColorKeyAlphaEffect), new
PropertyMetadata(((double)(0.3D)), PixelShaderConstantCallback(1)));
        public ColorKeyAlphaEffect()
        {
            PixelShader pixelShader = new PixelShader();
            pixelShader.UriSource = new Uri("/palimpsest crystal
ball;component/Shader/ColorKeyAlpha.ps", UriKind.Relative);
            this.PixelShader = pixelShader;
            this.UpdateShaderValue(InputProperty);
            this.UpdateShaderValue(ColorKeyProperty);
            this.UpdateShaderValue(ToleranceProperty);
        }
        public Brush Input
        {
            get
            {
                return ((Brush)(this.GetValue(InputProperty)));
            }
            set
            {
                this.SetValue(InputProperty, value);
            }
        }
        /// <summary>The colour that becomes transparent.</summary>
        public Color ColorKey
        {
            get
            {
                return ((Color)(this.GetValue(ColorKeyProperty)));
            }
            set
            {
                this.SetValue(ColorKeyProperty, value);
            }
        }
        /// <summary>The tolerance in color differences.</summary>
        public double Tolerance
        {
            get
            {
                return ((double)(this.GetValue(ToleranceProperty)));
            }
            set
            {
                this.SetValue(ToleranceProperty, value);
            }
        }
    }
}
```

FIGURE 116: COLORKEYALPHA.CS

The pixel shader was then incorporated within the mainpage as follows.

```
<UserControl x:Class="palimpsest_crystal_ball.MainPage"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
         xmlns:Shader="clr-namespace:palimpsest_crystal_ball.Shader"
    mc:Ignorable="d"
    d:DesignHeight="300" d:DesignWidth="400">
         <UserControl.Resources>
                  <Storyboard x:Name="sbAlphaChange">
                           <DoubleAnimation Duration="0:0:20" From="1" To="0"
Storyboard.TargetProperty="(UIElement.Effect).(ColorKeyAlphaEffect.Tolerance)"
Storyboard.TargetName="cball" d:IsOptimized="True"/>
                  </Storyboard>
        <Storyboard x:Name="sbAlphaChangeReverse">
            <DoubleAnimation Duration="0:0:12" From="0" To="1"
Storyboard.TargetProperty="(UIElement.Effect).(ColorKeyAlphaEffect.Tolerance)"
Storyboard.TargetName="cball" d:IsOptimized="True" Completed="DoubleAnimation_Completed"/>
        </Storyboard>
    </UserControl.Resources>

    <Grid x:Name="LayoutRoot" Background="White">
        <Image Source="new.jpg" Stretch="Fill" MouseLeftButtonDown="Image_MouseLeftButtonDown"
Cursor="Hand" ToolTipService.ToolTip="click to start transition"/>
        <Image Source="old.jpg" Stretch="Fill" MouseLeftButtonDown="Image_MouseLeftButtonDown"
Cursor="Hand"  x:Name="cball" ToolTipService.ToolTip="click to reverse transition"
Visibility="Collapsed">            <Image.Effect>
                 <Shader:ColorKeyAlphaEffect x:Name="AlphaTolerance" Tolerance="1"/>
        </Image.Effect>
         </Image>
     </Grid>
</UserControl>
```

FIGURE 117: MAINPAGE.XAML

With the associated C# code as follows.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Animation;
using System.Windows.Shapes;

namespace palimpsest_crystal_ball
{
    public partial class MainPage : UserControl
    {
        int reveal = 0;

        public MainPage()
        {
            InitializeComponent();
        }
        private void Image_MouseLeftButtonDown(object sender, MouseButtonEventArgs e)
        {
            if (reveal == 0)
            {
                cball.Visibility = Visibility.Visible;
                sbAlphaChange.Begin();
                reveal = 1;
            }
            else
            {
                sbAlphaChangeReverse.Begin();
                reveal = 0;
            }
        }
        private void DoubleAnimation_Completed(object sender, EventArgs e)
        {
            cball.Visibility = Visibility.Collapsed;
        }
    }
}
```

FIGURE 118: MAINPAGE.XAML.CS

LATER EXPLORATIONS OF PLACE AND TIME

The portfolio provides a record of the iterative methodology's impact on refinements and improvements to interactive works. Many of the earlier works described above have helped influence later works. This section describes one particular work, *CCTV*, to illustrate this relationship between works in the portfolio and the iterative methodology utilised in its development.

CCTV

A screenshot of the opening screen is shown in Figure 119. *CCTV* is one of several later works included in the portfolio. It was itself iteratively developed through several releases, witnessing the addition of new features – such as ghostly apparitions and random calls to sound sources in Freesound tagged with "London" – into later versions. Other later techniques, such as pixel shaders (as illustrated in the top right hand and lower left hand "cameras" of Figure 119), were also utilised, building up a rich palette of layers of sights and sounds of London, past and present.

FIGURE 119: CCTV MAIN SCREEN

Earlier interaction techniques are also incorporated into the work, such as left and right mouse movements to fade in and out images (Figure 120).

FIGURE 120: SLIDER TECHNIQUE IN CCTV

FIGURE 121: THE ALL-SEEING EYEBALL IN CCTV

As well as earlier techniques for navigating and interacting with the layers, the work also incorporates some unexpected elements, with an eyeball[44] occasionally appearing to watch the movements of the user (illustrated in the top left-hand corner of Figure 121). The user can also interact with the eyeball itself. If the user wishes (and their PC is suitably equipped) they can also insert themselves into the work, appearing in a pixel-modified form within one of the on-screen camera windows.

FIGURE 122: EARLIER WORKS LAYERED INSIDE CCTV

Earlier works are also layered inside CCTV, including the moving footage of Trafalgar Square past and present (Figure 122), explored in earlier work.

[44] Based on the code from Silverlight Eyeballs. http://www.pay4foss.org/jumpstation/sliball/. Retrieved 27.01.2012.

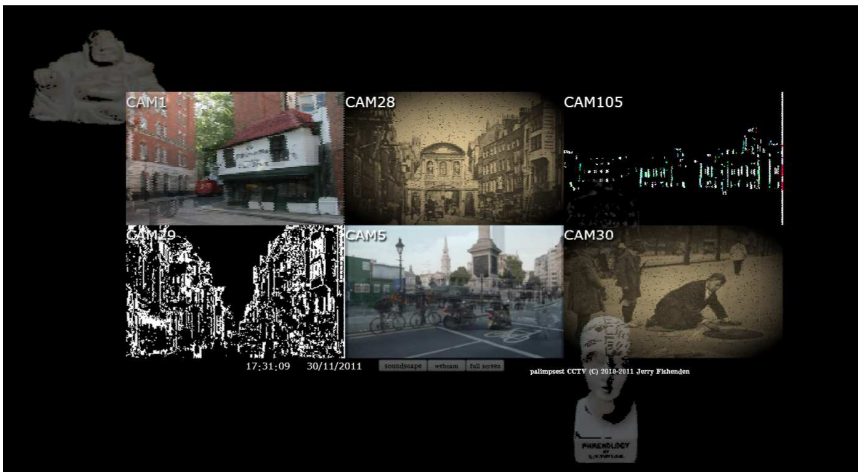


FIGURE 123: GHOSTLY, WHISPERING APPARITIONS IN CCTV

Alongside the appearance of the all-seeing eye, CCTV also features ghostly apparitions that appear and float around the screen, apparently mouthing unheard sentiments (Figure 123). These apparitions started as static images photographed with greenscreen backgrounds by the researcher. They were then processed in the package CrazyTalk to make them "speak", saved as videos with a transparent background (achieved via the use of greenscreen) and then incorporated into the work.

FIGURE 124: THE CLASS VIEW OF CCTV

CCTV uses a variety of classes (Figure 124). To illustrate how classes have been used, one of these is the class that handles the ghostly apparitions. The actual appearance is defined in a XAML template (Figure 125).

```
<UserControl
xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
xmlns:Synergist_Effects="clr-
namespace:Synergist.Effects;assembly=Synergist.Effects"
xmlns:ee="http://schemas.microsoft.com/expression/2010/effects"
x:Class="CCTV.GhostImage"
mc:Ignorable="d"
d:DesignHeight="346" d:DesignWidth="366">

<Canvas x:Name="panelGhosts" >
<Canvas.Effect>
<ee:PixelateEffect Pixelation="0.49"/>
</Canvas.Effect>
<MediaElement x:Name="meghost" Height="346" Width="366" Opacity="0.415"
MediaEnded="MediaElement_MediaEnded" >
<MediaElement.Effect>
<Synergist_Effects:ChromaKeyAlphaEffect ColorKey="Black"/>
</MediaElement.Effect>
</MediaElement>
</Canvas>
</UserControl>
```

FIGURE 125: XAML CODE FROM THE GHOSTIMAGE CLASS

The associated C# managed code is shown in Figure 126.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Animation;
using System.Windows.Shapes;

namespace CCTV
{
    public partial class GhostImage : UserControl
    {
        public Point Velocity;

        public GhostImage()
        {
            InitializeComponent();
        }

        public double x
        {
            set
            {
                this.SetValue(Canvas.LeftProperty, value);
            }
            get
            {
                return (double)this.GetValue(Canvas.LeftProperty);
            }
        }

        public double y
        {
            set
            {
                this.SetValue(Canvas.TopProperty, value);
            }
            get
            {
                return (double)this.GetValue(Canvas.TopProperty);
            }
        }

        private void MediaElement_MediaEnded(object sender, RoutedEventArgs e)
        {
            MediaElement me = sender as MediaElement;
            me.Position = TimeSpan.Zero;
            me.Play();
        }

    }
}
```

FIGURE 126: C# CODE FROM THE GHOSTIMAGE CLASS

The actual ghost image video to be used is determined by code in the main class function (Figure 127).

```
// below for ghosts
        private List<GhostImage> GhostImages; // list of ghosts
        private int numGhostImages = 3; // number of ghost images, default value
        private int TotalGhostImages; // total number of ghost images
        private int StartCount = 0;
        private int GhostIterationCount = 0; // checks which iteration of ghosts we are on
        private Random Rand = new Random(); // used to randomise where ghost images appear on the screen when created

…..

// animate the ghost
            GhostImages = new List<GhostImage>();
            TotalGhostImages = numGhostImages;


…
private void moveghost()
        {
            foreach (GhostImage nextGhostImage in GhostImages)
            {
                Canvas.SetLeft(nextGhostImage, Canvas.GetLeft(nextGhostImage) + nextGhostImage.Velocity.X);
                Canvas.SetTop(nextGhostImage, Canvas.GetTop(nextGhostImage) + nextGhostImage.Velocity.Y);

                if (Canvas.GetLeft(nextGhostImage) > (App.Current.Host.Content.ActualWidth - 470))
                {
                    nextGhostImage.Velocity.X = -Rand.Next(1, 3);
                    Canvas.SetLeft(nextGhostImage, App.Current.Host.Content.ActualWidth - 471);
                }
                else if (Canvas.GetLeft(nextGhostImage) < 0)
                {
                    nextGhostImage.Velocity.X = Rand.Next(1, 3);
                    Canvas.SetLeft(nextGhostImage, 0);
                }

                if (Canvas.GetTop(nextGhostImage) > App.Current.Host.Content.ActualHeight - 120)
                {
                    nextGhostImage.Velocity.Y = -Rand.Next(1, 3);
                    Canvas.SetTop(nextGhostImage, App.Current.Host.Content.ActualHeight - 121);
                }

                else if (Canvas.GetTop(nextGhostImage) < 0)
                {
                    nextGhostImage.Velocity.Y = Rand.Next(1, 3);
                    Canvas.SetTop(nextGhostImage, 1);
                }

            };
        }

        private void RemoveGhostImage()
        {
            foreach (UIElement ghostelement in panelGhosts.Children.ToList())
            {
                GhostImage aGhostImage =  ghostelement as GhostImage;
                panelGhosts.Children.Remove(ghostelement);
            }

            foreach (UIElement ghostelement in GhostImages.ToList())
            {
                GhostImage aGhostImage = ghostelement as GhostImage;
                GhostImages.Remove(aGhostImage);
            }
        }

        private void CreateGhostImage()
        {
            for (int i = StartCount; i < TotalGhostImages; i++)
            {
                GhostImage nextGhostImage = new GhostImage();
                nextGhostImage.Velocity.X = Rand.Next(-2, 2);
                if (nextGhostImage.Velocity.X == 0)
                    nextGhostImage.Velocity.X = 2;
                nextGhostImage.Velocity.Y = Rand.Next(-2, 2);
                if (nextGhostImage.Velocity.Y == 0)
                    nextGhostImage.Velocity.Y = 2;

                int GIleft, GItop;
                GIleft = Rand.Next(0, (int)App.Current.Host.Content.ActualWidth);
                GItop = Rand.Next(0, (int)App.Current.Host.Content.ActualHeight);
                Canvas.SetLeft(nextGhostImage, GIleft);
                Canvas.SetTop(nextGhostImage, GItop);
                GhostIterationCount = random.Next(6);
                if (GhostIterationCount == 0) { nextGhostImage.meghost.Source = new Uri("movies/pman.wmv", UriKind.Relative); }
                if (GhostIterationCount == 1) { nextGhostImage.meghost.Source = new Uri("movies/dollremember.wmv", UriKind.Relative);
}
                if (GhostIterationCount == 2) { nextGhostImage.meghost.Source = new Uri("movies/actionman.wmv", UriKind.Relative); }
                if (GhostIterationCount == 3) { nextGhostImage.meghost.Source = new Uri("movies/netsuke1.wmv", UriKind.Relative); }
                if (GhostIterationCount == 4) { nextGhostImage.meghost.Source = new Uri("movies/netsuke2.wmv", UriKind.Relative); }
                if (GhostIterationCount == 5) { nextGhostImage.meghost.Source = new Uri("movies/russiandoll.wmv", UriKind.Relative);
}
                nextGhostImage.meghost.Play();
                GhostImages.Add(nextGhostImage);
                panelGhosts.Children.Add(nextGhostImage);
            }
        }

        // if a user clicks on the ghosts, they will disappear
        private void panelGhosts_MouseLeftButtonDown(object sender, MouseButtonEventArgs e)
        {
            panelGhosts.Visibility = Visibility.Collapsed;
        }
```

FIGURE 127: CCTV EXTRACT OF GHOSTIMAGE CODE FROM MAIN

An overview of the file and directory structure of CCTV is shown in Figure 128. Other compositions use similar structures, storing underlying audio, images and moving images in separate folders and with custom pixel shaders defined in another folder.

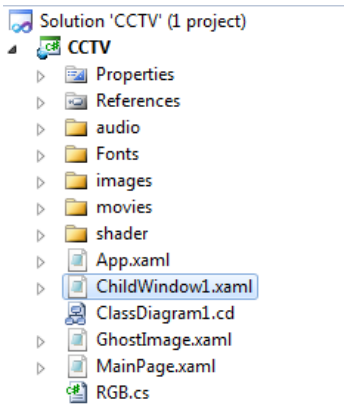


FIGURE 128: THE FILE AND DIRECTORY STRUCTURE OF CCTV

Full code for *CCTV* is included on the *Source Code* DVD.

PERFORMANCE ISSUES AND TUNING

This section summarises some of the issues encountered with technical performance during the research and their attempted mitigations.

BACKGROUND

The primary development environment used was Microsoft's Visual Studio 2008 and 2010 and Expression Studio, Versions 2, 3 and 4. Initial work commenced using Visual Studio 2005 and Expression Studio Version 1. Version 1 of Silverlight only worked with Javascript, not with managed code. Later versions worked with managed code and C# was used.

PERFORMANCE ISSUES AND OPTIMISATION

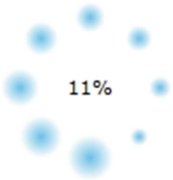


FIGURE 129: LONG LOAD TIMES WITH COMPLEX COMPOSITIONS

Some of the works used a significant number of embedded resources. Whilst initial loading performance could be optimised by removing the resources from the .xap and loading them dynamically from file content, doing so had negative impacts on the user experience since resources were then slow to load within the composition. To resolve these issues, various resources were consulted including:

- "Deep Dive: Building an Optimized, Graphics-Intensive Application in Microsoft Silverlight" (http://channel9.msdn.com/pdc2008/PC06/ on 02.12.2009)

- http://blogs.silverlight.net/blogs/msnow/archive/2008/11/03/silverlight-tip-of-the-day-67-silverlight-performance-tips.aspx
- Windows Performance Analysis kit - http://msdn.microsoft.com/en-us/performance/default.aspx
- http://blogs.msdn.com/seema/archive/2008/10/08/xperf-a-cpu-sampler-for-silverlight.aspx

To facilitate trouble-shooting, it is possible to set the browser to display the current frame rate of a Silverlight application using the EnableFrameRateCounter parameter:

```
<param name="EnableFrameRateCounter" value="True" />
```

FIGURE 130: THE FRAME RATE COUNTER

The four numbers displayed are:

- the frame rate
- kilobytes of GPU memory being used
- total number of GPU accelerated surfaces
- number of GPU accelerated surfaces that are not explicitly asked to be GPU accelerated – or the number of implicit surfaces

Testing with *autobionodes*, one of the works which exhibited performance issues during realisation, at this stage produced the following reported results:

Initial: between 51.36-71.00fps
Next layer added: around 31.66fps
Next layer added: around 21.21fps
Next layer added: around 6.45fps

It is also possible to set a maximum frame rate. *autobionodes* was therefore deliberately constrained to 15fps to see how it would appear.

```
<param name="MaxFrameRate" value="15" />
```

The results were:

Initial: c. 15fps
Next layer added: c. 15fps
Next layer added: c. 15fps
Next layer added: c. 8.52fps

This provided a more even performance over the first 3 layers of images, but declined once again after the addition of the third set of nodes. GPU hardware-based acceleration is also supported and this is also enabled through an optional parameter, EnableGPUAcceleration. The following was therefore added to the configuration:

```
<param name="EnableGPUAcceleration" value="True" />
```

The results were:

Initial: c. 15fps
Next layer added: c. 15fps
Next layer added: c. 19fps
Next layer added: c. 8fps

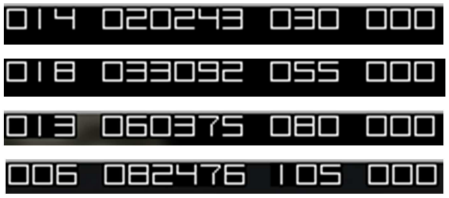
Whilst the GPU acceleration seemed to slightly boost the fps beyond the max stated of 15, it still dropped to the same poor fps as the fourth layer was added.

Cache visualisation is another test feature that highlights areas of an application that are not taking advantage of bitmap caching on the video card. This parameter was therefore also enabled.

```
<param name="EnableCacheVisualisation" value="True" />
```

This did not highlight any areas needing attention.

Adding the CacheMode="BitmapCache" into the Canvas for both Particle2.xaml and scene2.xaml did little to improve the frame rate either.



As can be seen above, the fps continued to drop significantly on the addition of the 4th layer.

One possibility was that a mix of the size of images, and the number, were impacting the efficiency of the processing associated with manipulating their on-screen behavioural characteristics. However, a comparison with *bionodes*, which does not use images, but an ellipse with a radial gradient brush, appeared to show little difference in performance. As a second layer was added in *bionodes*, performance also dropped.

FIGURE 131: FPS RATE IN BIONODES AFTER SECOND LAYER ADDITION

This suggested issues with the performance of the actual code computing the behaviours of the nodes on-screen. However, at this stage the *bionodes* code had not been brought into line with the updates to code efficiency made to *autobionodes*. The next step was therefore to update the codebase and revalidate its performance characteristics before any conclusions could be drawn and remedial actions planned.

After these changes, the initial layer and second layer fps performance was:

FIGURE 132: FPS RATE IN BIONODES (BOTH LAYERS) AFTER CODE OPTIMISATION

The code changes appeared to have helped optimise the frame rate performance of *bionodes*. To validate what the unconstrained fps performance would be like, the MaxFrameRate constraint was set to 1,000 (the default is 60) and the test re-run.

FIGURE 133: ACTUAL FPS IN BIONODES WITH NO MAXIMUM CONSTRAINTS

From these test results, it was clear that the fps dropped significantly as a direct consequence of the second layer of *bionodes*.

The conclusion was that the underlying common codebase for both *bionodes* and *autobionodes* needed improving if the frame rate were to perform well enough to meet the required composition effects that the researcher intended. The minimum requirement was to ensure that the frame rate remained above 15fps at all times: anything below this was too jittery for the composition.

Xperf was installed and *autobionodes* run for a test period.

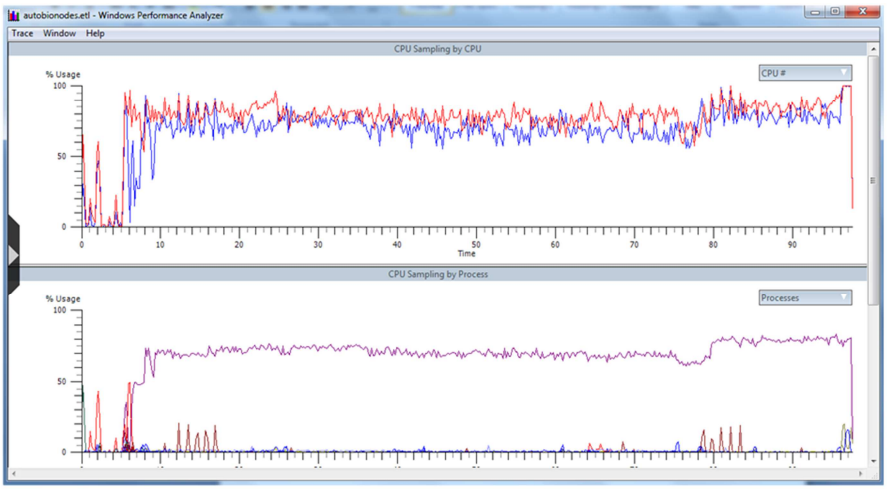


FIGURE 134: XPERF MAIN SCREEN OVERVIEW OF AUTOBIONODES PERFORMANCE

XPerf captures everything on the host computer, but the key files of concern here are those related to Silverlight: agcore.dll, npctrl.dll and coreclr.dll.

Line	Process	Thread ID	Thread Start Module	Thread Start Function	Cpu Usage (ms)	% Cpu Usage	% Relative Cpu Us...
1	⊟ iexplore.exe (2204)				3,109.319 827	70.20	70.82
2		5,700	iertutil.dll	⊞ Unknown	1,199.865 929	27.09	27.33
3		3,500	agcore.dll	⊞ Unknown	919.826 642	20.77	20.95
4		1,844	agcore.dll	⊞ Unknown	910.085 995	20.55	20.73
5		1,384	coreclr.dll	⊞ Unknown	47.431 928	1.07	1.08
6		3,764	agcore.dll	Unknown	14.275 942	0.32	0.33
7		4,272	agcore.dll	Unknown	11.409 723	0.26	0.26
8		600	dsound.dll	Unknown	4.205 027	0.09	0.10
9		1,096	npctrl.dll	⊞ Unknown	1.294 315	0.03	0.03
10		5,412	agcore.dll	Unknown	0.642 021	0.01	0.01

FIGURE 135: INITIAL XPERF DETAILED REPORT

Two working questions arose:

- why where the symbols not being correctly loaded to enable a more detailed drilldown into the agcore function? [which involved a check of reference PATHs and to ensure binary versions were all identical]
- why were there so many separate instances of agcore?

After re-coding *autobionodes* as a standalone application, the tests were re-run.

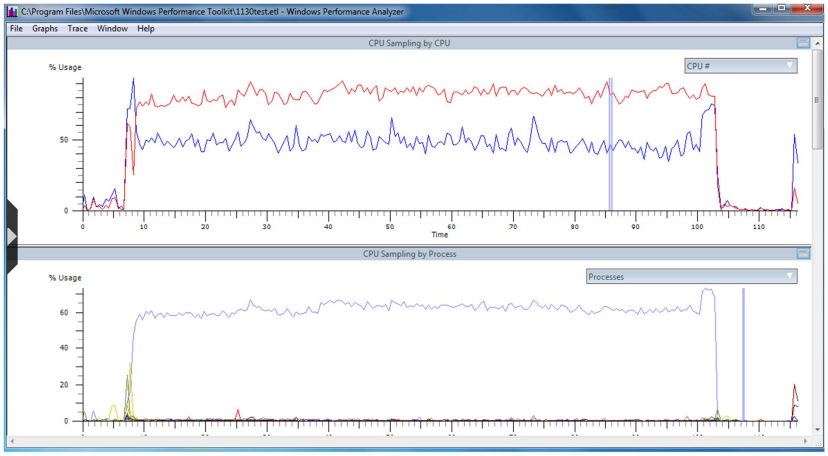


FIGURE 136: AUTOBIONODES AS A STANDALONE APPLICATION

Within the drilldown, agcore.dll only appeared once.

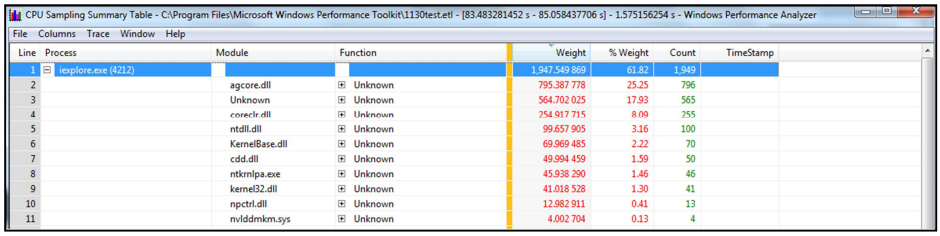


FIGURE 137: SINGLE OCCURRENCE OF AGCORE.DLL IN STANDALONE TEST

This suggests that the multiple occurrences in the other example were due to the way the variety of pages had been integrated together within the composition as originally designed. However, the performance of the standalone version of *autobionodes* when re-run with fps measurements was no better.

The general conclusion after trouble-shooting in several works is that certain compositions in the portfolio push the design and realisation environment to the bounds

of its current performance limits. This in part may be attributable to the use of the Silverlight environment for creative purposes not originally foreseen by the product design team.

CHAPTER 4: USER EXPERIENCE

This Chapter describes the role of user experience testing in evaluating and improving the works in the portfolio. Throughout the research, the development, testing and evolution of the portfolio's content was a cyclic, iterative process, with works and techniques being developed and informed through systematic online and lab-based usability testing.

ONLINE USABILITY 1 (OU1) FEEDBACK

The initial online user feedback survey detailed in OU1 ran from April 2009 to August 2009 on the researcher's Web site. Links were provided to the survey both from the landing page and the main site home page. In addition, details about the survey and the approach taken to the collection and use of data were available wherever a link to the survey was provided. A total of 30 surveys were completed. Overall response rates within the survey questions are shown in Figure 138.

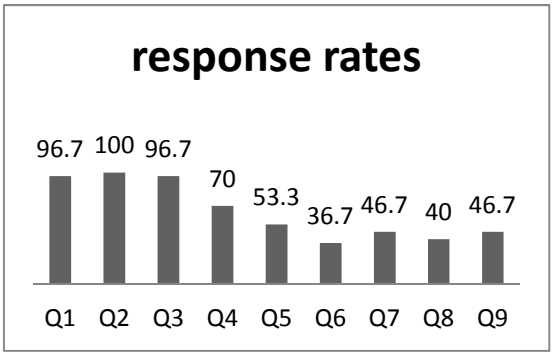


FIGURE 138: RESPONSE RATES BY QUESTION

The self-classification of respondents to the survey Q1 in terms of their familiarity with using a PC (where 1 is novice and 10 expert) is shown in Table 9. The lowest grading anyone self-classified was 6, the highest 10 and with the largest group self-classifying as an 8.

Response	Number of respondents
6	2
7	6
8	13
9	4
10	4

TABLE 9: SELF-CLASSIFICATION OF PC PROFICIENCY

On Question 2, relating to the ease of use of the compositions, 28 respondents indicated they found them easy with 2 indicating otherwise, shown in Table 10.

Response	Number of respondents
Yes	28
No	2

TABLE 10: QUESTION 2, EASE OF USE

On the question of how evocative the compositions were of the past (Question 3), 28 respondents stated that they found the navigation of past and present images and sound evocative, with 1 indicating that they were not.

Response	Number of respondents
Yes	28
No	1

TABLE 11: QUESTION 3, EVOCATIVE OF THE PAST

For the remaining closed question (Question 7), regarding which model of representing time worked best (cyclic, linear, or didn't care/no difference), the results are shown in Table 12.

Response	Number of respondents
Cyclic	13
Linear	2
Didn't care/no difference	14

TABLE 12: QUESTION 7, MODELS OF REPRESENTING TIME

Although there was a slight majority in favour of indicating no difference, between the two other options the cyclic model was notably more popular, with 13 respondents favouring it over the 2 who indicated a preference for the linear model.

For the first of the free-form questions (Q4 – "How could the composition interfaces be improved?"), 21 responses were received and are shown, verbatim/uncorrected, in Table 13.

Q4R1	Slow to load.
Q4R2	Some of the pieces are too slow too load - the images and sounds do not start crisply.
Q4R3	Flash
Q4R4	more user control
Q4R5	luv the carousel - would like to be able to re-size
Q4R6	I'd like to see more integration between them, so that they become parts of a bigger story not separate isolated pieces.
Q4R7	You should allow the user more configuration options to allow them to fine tune the navigation methods.
Q4R8	finish them
Q4R9	I think that alternative designs of the magnifying glass would be nice.
Q4R10	enjoyed, not seen anything like it b4
Q4R11	flash too please
Q4R12	full screen when they start
Q4R13	make faster - some slow to load,
Q4R14	scroll wheel to zoom in/out?
Q4R15	interlink in some way
Q4R16	start full screen
Q4R17	video content slow to download and start, sometimes broken up
Q4R18	Sorry - I cdnt make it work on MacOs via mobile modem in a coffee shop. It zoomed in and out, but didnt pan
Q4R19	greater user control would be very useful, maybe letting the user increase the size of the lens and the amount it reveals. Also, more work on the sound side - seems a bit of a poor relation in the samples at the moment. Is there an equivalent of the visual lens for sound? And then maybe both could be adapted by the user, either together or seprately.
Q4R20	more options/intractions
Q4R21	re-size the viewer

TABLE 13: QUESTION 4, INTERFACE IMPROVEMENTS VERBATIM RESPONSES

Q5 ("What was your favourite composition - and what made it work well for you?") responses are shown verbatim in Table 14.

Q5R1	The magnifier that revealed the past.
Q5R2	the radio - mix of sounds, humour and interface. It was more complete than some ideas.
Q5R3	luv the carousel way of moving between photos
Q5R4	The lens for exposing the way a place looked before is good - more past and contemporary images/sounds.
Q5R5	The street views (old and new), both the still and moving ones.
Q5R6	good ideas but incomplete
Q5R7	interactive historic maps
Q5R8	maps + moving street (old music hall)
Q5R9	the maps - new way of finding out what has changed
Q5R10	the Emnpire bdng w/moving images - seems like people from the past are walking thro it
Q5R11	i remember - it really touched me - (the representation from photo to inner brain and back again that got me!). very eerie music and well matched to the visual
Q5R12	old music hall - moving images, sounds
Q5R13	Cant say - see below
Q5R14	the moving street with old images underneath it was good. they need to get lined upa bit better in some of the samples.
Q5R15	old street view - like looking back in time
Q5R16	the old chisick empire, brought the past alive

TABLE 14: QUESTION 5, FAVOURITE COMPOSITION VERBATIM RESPONSES

Q6 ("What was the composition that worked least well for you - and why did it not work?") verbatim responses are shown in Table 15.

Q6R1	Some of them came up blank (running Firefox on Mac)
Q6R2	The London music college was a fun interface, but very noisy.
Q6R3	They all work - but some are clearly incomplete and they need to be better themed into each other
Q6R4	The window panes - no interaction and limited content.
Q6R5	the deep zoom i had problems (lost picture, had restart
Q6R6	problems with the turning the pages
Q6R7	the London picture gallery - sounds are too repetitive
Q6R8	Ditto
Q6R9	the old maps of west london was a good idea, but it feels unfinished.
Q6R10	carousel - repititive, not plus content
Q6R11	the london gallery was too reptative

TABLE 15: QUESTION 6, LEAST PREFERRED COMPOSITION VERBATIM RESPONSES

Q8 ("Are there any particular sounds/images/pieces that really impacted you? If so, which ones? And why?") verbatim responses are shown in Table 16.

Q8R1	the radio used some very evocative/imaginative sounds
Q8R2	the circling auto=biography
Q8R3	The story with turning pages has a lot of potential. Carefully constructed sound would enhance it, as would moving and other unexpected graphic ideas.
Q8R4	good ideas, will review again when finished
Q8R5	The I Remember composition - the combination of images and sounds, and the fragmentation at the end.
Q8R6	like the story books from carousel
Q8R7	as above, the Empire bdng
Q8R8	i remember piece (see comments above)
Q8R9	cant say yet
Q8R10	the children in the old street being revealed by the lens. I'd like to be able to do something like this with my old photos from when I was growing up - could you make the source code available, or make it possible to load our own photos onto the site?
Q8R11	old street view
Q8R12	like the time radio idea but more sounds

TABLE 16: QUESTION 8, MOST IMPACTFUL COMPOSITION VERBATIM RESPONSES

Q9 ("If you have any other comments about how you'd like to see this work develop please enter them here") verbatim responses are shown in Table 17.

Q9R1	I had problms on Linux. Worked fine on my Mac.
Q9R2	use flash
Q9R3	Jerry - I will visit again. There are interesting ideas here I want to explore more.
Q9R4	I will come and have a look again when you have progressed this work.
Q9R5	will visit more when new on site
Q9R6	the one with moving image better
Q9R7	feels incomplete/fragmentary at the moment? more/longer narrative?
Q9R8	a lot of it is fragmentary at the moment - the i remember one is much better, more like that
Q9R9	will visit again
Q9R10	Jerry - I'd better try this again with decent connection, and will try on XP as well as Mac OS. So pse treat this as feedback on failed first attempt
Q9R11	some of my comments above. Thanks [name redacted]
Q9R12	bit short something longer
Q9R13	more sound, images and tools to explore
Q9R14	maybe put some of these ideas togther into a more complete piece

TABLE 17: QUESTION 9, OTHER FEEDBACK VERBATIM RESPONSES

The various responses were assessed for patterns of potential relevance to the feedback methodology being utilised in this research, with the following elements subsequently abstracted:

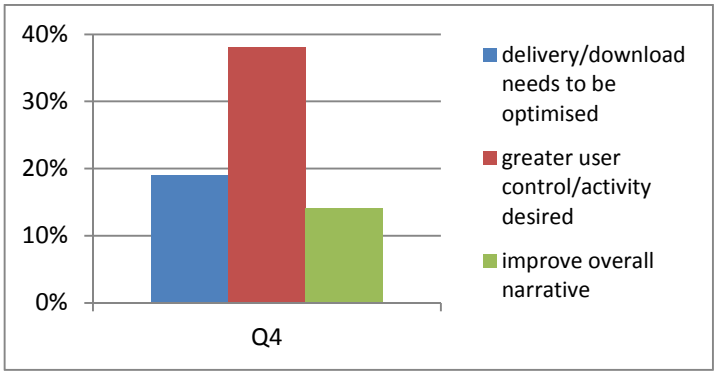


TABLE 18: Q4 CATEGORISED FEEDBACK

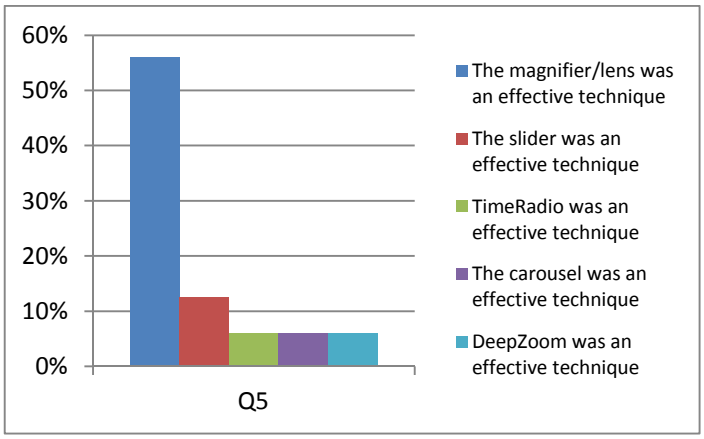


TABLE 19: Q5 CATEGORISED FEEDBACK

Responses to Q6 were less easily categorised, with a range of opinions concerning which of the compositions proved least effective. An underlying element however related to the need for improved narrative structures and content (rather than the episodic, or

'fragmented', nature of some of the compositions utilised for this online feedback). For Q8, the categorisations are shown below.

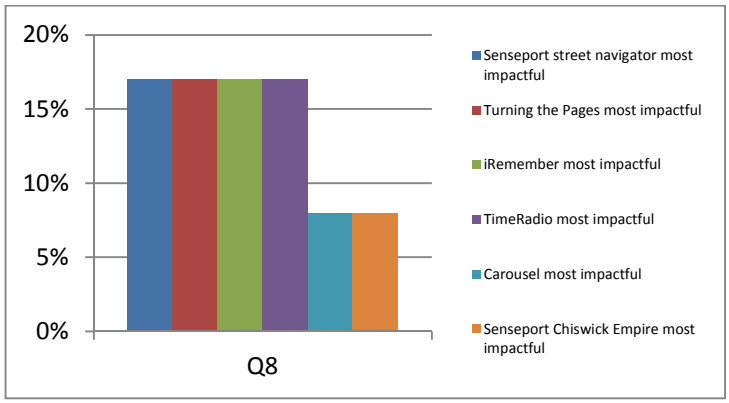


TABLE 20: Q8 CATEGORISED FEEDBACK

On Q9, 36% were categorised as indicating a preference for an improved overall narrative. Several cross-platform compatibility issues were identified, which were out of scope for the researcher (although technical testing continued to take place cross-browser and cross-platform wherever possible, the principal targets remained Internet Explorer and Chrome running on the Windows platform).

Key conclusions drawn from the online survey feedback, with particular relevance to the research questions, included the following:

- feedback was provided by a reasonably competent range of users [self-classified in Q1 in the range of 6-10, with 10 being 'expert']
- a high level of consensus existed that the compositions were easy to use [93.3% of respondents to Q2]
- the compositions were evocative of the past [96.6% of respondents to Q3]
- delivery/download needed to be optimised [19% of respondents to Q4]
- greater user control/interactivity was desired [38% of respondents to Q4]
- improvements to overall narrative structure were required [14% of respondents to Q4]
- the magnifier/lens was an effective technique [56% of respondents to Q5]
- the slider was an effective technique [12.5% of respondents to Q5]
- TimeRadio/carousel/DeepZoom were effective techniques [6% apiece of respondents to Q5]
- improvements were suggested to the coherence of the overall narrative structure [implicit in responses to Q6]

- where cyclic or linear temporal interactive and presentational models are being considered, there is preference toward cyclic as being the more effective of the two [Q7 44.8% against 6.9%]
- there was no strong preference in terms of navigation and presentational methods in terms of their impact [Q8], with respondents mixed in what worked best for them
- improvements to the overall narrative structure were highlighted as an issue in [Q9]

The conclusions thus became inputs to the next range of iterative development of the compositions. The specific inputs and the areas for review during the next cyclic stage of development were:

Feedback input	Proposed exploratory actions during next cycle of realisation
delivery/download needs to be optimised	• evaluate alternative encoding options to optimise visual and aural elements without loss of appropriate fidelity • evaluate alternative sourcing of streaming
greater user control/interactivity desired	• evaluate additional interaction elements within realisations
improvements to overall narrative structure required	• progressively build up longer works with extended narrative, but with retention of user-interaction
the magnifier/lens was an effective technique: potential to apply to audio as well	• further develop/utilise the magnifier/lens • prototype and evaluate audio equivalents
the slider was an effective technique	• integrate the slider as an additional interaction element within realisations
TimeRadio/carousel/DeepZoom were effective techniques	• utilise these alternative representational and interaction models in other pieces
improvements were suggested to the coherence of the overall narrative structure	• develop various models of composition
where cyclic or linear temporal interactive and presentational models are being considered, there is preference toward cyclic as being the more effective of the two	• consider primary emphasis on the cyclic model over the linear
there was no strong preference in terms of navigation and presentational methods in terms of their impact, with respondents mixed in what worked best for them	• develop and explore a variety of options for interaction to enable users to utilise and explore those that work optimally for them

TABLE 21: INPUTS TO NEXT REALISATION CYCLE BASED ON INITIAL FEEDBACK

These conclusions provided useful inputs to the next stage of iterative development of the portfolio. Of particular relevance was the finding that the majority of respondents indicated that they found the sample compositions evocative of the past.

ONLINE USABILITY 2 (OU2) FEEDBACK

OU2 ran from March 2010 to August 2010. Feedback received during this period, utilising star ratings, is shown in the table below (in the order in which the techniques were displayed on the research page).

Technique	Overall star rating
Senseport lens (overall)	4.4 (106 votes)
Senseport lens – Cleopatra's needle	4.1 (76 votes)
Senseport lens – Cenotaph	4.3 (89 votes)
Senseport lens – London maps	4.6 (93 votes)
Senseport lens – West London streets	4.3 (78 votes)
Senseport lens – Chiswick Empire	4.1 (73 votes)
Senseport lens (magnifier) – Chiswick Empire	3.2 (71 votes)
Mouse-controlled slider (overall)	4.0 (75 votes)
Mouse-controlled slider – old Fleet river (moving)	3.4 (71 votes)
Mouse-controlled slider – old Fleet river (still)	3.4 (70 votes)
Mouse-controlled slider – West London streets	4.4 (76 votes)
Mouse-controlled slider – Trafalgar Square (moving)	4.5 (79 votes)
Mouse-controlled slider – West London hybrid	4.2 (76 votes)
Other techniques (overall)	3.8 (70 votes)
Other techniques – Tyburn tree	3.9 (86 votes)
Other techniques – Mansion House (hidden sounds)	4.0 (74 votes)
Other techniques – streets deepzoom	2.8 (72 votes)
Other techniques – 3d homes	3.3 (76 votes)
Landing Pages (overall)	41 (54 votes)
Landing Pages – linear	3.1 (75 votes)
Landing Pages – cyclic	4.3 (83 votes)
Landing Pages – rotational	4.1 (90 votes)

TABLE 22: STAR RATINGS OF VARIOUS TECHNIQUES, 2ND STAGE ONLINE FEEDBACK

The star rating feedback revealed that some of the examples within techniques were more closely ranked than the overall star rating for the technique as a whole. For example, whilst the mouse-controlled slider was only ranked 4.0 overall to the lens 4.4 overall, some specific examples – notably the Trafalgar Square use of the mouse-controlled slider – were ranked at 4.5, which matches the highest score of any lens example (the 4.5 of London maps). This suggests some of the content and the way it works for users in a specific context is as important as the nature of the generic technique. This indicates that well-designed, evocative compositional content can prove as important to user perception as the nature of the technique utilised.

Qualitative, free-text feedback was also provided:

Ref ID	Comment
01	Love it !
02	are these available to download and re-use? I would like to do something similar with some local history photos of York.
03	the full screen option doesnt work well with some of them
04	The ones that reveal the past hidden behind the present are awesome!!
05	Hi Jerry, I find the theme ethereal. I imagine it to be very appealing to most people. The senseport lens: Seems a little voyeuristic which has novelty. I feel the photographs may be better positioned to help achieve seamless blending. The overlaying of the maps is cool. I played with this idea using an aerial image (I nicked from google maps) de saturated to black and white, then I added layers of colour to it gradually.I do not like the magnifying glass design, I feel it is too crude and distracts from the imagery. The mouse control slider: It gives one more control therefore allowing for personal perspective (sort of white space or the viewer is getting to see what hey want) The moving imagery and still images are both evocative. I feel the control slider is best. Other techniques: Much preferred the above techniques, the third other, was a bit google earthy. I prefer the cyclic model . The page turning seemed so much more fitting . Maybe it helps tie the past with the future - the real with the digital. I feel your research project pushes/plays with the boundaries of digital capability. Bringing to digital reality what the brain can so easily provide but what in reality (tangible reality) can be so difficult to share. Showing others what we

	see. It works on a number of levels as any good research should. It is most certainly inspiring. I wonder how it would be to actually project some of those historical images in reality. A sort of superficial trapped in time bubble using 3D photography or holography techniques although one can't go back and capture 3D images. Hmm yes, time travel would have to be the key to that one lol! Also, most of those images overlaid would work using lenticular interlacing and lenses. This is personal opinion. I hope it is of some help.
06	more please!
07	The effects are impressive when the photos are well aligned with each other - but lose their effect when they are not. When moving to full screen, some of the examples are distorted.
08	I did enjoy the maps in particular. - it would be good to be able to use the lens to view backwards in time beyond more than one map; - being able to resize or zoom the lens might also be an interesting device? Thank you.

TABLE 23: FREE TEXT FEEDBACK, SECOND STAGE ONLINE FEEDBACK

USABILITY LAB 1 (UL1) FEEDBACK

Some of the key patterns of behaviour that emerged during UL1 included:

Technique	Work	Observed Behaviour / Feedback
Lens	**Cenotaph**	
		Not realising the lens could be picked up and moved
		Wanting the lens to be bigger
		Appreciating the way the lens helped concentrate focus on a particular area
		Criticisms of the lack of perfection of alignment (including of perspective) between the older and newer images
		Commenting on inconsistencies in location of the lens when moving between full screen and normal modes
	Maps	
		Not realising the lens could be picked up and moved
		Criticisms of the lack of perfection of alignment (including of perspective) between the older and newer images
		Noting differences in the typography and detail of older and newer map
		Liking the use of audio in place of the silence of the Cenotaph example
		Commenting on inconsistencies in location of the lens when moving between full screen and normal modes
	Chiswick Empire	
		Not realising the lens could be picked up and moved
		Liking the way the modern moving images ghost into the old image
		Criticism of the lack of a "grounding/anchor" point between the two images (as the landscape has changed so much between them)
Mouse controlled slider	**West London Street**	
		Not using the slider
		Appreciating the degree of control the slider gives the user over the mix between the two images
		Criticisms of the lack of perfection of alignment (including of perspective) between the older and newer images
		Criticism that the slider changes too much – and that the lens provided a more focused area to concentrate on
		Request for a full-screen option
	Old River Fleet	

		Not using the slider
		Suggestion that a physical slider would be fun in place of using a mouse
		Some difficulties using the slider
		Suggestions of captions, more context about the images
	Trafalgar Square	
		Not noticing the slider for a time
		Appreciation of the fusion of time and space / more engaging work due to moving images
		Criticisms of the lack of perfection of alignment (including of perspective) between the older and newer images
		Request for more than 2 layers, so "you could go back further in time"
Other Techniques	**Tyburn Tree**	
		Powerful – "a non space now, but look at what used to take place"
		Flickering images are too short, not enough time to study and understand what is happening
		Appreciation of the sound
		Attempts to interact with the (non-interactive) gallows image as it appears
		"I don't really understand this one"
	Mansion House (hidden aural sounds)	
		Appreciation of the sound
		Not exploring or interacting with the work
		Mix of appreciation of sounds not being what is expected when exploring and comments that it's confusing that sounds don't relate to the images
		Desire for automatic full screen (as the exploration of the hidden soundscape works better in full screen mode)
		Desire for more distinction between overall soundscape and the highlighted/discovered sound
	"3D homes"	
		Lots of intensive, excited clicking
		Appreciation of the sound (soothing, calming, almost hypnotic when combined with the images)
		Laughter (often associated with repeated, frenetic clicking to bring images to the foreground)
		Not clear what it does, what impact it is having
Other Techniques – landing pages	**Linear Model**	
		Easy to navigate, understand, use
		Laughter at the humour
		Appreciation of the sound (in the old Guildhall School of Music piece when invoked)
		Appreciation of the innovative hovering motion of the menu elements (drawing attention to them rather than them being static)
	Cyclic Model	
		Most users did not understand how to turn the pages of the book [only one exception]
		Comment that the soundscape has a profound effect on how you "read the images"
		Easy to navigate, understand use, tempered with the way the mouse controls the speed of the visual carousel and its direction ("I don't seem able to control this")
		Some comments that it is liked less, one that it is better than the others
	Rotational Model	
		Appreciation of the sound ("very rich", "immediately arresting", "haunting") and its counterpoint with the flat, rotating images

		Imagery less appealing, dated, flat
Aural-only Technique		
		Created a different sense of space
		Ghostly/poltergeist effect
		Engaging, could be listened to for a long time (wanted more, not long enough)
		Desire to hear on sealed / binaural headphones
		Disquieting, with an air of menace
		Preference for the sound in the first part (more distant, less aggressive)
Experimental composition		
		Beautiful, poetical
		Wonderful landscape of sounds and images
		Physical and metaphysical
		Appreciation of the visual structure, the geometry, the ambient tones
		Very deeply relaxing
		Desire to hear on sealed / binaural headphones
		Uncertainty about the relationship between the opening section and the following ones – too big a juxtaposition
		Final section bubbles move too fast, less in keeping with the sound
		First section too jerky, poor framerate
		Desire for improved transition between the 3 sections (to morph more elegantly between them – move inside the head, the red cells then the memory cells)

The self-classification of respondents to Q1 (in terms of their familiarity with using a PC, where 1 is novice and 10 expert) is shown in Table 24. The lowest grading anyone self-classified was 5, the highest 10 and with the largest groups self-classifying equally as an 8 and a 10.

Response	Number of respondents
5	1
6	1
8	3
9	1
10	3

TABLE 24: SELF-CLASSIFICATION OF PC PROFICIENCY

All of the lab participants indicated that they found the various techniques used to explore the past of place easy to use.

Response	Number of respondents
Yes	9
No	0

TABLE 25: RESPONSES REGARDING EASE OF USE

With regard to whether the techniques for navigating past and present images and sound were evocative of the past the majority of respondents indicated they were, with one indicating they were not. In related feedback during the session, this participant qualified their negative response by indicating that they felt there were some improvements to be made to the techniques (detailed in their feedback on the end of lab form).

Response	Number of respondents
Yes	8
No	1

TABLE 26: RESPONSES TO WHETHER THE TECHNIQUES WERE EVOCATIVE OF THE PAST

The more qualitative responses to the form are considered below. There are not always nine separate responses to some of these questions: some participants did not provide specific feedback (e.g. a general comment such as "I forgot the ones that don't work so well, unless they are really noticeably bad, which none were").

How the interfaces could be improved
use large scale projection, surround sound and an alternative, more physical interface rather than the use of a mouse to heighten the visceral experience
use of binaural headphones
granularity of control over the images (the reason why for some participants the mouse controlled slider was considered more effective than the lens as it provided for user-based granularity of control)
the provision of an increased number of layers of the past rather than just two (so you can drill back further in time in a particular place)
the provision of interactivity in the experimental piece (to interact with the memory spheres)
better visual cues and information as to where the mouse is and how to use the interfaces
enable full screen mode by default
instead of sliders, enable the movement of the mouse (e.g. left to right) to be the trigger and control for the blending of layers of time
consistency of location and focus when moving between full screen and normal screen modes

TABLE 27: INTERFACE IMPROVEMENTS

When asked to identify their favourite technique or example, participants responded with:

Favourite technique or example
the mouse-controlled slider (control over the image and the rate of its revelation)
the experimental work
the experimental work, with its very evocative and effective sound. Also the moving images of Trafalgar Square
the moving images of Trafalgar Square
the piece with the hidden sounds to be found, particularly the contrasting juxtaposition of image and sound
the senseport lens
the mouse-controlled slider
the pieces where there were items to ground the different images of past and present (structures, buildings that were there in both past and present for example). Also, the Trafalgar Square piece with moving images
mouse-controlled slider, providing interactivity with the user in control of the experience

TABLE 28: FAVOURITE TECHNIQUE OR EXAMPLE

When considering the example or technique that worked least well, participants responded:

Least favourite example or technique
the cyclic model
the rotational model
the piece with the hidden sounds
Tyburn tree (slippage between the gallows and modern image did not work) and the river Fleet (lack of historical detail)
the autobiographical elements (felt like prying, evoked least interest)
the senseport lens
pieces where there was no contiguity between past and present images. Also, the jerky frame rate at the beginning of the experimental work
the senseport lens

TABLE 29: LEAST FAVOURITE TECHNIQUE OR EXAMPLE

Asked to consider the linear and cyclic landing pages, and which worked best, the responses were as follows:

Response	Number of respondents
Linear	3
Cyclic	5
Didn't care / no difference	1

TABLE 30: RESPONSES TO WHICH REPRESENTATION OF TIME WORKED BEST

When asked whether there were any particular sounds/images/pieces that really impacted them – and, if so, which ones and why – the responses provided were:

Sounds/images/pieces that most impacted the user
the experimental piece, where the orange spheres shifted and connected with each other and then morphed into representations of your memories. I felt more connected with the images as they arose because of the way you had constructed the initial orange spheres. It made me consider the internal and external networks that exist in our everyday lives and made me consider not only your life but the passing of my own. It also made me consider the non-linearity of time and how memories work in clusters. Very powerful. The sound was driving the images in a very subtle way but allowed enough space for me to have these considerations.
the experimental piece, the sound composition was excellent
the aural only piece, which had two sounds interacting
the experimental piece, particularly its last two phases because of the interplay between the sound and image, the fragmentation of memories. I also liked the landing pages with snapshots that summarised a lifetime and the creation of narrative framed in the book [turning the pages] format
the Mansion House [hidden sounds] photo, mainly because it appealed more to my imagination
the experimental work, the abstract red cells – the sound and visuals engaged me
the moving images of Trafalgar Square. The Cenotaph and maps. These were the most poignant connections between past and present because the link between the two was highly explicit
the haunting, whispering voices. They created a real, effective mood.

TABLE 31: WORKS WITH MOST IMPACT

On the final, open-ended question about how the participants would like to see the work develop, the following responses were provided:

Development of the works
consider how and where you present the work. The usability lab space and the colour, lightness and tranquillity creates a very particular context in which to view and hear the work
I would like to see the work further developed into projections, installations etc.
ensure accuracy in alignment of overlapping scenes. Use of the slider throughout the pieces. It might also be more effective if people did not meet the composer prior to experiencing this, given how personal – and engaging, absorbing – some of the work is
make the images of the experimental piece more interactive, with sound also responding to the interaction. And more than 2 layers of history at a time
I particularly liked the autobiographical strand throughout the work. The combination of different types of images in a single work – maps, illustrations, movie clips – would be interesting to see
the experimental piece needs to evolve into a more unified work, with perhaps more original music not so based in recognisable genres
what has this left me with? The images of Trafalgar Square then and now. More content, stories, layers of information. Less interface, more content. Work on triggers and subtlety for those triggers – the Marconi quote in the hidden sounds piece is a good example. The trigger was also in the text – there are 14 sounds to find. Incorporating these prompts in a more intuitive way could be a benefit.
the cyclic interface for the landing pages, although it was not explicit to me whether content was representing a linear time-based narrative. This was much more explicit with the linear landing page

TABLE 32: HOW THE WORKS COULD BE DEVELOPED

CONTIGUITIES AND DIVERGENCES: ONLINE AND USABILITY LAB FEEDBACK

With the evidence gathered both online (OU1 and OU2) and in the usability lab (UL1), some contiguities and divergences were noted. Of those expressing a preference for cyclic or linear representations in each of the online, star rating and usability lab environments, the results are shown in Table 33.

Model	Online	Star rating	Usability lab	Overall
Cyclic	13 (87%)	62 (53%)	5 (63.5%)	80 (58%)
Linear	2 (13%)	54 (47%)	3 (37.5%)	59 (42%)

TABLE 33: COMPARISON OF FEEDBACK ON REPRESENTATIONAL MODELS OF TIME

There was a clear divergence in the initial online feedback model, where the cyclic model appeared to be very heavily favoured over the linear. However, both the star rating feedback and the usability lab feedback were more balanced (the star rating feedback notably so). The overall rating indicated a preference for cyclic over linear, but on a much

less persuasive scale than earlier online feedback. The key question here, that remained unanswered, is the causality of such underlying divergences in feedback. The value of the usability lab over the online usability testing is its capacity to help capture and analyse the reasons *why* people provide the feedback they do. This provides valuable insight that enables a better evaluation of the importance of the feedback and the nature of potential changes in the crafting of a composition that might help provide a more evocative and effective experience.

There were also divergences with regard to preferred techniques for navigating palimpsests. The online star rating system indicated a preference for the lens (rated 4.4 with 106 votes) over the mouse-controlled slider (rated 4.0 with 75 votes). It is not immediately evident why more participants provided feedback on the lens than the mouse-controlled slider. Reasons could include the relative placement of the works on the page (with the lens preceding the mouse-controlled slider examples), or that visually some people were drawn to interact more with one than the other. However, by contrast in the usability lab there was a distinct preference expressed for the mouse-controlled slider, supported by the rationale that it provided greater granularity of control for the user in terms of how they could intermix past and present. This is offset by observational data that some participants did not understand how to use the lens at all (and therefore could not sensibly comment on it, although the fact it was not obvious to them how it was to be used provided actionable design improvement feedback). Also, some feedback indicated that the lens enabled participants to focus on just a subset of an image rather than the entire image.

USABILITY AND IMPACT

In terms of the generic usability areas assessed during the lab stage, and their impacts upon the participants, the following elements were identified from the feedback.

Usability area	Description	Observations
Efficiency	the time taken to, and ease with which users, complete relevant tasks (such as interacting with palimpsestic content, using the various interactive tools)	• Wide variability – lab sessions ranged from 24 minutes to 50 minutes • Some users clicked more rapidly through compositions; others dwelt for a long time on particular aspects of interest to them
Accuracy	whether users interact in the expected way or deviate (that is, behave in ways the composer did not intend or anticipate), indicating that the composition's presentation, design and associated techniques may not be optimal for	• Some participants did not utilise the lens. Clearer cues are needed on how the lens is to be used, or an alternative approach (such as the mouse cursor *being* the lens by default) need to be considered to enable its more effective, ubiquitous use • Some participants indicated difficulties noticing and using the mouse-controlled slider. More consistent positioning and highlighting of the slider is required, or the mouse itself needs to act as the slider and modify the content based on its on-screen positioning

	the composer's intended purpose	and movement • Some participants did not explore the hidden sounds example, indicating a preference for more visually-driven works. Others indicated that better visual cues were needed to guide them to find the sounds and that full screen mode by default would make the piece easier to use. Some users went into works and did not interact with them at all (they looked at them and then exited without using, for example, the lens, or exploring embedded sounds). Better "signposting" of intent and interaction options may help overcome this lack of connective cognition. • Some users attempted to interact with author-led works that offered no interactivity experiences. This may have been in part related to their positioning – coming after other works had offered such interactivity. The option exists to bifurcate works, their techniques and the compositional intention/reception dependent upon their intended performance space: so providing interactive techniques for pieces delivered over the internet, but potentially presenting non-interactive works in installation and performance spaces. Offset to the latter is the idea of physical interfaces that would still allow interaction to some degree (provided it is relevant to the work envisaged) • There were several examples of multiple, frenetic (almost obsessive) clicking on the 3d homes example, sometimes combined with laughter and several participants stated they found it compulsive and to a degree therapeutic (because of the calming sound juxtaposed with the fast interaction and movements of the houses). This was not expected and suggests a possible area for further exploration.
Recall	how well the user is able to recall content or elements of the composition afterwards, and to identify those elements, ideas (visual and/or aural) or techniques that were most, or least, significant for them	• "The sound appeals to me, it has a reverse effect to it which is nice because we're moving backwards in time" • "The ones that are more dynamic I enjoy, I feel like playing with, getting engaged with." • "Soundscape has a very profound effect on how you read the images" • "Really spatialised [sound], and I was looking for where the sounds were coming from and expecting to look at things on the periphery of my vision. I think that would work really well where you've got a street panorama where you want to sync with movement on the edge of the screen. I like the atmosphere of the sound and the different sense of space that it provides." • "The most memorable are the final two phases of the last work shown - because of the interplay between the sound and image, fragmentation of memories."
Emotional response	how the user feels about the compositions, whether they feel they have evoked a sense of the past of place or person	• "It made me consider the internal and external networks that exist in our everyday lives and made me consider not only your life but the passing of my own. It also made me consider the non-linearity of time and how memories work in clusters. Very powerful. The sound was driving the images in a very subtle way but allowed enough space for me to have these considerations." • "These [provided] the most poignant connections between past and present because the link between the two was highly explicit" • "Makes me wonder what it would have been like to have lived in that time." • "Some wreathes lying around the bottom of the cenotaph, it's rather beautiful" • "Oh, bring back the green fields!" • "What you get in effect is a vision of a rural, less populated time." • "It's intense, it's mind-blowing for me." • "You can control how much of the past and how much

		of the present you are looking at. I think this is really effective." • "Even the texture/tone of those images makes you feel nostalgic." • "[That's] so powerful." • "I like [the] fusion of time and space." • "This is the most engaging image that I've looked at. The sense of time. Yeah. It really is, it works well. It's about what's going on, not just the architecture." • "It's a non-space now ... but look at what used to take place" • "[Makes me think about] the whole notion of place, and how areas are given significance." • "There is an element of the melancholic I think which is interesting. As we live in the present but also in the past we cannot exist, we could not exist, without our memories. And so it is quite an interesting bit of meandering through these spaces, through these places." • "... expansiveness, the kind of space it creates, not only where I'm sitting but a weird sense of space behind me" • "... takes me out, some notion of other" • "Wonderful landscape of sounds and of images." • "Poetical and full of potential. So physical and metaphysical." • "I'm being watched. Looking back at the soul."

TABLE 34: USABILITY RESPONSES

INITIAL SUMMARY AND POTENTIALITY

The usability feedback was an insightful resource for further development and refinement of the portfolio. The methodology adopted also indicated clear potential not only for the development of the composition portfolio within the scope of this research, but also as a more universal framework for assessing the way in which users experience and interact with IDT compositions: the nature of the qualitative feedback, the insight into the understanding of why and how users interacted with the works, and the experiences and reactions and responses they demonstrated, all indicated clear potential for utilisation by any artist or researcher wanting to better understand the nature of the experiential interplay between an interactive digital artwork and a user.

The interplay of artistic intent, compositional techniques, user reaction and consequential feedback is in part about potential alignments and divergences between artistic intent and reception – see for example research by Rob Weale (2006) in the domain of electroacoustic composition. Remote usability feedback can be difficult to interpret in terms of its causality due to the lack of context: for example, UL1 illustrated that some users did not determine how to successfully use the lens, so their feedback on its effectiveness needs to be interpreted in that context. Whilst more data could be collected from remote users (including in-place free-form feedback as well as the qualitative star rating system), it would not be able to capture major misalignments such as users not interacting with the lens in the manner anticipated. With the remote feedback it was not

possible to determine if the user had successfully used the lens and was providing feedback in that context, or had failed to use the lens and was therefore providing feedback based on an alternative (negative) experience of the technique. It is also unknown what environment online participants occupied (home, office, internet cafe, etc.), or the nature of the equipment (PC, laptop, sound system quality, screen size and resolution) they were using to interact with the site, and the impact that such unknown contexts may have had on their concentration and perception. Whilst it is possible to remotely track information about the remote users' technical environments, and even potentially to capture their sessions with screen-grabs and webcams, it cannot easily capture their wider contextual environment.

The usability lab offers a greater degree of data gathering and analysis within a known context and is thus better suited for the capture of more detailed feedback. Its role was therefore essential in terms of understanding and analysing in greater depth the qualitative feedback gathered online to help understand the causality of some of the responses. Whilst remote testing of how well users are interacting with and experiencing the compositions online is invaluable, particularly in helping improve works largely intended for performance over the internet, UL1 helped provide more detailed context and a better-informed analysis of *why* certain feedback was being provided. It provided a deeper, more precise level of understanding supported by the ability to gather and analyse both observational behaviour and the commentary (real-time oralisation and more reflective textual) of participants.

There was clear compositional value in the feedback received both online and in the controlled environment of the usability lab. It helped identify areas where the interfaces and techniques could be modified and improved to achieve a closer alignment between the effects that the composer sought to evoke and those perceived. It provided insight into the extent to which the researcher's intentions were being achieved, through both compositional techniques and experimental works. This insight extended to the aural-only tests of the usability lab, providing feedback on and insight into the impact of different impulse responses, both authentic and synthetic, upon user perception and evocation.

There were broader considerations raised by the data gathered for a composer working in the domain of IDTs, some of which the feedback both online and in the usability lab highlighted. This included the extent to which people respond differently to the same content. In this context, the qualitative feedback related to emotional response (how the user feels about the compositions; whether they feel they have evoked a sense of the past

of place or person) is relevant. In particular, with regard to testing the hypothesis that IDT compositions can evoke an awareness of, and an emotional connection with, the past of a place or person in an audience, independent of their current location, participant feedback suggested a notable alignment or resonance with the researcher's intent. This is particularly strongly evidenced in comments such as:

- "It's intense, it's mind-blowing for me"
- "Poetical and full of potential. So physical and metaphysical"
- "[Makes me think about] the whole notion of place, and how areas are given significance"
- "It ... made me consider the non-linearity of time and how memories work in clusters. Very powerful. The sound was driving the images in a very subtle way but allowed enough space for me to have these considerations"
- "... takes me out, some notion of other"
- "Wonderful landscape of sounds and of images."

Such feedback was particularly evident in response to the experimental composition, the inclusion of which specifically sought to explore what for the researcher is a *punctum*. Some participant feedback gathered from exposure to this work indicated a clear degree of strong personal evocation and emotion, an outcome which suggests the appropriate combination of techniques for both aural and visual content are capable of approaching the realisation of the punctum, of something – to paraphrase – that "so pierced the user".

INCORPORATION OF FEEDBACK INTO TECHNIQUES AND COMPOSITIONS

The feedback and consequential analysis from OU1, OU2 and UL1 provided creative inputs to the next iteration of composition, with specific reference to those techniques that users indicated evoked the strongest sense of past of place. This enabled further refinement of the works, both audio-visual and aural-only. The lessons learned from these initial feedback sessions, and subsequent usability testing as this research progressed, were incorporated where appropriate into the portfolio with the intention of strengthening its evocative and connective potential.

Feedback from the online survey, star-rating system and initial usability lab indicated a variety of areas where modifications might improve both usability aspects of the experimental techniques and the effectiveness of their evocation of the past. Such feedback ranged from some users not understanding how to use the mouse-controlled slider and lens through to a desire for alternative physical interfaces to the usual

PC/keyboard/mouse and the exploration of more immersive aural elements (notably suggestions relating to the utilisation of binaural and surround sound).

This section explores the incorporation of the usability feedback, with the intention of improving the techniques and compositions developed during this research.

MOUSE CONTROL MODIFICATIONS

Evidence from UL1 demonstrated that some users did not utilise as intended two principal techniques developed for palimpsest exploration and navigation: the mouse-controlled slider and the lens. In particular, in terms of *accuracy* the usability lab feedback found that:

- some participants did not utilise the lens. Clearer cues are needed on how the lens is to be used, or an alternative approach (such as the mouse cursor being the lens by default) need to be considered to enable its more effective, ubiquitous use
- some participants indicated difficulties noticing and using the mouse-controlled slider. More consistent positioning and highlighting of the slider is required, or the mouse itself needs to act as the slider and modify the content based on its on-screen positioning and movement

Based on the two primary resolution concepts outlined above – the mouse *as* slider and the mouse *as* lens – it was decided to prototype potential replacements for the previous techniques to address their identified user interaction misalignments. More accurately, these two alternative designs for the techniques might better be described as retaining the mouse as the control mechanism, but the cursor itself acting, respectively, as the slider and as the lens.

MOUSE AS SLIDER

The mouse-controlled slider was originally realised as an on-screen displayed slider control that the user could click on and orientate from one side to the other, progressively revealing or masking underlying palimpsests of the past of place. The revised technique removed the need for an on-screen slider control and the mouse and its sideways movements provide the slider interaction directly. By moving the mouse sideways (left to right, or right to left), the user could control the interaction and revelation of the palimpsest, and the degree to which the various layers of time interacted, in the same way as they previously utilised the on-screen slider control. The sideways movements of the mouse in effect became the movements of the slider.

FIGURE 139: SIDEWAYS MOVEMENTS OF THE MOUSE REPLACE THE ON-SCREEN SLIDER

The assumption, later evaluated in subsequent usability feedback, was that this new design would no longer rely upon users noticing the on-screen slider and utilising the mouse to click on and drag it. By moving the mouse alone, users would be able to merge and reveal alternate on-screen visual layers. A secondary aesthetic benefit was that the onscreen representation became less cluttered, since no control surfaces were required to be displayed leaving the work to be appreciated without the unnecessary intrusion of technical aspects related to its interactivity mechanism.

MOUSE AS LENS

The lens was originally realised as an on-screen displayed control that the user needed to click and hold with the mouse in order to select the lens and move it around the screen. Releasing the mouse also released control of the lens. Wherever the lens passed over, imagery from the past was revealed. The revised technique removed the need to click and hold on the lens. Instead, the cursor itself became the lens. As the mouse was moved (without requiring anything to be selected or any mouse or other interface buttons to be held) the lens moved around the screen, revealing the underlying palimpsests of the past of place.

FIGURE 140: THE MOUSE AS THE LENS

The assumption, evaluated in subsequent usability feedback, was that this new design would no longer rely upon users noticing the lens and understanding what it was there for

or how they needed to interact with it. By moving the mouse alone, users would be able to experience the lens and its effect in terms of navigating the past of place.

ALTERNATIVE HUMAN MACHINE INTERFACES

Feedback gathered during the usability lab included the suggestion:

> use ... [a] more physical interface rather than the use of a mouse to heighten the visceral experience.

Based on this feedback, it was decided to explore alternative physical interfaces to the keyboard/mouse. Whilst these would not be readily suitable for use over the internet (unless remote users were prepared to make modifications to their own physical setup), they would be usable in installation spaces and in updated usability lab testing, where their impact on users, their perceptions and the consequential evocation/interaction with the compositions and techniques could be assessed.

HMI PROTOTYPE ONE: XBOX 360 CONTROLLER

Video game console controllers are a widely used alternative hardware interface better suited to gameplay, and hence interaction with aural and visual content, than the keyboard and mouse combination traditionally used with PCs. Whilst intended for use with video game consoles, they provide a readily available alternative hardware device that can also be utilised with PCs, when adapted with appropriate interfaces and software. To explore the potential use of a physical controller, prototyping took place with a wireless Xbox 360 controller. To connect this to a PC, the optional adaptation kit (a wireless receiver with PC drivers) was acquired. In addition, software was required to enable the controller to be appropriately mapped to the desired mouse functions (notably movements within X and Y co-ordinates). For this purpose, the JoyToKey[45] software was used. A custom configuration was created for use with the palimpsests slider and senseport lens techniques enabling the left and right thumb sticks to control navigation along the X and Y axes respectively (although only the X axis is relevant in the case of the mouse as slider control).

FIGURE 141: XBOX 360 WIRELESS CONTROLLER AND PC ADAPTOR

[45] Downloaded from http://www.electracode.com/4/joy2key/JoyToKey%20English%20Version.htm. June 2010

Whilst most of the computer-based work of this research aims to be platform-agnostic (using the cross-platform Microsoft Silverlight plug-in), use of the Xbox 360 controller is platform specific (the wireless adaptor and its associated driver are Windows only, as is the JoyToKey software). However, since this alternative human machine interface was envisaged for deployment in the usability lab and potential installations, this was not an unacceptable constraint. Once both the wireless controller driver and JoyToKey software were installed and configured prior to launching the Silverlight-based techniques, the lens and mouse as slider both worked with the Xbox 360 controller enabling user control via the thumb sticks without any further modification.

Although successful as a prototype, the look and feel of a video games controller was not ideally aligned with the contextual artistic intent of the compositions, for which a more unusual dedicated controller would prove more appropriate. In a final form, a steampunk, retro-technology look and feel, would offer the type of artistic contextualisation intended by the researcher. Work thus continued with exploring how such a more dedicated controller might be constructed.

HMI PROTOTYPE TWO: PHIDGETS

The researcher decided to explore alternative ways for users to control and interact with techniques and content. For example, what if users could interact with content in non-physical ways – such as by moving around an installation space, or by making a noise or gesture – or by using alternative physical control surfaces, such as turning dials and knobs on a custom-designed piece of installation equipment? To explore these ideas in more detail, a prototyping environment that provided a range of sensors and controls was required, and for this reason Phidgets[46] were chosen. Phidgets provide and support a wide range of sensors, programmable from a variety of devices, including a PC.

Phidgets facilitate modular electronic building blocks for low cost USB sensing and control. They provide an inbuilt API that works across a diversity of programming languages, including C/C++, C#, Cocoa, Delphi, Flash AS3, Flex AS3, Java, LabVIEW, MATLAB, Max/MSP, MRS, Python, REALBasic, Visual Basic.NET, Visual Basic 6.0, Visual Basic for Applications, Visual Basic Script, and Visual C/C++/Borland.NET. The creative technology techniques and compositions developed during this research are a mix of Javascript and C# programming languages, both of which can be used (alongside other languages) for developing Silverlight applications. However, Silverlight applications are designed to be cross-platform and the Silverlight environment is effectively sandboxed to

[46] See http://www.phidgets.com

achieve this: it does not support platform-specific APIs and hooks (since that would break cross-platform compatibility). Phidgets would not therefore work with Silverlight. However, Silverlight is the cross-platform derivative of the platform-specific Windows Presentation Foundation (or WPF). As the name suggests, WPF only runs on Windows, but is therefore able to incorporate the Phidgets device driver for Windows. For this reason, it was decided to utilise WPF in order to explore Phidgets as a potential method of providing an alternative human machine interface. The intent was for this alternative interface to be used in the usability lab and installation space environment, where cross-platform compatibility would not be a design issue (in contrast to those pieces intended to be experienced on the internet).

A Phidgets 1018 Phidget Interface Kit 8/8/8 was acquired as the control centre for a range of Phidgets sensors. The 1018 connects directly to a computer via the USB port and provides 8 analogue inputs with configurable data acquisition rates, 8 digital inputs with hardware noise filtering, 8 digital outputs and a 5V terminal block beside analogue input 7 and digital output 7.

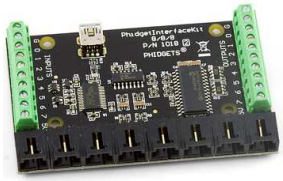


FIGURE 142: THE PHIDGETS 1018 UTILISED IN ALTERNATIVE HMI PROTOTYPING

A range of sensors was also acquired (touch sensor, force sensor, slider sensor, precision light sensor, rotation sensor, magnetic sensor, sound sensor, sonar sensor) together with some generic switches and a mix of LEDs. Initial work concentrated on providing a physical interface to an existing compositional technique: the slider sensor was used with a composition example that previously utilised the mouse-controlled slider. Where the interaction had previously relied on movements of the mouse, this prototype hardware controller enabled the physical slider to be moved backwards and forwards, respectively revealing and hiding the hidden layers of a place over time.

FIGURE 143: PHIDGET SLIDER SENSOR

Usability lab feedback included a request to be able to navigate and explore more than two layers, so "*you could go back further in time*". With a variety of physical controls now

available, the potential for them to provide a means of enabling additional layers was explored. Two sensors were used for this:

the rotation sensor – mixing in a third layer (image) of the same place as it is rotated one way and removing it as the sensor is rotated in the other direction

the force sensor – mixing in a fourth layer (image) of the same place when pressure is applied to the sensor and removing it when pressure ceases to be applied

FIGURE 144: OTHER PHIDGET SENSORS

In addition, the precision light sensor was programmed to randomly mix the two initial layers, adding a slightly unstable feel to the palimpsest navigation since changes in prevailing light conditions, or movements around the light sensor, resulted in fluctuations to the mix of layers. The touch sensor was used to provide a binary reveal/hide single-touch way of revealing the underlying visual image.

During subsequent discussions of the usability feedback and prototype hardware interfaces between the researcher and the primary supervisor, the idea of a physical timeline (perhaps analogous to the meridian line that exists in Greenwich) emerged. For an installation, this might take the form of a line on the floor – the nearer the projection screen a user moves, the further back in time they travel; moving further away, the more they return to the present day. They would thus be able, dependent on their physical positioning, to "walk into the past". This concept was explored with the sonar sensor (able to detect objects from 0 cm to 6.45 meters with approximately 2.5 cm resolution).

FIGURE 145: PHIDGET SONAR SENSOR AS A PALIMPSEST CONTROL DEVICE

The sonar sensor was prototyped with two alternative subroutines. In one, the closer to the sensor a person approached the further back in time the layer of images displayed. In the other, the reverse applied. Both models worked in initial tests, with some occasional fluctuation of the interplay of layers due to the lack of any smoothing function being applied to the sonar sensor.

FIGURE 146: PROTOTYPING WITH PHIDGETS

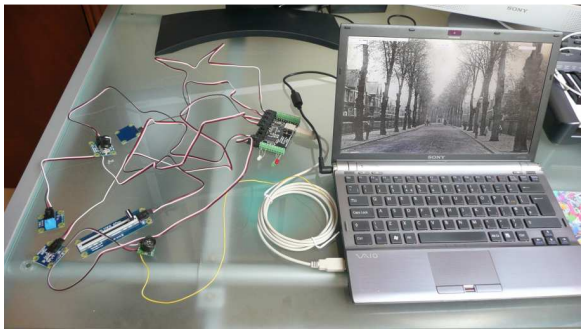


FIGURE 147: TESTING PHIDGETS WITH VISUAL PALIMPSESTS

After the conclusion of these initial tests, a subset of the interface devices was subsequently fitted into basic hardware enclosures.

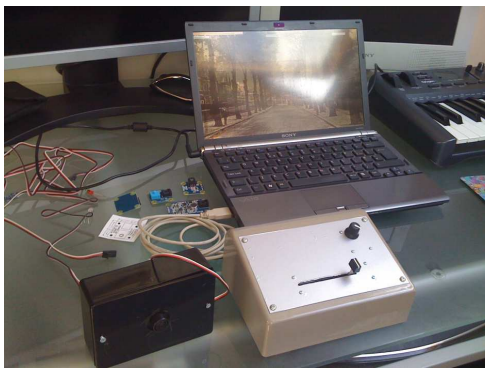


FIGURE 148: PROTOTYPE HARDWARE INTERFACE, CUSTOM ENCLOSURE

The slider control and rotational control were fitted in the main enclosure, with the sonar sensor installed in its own dedicated enclosure so that it could be situated separately from the main control surfaces. Early testing using the researcher's home studio (which utilised a HD projection system and 86" display screen) confirmed its suitability to provide a way

of navigating the layers of time and place based on how far from a screen the user was situated. The sonar sensor calibrates on initiation and occasionally provided erratic readings, but this also created an interesting artistic effect, destabilising the layers as they blend and morph. For more precision control, it would be possible to use several sonar sensors configured in an array in such a way that they more accurately determine the physical location of a person and hence the way in which the installation interacts with them. A smoothing function could also be utilised to prevent the occasional fluctuation of readings. However, for the purposes of this research it was decided to intentionally retain the version with occasional image destabilisation and to formally evaluate this prototype and the impact upon user experience in the second usability lab.

ONLINE USABILITY 3 (OU3) FEEDBACK

In the table below, the updated compositions that utilise the mouse as slider and mouse as lens are: the three Portsmouth Street works; Trafalgar Square; and the two map works. The original works tested are: Book; TimeRadio; TimeTV; Aural palimpsests of time and place; 13 Portsmouth Street (emergent).

Technique	Overall star rating	From (date)
Book	3.9 (50 votes)	14.10.2010
TimeRadio	4.3 (82 votes)	10.09.2010
TimeTV	4.0 (94 votes)	26.08.2010
Portsmouth Street, London (partial)	4.4 (104 votes)	20.08.2010
Portsmouth Street, London (full)	4.1 (101 votes)	20.08.2010
Portsmouth Street, London (palimpsest Lens)	4.2 (100 votes)	20.08.2010
Aural palimpsests of time and place	3.8 (100 votes)	20.08.2010
Trafalgar Square palimpsests of time and place	4.2 (96 votes)	21.08.2010
13 Portsmouth Street (emergent)	4.6 (101 votes)	24.08.2010
Map palimpsest 1	3.8 (88 votes)	23.08.2010
Map palimpsest 2	4.0 (90 votes	23.08.2010

TABLE 35: ONLINE FEEDBACK (PART 3), AUDIO-VISUAL WORKS

The purpose of the usability testing on aural-only works was to test the impact and responses to the application of original and synthetic impulse responses to sounds as part of the exploration of the extent to which users distinguish between or are differently impacted by the nature of synthetic or original sounds. These included the impulse response recordings made at London's Geffrye Museum, together with those synthesised with the Voxengo impulse modelling software.

Technique	Overall star rating	From (date)
"far away to right up close" (s)	4.3 (55 votes)	24.08.2010
"flute at the Geffrye Museum"		
Reference flute	2.0 (54 votes)	
Flute (with 1630 hall impulse response)	4.3 (55 votes)	
"clarinet in varied acoustics"		
Clarinet original sound	2.0 (51 votes)	
Clarinet in 18th century room (s)	3.7 (30 votes)	
Clarinet in a school hall	3.8 (39 votes)	
Clarinet in a labyrinth (s)	3.6 (34 votes)	
Clarinet in a small prehistoric cave (s)	2.1 (33 votes)	

Clarinet in a kitchen	4.3 (40 votes)	
Transaural (s)	4.2 (46 votes)	
(s) = synthetic impulse response		

TABLE 36: ONLINE FEEDBACK (PART 3), AURAL-ONLY WORKS

This online usability stage was the first to use the updated slider and lens techniques based upon earlier feedback. The findings related to the audio-visual works indicated that the slider and lens were regarded as equally effective techniques (4.1 slider, 4.2 lens), with the work utilising a partial revelation of a palimpsest, using the slider method, being slightly more evocative with 4.4. However, the new technique developed using custom pixel shaders (the emergent technique) was rated 4.6 in terms of its effectiveness in evoking the past of place. The *TimeRadio* work was also highly ranked, achieving a 4.3 rating (itself another work utilising custom pixel shaders).

The findings from the aural only works produced highly varied responses, ranging from the 4.3 of the "Flute (with 1630 hall impulse response)" and 4.3 of the "Clarinet in a kitchen" to the low 2.0 of the "reference flute" and "clarinet original sound". Whilst high ratings were given to those works incorporating authentic rather than synthetic impulse responses - "Flute (with 1630 hall impulse response)" (4.3) and "Clarinet in a kitchen" (4.3) – similar results were also produced for those using synthetic IR's – "far away to right up close" (4.3) and "Transaural" (4.2). These results suggest that the impact of authentic or synthetic content on a user is less related to whether an IR is artificially or authentically originated, but related to the context and nature of the resulting sound: the findings suggest that the "drier" the nature of the sound (such as the unprocessed/raw characteristics of the clarinet and flute, or the relatively dry characteristics of the ambience of the "small prehistoric cave" with its low rating of 2.1), the less evocative or attractive the participants found the sound, rating those more highly that were more resonant.

USABILITY LAB 2 (UL2) FEEDBACK

The following feedback was provided through the onscreen star-rating feedback mechanism by the nine users over the two days (where 1 is least effective and 5 most effective).

Composition/ Technique	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	Average (mean)
Palimpsest Lens	4	5	5	4	3	5	4	5	5	4.44
Palimpsest Slider	4	3	3	3	4	5	4	3	5	3.78
Emergent	3	3	4	4	2	5	5	4	3	3.67
Emergent Stereoscopic	4	4	5	4	3	5	5	4	4	4.22
Aural Soundscapes 1	3	4	5	3	5	5	5	3	4	4.11
Aural Soundscapes 2	5	3	3	3	4	5	3	4	3	3.67
Palimpsest Navigator	4	3	4	5	3	5	5	4	4	4.11
Projection, Amplified Sound, Sonar Sensing and Physical UIs	5	4	4	5	5	5	5	5	5	4.78

TABLE 37: USABILITY LAB 2 RATING FEEDBACK

The use of large scale projection, sound and the sonar sensor in particular exhibited a notable impact on the extent to which users felt the composition evoked an enhanced sense of the past of place: the overall rating of 4.78 exceeds anything recorded in any other usability session, either online or in the labs. This was achieved with synthetically created stereoscopic (anaglyphic) still images and field recorded sounds. Other feedback provided by users, both through oralisation and through the use of the optional comments box, was as follows (with minor corrections solely for grammar/spelling for clarity):

Technique	Feedback
Palimpsest Lens	
	it really shows the differences and similarities between time. I love that there are people in the photo in the past, really brings to life the photo, even if it is just a snapshot of life on the road.
	zoom?
	is better line-up of older image possible?
	very evocative, especially seeing the people. Interesting seeing the buildings which have now gone, particularly the church spire
	I think it is a very interesting technique and reveals the atmosphere of the past of the city
	very effective visually but some audio would certainly help to put the viewer inside the moment in time as well. As a glimpse into the past its great but audio or moving imagery would add a more immersive aspect
	really effective, really nice, makes you explore and compare before and after images
Palimpsest Slider	
	really great to see both whole pictures, not just a segment of the photo. Really highlights how the space has changed
	not as effective as previous - but would this have been my response if the order of the tests had been reversed?
	I liked this, but for some reason not as much as the previous one. However, the midpoint where the two eras are superimposed was very effective
	more natural transition
	it is even better than the previous one in terms of showing the whole picture, though I personally find the double view we get at some point a bit confusing
	more effective than the last for me, as the view of the whole street gives a more realistic impression of the street as it was and allows me to take it into perspective. The previous one was good for comparing elements of old and new and how things have changed but this one is a better and more pleasing visual experience for me
	I thought the previous example was slightly easier to see the additional details, to see something that you may have missed

	this obviously has a bigger viewing angle, so you see more, while still only moving your mouse ever so slightly
Emergent Technique	
	fun, showing the changes gradually. The Old Curiosity shop sign is the focal point of the change, as doesn't change! Great effect but would be good to pair with some of the other roll over effects so you can study the changes
	digital texture of the blend or fade was a little off putting
	transition needs to be a bit faster for my taste
	speed of transition and use of colour very effective
	I find this technique very fascinating and artistic. I think that so far it was the best way to switch the view from past to present or vice versa and to gradually change the atmosphere.
	this is my favourite so far as it has a more organic feel and really gives a sense the past and future morphing together or of one growing into/out of the other
	good, although obviously you don't have the comparison of the building before [*this user did not click on the image and therefore did not witness the effect*]
Emergent Technique 3D/Stereoscopic	
	makes it feel more real, like you could step in the photo. I think children would love this!
	reveal and hide were the wrong words I think - most effective on older image but both good
	enjoyed the added depth to the image
	I find each technique better than the previous one, but unfortunately I started with a score of five so I cannot rate it any higher than the previous ones. This one is amazing in building the perception of changing the time and atmosphere and it looks very real. In terms of getting to actually feel the past, this technique is, in my opinion, the best so far
	slightly better in 3D as you feel more absorbed by the experience. However, there is less of the organic feeling that was present in the previous picture, because the two layers created by the 3D effect the feeling of the past/ present being superimposed upon the other which is an interesting experience also, but a less organic one
	hard to tell what you were looking at during the white dissolving section, but the 3D effect is good
	feels like a nicer effect through the looking through this little hole in the wall but still kinda slow effect :(
Soundscape 1	
	really helps bring to life the busy street and really like you could connect with what life was life. Would be good to hear all the sounds together as an option and then pick into aspects of the sound for better clarity, so you feel immersed in the story and sounds of the photo.
	very engaging
	technique highly rated - occasionally distracted by the actual sounds - too many birds? Of the wrong kind?
	this is fun and adds to the details of the scene
	it is a very powerful technique and the sounds evoke so many different sensations, I nearly felt as I was at the street on that sunny afternoon. The only thing that I found a bit distracting from the calm perception of authenticity, that the experience builds, was that sometimes the particular sound played was a bit too much louder than all the background noises, which makes it a kind of separated from the atmosphere in general and thus a bit unnatural
	really like this one, the addition of audio makes it a really interactive visceral experience and kind of makes you feel like you are snooping on someone's lives, or conversations, from the past. Definitely puts the viewer in the place in time more physically than the others
	possibly needs icons or numbers over the background to know where you are pointing at
	its like playing a game, and it makes me want to explore everything, so I don't miss a sound or funny little detail
Soundscape 2	
	completely new way of interacting with place, really fascinating to hear all the different sounds as layers up to feel all the different pulses of a place. Would be a great compliment to photos and video.
	I was not sure what to do - some words on the left disappeared too quickly. But I sense something interesting ...
	I enjoyed the overall effect, but am a bit baffled by this one - maybe because I have a hearing impairment?

	this technique is very effective and what I particularly liked about it was that the soundscape changes gradually and it builds up a very natural perception about the atmosphere of the particular place in the past. This was what I pretty much meant in my comment about the previous technique. The only thing that could possibly make it even more powerful, could be the incorporation of some visual images, like slides fading naturally from one to another
	not as effective as the others but a lot of fun to pay around with and an interesting experience in itself. The sounds are less specific and so create interesting soundscapes in themselves which are wonderful, and sometimes scary, to explore but they do not quite invoke the past in the same way for me as previous ones very conceptual too!
	this is very random, choosing bubbles by no particular criteria makes it a very random experience. The feeling of location is there, I do feel like being at the relevant place, but I think being able to choose sounds based on what they represent (eg little images or icons) would feel more intuitive and explorative for me. That would make me want to click around more and combine different sounds together.
Palimpsest Navigator	
	I thought it was great - a universe of memories brought to life in different ways. I think for the younger generations and more technologically aware people, it would be really fun and interactive, with lots of different mediums. For those with not great eye sight or finding technology a bit more difficult, it would be great to build up the signposting
	evocative of the past. Early 20th century. Place somewhat ambiguous. London perhaps?
	took a while to understand the 4 button's functions but I found I got into it as time passed. Very good sound for such small loudspeakers!
	good to have the whole range of effects brought together
	the palimpsest navigator was an amazing experience. I absolutely enjoyed it and I think that it creates a sensation of being absorbed in time. The audio was both very interesting and built a very natural perception of the past. The only thing that I reckon could be improved about it is the layout of the texts - as there are a lot of them and they are all the same colour, sometimes when they layer on top of one other, it is difficult to read them. Maybe if it was possible to make the text, that we have clicked on, stand out a bit better (by making all the other texts in the background fade more or become less focused, for example) it would be better. Anyway, it was an incredibly delightful experience, very creatively, beautifully and aesthetically realized
	definitely the best so far as the many options give you the chance to really explore the past. Interesting that reading was one of my favourite parts of it, and probably more so than the video or audio, but I still find the imagery and the Trafalgar Square video the most interesting. Gives you more content all at once which I like as it immerses you in the history of it all at once as a more full and rounded experience
	would be awesome in 3D! A nice environment to explore and spend time in. The options for putting various types of content are endless here. It's a good idea for a museum piece I think.
Large Screen Projection and Custom Control Interfaces	
	great way to feel 'part' of the photo and feel in the history, especially with surround sound! Be great to have the sounds changing as you enter into a new photo, to reflect the sounds of the era if possible. Would be really great with a few photos from a long time line of a place and then it would be like walking through history - especially as you approach the screen! Can imagine it in the big museums, you walk along towards the Imax screen going through the different ages, with different sounds and smells and artefacts on your left and right of the different ages! Although, I am sure that would be hugely expensive....
	interactivity was very engaging. Controls felt very precise with the knob and slider. Walk along the line was good fun. The sound was more important or felt more important on the walk interface. 3D added very little for me. It would be interesting to do the same without 3D
	I preferred the fader to the knob; walking produced a jerky result though I liked the principle - other haptic interfaces possible?
	I liked the immersive effect of seeming to walk into the scene. I found the sound worked better for me with this one too. The controls are effective in enabling more control of the transition, especially the sliding one.
	As most interactive [*believed to be the rationale for a score of 5*]
	It was a very real experience and in terms of bringing you from the present to

	the past, it probably is the most efficient one, because of the 3D images and their graduated change from one view to another in combination with sound. Of course, the big screen makes it more realistic and the fact that you actually interact with the screen by causing the transition, makes the whole experience very realistic. It is as if you are literally walking from present to past
	really like the audio in the example it worked really well with the imagery and they combined in a much more effective way for me than any of the others. Gave me more of a feeling of the time and place and felt more involved in the piece, this was also because of the large screen size and the fact it was in 3D. The way the audio changed as you got closer to the screen really worked too
	I like interactive installations a lot and it suits the view of a street that you can walk into. The transition could be smoother but that's technical details that are not really that important at this stage I guess. A stronger 3D effect, especially with the view of this ally [*street*] would be absolutely awesome. I think this would be nice with the left right transition thing as well, instead of approaching the projection. Walking backwards is always kind of awkward but left and right would be fine. This would allow people to see the transition by just walking past for example, without realising they are the actors for the installation

TABLE 38: USABILITY LAB 2 EXTENDED FEEDBACK

Users' self-classification of their proficiency with the use of PCs produced the following results:

Response	Number of respondents
7	2
8	2
9	2
10	3

TABLE 39: SELF-CLASSIFICATION OF PC PROFICIENCY

All of the lab participants indicated that they found the various techniques used to explore the past of place easy to use:

Response	Number of respondents
Yes	9
No	0

TABLE 40: RESPONSES TO WHETHER TECHNIQUES WERE EASY TO USE

With regard to whether the techniques for navigating past and present images and sound were evocative of the past of place respondents indicated they were:

Response	Number of respondents
Yes	9
No	0

TABLE 41: RESPONSES REGARDING TECHNIQUES EVOCATIVE OF THE PAST OF PLACE

In terms of improvements to the techniques and interfaces the following responses were provided:

Feedback on possible improvements to techniques and interfaces
• perhaps with more signposting in the universe of different mediums [Palimpsest Navigator] to interact with for those not as technologically confident. Be great to either have surround sound or headphones for the one on one experience and to get lost in the sound of a place
• less repetition of content. More information levels. On some pieces I wanted to drill down and find out more
• just the haptics might be extended – squidgy rubber thing? Shapes and textures?
• They are already very effective. There might be a few things that might be improved and I have written about them in my comments. Still it is only my personal opinion
• The first 3D image could be improved by making it larger as the rest of the computer screen not taken up by the image seemed to distract the vision when the 3D glasses were on. The audio worked really well for me in some examples especially when with imagery or video or text, but on its own I found it a little less able to evoke the feeling of past than some of the others
• Possibly some icons during the screen where you place the mouse over to create the sounds
• Faster transition maybe, little hints sometimes that a certain technique is used here … a little icon that indicates you have to use the mouse left and right for example

TABLE 42: USABILITY LAB 2 IMPROVEMENTS

The selection of the favourite work from the examples provided covered a range of options:

Favourite works
• I liked the combination of mediums. I loved the large screen approach with sound, but also fund it easy to explore in sections on a smaller screen. I think the combination of approaches is most successful, so that text, images, sounds, on their own or together helps buildup the layers to feel part of the place
• sliders both physical and virtual, moving image of Trafalgar in particular
• the lens was very good - the slivers section of the website engine, too. Good sound overall
• The last one - because of the way it combined several techniques to create an overall environment
• 3D walk through with sound. I find the strong sound interaction important. But, that may be personal
• It is indeed very difficult to pick up one - all of them provoked very realistic perceptions. If I have to choose, it would probably be both the screen and the navigator, because of the combination between images and sounds which were combined very well and built a fascinating overall expression. And then, the level of interaction with them was, I would say higher than with the still images, thus more engaging and it made the experience very real
• the big one with lots of ideo and audio and text and imagery was really good and very interactive and evocative. the large screen projection was also really good as the mixture of size interactivity and 3d and interactive audio really worked well. This was probably my favourite
• I liked the first best, it had the effect of placing a magnifying glass over the screen and it felt evocative
• I did like the 3D images looking through the hole a lot. The effect of looking through a hole was very effective and nice. I liked the left and right transition technique as well, it's very intuitive and smooth

TABLE 43: USABILITY LAB 2 FAVOURITE WORKS

With regard to the composition that worked least well:

Compositions that worked least well
• I enjoyed the snippets but for someone with poor eye sight, they might have been hard to read. The snippets and segments of photos took a little too long to load for me. It would of been great to also have a click function to speed up their presence on screen too
• slow fades. Not knowing if I was in control on some of the pieces, eg sound slivers
• left/right mouse move for time didn't work for me
• The audio only example worked least well for me, I much prefer having visual cues
• Charles Dickens fade in and out: too bitty for me
• I would not say that there was one that worked least for me. They were all different, each of them was really interesting and managed to visualise either a more general impression of the past, or a particular aspect of it, like the glimpse of a place, a moment, a soundscape, etc
• probably the audio on its own
• I wasn't as sure about the internet site page, as there were lots of versions of the images, and I thought that was a bit confusing, but otherwise the design was good
• the sound one with the bunch of bubbles was a bit confusing or overpowering. I liked the one before that with the image because it was more of a play to find the spots that play sound. The second one is generally a good idea I think but I would have preferred icons or even text that suggests the sound behind it. maybe even making it more interactive using drag and drop ideas, dropping different sounds into a pot that plays them all and such maybe. The color change of the bubbles was too subtle at the start. It wasn't clear immediately that the active bubbles will change color, or that this color change has something to do with the bubbles playing the sound. I know it was written next to it, that's how I figured it out but maybe if the bubbles change immediately on mouseover it would become more clear. Also in the iremember bit of the interactive environment, the one video with the guy talking and the image changing in weird shapes, that was confusing. I didn't know whether I triggered the change by doing something with my mouse or not.

TABLE 44: COMPOSITIONS THAT WORKED LEAST WELL

Thoughts on the large-screen projection, speakers and hardware:

Thoughts on alternatives
• Really exciting! The more it can be developed, the better!
• The position of the walk for the large screen could be looked at. More information and content. This could help to define place more ….
• Large screen - not sure if this would work in practice - only one viewer? Maybe a Wii with personal ID could separate multiple users?
• This is really captivating and really positively growing! :)
• To be honest, I cannot think of anything that I have not said before. I myself am just beginning to

learn how to use the new creative technologies and I am still far from being able to use them in order to create something with them. That is why I was so impressed with all of the techniques, the realistic and aesthetically beautiful impressions that they create.
• definitely the larger screen worked really well and the 3D element
• I like the screen technique. I like big projections and interactivity

TABLE 45: USABILITY LAB 2 ALTERNATIVES

As to which had had the most impact on the user:

Most impact
• The little children playing on the street in the big picture. The man pushing the chart in the video overlapping. I really enjoyed this technique. Seeing old and new literally collide and realise how much the world has changed. The cart looked heavy!
• Moving image fade was very engaging. Big Ben sound animated piece was great. I don't know why. It seemed to have very little interactivity and very little information
• Trafalgar Square - but that's because it was a movie I suspect. Are there techniques to better line up new to old?
• Roll over haunting sounds (Milk Cart) (Audio) Sorry not sure the name of the piece
• All of them impacted me in a different way, but I think that the changing images, which were in combination with sounds, had the strongest effect on me - they created a more overall perception.
• the ones that I was already familiar with were more evocative to me
• again, I liked the first because I felt that it was evocative and easy to use - maybe this could have some sounds included too?
• being a foreigner myself, I find the images most interesting that I recognise myself, like Trafalgar square and such. Obviously the more of a connection I can make to the image myself the more it will impact me when I see the past image

TABLE 46: USABILITY LAB 2 MOST IMPACT

Other comments provided:

Other comments
• Thank you for involving me, really enjoyed today
• Increase the levels of information, less repetition of content
• You might like users to feedback after a break away from the experience - what were their longer term memories, effects of using, etc
• I would love to see it projected and interacted with in a huge Victorian (?) Square. Trafalgar maybe
• I would just be very happy to see the final result. I am sure it will be even more inspiring!
• I think a lot of these pieces are very suitable for museums and exhibitions. I can imagine them working very well in such an environment. Have you ever seen a music video by the white stripes (can't remember the song...) where they project past scenes onto the current one and with that they show his memories of the places while he is there in his present state. It was a really nice effect. Maybe your work would work quite well in a similar way. If you project the image of an old building or room directly onto the new one... it will seem like a weird overlay, a weird ghost-type world. I think that would be very nice to bring across this sense of past and present.

TABLE 47: USABILITY LAB 2 OTHER COMMENTS

USABILITY AND IMPACT

In terms of the generic usability areas assessed during the lab stage, and their impacts upon the participants, the following elements were identified from a combination of the feedback and observations of the usability lab session, and categorised within the overall taxonomy:

Usability area	Description	Observations
Efficiency	the time taken to, and ease with which users, complete relevant tasks (such as interacting with palimpsestic content, using the various interactive tools)	• Wide variability – lab sessions ranged from 17 minutes to 1 hour and 40 minutes • Some users clicked rapidly through multiple options and compositions without waiting for content to develop; others dwelt for a long time on particular aspects of interest to them
Accuracy	whether users interact in the expected way or deviate (that is, behave in	• The context of non-interactive content within interactive content caused confusion with many users, who wanted to interact with all content

	ways the composer did not intend or anticipate), indicating that the composition's presentation, design and associated techniques may not be optimal for the composer's intended purpose	• A problem with non-text characters (such as speech marks) caused some problems with the feedback pages that had to be amended on the fly within the lab sessions • Some users went into works and did not interact with them at all (they looked at them and then exited without waiting, for example for works to develop). Better "signposting" of intent and interaction options may help overcome this lack of connective cognition. • Some users found the multiple instances of the same work within the layered environment of Palimpsest Navigator confusing, potentially bordering on irritating, as they realized each time they clicked on the same image they invoked the same work • Some users did not use the tools as expected – for example, not clicking on the image to initiate the emergent palimpsest transition • Techniques such as the mouse over initiation/cessation of aural content (such as in Aural 2) were unclear to some users, for whom a more controllable/obvious click to start/stop may have worked better • Some users were unsure how to exit from, for example, *Palimpsest Navigator*; others accidentally ended full screen mode • In the Aural works of *Palimpsest Navigator,* it was, by design, possible to simultaneously invoke more than one sound at once, which caused confusion to some users
Recall	how well the user is able to recall content or elements of the composition afterwards, and to identify those elements, ideas (visual and/or aural) or techniques that were most, or least, significant for them	• "I think the combination of approaches is most successful, so that text, images, sounds, on their own or together helps build up the layers to feel part of the place" • "Transition needs to be a bit faster for my taste" • "Too many birds? Of the wrong kind?" • "Is better line-up of older image possible?" • "Possibly needs icons or numbers over the background to know where you are pointing at" • "Less repetition of content" • "… a little icon that indicates you have to use the mouse left and right for example" • "Sliders both physical and virtual, moving image of Trafalgar in particular" • "The lens was very good – the slivers section of the website engine, too. Good sound overall" • "... the screen and the navigator, because of the combination between images and sounds which were combined very well and built a fascinating overall expression." • "The big one [Palimpsest Navigator] with lots of video and audio and text and imager was really good and very interactive and evocative" • "The large screen projection … as the mixture of size interactivity and 3d and interactive audio really worked well" • "I did like the 3D images looking through the hole a lot. The effect of looking through a hole was very effective and nice. I liked the left and right transition technique as well, it's very intuitive and smooth" • "The snippets and segments of photos took a little too long to load for me. It would have been great to also have a click function to speed up their presence on screen too" • "Left/right mouse move for time didn't work for me" • "The speed was a little too slow"
Emotional response	how the user feels about the compositions, whether they feel they have evoked a sense of the past of place or person	• "This is so cool" / "This is really cool" / "That's really good" / "I really like that one" / "I like that, very effective" • "It really shows the differences and similarities between time … really brings to life the photo" • "Very evocative, especially seeing the people"

		• "Really effective … makes you explore and compare before and after images" • "Really gives a sense [of] the past and future morphing together or of one growing into/out of the other" • "It's like you're in the image" • "Very engaging" • "… I nearly felt as if I was at the street on that sunny afternoon" • "… an amazing experience" • "It's like a glimpse back into the past" • "Makes me feel like I'm listening in on a secret conversation from the past" • "Really awesome, really interactive" • "This is fascinating" • "Makes me want to explore everything so I don't miss anything" • "… like looking back through space and time" • "… I was so impressed with all of the techniques, the realistic and aesthetically beautiful impressions that they create"

TABLE 48: USABILITY RESPONSES

ONLINE USABILITY 4 (OU4) FEEDBACK

The summary of the feedback received is shown in the table below.

Composition	Rating	Votes cast
Cenotaph (lens)	4.7	76
Cleopatra's Needle (lens)	3.6	66
Fleet River (slider)	3.3	64
Old Curiosity Shop (partial)	3.7	64
Old Curiosity Shop (slider)	4.2	69
Old Curiosity Shop (lens)	4.3	72
Old Curiosity Shop (emergent)	4.6	74
West London map (slider)	4.1	69
Sounds of the City	4	72 / 63[47]
3D stereoscopy	3.9	16
Trafalgar Square (slider)	4.7	72
Trafalgar Square (slider with edge effect)	3.8	68
London moving pages	3.6	69
LondonLive	4.1	63
Palimpsest Navigator	4.5	71
CCTV	4.6	73
Palimpsest Book	4	64
TimeRadio	4.6	72
TimeTV	3.4	65
Memories of Times Past	4.5	59
Plasma	3.2	61
Bionodes	3.8	60
Autobionodes	4.4	67
fMRI Simulation	3.9	59
Personal fMRI	2.3	60
iRemember	4.1	61
Old GSM	4.1	57
Old GSM (random)	2.8	56
Old GSM (interactive)	4.1	59
Palimpsest 3D	2.3	53
Landing Page 3D	2.7	54
3D cube	3	54
3D cube (variant 1)	2.9	52
Clocktower Emitter 1	4.2	64
Clocktower Emitter 2	3.4	58

TABLE 49: ONLINE FEEDBACK PART 4 SUMMARY

[47] The same composition appeared in two different feedback areas. Whilst the number of responses varied, the overall rating was identical in both of the locations where it was presented

OU4 further confirmed earlier feedback, including that the content of a technique is as relevant as the technique itself: for example, the identical technique of the palimpsest lens produced notably differing levels of feedback (4.7 for the Cenotaph and 3.6 for Cleopatra's needle). It also showed similar preferences for works to those in the usability lab – for example, the Palimpsest Navigator with 4.5 received 4.11 in the usability lab. It is interesting to note the significant variations in responses to the different versions of the Old Guildhall School of Music (GSM), with the random version scoring significantly less (2.8) in relation to the author-led and interactive versions (both 4.1). Whilst it is difficult to reach any definitive conclusion about why this may be the case, one possibility is that the author-led and user-led versions both have a clear, and understandable, authorial voice, unlike the randomised version. This is an area of potential exploration as part of further research into the nature of user interaction with digital art.

SUMMARY

The methodology utilised in the iterative development of the portfolio incorporated both online and lab-based usability testing. This testing intentionally sought to explore the extent to which the underlying research questions could be addressed. Online usability testing gathered 5,451 responses and the lab-based testing involved two groups of nine users over two days at different stages in the development of the portfolio. The resulting findings and analyses discussed in this Chapter provide insight into the way that users experience and respond to IDT works both online over the internet and in the usability lab.

With regard to the evocation of an enhanced awareness of and emotional connection with the past, 96.6% of respondents online and 94% of lab respondents indicated that they found their interaction with the compositions and techniques evocative of the past of place. The lab sessions assessments across the key areas of efficiency, accuracy, recall and emotional response have further indicated an evocation which at least borders on the *punctum* – with users reactions oralised in contemporaneous and post-lab feedback such as:

- It's intense, it's mind-blowing for me." (UL1)
- "[That's] so powerful." (UL1)
- "engaging … it made the experience very real" (UL2)
- "… an amazing experience … a sensation of being absorbed in time" (UL2)
- "A very real experience …. it is as if you are literally walking from present to past" (UL2)

The research findings have also identified those IDTs that work most effectively, with feedback data also indicating that the nature of the content itself has a clear impact on the way in which techniques are perceived. Overall the visual techniques that have significant impact included the palimpsest lens and slider (regularly achieving ratings of over 4), and the aural impact of impulse responses and HRTF-related spatialisation techniques (with the transaural test registering above 4, and some works utilising IR's similarly rating highly).

With regards to the impact of authentic and synthetic content, the feedback on the aural techniques, including the role of impulse responses and convolution reverb, indicated no particular distinction between authentic and synthetic elements but suggest that the nature of the overall sound design is a more significant determinant, with an apparent preference amongst listeners for sounds with more reverberant characteristics over those with a drier sound. Likewise with visual content, no distinction was apparent between images based on authentic sources and those synthesised by the researcher. The conclusion to be drawn from this is that perhaps of most relevance is the contextualisation of both visual and aural sources, and the way they are encountered and interacted with in works.

The final usability lab's exploration of the impact of alternative HMI's and large screen projection and amplified sound provoked the highest rated feedback of any techniques or compositions tested, and thus justified earlier feedback indications that they would prove more effective and engaging. This also highlights how the methodological engagement of users in the iterative design of IDT compositions can help improve a final composition for both composer and audience alike in terms of maximising its intended artistic impact.

Whilst this research has evolved its iterative methodology with the objective of answering two specific questions, the methodology would appear to have more general applicability to the wider research and understanding of the way in which users interact with and experience interactive digital technologies.

CHAPTER 5: COMPOSITIONS

This Chapter details the IDT portfolio developed during the course of this research.

LOCATION OF THE PORTFOLIO

The portfolio is hosted online. This Chapter contains URLs within each section to locate the relevant portfolio work. An online introduction to this work and an exploration of the Palimpsest Navigator can also be accessed at http://palimpsests.org.

One composition has been released onto the Windows Mobile 7 platform as a free mobile application. This is an aural-oriented work entitled *sonic London* which enables the user to experience original contemporary soundscapes from two London locations – Piccadilly Circus and Trafalgar Square – together with 20 interpreted, dynamically varied alternative soundscapes of those locations. At the time of writing, details of this composition are available online at http://www.freewarepocketpc.net/wp7/download-sonic-london.html and also provided in this Chapter's guide to the portfolio.

Some of the compositions make real-time use of Freesound[48] audio content. However, the Freesound programmatic interface service was in test and development mode during the development of the portfolio – with the result that, on occasion, it was not possible for the composition to access relevant content due to changes in the application interface or data formats used. Future changes too may impact compositions and whether they are able to successfully access Freesound resources. Most works provide alternative soundscapes that can be user-selected in the event of Freesound sources not being available, or aim to gracefully decline to indicate that problems exist with accessing the interface. Other works also make use of the Twitter and flickr APIs. Note that all of the unique developer API keys used by the researcher have been removed from the source code: anyone wishing to re-use or build upon this code would need to obtain their own developer keys and insert them where required.

TECHNICAL NOTE

The composition portfolio requires the use of the Microsoft Silverlight browser plug-in[49]. Whilst the compositions have been extensively tested on various browsers – including Internet Explorer, Chrome, Firefox and Safari – and across both the Apple Mac and Microsoft Windows operating systems, optimal performance has proved most consistent

[48] See http://www.freesound.org/
[49] Downloadable via http://www.microsoft.com/silverlight/ as of 05.06.2012.

with Internet Explorer and Chrome. Some limited testing has also taken place with the Mono Moonlight[50] Linux version of Silverlight. However, whilst some compositions may work in this environment, particularly earlier works, it cannot be guaranteed since the Moonlight technical releases are several versions behind the Silverlight roadmap and its future direction appears uncertain. Some prototyping has also recently taken place using HTML5[51], with both the palimpsest lens and palimpsest slider successfully ported to this environment. However, whilst the HTML5 specification is being finalised some cross-browser compatibility issues remain.

AUDIO-VISUAL COMPOSITIONS

PALIMPSESTS.ORG

The screenshots below show how the palimpsests.org site currently appears online.

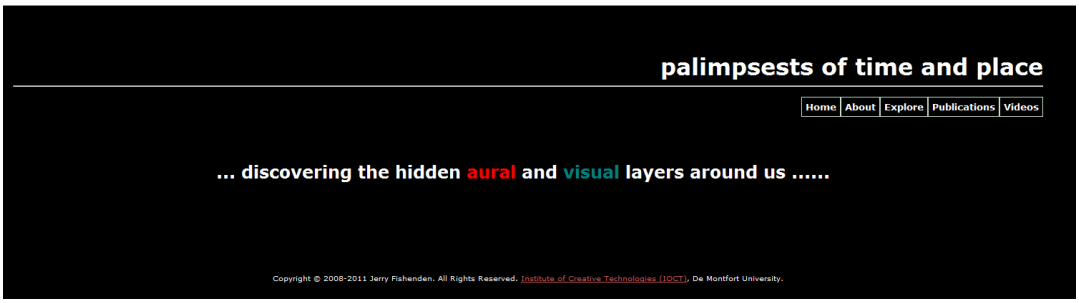


FIGURE 149: PALIMPSESTS.ORG HOME PAGE

FIGURE 150: PALIMPSESTS.ORG ABOUT PAGE

FIGURE 151: PALIMPSESTS.ORG EXPLORE PAGE

[50] Downloadable via http://www.go-mono.com/moonlight/ as of 05.06.2012
[51] See http://www.w3.org/TR/2011/WD-html5-20110525/. 05.06.2012

When clicking the “start exploring” button, the user is taken to the *Palimpsests Navigator* landing page.

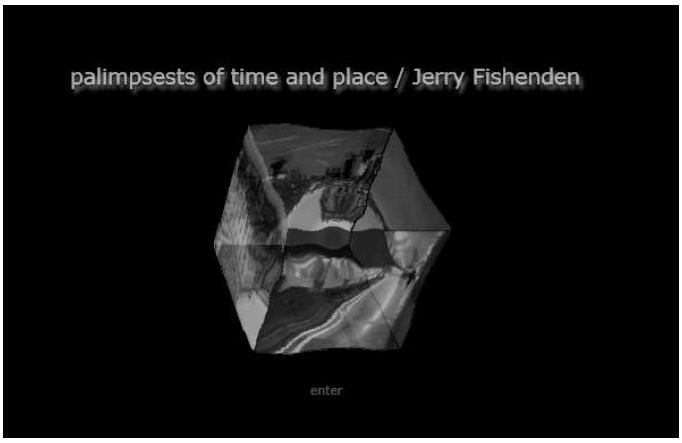


FIGURE 152: PALIMPSESTS NAVIGATOR LANDING PAGE

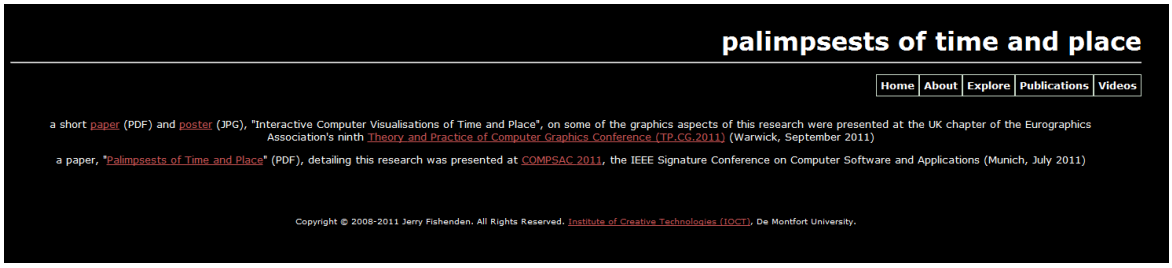


FIGURE 153: PALIMPSESTS.ORG PUBLICATIONS PAGE

FIGURE 154: PALIMPSESTS.ORG VIDEOS PAGE

The underlying work, *Palimpsest Navigator*, was evaluated in UL2 and OU4.

CCTV

This work presents an on-screen CCTV monitoring system that reveals London past and present. This work is premised on the basis of a unique CCTV control system that picks up images of past and lost London rather than contemporary London. It incorporates still and moving snapshots of people and places from London's past and present. The work can be either experienced passively (since its content and behaviour will continue to change and modify over time based on embedded events), or interactively, enabling the user to

explore more of the landscapes and soundscapes. Occasionally ghostly images of objects and people drift across the screen. The user can also choose to put themselves into the work via a webcam, which modifies the imagery using custom pixel shaders. The user's interactions are themselves occasionally observed by the appearance of an all-seeing "eye". The soundscapes offer various options from which the user can select. On first launching, a random soundscape with a "London" metatag will be retrieved dynamically from Freesound. When that soundscape is complete, another will be retrieved – and this process will continue indefinitely. The nature of the sounds retrieved will vary randomly depending on what content is available on Freesound as well as a consequence of the randomisation feature responsible for retrieving the sounds. There are also several composed soundscapes that can be selected to accompany the CCTV images. These are intentionally "synthetic" (in the sense that they do not seek to provide an "authentic" soundscape recorded in London, but are musically-oriented pieces intended to provide a variety of styles, each capable of enhancing the contextual experience of the overall work). The intention is to provide users with a choice of soundscape styles, enabling them to find one that best helps evoke for them an enhanced experience of the work. The composition builds on a variety of techniques developed using the iterative methodology refined through usability testing. Its user interactivity draws upon refined techniques such as the palimpsest slider, enabling users to explore layers of the past of place of selected on-screen content. Other earlier trial works, such as *surveillance*, have also impacted this work.

FIGURE 155: CCTV SCREENSHOTS

Online at http://fishenden.com/research/portfolio/CCTV/default.html and draws in particular upon *surveillance*, *palimpsest lens* and *palimpsest slider*. It was evaluated in OU4.

MEMORIES OF TIME PAST

Memories of Time Past is an autobiographical work, containing an array of images from the researcher's past. It provides a visualisation of the chance interaction of different images-as-memories from the past, forming and breaking random memory clusters. This is a personal evocation of past people and places with meaning for the researcher and an opportunity to test whether what is, for the researcher, a punctum, can also be experienced in that way by users who have no direct connection with the places or people or emergent memory clusters portrayed. These chance individual memories (images) are initially blurred, out of focus, until they encounter each other, at which point they come into focus and interact with each other. Chance clusters of memories join together, sometimes separating and sometimes travelling together and interacting with other memories. The piece is intended to capture the way in which the recall of memory is often a matter of serendipity and the way that one chance memory can lead to a connection with another. The realisation of the work at the level of individual memories is different on each invocation.

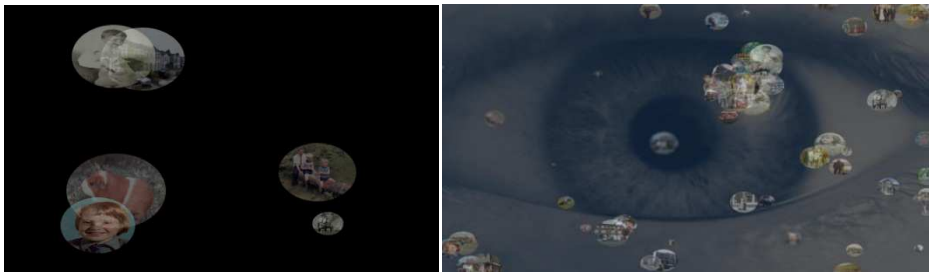


FIGURE 156: MEMORIES OF TIME PAST SCREENSHOTS

Online at http://fishenden.com/research/portfolio/Memories/index.html and draws upon *bionodes*. It was evaluated in OU4.

TIMERADIO

This work presents an on-screen vintage (and somewhat temporally unstable) radio capable of tuning into any sound ever made. It is inspired by Charles Babbage's observation: "*The air itself is one vast library, on whose pages are for ever written all that man has ever said or woman whispered*". The desire was to create an "other worldly" radio, one that could tune into any sound ever made. A vintage radio owned by the researcher was photographed and loaded into a computer and then edited to achieve the basic shell. The casing was modified with a magic tuning eye of the kind often seen on old valve radios to provide the radio with more visual animation. After experimentation, several pixel shaders were applied to lend the radio an old, flickering appearance, sepia tint and generally aged/unstable feel. The original on/off and tuning buttons were used

respectively to achieve the same functions via mouse clicks. In parallel, a wide range of soundscapes were designed and recorded, ranging from some that appear to be authentic, recognisable sounds (such as bells ringing and birdsong), through to ones more musical in nature. Random selections are made from these underlying compositions (over 50, although the repository is capable of indefinite expansion to increase the variability of the experience). The radio itself and its appearance and behaviour are designed to be as unusual as its abilities.

FIGURE 157: TIMERADIO SCREENSHOT

Online at http://fishenden.com/research/portfolio/TimeRadio/index.html and draws upon earlier *TimeRadio* prototypes. It was evaluated in OU3 and OU4 and is included as one of the layered works within *Palimpsest Navigator*, evaluated in UL2.

SONIC PALIMPSESTS

This work enables users to consider and explore alternative soundscapes from two of London's most iconic locations. It uses original field recordings made in London's Piccadilly Circus and Trafalgar Square. The user is able to select one of the locations using the radio button, with Piccadilly Circus the default. For the chosen location, the original sound recording can be toggled on/off using the check button towards the lower centre of the screen. Each of the twenty circles contains a processed version of the original sound which will itself vary with each invocation. Passing the cursor over a circle will start the sound; passing it over again will stop it. Multiple sounds can be stopped or started at the same time, leading to a widely varied series of layered aural experiences based on the nature of the user's interactions. Sounds currently playing are indicated by an animated circle. This composition has an extended loading time due to the size of the underlying WAV sound files.

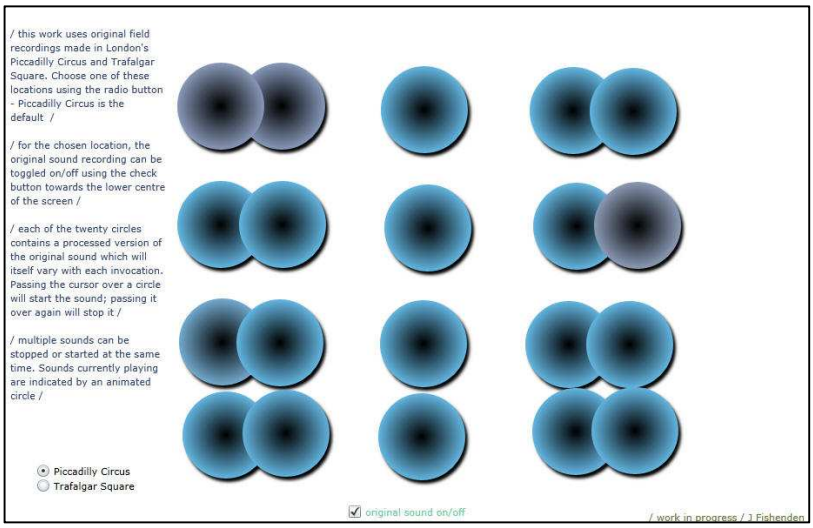


FIGURE 158: SONIC PALIMPSESTS SCREENSHOT

Online at http://fishenden.com/research/portfolio/sonic%20palimpsests/index.html and draws upon earlier experimentation with impulse responses. It was evaluated in UL2. This work was developed in parallel with the *sonic London* app released in the Windows Mobile marketplace, with the downloads and feedback on that app[52] providing a form of extended usability testing "in the wild".

TIMETV

The desire was to find a more atmospheric and contextualised way of presenting old images of place in a new and more engaging way. The idea of *TimeTV* is to offer an alternative context to the display of old images than that usually provided online (which generally consists of simple "slide shows" where one image is replaced by another with little ceremony). A custom sound was designed which plays each time the knob is clicked to display another image. Custom pixel shaders were used to lend the images their "poor reception" form.

FIGURE 159: TIMETV SCREENSHOTS

[52] Rated with 5 stars by those users who have downloaded and provided feedback. Downloaded 179 times as of 07.06.2012

Online at http://fishenden.com/research/portfolio/TimeTV/default.html and draws upon *TimeRadio* extended to a visual dimension, and work with pixel shaders. It was evaluated in OU3 and OU4.

LONDONLIVE

LondonLive is a constantly updating display of captured layers of contemporary London, retrieving and displaying in real time images tagged with London interest from flickr, tweets from Twitter and sounds from Freesound. It intent is to capture the richness and constantly changing events of contemporary living, breathing London. *LondonLive* provides layers of current London – aural and visual – and uses social media to retrieve breaking mentions of events, places and people related to London as they happen. Sound is retrieved from Freesound, drawing down sounds tagged with London content. The piece is thus a never-ending work, capturing both the timelessness of the city and its hub as a melting pot of history, people, thoughts, sounds and activities.

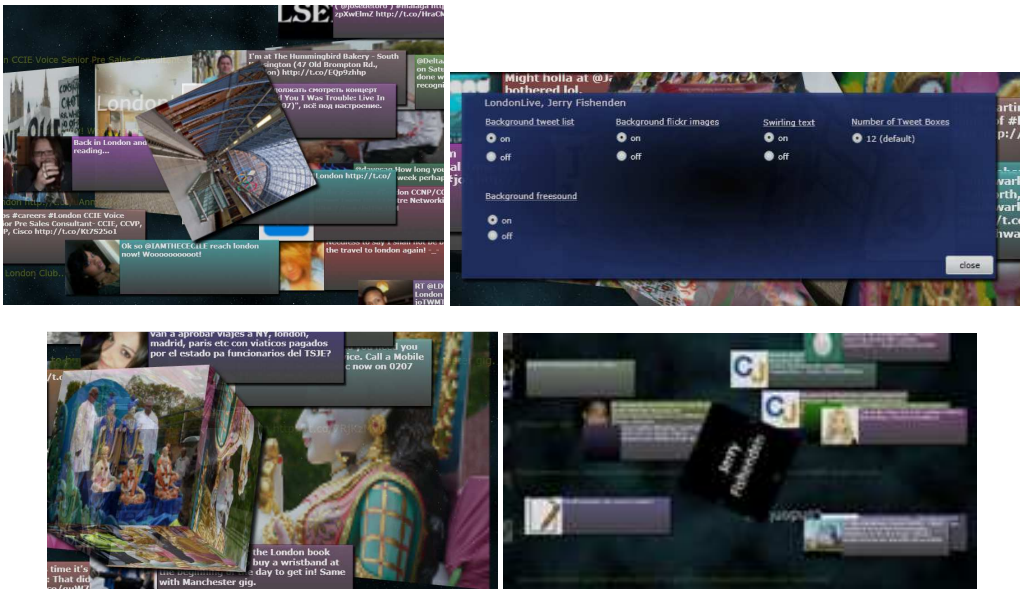


FIGURE 160: LONDONLIVE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/LondonLive/default.html and draws upon the earlier rotating cube. It was evaluated in OU4.

PALIMPSEST BOOK ("I REMEMBER")

This work presents an on-screen book, the pages of which can be turned. Each double-page spread contains an old memory/image related to the researcher on the left-hand page and some text related to the theme of "I remember …." on the right-hand page. The work is accompanied by an original soundscape. The desire was to create an ethereal, slightly unstable visualisation of a book – as if it is being projected from the past and is

barely able to stabilise in the present. The initial online realisation of a book (as seen in the cyclic/carousel work), only provided a rudimentary book and page-turning facility and had no real sense of presence. Several options were tried using aged images, but this also failed to create the desired effect. Work therefore started on examining pixel shaders, which apply novel real-time transformations to images. After further experimentation with a range of existing and custom (created) shaders, a variety were selected that provided the look and feel desired. Together they bring several effects that create the result seen in this composition: a slight flickering, as if the book is being projected by an old style film projector; random pixelation (emulating the drop-out of some elements); and random lines passing across the screen (as with old film when scratches randomly appear and disappear from the projected image).

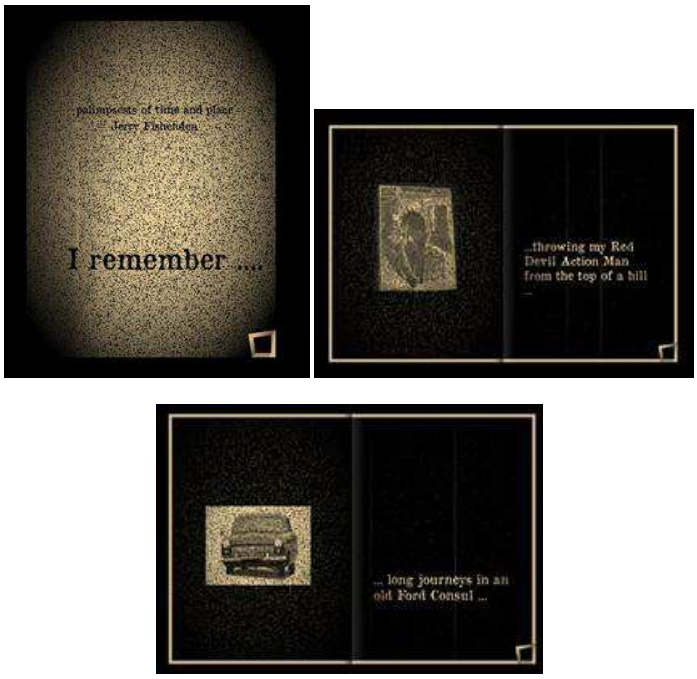


FIGURE 161: PALIMPSEST BOOK SCREENSHOTS

Online at http://fishenden.com/research/portfolio/book/index.html and draws upon earlier interactive book prototypes and René Schulte's pixel work. It was evaluated in OU3 and OU4 and features as one of the integrated works within *Palimpsest Navigator*, evaluated in UL2.

THE OLD GUILDHALL SCHOOL OF MUSIC

The Old Guildhall School of Music is a collection of three pieces, offering alternative experiences of the content. They are an exploration of what the old Guildhall School of Music and Drama once meant to the researcher. During the mid-1970s the researcher travelled weekly for music tuition to the old Guildhall School of Music in London's John

Carpenter Street near Blackfriars. The building was a microcosmic acoustic environment, uniquely its own. It has left forever memories of a building alive with the diverse, echoic sounds of rehearsal: from the human voice to the tuba. Of a building that seemed to ooze the sound of music layered through its history from its very walls. Of a friendly, ageing, echoing location devoted to learning the performance of music from its construction as a dedicated building in 1886. To stand in the corridors of the building was to hear combinations of sounds and enthusiasm and frustration, each unique to a particular moment in time. These works attempt to capture a sense of what this building once meant. They were evaluated in OU1 and OU4.

1. Old Guildhall School of Music (author-led)

The piece is non-interactive and presented as an authored work. Its performance is the same each time it is experienced.

Figure 162: Old GSM, Author-Led, screenshots

Online at http://fishenden.com/research/portfolio/GSM/Default.html.

2. Old Guildhall School of Music (random)

An alternative exploration of what the old Guildhall School of Music and Drama once meant to the researcher. Unlike the first piece, this work utilises the random selection of sounds and their layering, differing each time the work is launched. This work uses an alternative way of presenting the content to explore whether a more chance and random work (which better reflects the random soundscapes encountered in the building) might provide a more evocative re-creation.

Figure 163: Old GSM, Random, screenshots

Online at http://fishenden.com/research/portfolio/GSM%20random/Default.html

3. Old Guildhall School of Music (interactive)

This piece explores another way of enabling a user to understand what the old Guildhall School of Music and Drama once meant to the researcher. Unlike the first two versions, this work adopts an interactive technique whereby users can start and stop sounds, choosing which to layer, via on-screen interactive globes. It uses alternative ways of presenting the composition to explore whether a more interactive work may engage with and hence communicate intent more effectively with a user.

Figure 164: Old GSM, Interactive, screenshots

Online at http://fishenden.com/research/portfolio/GSM%20interactive/Default.html

iRemember(it will be)

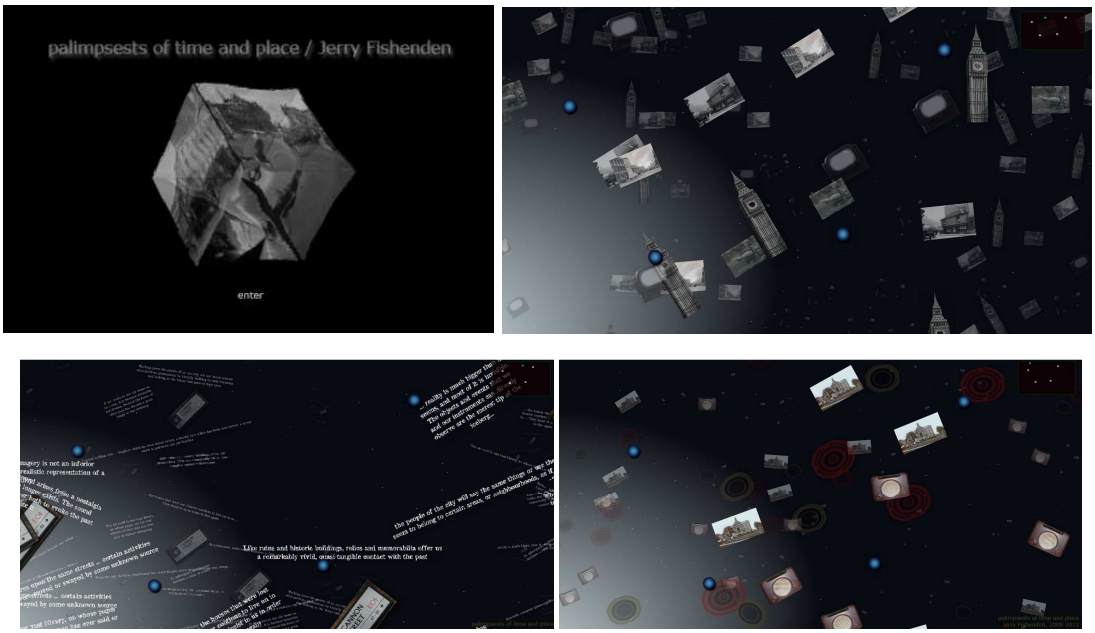
An exploration of memory; layers of environmental sounds (children, birds, the sea) and half-recollected ambiences and music from the past interweave with more ambiguous sounds (digital clocks or medical machines?) and meanings (what sort of "stroke" is being spoken about?). And are the sounds we hear actuality recordings, or simulations ...? Designed for large screen projection and amplified audio, the premiere of this work took place in Leicester in February 2009. It explores the impact of various visual and aural "memories", blurring between authentic and synthetic and exploring double-meanings in both vision and sound. It is an exploration of ambiguity and the unreliability of memory.

FIGURE 165: IREMEMBER(IT WILL BE) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/iRemember/Default.html. It was evaluated in OU1 and OU4.

PALIMPSEST NAVIGATOR

This piece provides a layered environment in which various works and techniques can be explored. The environment itself is designed as a series of layers and intended to create a context in which the compositions can best be experienced. It draws upon various earlier experiments into ways of presenting time and content, including rotational, cyclic and linear. It aims to provide an immersive, experiential and slightly magical space in which the portfolio can be explored in a rich audio-visual environment. It is itself a layered – palimpsestic – environment, with layers of works to be explored and interacted with. The soundscape is designed to evoke an atmosphere of "other-worldliness", of an essence of beauty in the nature of time and place: part of establishing a context in which the embedded layers of composition can best be explored and appreciated.



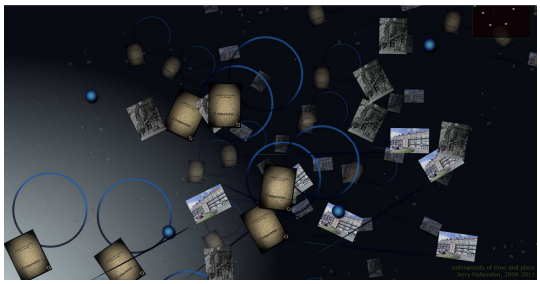


FIGURE 166: PALIMPSEST NAVIGATOR SCREENSHOTS

Online at http://voetek.com/palimpsests/portfolio/index.html and draws upon prototypes of the presentation of time (cylic, linear, rotational) and many other works in the portfolio. It was evaluated in UL2 and OU4.

PORTSMOUTH STREET, LONDON (PARTIAL)

Using mouse movements (left/right), this piece blends a contemporary London street scene with selected image content from the same scene in c. 1904. The creative intent is to enable the user to experience through their direct interaction a hidden partial layer of a particular location from a previous point in its past. Leftwards movements of the mouse progressively reveal the earlier partial image from that location. The user has a high degree of granularity when using the control and is able to fine tune the mix of images – from everything being the "now" image to bringing the "then" partial image fully layered into the present day. By design, no sound is used in this specific work

FIGURE 167: PORTSMOUTH STREET (PARTIAL) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/13PSpartial/default.html and draws upon earlier prototypes and their iterative refinement. It was evaluated in OU3 and OU4.

PORTSMOUTH STREET, LONDON (FULL)

Using mouse movements (left/right), this piece blends a contemporary London street scene with selected image content from the same scene in c. 1904. It aims to enable the user to experience through their direct interaction a hidden layer of a particular location from a previous point in its past. Leftwards movements of the mouse progressively reveal an earlier view of the same location. The user has a high degree of granularity when using the control and is able to fine-tune the mix of images – from everything being the "now"

image to everything being the "then" image with all in-between transitional steps. By design, no sound is used in this work.

FIGURE 168: PORTSMOUTH STREET (FULL) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/13PSfull/default.html and draws upon earlier prototypes and their iterative refinement. It was evaluated in OU3 and OU4.

PORTSMOUTH STREET, LONDON (PALIMPSEST LENS)

By using mouse movements to control a lens able to "see through time" this work overlays a contemporary London street scene with image content revealed from the same scene in c. 1904. The creative intent is to enable the user to experience through their direct interaction a hidden layer of a particular location from a previous point in its past. Movements of the mouse control the movements of the lens around the screen, wherever it is positioned revealing an underlying image of the same location earlier in its history. The user can move the lens around any part of the screen and can also change the size of the lens through use of the mouse scroll wheel. By design, no sound is used in this specific work.

FIGURE 169:PORTSMOUTH STREET (PALIMPSEST LENS) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/13PSlens/default.html and draws upon earlier prototypes and their iterative refinement. It was evaluated in OU3 and OU4.

AURAL PALIMPSESTS OF TIME AND PLACE

This work uses mouse movements around the screen to enable hidden sounds embedded in the landscape to be heard. Sounds are not just those heard at the time of the image, but those from any point of the past (and future) of the location. The creative intent is to enable the user to explore and experience original and alternative soundscapes of place through their direct interaction with hidden aural layers embedded in an historic London street scene. Movements of the mouse around the screen reveal these hidden sounds, the

presence of which is reinforced by a visual cue as the custom cursor (in the shape of an old gramophone horn), which swirls and transforms when it is positioned over a hidden sound. All sounds are playing when the composition is invoked, providing an audio backdrop of 14 separate sounds. When a hidden sound is triggered by the presence of the cursor, it increases in volume, coming to the aural foreground above the other sounds. When its focus is removed, the sound returns to the background hubbub.

FIGURE 170: AURAL PALIMPSESTS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/auralpalimpsests/default.html and draws upon an earlier prototype and its iterative refinement. It was evaluated in OU3, UL2 and OU4.

TRAFALGAR SQUARE PALIMPSESTS OF TIME AND PLACE

This provides a view of Trafalgar Square today and in 1920, with the 1920's view modified by a pixel shader. The artistic intent is to allow users to reveal and explore hidden layers of the past of Trafalgar Square – in this case, ghostly outline palimpsests from the 1920's. In place of the custom on-screen slider of the earlier work, this piece dispenses with the slider and enables left/right movements of the mouse to control the extent to which the two layers merge and transition between each other. The older, 1920's view of London is dynamically modified by a custom pixel shader to be shown as outlines rather than in full detail, exploring how different techniques can portray the past in ways other than the strictly literal and authentic. These ghostly line images are perhaps at their most evocative when mixed partially into the present day view of Trafalgar Square – and the user has full control over both the extent of the mix and the extent to which the older images are outline only or unmodified.

FIGURE 171: TRAFALGAR SQUARE PALIMPSESTS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/trafsqlayers/default.html and draws upon earlier prototypes (e.g. slider control, custom pixel shader development) and their iterative refinement. It was evaluated in OU3 and OU4.

13 Portsmouth Street, London (emergent)

This piece explores an alternative technique for revealing palimpsests of the same place over time. A mouse click initiates an alpha filtration technique that progressively reveals the older image beneath the newer (and vice versa when the mouse is clicked again). This work uses a contemporary London street scene with selected image content from the same scene in c. 1904. It aims to provide a new and evocative way of revealing hidden layers of the past of place. It introduces a new technique based on the application of pixel shader technology. Once the user initiates the transformation/revelation, the current image is progressively replaced with a 1904 image of the same place. It is designed to produce an effect as if the underlying image is progressively burning through the screen. Clicking again reverses this effect and brings us back to the present day. By design, no sound is used.

Figure 172:13 Portsmouth Street, Emergent, screenshots

Online at http://fishenden.com/research/portfolio/13PSemergent/default.html and draws upon earlier prototypes (including slider, lens, and custom pixel shaders) and their iterative refinement. It was evaluated in OU3, UL2 and OU4.

Map palimpsest 1

This work explores a technique for navigating between maps of the same place, revealing palimpsests of the same area over time. This example uses three maps of the same place. It incorporates feedback from earlier work with maps to make the movement between different maps of place over time more intuitive. User interaction utilises a mouse scroll wheel, rotating it downwards moving back in time and upwards forwards in time. The user has fine-grained control over the extent to which each of the three layers is shown alone or mixes with the corresponding earlier or later map.

FIGURE 173: MAP PALIMPSEST 1 SCREENSHOTS

Online at http://fishenden.com/research/portfolio/mapsscrollwheel/TestPage.html and draws upon earlier map and slider prototypes and their iterative refinement. It was evaluated in OU3.

MAP PALIMPSEST 2

This work explores a technique for navigating between maps, revealing palimpsests of the same place over time. This example uses three maps of the same place. It incorporates feedback on earlier work with maps and aims to make the movement between different maps of place over time more intuitive. User interaction utilises left or right mouse movements which move the on-screen images back and forwards in time. The user has fine-grained control over the extent to which each of the three layers is shown alone or mixes with the corresponding earlier or later map.

FIGURE 174: MAP PALIMPSEST 2 SCREENSHOTS

Online at http://fishenden.com/research/portfolio/mapsmouseslider/default.html and draws upon earlier map and slider prototypes and their iterative refinement. It was evaluated in OU3 and OU4.

STEREOSCOPY TEST

This work explores a "3D" element using digitally created anaglyphic techniques, requiring the use of red/cyan glasses. It aims to produce a heightened effect as the user engages in revealing the palimpsest past of a place beneath the present. Once the user initiates the transformation/revelation, the current 3D image is progressively replaced with a 1904 3D image of the same place. It is designed to produce a more immersive, deeper effect as a consequence of the 3D transformation, with layering effects evident during the transition (when it appears as if the layer being revealed is above the other layer, until, as the effect concludes, it too then appears to be deeper inside the screen as a consequence of the 3D

processing). Clicking again reverses this effect and brings us back to the present day. By design, no sound is used.

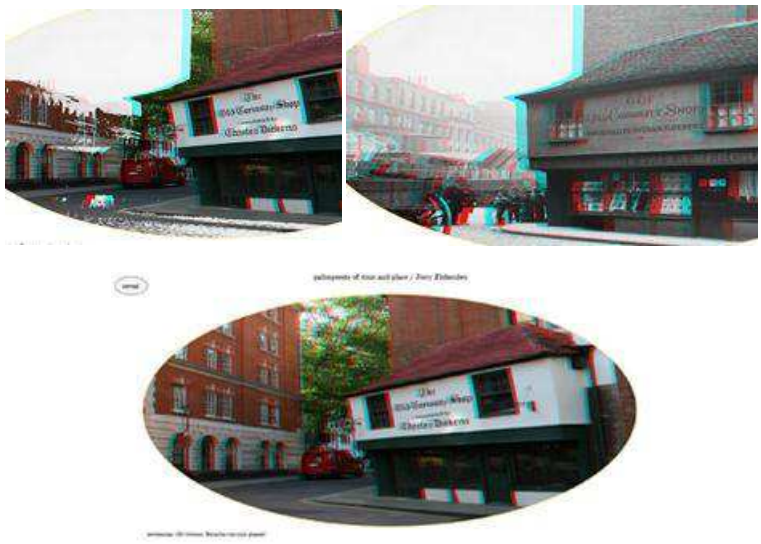


FIGURE 175: STEREOSCOPY TEST SCREENSHOTS

Online at http://fishenden.com/research/portfolio/stereoscopy13PS/index.html and draws upon earlier prototypes and their iterative refinement. It was evaluated in OU3, UL2 and OU4.

HRTF/BINAURAL TEST

This is an aural-only technique requiring the use of headphones. It experiments with the head related transfer function (HRTF) to simulate surround-sound, with the whispers that can be heard moving around (behind, beside, in front of and inside the listener's head). The desire is to create a more immersive, "sound all around" environment for the listener. This work aims to test the extent to which processing using binaural techniques achieves this. It utilises the Wave Arts Panorama 5 HRTF plug-in to assess its effectiveness in creating a binaural "surround-sound" experience for listeners both online and in the usability lab.

Online at http://fishenden.com/research/portfolio/HRTF/HRTFwhispertest.mp3 and requires headphones. It was evaluated in OU3.

FLUTE AT THE GEFFRYE MUSEUM

This is an aural-only technique comparing a dry recording of a flute with a subsequent "wet" version utilising an original impulse response obtained in one of the historic rooms at London's Geffrye Museum. The intent is to modify sounds through the application of impulse responses for artistic effect and to assess the impact they have on listeners. This forms part of evaluating whether authentic or synthetic impulse responses work more

effectively in terms of their impact upon the listener's experience. This utilises an authentic impulse response obtained by the researcher utilised with Cubase's REVerence convolution reverb plug-in.

The reference flute is online at http://fishenden.com/research/portfolio/audiotechniques/flute%20dry.mp3.

The flute with the impulse response from the 1630 hall applied is online at http://fishenden.com/research/portfolio/audiotechniques/flute%20GM%20Hall%201630.mp3

They were evaluated in OU3.

CLARINET IN VARIED ACOUSTICS

This is an aural-only technique comparing a dry recording of a clarinet with a series of "wet" recordings utilising "found" and synthetic impulse responses. The intent is to enliven sounds through the application of impulse responses for artistic effect and to assess the impact they have on listeners. This forms part of testing whether authentic or synthetic impulse responses work more effectively, or whether any difference exists between them in terms of user perception. A variety of authentic impulse responses were utilised with Cubase's REVerence convolution reverb plug-in. Impulse responses utilised include those provided with REVerence together with synthetic ones created by the researcher using Voxengo's impulse response modelling tool.

The clarinet (original sound) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetdry.wav

The clarinet (18th century room) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetfr18thcsalonimpulseresponse.wav

The clarinet (school hall) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetschoolhallimpulseresponse.wav

The clarinet (labyrinth) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetslabyrinthimpulseresponse.wav

The clarinet (small prehistoric cave) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetsmcaveimpulseresponse.wav

The clarinet (kitchen) is online at http://fishenden.com/research/portfolio/audiotechniques/clarinetkitchenimpulseresponse.wav

They were evaluated in OU3.

TRANSAURAL

This is an aural-only technique aiming to enable a pair of stereo speakers to create sounds that appear to, in part, come from beyond the normal stereophonic space. This is part of a wider exploration of the potential applications of spatialised sound. The intent is to make sounds appear to be coming from outside the anticipated stereo space (applying some of the more extreme potential effects of transaural processing). This utilises Wave Arts Panorama 5 to process sound transaurally.

Online at http://fishenden.com/research/portfolio/audiotechniques/transaural1.mp3. This was evaluated in OU3.

ALTERNATIVE (PHYSICAL) USER INTERFACES: XBOX 360 CONTROLLER

This utilises a commodity Xbox 360 wireless controller as an alternative interface to the mouse to provide a more intuitive and more physical means of controlling the palimpsest techniques and compositions. Prototyping took place with a wireless Xbox 360 controller, connected to a PC via the optional adaptation kit. JoyToKey[53] software was used to map controller use to equivalent mouse movements. A custom configuration was created for use with the palimpsest slider and senseport lens techniques enabling the left and right thumb sticks to control navigation along the X and Y axes respectively (although only the X axis is relevant in the case of the mouse as slider control). Use of this alternative HMI led to work with a more custom-designed interface (described below).

ALTERNATIVE (PHYSICAL) USER INTERFACES: CUSTOM UNIT

This utilises a custom designed and constructed prototype hardware interface to provide a more intuitive and more physical means of controlling the palimpsest techniques and

[53] Downloaded from http://www.electracode.com/4/joy2key/JoyToKey%20English%20Version.htm in June 2010

compositions. Its purpose was also to provide alternative (non-tactile) means of interacting with content, such as sonar (movement) sensor controllers.

A Phidgets 1018 Phidget Interface Kit 8/8/8 was acquired as the control centre for a range of Phidgets sensors and used with the WPF programming toolkit. A range of sensors was also acquired (touch sensor, force sensor, slider sensor, precision light sensor, rotation sensor, magnetic sensor, sound sensor, sonar sensor) together with some generic switches and a mix of LEDs. Some of the equipment was built into a custom set of enclosures. This alternative HMI was evaluated in UL2.

FIGURE 176: CUSTOM HMI SCREENSHOTS

PALIMPSESTS OF LONDON (AUDIO-VISUAL WORK)

This is an extended experimental composition that brings together synthetic and authentic images of London and synthetic and authentic sounds into a work with integral user interaction. It combines a variety of interactive and presentational ideas and leads the user on a voyage through a personal perspective of London, its past and present. This work utilises various interconnected scenes, with user interaction largely determining when one scene moves on to another. A variety of techniques were brought together in this composition, including ways of layering and revealing both images and sounds. It uses a variety of specialist coding techniques, such as particle emitters, to produce novel visual effects – applying them in unexpected ways, such as to images of the Big Ben clock tower.

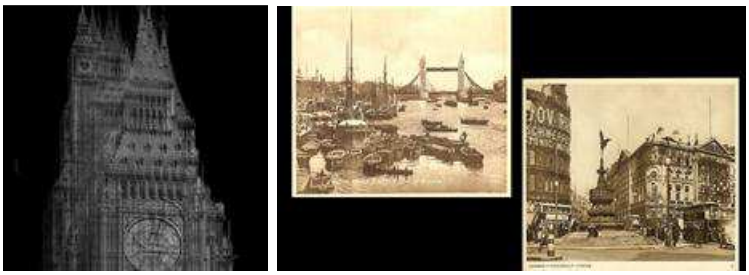


FIGURE 177: PALIMPSESTS OF LONDON SCREENSHOTS

A working test of elements of this work is online at http://fishenden.com/research/portfolio/Palimpsests of London/default.html and draws upon earlier techniques and refinements (slider, particle emitters).

PLASMA

This is an audio-visual composition intended to represent the lowest physical level internal flow of memories within the brain, where reality is created, stored and recalled. It aims to create an artistic interpretation of the ebb and flow of low-level activity within the brain and forms part of a series of inter-related works aimed at providing an artistic interpretation of the way memory is retained and modified within the mind.

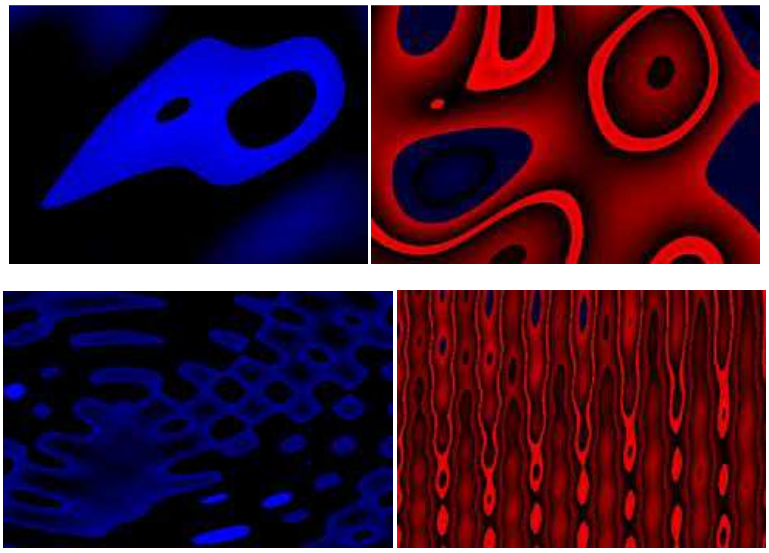


FIGURE 178: PLASMA SCREENSHOTS

Online at http://fishenden.com/research/portfolio/plasma/default.html. Evaluated in OU4.

BIONODES

An audio-visual composition operating at the next layer above "plasma" (described above). Represents individual low-level memories floating around and their chance bonding and interaction with others, via spontaneous and often ephemeral synaptic connections. It

aims to create an artistic, dreamlike interpretation of the creation and interlinking of memory nodes within the brain, with chance movement and synaptic interconnection between them. This forms a layer above the previous "plasma" representation.

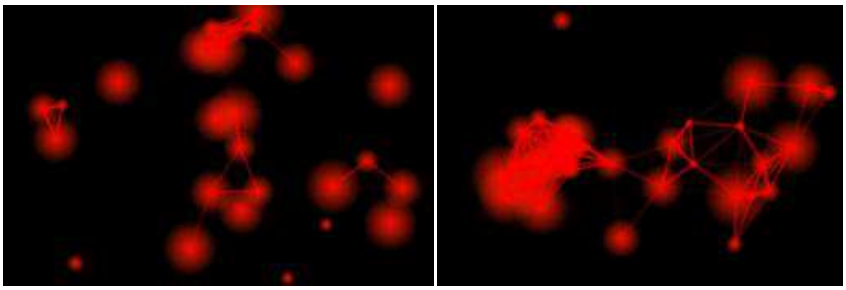


FIGURE 179: BIONODES SCREENSHOTS

Online at http://fishenden.com/research/portfolio/bionodes/default.html and draws upon the work of Jeff Paries. Evaluated in OU4.

AUTOBIONODES

This is an audio-visual composition operating at the next layer above "bionodes" (described above). It represents individual memories (images) of the researcher floating around and their chance bonding and interaction with others, via spontaneous and often ephemeral synaptic connections. These personal memories are out of focus and hard to recall until they chance upon other memories, form synaptic interconnections and come into focus, sometimes breaking away to interact with other memories, sometimes staying together – with some memories never linking, but staying ill-focused and beyond conscious reach.

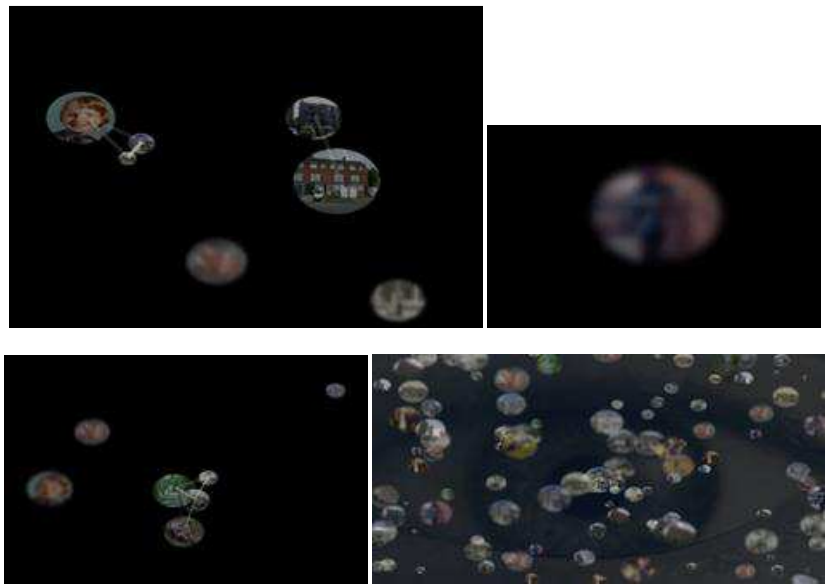


FIGURE 180: AUTOBIONODES SCREENSHOTS

Online at http://fishenden.com/research/portfolio/autobionodes/default.html and draws upon bionodes. Evaluated in OU4.

CLOCKTOWER EMITTER 1

This work involved experimentation using computer visualisation techniques to create unusual effects – in this example, a somewhat Magritte-esque effect of multiple clocktowers. Online at http://fishenden.com/research/portfolio/mclocktower/.

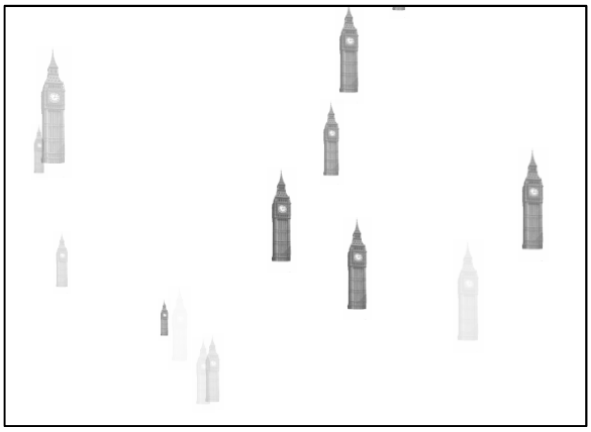


FIGURE 181: CLOCKTOWER EMITTER 1 SCREENSHOT

CLOCKTOWER EMITTER 2

This work explores an alternative aspect of experimentation with computer visualisation techniques, producing multiple layers of dynamically sized images. Online at http://fishenden.com/research/portfolio/eclocktower/.

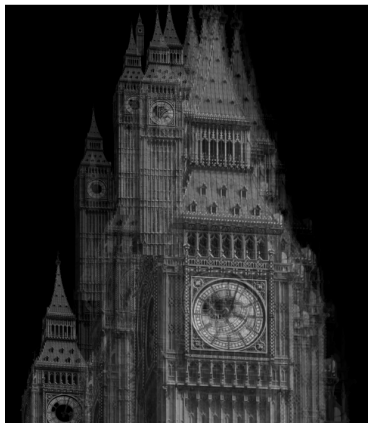


FIGURE 182: CLOCKTOWER EMITTER 2 SCREENSHOT

3D CUBE

This work developed an updated technique for 3D-like rotational cubes, in this example including a counter-rotating object within the cube operating within its own rotational space. Online at http://fishenden.com/research/portfolio/3dcubeplain/.

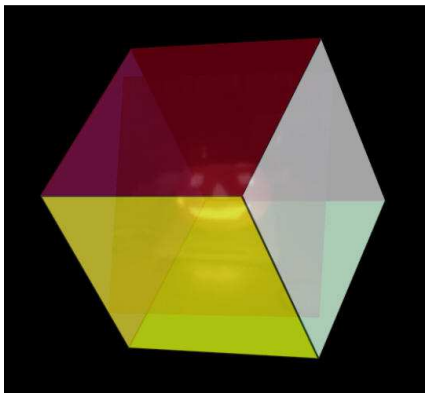


FIGURE 183: 3D CUBE SCREENSHOT

3D CUBE VARIANT

This takes the 3D cube example above and applies experimental pixel shader techniques, modifying the rotational images in real time. Online at http://fishenden.com/research/portfolio/3dcubeshader/.

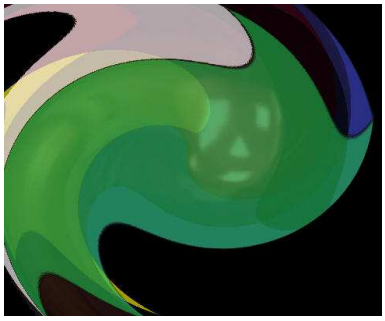


FIGURE 184: 3D CUBE VARIANT SCREENSHOT

SLIVERS OF TIME (AUTOBIOGRAPHICAL)

An audio-visual composition that progressively reveals variable size slivers of past memories (images) which layer on top of each other, building up a rich visual tapestry of snatched insights into the researcher's life. It aims to explore an alternative way of conveying a personal sense of past places and people to an audience. Snatches of visual memories appear on-screen, triggered by embedded events in the soundtrack.

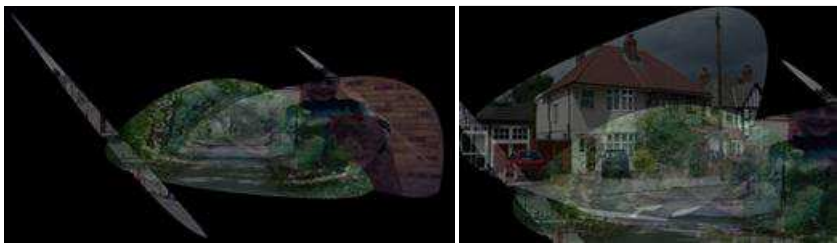


FIGURE 185: SLIVERS OF TIME (AUTOBIOGRAPHICAL) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/composition2/default.html. It can be invoked by clicking on the third rotating image from the right at the top of the screen.

SLIVERS OF TIME (PLACE)

An audio-visual composition that progressively reveals variable size visual slivers of a specific place (the Chiswick Empire) using both contemporary and older images. It aims to explore an alternative way of conveying a sense of past places and people to an audience. Snatches of visual memories appear on-screen, triggered by embedded events in the soundtrack.

FIGURE 186: SLIVERS OF TIME (PLACE) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/composition2/default.html. It can be invoked by clicking on the second rotating image from the right at the top of the screen.

SLIVERS OF TIME (BIOGRAPHICAL)

An audio-visual composition that progressively reveals variable size visual slivers of the Chiswick Empire, the current image (where the building no longer stands) slowly fading to be replaced by the Empire as it was, as a local resident recalls his memories of the place during its heyday. This composition aims to explore an alternative way of conveying a sense of someone's personal recollection of lost places and people to an audience. Snatches of visual memories appear on-screen, triggered by embedded events in the soundtrack.

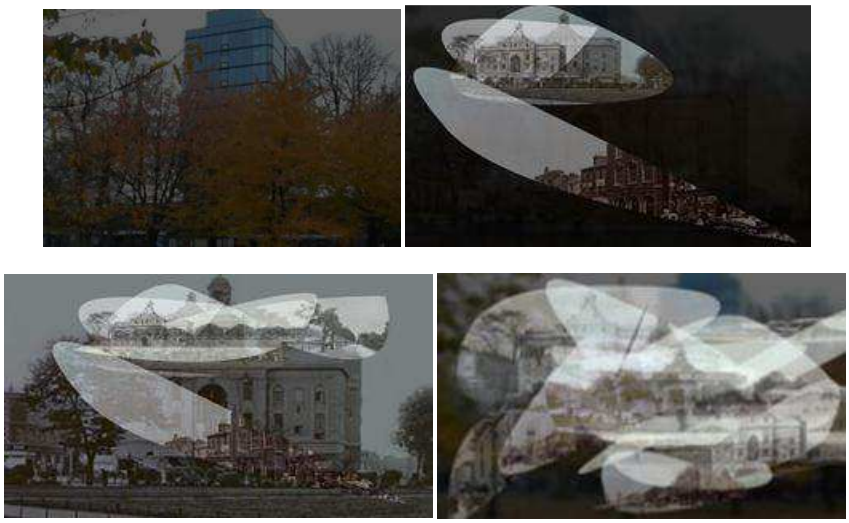


FIGURE 187: SLIVERS OF TIME (BIOGRAPHICAL) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/composition2/default.html. It can be invoked by clicking on the first rotating image from the right at the top of the screen.

TYBURN TREE (UPDATED)

This work is a revised version of the original Tyburn Tree (detailed later in this Chapter) and aims to make users better aware of what once happened at what is now a rather banal and traffic-dominated place.

FIGURE 188: TYBURN TREE (UPDATED) SCREENSHOTS

Online at http://fishenden.com/research/portfolio/TyburnTree2/index.html and draws upon the original Tyburn work together with other techniques (notably pixel shaders).

SYNTHETIC FMRI

Part of a creative visualisation of the exploration of the nature of internal memory and recollection for incorporation into an extended work. See *Personal fMRI*. Online at http://fishenden.com/research/portfolio/mrisite/.

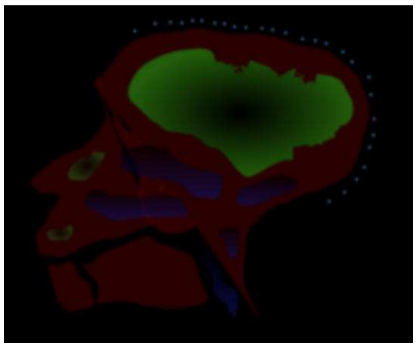


FIGURE 189: SYNTHETIC FMRI SCREENSHOT

PERSONAL FMRI

A creative exploration of techniques developed to support a later extended work built around autobiographical memories of people and places from the researcher's life. See *Memories of Times Past*. Online at http://fishenden.com/research/portfolio/personal%20fmri/.

FIGURE 190: PERSONAL FMRI

3D MEMORIES

This work is an iterative enhancement to "3D homes". The images are animated, they start small and grow in size as they move towards the front of the screen. Clicking on an image produces a random soundscape and causes the selected image to be pinned to the middle of the screen until the user clicks on another image, or the soundscape completes, at which point the screen returns to its previous formation. It aims to explore an alternative way of representing images and memories of place and things onscreen, in an attractive and compelling way, whilst still providing an element of user interaction. As a user clicks on an image, a random soundscape is invoked – the image folding away and re-joining the others when the sound completes.

FIGURE 191: 3D MEMORIES SCREENSHOTS

Online at http://fishenden.com/research/portfolio/landingpage3D/default.html and draws upon the original 3D work and the soundscapes from *TimeRadio*. Evaluated in OU4.

HTML 5 WATCHING/EVALUATION

HTML5 is currently a draft specification which, when complete, may be able to do much of what is currently achieved through proprietary browser plug-ins such as Microsoft Silverlight and Adobe Flash. This activity evaluated the extent to which some of the original techniques developed in this research may be implementable in HTML5 and the extent to which such techniques will work interoperably between differing browsers.

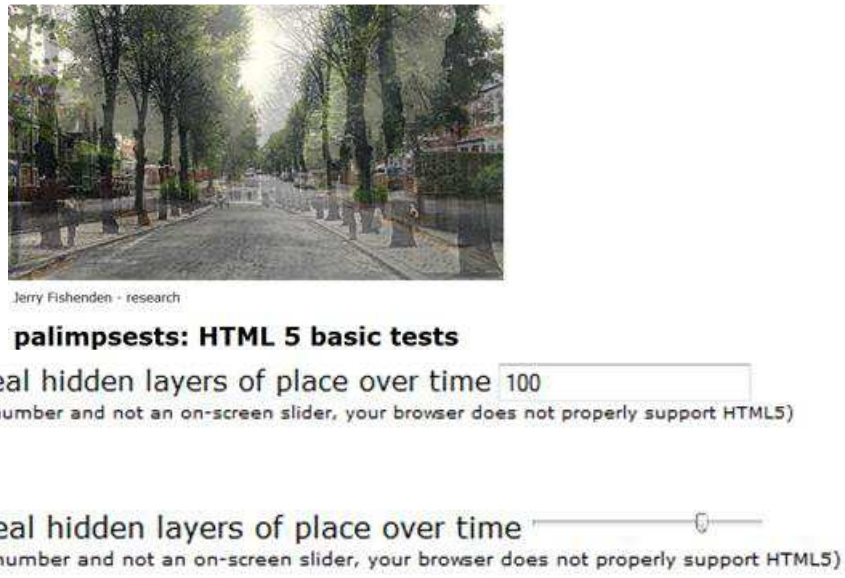


FIGURE 192: HTML PROTOTYPE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/html5/test/ and http://fishenden.com/research/portfolio/HTML5/test/lens.html (HTML5 adaptation of

the lens technique) and
http://fishenden.com/research/portfolio/HTML5/test/slider.html (HTML5 adaptation of the slider technique)

MOBILE COMPOSITIONS

A mobile application, "sonic London", based on aspects of this project was released onto the Windows Phone 7 platform during 2011.

SONIC LONDON

sonic London draws upon ideas developed during this research, including the concept of layers of sound that can be discerned behind the surface, and visual ideas developed and refined through the iterative methodology such as the rotating cube mapped with differing visual images of place over time and the use of interactive pulsing buttons seen in works such as the Guildhall School of Music. The adaptation of the work to a mobile device raised several design challenges, notably the size of the overall application: the sounds were originally all high quality stereo WAV format, but these exceeded the size of application permitted and would have presented prohibitive download times. Instead, they were processed into mono WAV files, although this still left the application as a considerable size. WAV files were used in place of compressed files such as MP3 since the ability to manipulate them (notably their pitch, using randomised parameters) was only possible in the Windows Phone 7 (WP7) design environment for WAV files.

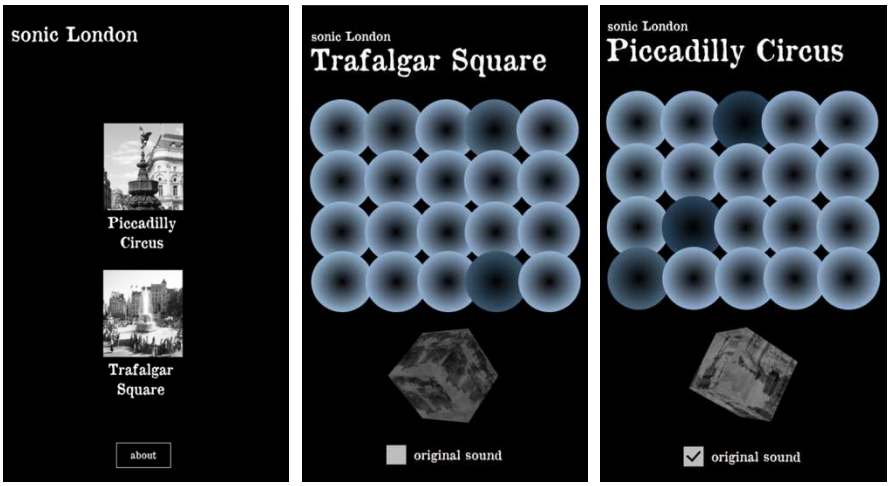


FIGURE 193: SONIC LONDON SCREENSHOTS

DMU SQUARE MILE

A prototype application based on aspects of this research was developed for the Android platform and tested on the Motorola Xoom as part of ongoing work for the DMU Square Mile project. This is based on an earlier prototype developed for *Lost London*. Images of the DMU Square Mile application running on a simulator are shown below. They incorporate the lens and slider techniques developed during the course of this project.

FIGURE 194: DMU SQUARE MILE TABLET APP SCREENSHOTS

EARLIER WORKS AND TECHNIQUES

LAUNCH CAROUSEL (BRITISH LIBRARY DEMONSTRATOR)

This is an experimental website landing page that provides an overview of selected compositions in the form of a rotating visual carousel. It enables users to click on any of the rotating thumbnails, which freezes the carousel and enables them to read a brief narrative description of the work in a larger pane view of the item chosen. They can then choose whether to launch the selected composition (which will open in a separate browser window), or close the enlarged pane and continue exploring other available compositions. The carousel is accompanied by sound that creates an atmospheric context: this sound stops when one of the compositions is launched and only resumes after the composition has completed and the child browser window terminated.

The creative intent is to enable a user to experience a variety of original compositions displayed initially in a cyclic form, representing one possible theoretical model of the nature of time. It is one of several landing pages intended to present a compelling way of interacting with and launching content – one that is also intended to determine whether any one particular representational model proves more effective with users than another. The work establishes an atmospheric context through the use of an original soundscape combined with visual imagery that reacts to mouse movements (slowing, accelerating or halting the rotation of the elements). The landing page is designed to establish a particular, other-worldly atmosphere in advance of one of the specific underlying compositions being launched.

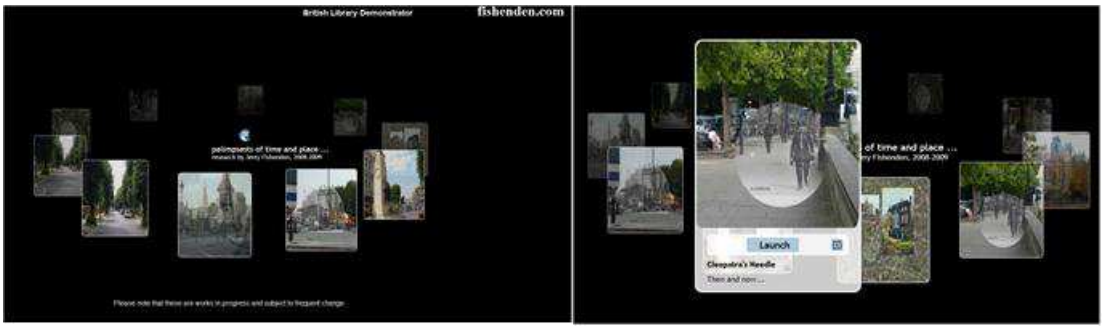


FIGURE 195: LAUNCH CAROUSEL SCREENSHOTS

Online at http://fishenden.com/research/portfolio/bl/. This work was discussed with the British Library about its possible application to the exploration of British Library archives, both aural and visual. Evaluated in OU1 and UL1.

CHISWICK STREET – SLIDER

User movement of an on-screen horizontal slider transitions between a contemporary image of a Chiswick (west London) street at the far left extreme of slider movement and one from the nineteenth century (sourced from an original post card) at the far right extreme of slider movement. At intermediate stages, the on-screen visualisation provides a merged view of the two images, the balance determined by the user's movement and positioning of the slider.

The creative intent is to enable the user to experience, through direct interaction, a hidden visual layer of a particular location from a previous point in its past. The user has a high degree of granularity when using the control and is able to fine tune the mix of images – from everything being the "now" image to everything being the "then" image, to anywhere in-between with a hybrid blend of both images (drawing on the theme of the palimpsest). By design, no sound is used in this specific example, although the potential for also transitioning between contemporary and older sound sources is explored in other techniques.

FIGURE 196: CHISWICK STREET SLIDER SCREENSHOTS

Online at http://fishenden.com/research/portfolio/Chiswick%20street/Default.html. Evaluated in OU1, OU2 and UL1.

CHISWICK STREET – SENSEPORT LENS

The creative intent is to enable the user to experience and reveal, in a novel way, a hidden layer of a particular location from a previous point in its past. This work enables the user to select an on-screen "lens" by clicking on it with the mouse. The potential for this interaction is emphasised by a sound playing when the mouse cursor passes over the lens, as well as the cursor changing from a pointer to a hand. Whilst selected, movement of the lens around the displayed "now" image reveals an earlier view of the same street scene hidden below the contemporary scene (the "then" image). The sound is also intended to create a slightly magical context for the lens and what it is capable of revealing. The lens thus acts as a *lens through time*, rather than the more customary role of a magnifying glass.

FIGURE 197: CHISWICK STREET LENS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/senseport%20streets/Default.html. Evaluated in OU1 and OU2.

MORPHING MAPS

Three West London Maps – from 2008, 1920 and c.1805 – are presented in layers. Initially only the 2008 map is visible. As the user moves the on-screen slider it blends the displayed artefacts backwards and forwards in time, gradually revealing the earlier maps the further back in time the slider is moved. As the user passes through the era when the Chiswick Empire existed (1912-1959) it flickers into life on its site by Turnham Green. If the user stops the slider in this era the image will grow to be viewed. Clicking on the Empire switches audio on/off. The red dot is Hogarth's House, which was present throughout the time period of all three maps. Clicking on the dot brings up a photo of the house. Clicking on the red dot again removes the photo. The blue dot is Duke's Avenue. Clicking on the dot brings up two photos that morph in and out of each other from the twentieth and nineteenth century, accompanied by (synthetic) sounds of children playing from the 19th century. Clicking on the blue dot again removes the experience.

This work brings together a variety of interactive and user-responsive techniques in one work. It uses these different user interaction techniques and visualisation methods to

provide a novel means of a user exploring the past of place. Three maps of the same period and some local historic landmarks are layered in ways that enable the user to explore how the landscape and soundscape of this particular part of West London have changed over time.

FIGURE 198: MORPHING MAPS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/morphing-maps/Default.html. Evaluated in OU1 and OU2.

CHISWICK EMPIRE – SENSEPORT LENS

This work explores an alternative visual method of designing a lens capable of displaying the past of place, as well as introducing moving video footage rather than solely still photography. The magnifying glass-like design of the senseport lens in this example also pulsates, as if unstable and moving in and out of the present time.

The user can select the on-screen "lens" by clicking with the mouse. The potential for this interaction is emphasised by the cursor changing from pointer to hand. Whilst selected in this way, movement of the lens around the displayed image reveals an earlier view of the same street scene hidden below the contemporary scene. The contemporary scene is video rather than a photograph. The older image is a photograph. The lens design is modelled on that of a vintage magnifying glass. Contemporary traffic noises from the video soundtrack are intentionally audible. Both audio and moving images of the present are looped.

FIGURE 199: CHISWICK EMPIRE LENS SCREENSHOTS

Evaluated in OU1, OU2 and UL1.

CHISWICK MAPS – SENSEPORT LENS

The creative intent is to enable the user to experience and reveal in a novel way a hidden layer of maps that enable an exploration of the past of place. This is achieved through an intuitive on-screen "lens" that reveals a faint image of the underlying past of the same place beneath the image of the present day. When the user selects the lens the "then" map image becomes much clearer and can be moved around the map of the present day revealing beneath it the past map at that particular location. When the cursor moves across the lens prior to its selection, an associated original sound is played, acting as an aural cue to reinforce the fact that it is possible to interact with and control the lens. The sound is also intended to create a slightly magical context for the lens and what it is capable of revealing. The lens thus acts as a lens through time, rather than a more customary role such as a magnifying glass.

FIGURE 200: CHISWICK MAPS LENS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/senseport%20maps/Default.html. Evaluated in OU2 and UL1.

TRAFALGAR SQUARE – SLIDER

User movement of the on-screen slider transitions between a contemporary moving image of Trafalgar Square at the far left extreme of slider movement and moving images from the 1920s at the far right extreme of slider movement. At intermediate stages, the on-screen visualisation provides a merged view of the two images, the balance determined by the user's movement of the slider, including intermediate stages where both then and now images coexist, providing ghostly imprints of the past of what once happened in Trafalgar Square on the present.

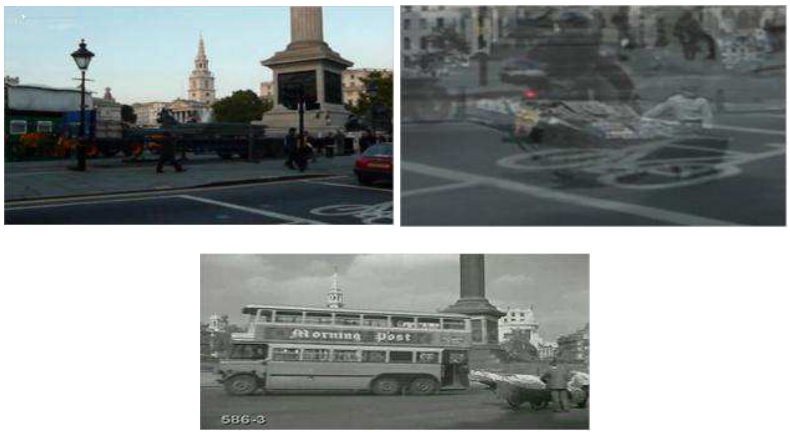


FIGURE 201: TRAFALGAR SQUARE SLIDER SCREENSHOTS

Online at
http://fishenden.com/research/portfolio/Trafalgar%20Square%20moving/default.html.
Evaluated in OU2 and UL1.

CLEOPATRA'S NEEDLE – SENSEPORT LENS

The creative intent is to enable the user to experience and reveal in a novel way a hidden layer of a particular location from a previous point in its past. In this work, a user is able to experience the street scene along London's Embankment adjacent to Cleopatra's needle as it is now and as it was in the past. The ability to reveal and navigate the past hidden beneath the present is achieved through an intuitive on-screen "lens" that reveals a faint image of the underlying past of the same place beneath the image of the present day. When the user controls the lens the "then" image becomes much clearer and can be moved around the screen revealing the past of whatever part of the scene it moves across. When the cursor moves across the lens prior to its selection, an associated original sound is played, acting as an aural cue to reinforce the fact that it is possible to interact with and control the lens. The sound is also intended to create a slightly magical context for the lens and what it is capable of revealing. The lens thus acts as a lens through time, rather than a more customary role such as a magnifying glass.

FIGURE 202: CLEOPATRA'S NEEDLE LENS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/cleopatra/Default.html and the revised version is online at http://fishenden.com/research/portfolio/cleopatralens/default.html. Evaluated in OU2 and OU4.

THE CENOTAPH – SENSEPORT LENS

The creative intent is to enable the user to experience and reveal in a novel way a hidden layer of a particular location from a previous point in its past. In this work, the user is able to experience the street scene along London's Whitehall by the Cenotaph memorial, as it is now and as it was in the past. The ability to reveal and navigate the past hidden beneath the present is achieved through an intuitive on-screen "lens" that reveals a faint image of the underlying past of the same place beneath the image of the present day. When the user uses the lens the "then" image becomes much clearer and can be moved around the screen revealing the past of whatever part of the scene it moves across. When the cursor moves across the lens prior to its selection, an associated original sound is played, acting as an aural cue to reinforce the fact that it is possible to interact with and control the lens. The sound is also intended to create a slightly magical context for the lens and what it is capable of revealing.

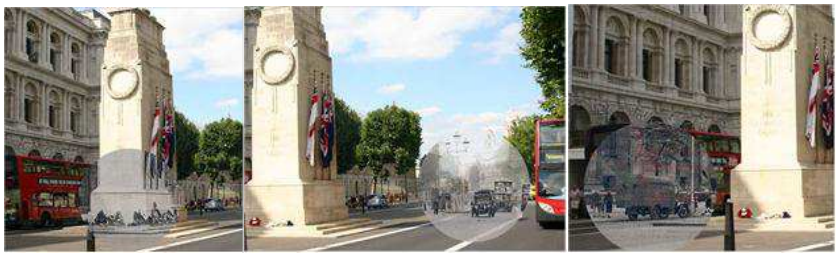


FIGURE 203: THE CENOTAPH LENS SCREENSHOTS

Online at http://fishenden.com/research/portfolio/cenotaph/Default.html and the revised version is online at

http://fishenden.com/research/portfolio/cenotaphlens/default.html. Evaluated in OU2, UL1 and OU4.

TYBURN TREE

This is a non-interactive piece. The screen displays a contemporary image of the junction by Marble Arch where Tyburn tree reputedly stood. Background ambient sounds are those recorded at the scene of the plaque that marks the location of the tree. Intermittently an image of the "tree" during a public execution flickers into place, accompanied by an "other worldly" sound.

The intent of this piece is to reveal some of what once happened at this particular place – namely the public hanging of more than 50,000 people. Today it is a busy, bland part of central London. But in the past it was countryside and had a very different purpose. The composition aims to find a way of surfacing the undercurrents and echoes of the past, of the events that once happened here so that people will think about the past of place when they pass through locations such as this in the future. It is thus in part an exploration of how the past of a place can live on in the present – if only we had some means of seeing, sensing and hearing it.

FIGURE 204: TYBURN TREE SCREENSHOT

Online at http://fishenden.com/research/portfolio/Tyburn Tree/default.html. Evaluated in OU2 and UL1.

LANDING PAGE (LINEAR)

This work provides an interactive navigable landing (or launch) page for content. Each of the menu options is visual and floats gently around. The options are laid out in a linear form. Some of the menu options are animated, including video footage. The creative intent is to enable a user to experience autobiographical original compositions set out in a linear form, representing one of the potential models explored for the representation of the nature of time. It is one of several landing pages intended to present a compelling way of interacting with and launching content that is also intended to determine whether any one particular representational model proves more effective with users than another. The

landing page is designed to establish a highly visual, simple to understand means of exploring a range of underlying content linked to each of the on-screen images (which are a mix of both moving and still). The underlying compositions range from simple text, to a collection of images.

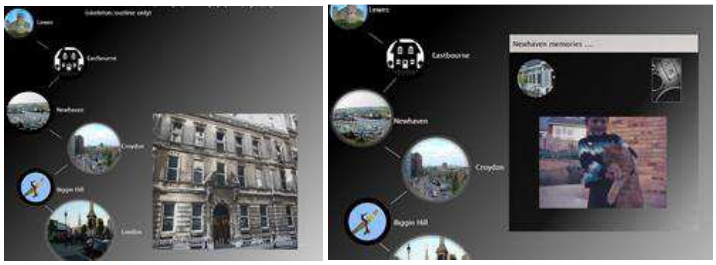


FIGURE 205: LINEAR LANDING PAGE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/autobiography_linear/Default.html. Evaluated in OU1, OU2 and UL1.

LANDING PAGE (CYCLIC)

This work provides an interactive navigable landing (or launch) page for content. Each of the menu options is visual and rotates around a central point. The options are laid out in a cyclic form. The creative intent is to enable a user to experience autobiographical original compositions displayed initially in a cyclic form, representing one of the theoretical models being explored for the representation of the nature of time. It is one of several landing pages intended to present a compelling way of interacting with and launching content that is also intended to determine whether any one particular representational model proves more effective with users than another. The work establishes an atmospheric context through the use of an original soundscape combined with visual imagery that reacts to mouse movements (slowing, accelerating or halting the rotation of the elements). The landing page is designed to establish a particular, other-worldly atmosphere in advance of one of the specific underlying compositions being launched. During the feedback and evaluation stage, all of these menu elements invoked the same underlying composition – an on-screen book containing a variety of random autobiographical memories ("I remember …").

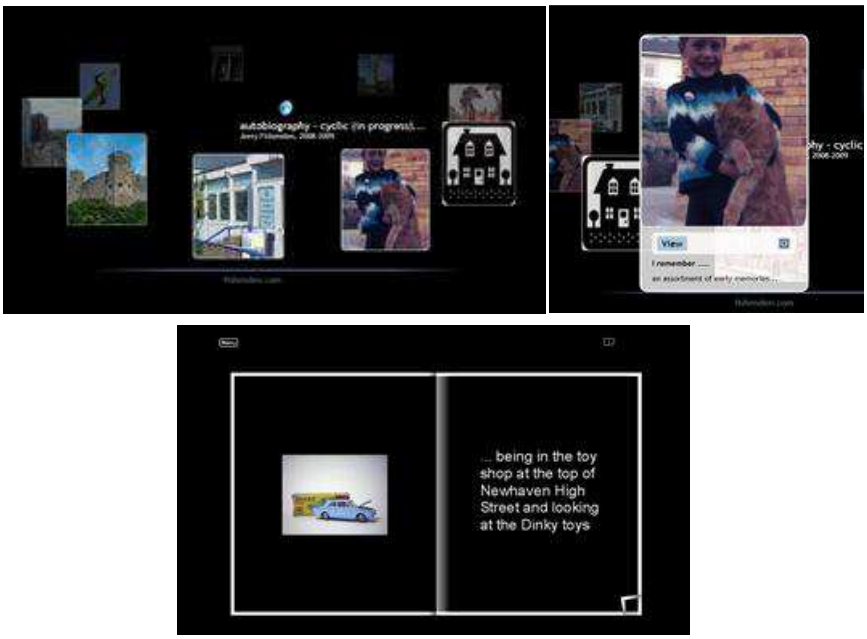


FIGURE 206: CYCLIC LANDING PAGE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/autobiography_cyclic/index.html. Evaluated in OU1, OU2 and UL1.

LANDING PAGE (ROTATIONAL)

This work provides a rotational landing (or launch) page for content. In the centre of the screen two pieces of text ("palimpsests" and "of time and place") rotate around a central point. The rotation and its relative position is accompanied by atmospheric sound, both musical and voices. This is one of several landing pages intended to present a compelling way of interacting with and launching content that is also intended to determine whether any one particular representational model proves more effective with users than another. The work establishes an atmospheric context through the use of an original soundscape combined with rotating visual imagery. The landing page is designed to establish a compelling atmosphere prior to the user launching an associated work.

FIGURE 207: ROTATIONAL LANDING PAGE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/rotational/default.html. Evaluated in OU2 and UL1.

3D HOMES

This work provides a "3D-like" perspective, containing images of the homes in which the researcher has lived. The images are animated, they start small and grow in size as they move towards the front of the screen. Clicking on an image produces an ethereal sound and causes the selected image to grow in size until it fills the whole screen, after which the screen returns to its previous formation. This work explores an alternative way of presenting images of the past and present. It does so by presenting the images in a "3D like" view, with a collection of images randomly displayed on screen in a variety of depths into the screen. The images float towards the viewer and enable interaction – by clicking on them, an image becomes larger, and also re-orientates the entire presentation on-screen around that image. The speed is deliberately meant to create a gentle, floating, almost dreamlike atmosphere: interaction provokes a faster, more responsive action, whilst being offset by a sound that is intentionally gentle.

FIGURE 208: 3D HOMES SCREENSHOTS

Online at http://fishenden.com/research/portfolio/palimpsest3D/default.html. Evaluated in OU1, OU2 and UL1.

AURAL PALIMPSESTS OF TIME AND PLACE (LONDON SOUNDSCAPE)

This work provides a static historic image of part of the City of London. Embedded within the landscape are fourteen soundscapes, all of which play together by default. They can be located and listened to with a "spotlighted" increase in their individual volume by moving the cursor around the screen until they are each found. This work focuses intentionally on the aural, the sounds of a particular place over time. The intention was not to restrict the hidden sounds to those that could have been heard in this location either today, or at the specific moment in time displayed in the image. It was instead to enable sounds that might have been heard here at any time (including before the construction of the City) and also sounds that might be heard here in the future.

FIGURE 209: AURAL PALIMPSESTS SCREENSHOT

Online at http://fishenden.com/research/portfolio/audioharness/default.html. Evaluated in OU2 and UL1.

IMPULSE RESPONSE

This work is aural only. The composition merges two differing impulse responses – the first dry and far away, the second closer and fuller. This work explores the impact of impulse responses on the way that users perceive a sound. In this example, the desire was to create an effect that started by sounding distant but which comes closer in a powerful, haunting way that has an impact on the listener.

This work was developed using Cubase 5 and the REVolution impulse response / convolution reverb VST module. The same sound was processed using two very different impulse responses, with the sound automated to move from one to the other. It formed part of an assessment of the impact of impulse responses, when used on the same material, in terms of the impact created on a listener.

Online at http://fishenden.com/research/portfolio/audiotechniques/example1.wav. Evaluated in UL1.

LONDON EVOCATIONS GALLERY

This work was itself a refined version of an earlier online gallery of images. It added sounds, selected randomly from an underlying collection, as users click on and examine images in more detail. It aims to provide users with an alternative, interactive way of examining images and sounds of the past, to build on the usual "photographic book" style of presentation, but to make it a more immersive and slightly unexpected experience (which is where the randomisation of audio comes into play – often using producing sounds that initially may appear to have little to do with the imagery, but perhaps on reflection may have some connection).

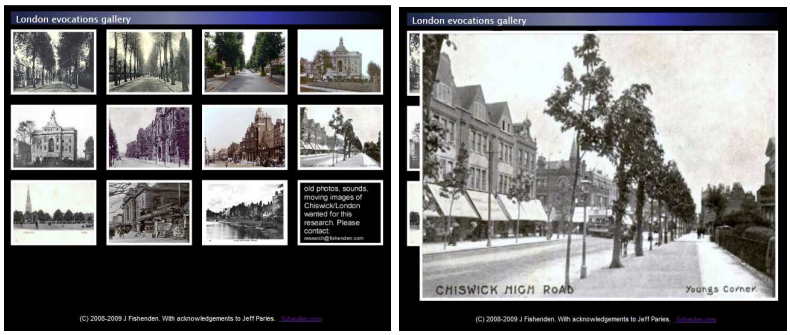


FIGURE 210: LONDON EVOCATIONS GALLERY SCREENSHOTS

Online at http://fishenden.com/research/portfolio/gallerysound/default.htm. Evaluated in OU1.

THROUGH THE WINDOW

A set of three rotating cubes of a window frame in an old house, overlaid with a sound from the past. This work aims to provoke users into considering how the sounds to be heard and images to be seen through the window of an old house will have varied over time. How in a sense that window is a literal window on the past, has lived through ages we have not ourselves witnessed.

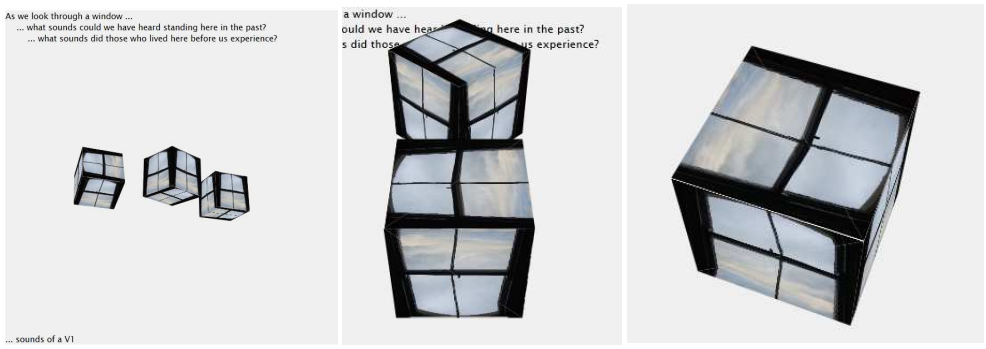


FIGURE 211: THROUGH THE WINDOW SCREENSHOTS

Online at http://fishenden.com/research/portfolio/windowframe/default.html. Evaluated in OU1.

SURVEILLANCE

This was developed as a prototype framework for a work examining surveillance cameras in London. Each box is a placeholder for an image of a surveillance camera. The work aims to provide users with a way of examining the many surveillance cameras on the streets of London – for them to become the one looking at those who use technology to keep us under surveillance. The work was developed as a framework, although the images captured of various surveillance cameras from around London were not loaded into the prototype.

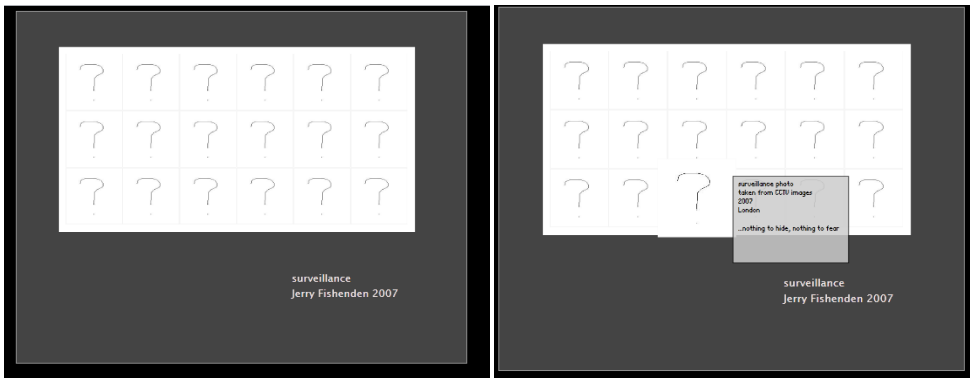


FIGURE 212: SURVEILLANCE SCREENSHOTS

Online at http://fishenden.com/research/portfolio/surveillance/default.html.

EARLIER TIMERADIOS

A set of early prototypes and developments to explore the idea of a radio able to tune into any sound ever made. The aim was to examine the different ways in which such a time radio could be represented, using rapid prototyping techniques, from a sketch-based time radio, to one designed entirely digitally to one incorporating images of a vintage radio.

FIGURE 213: EARLIER TIMERADIO SCREENSHOTS

Online at http://fishenden.com/research/portfolio/TimeRadio/TimeRadio.htm. Evaluated in OU1.

CHAPTER 6: CONCLUSIONS

This research examined the relationship between the development of a portfolio of interactive digital techniques and compositions, and its impact on user experiences of time and place[54]. It was designed to answer two research questions:

- What are some effective methods and techniques for evoking an enhanced awareness of past time and place using interactive digital technologies (IDTs)?
- How can users play a role in improving the development and impact of interfaces made with IDTs?

The principal creative and thematic element of the portfolio is the concept of the palimpsest, and its artistic potential to reveal visual and aural layers that lie behind the landscapes and soundscapes around us. This research thus contributes to an evolving cadre of works and creative interest in palimpsests, developing techniques and compositions in the context of testing, collating user experience feedback and improving the ways in which IDTs enable an artistic exploration and realisation of hidden layers, both aural and visual, of the past of place.

Three short, illustrative videos were produced during the course of this research, and hosted on YouTube: "palimpsests of time and place"[55], "more palimpsests of time and place"[56] and "palimpsests of time and place – prototype interfaces"[57]. They provide a record of the research at various stages of development.

The research explored the role that users can play in helping to improve the development and impact of interactive digital techniques, and in the identification of those techniques and methods that achieve this most effectively. It considered the concepts that Roland Barthes narrates in *Camera Lucida* (Barthes, 1981, originally published 1980), between the mix of general symbolism inherent in a photo – that which anyone would see (the *studium*), and that which was profoundly personal and intimate (the *punctum*). This research explored the potential of IDTs to discover the extent to which it might prove possible to convey a sense of the past of place that pierces the viewer (cf. p. 18) to another who had no direct link or association with the subject or place portrayed. User experience testing therefore sought to acquire feedback regarding the techniques developed during the course of this research that impacted and engaged users emotionally.

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[54] The portfolio is online at http://fishenden.com/research/research.html
[55] http://www.youtube.com/watch?v=pydi0KGPMek. 137 views. Retrieved 27.01.2012
[56] http://www.youtube.com/watch?v=-fNmuSfb2hU. 97 views. Retrieved 27.01.2012
[57] http://www.youtube.com/watch?v=m9ft3_H6ZY8. 73 views. Retrieved 27.01.2012

The research also aimed to understand the comparative impact of authentic and synthetic elements on user perception, inspired by Barry Truax's assertion that:

> The idealization of sound in the listener's memory is a practical fact ... One doesn't have to recreate the exact sound or environment for it to be evocative. Generally a tape recording of an actual sound is less effective than a skilful simulation that simplifies and idealizes it. (Truax, 2001, p. 30)

The research tested this assertion through the deliberative inclusion and contrast of authentic and synthetic elements (both visual and aural) in compositions and techniques, with subsequent assessments of their impact on users.

The portfolio includes a variety of techniques developed and improved during its testing and refinement. User experience feedback data played an essential role in influencing the development of the compositions, helping to refine interactive digital techniques that help to evoke an enhanced awareness of the past of place by identifying those techniques that worked most, and least, effectively for users.

The research is thus a combination of practice-based (in terms of its development of the composition portfolio), and practice-led (in terms of investigating new understandings about the practice and development of interactive digital technology compositions).

REALISATION

An iterative theory-composition-testing realisation cycle was developed and applied in order to optimise techniques for enabling users to navigate multiple layers of content, as well as finding methods that evoke an increased emotional awareness of, and connection with, the past of place over time. The realisation methodology comprised four iterative elements:

- **Content Origination**: the content draws on original source material re-used with permission from archives such as Getty Images and English Heritage (encompassing both still and moving images), as well as researcher originated and synthesised materials from practical field and studio work, together with third party source materials gathered by the researcher (such as old postcards, and the use of the Freesound[58] online collaborative database of Creative Commons licensed sounds). These source materials provide the basis of the works contained in the composition portfolio.
- **Content Pre-processing**: images and sounds may require manipulation to prepare them prior to their inclusion within the audio-visual environment – for

[58] See http://www.freesound.org/. Retrieved 13.01.2012

example, rendering contemporary photos in sepia tint to make them appear older; or applying an impulse response from an historic location to a sound; or the alignment of older and newer images, still and moving, so that they can be seamlessly morphed between; or for sounds to be processed to create greater spatiality, such as through the application of binaural and transaural techniques. Such pre-processing forms part of this stage.

- **Content Mapping**: the source material originated in the preceding stage may contain an existing logical and physical structure – such as within a single JPEG image comprising a shot of a particular part of a city at a particular moment in time. However, its relationship to other elements being used in the composition is initially ambiguous and not inherently structured. Various ways of mapping and representing compositions on-screen (and in terms of their sound design, including their relative spatialisation) were explored during this research as part of the development and refinement of this stage of the iterative methodology. The composition process considered the way in which visuals are structured on-screen, including design elements such as their Cartesian disposition (along x, y and z axes, or planes), their methods of navigation and opacity, movement, colour, texture, and shape. The interplay of artistic intent, technical methods, tools and interfaces is a key element at this stage in the methodology.
- **Content Interaction:** the compositions allow for user interaction, both structured and unstructured, randomisation, and author-led models (and combinatorial techniques). They also encompass physical interaction, using mouse and keyboard interfaces, as well as prototypes of dedicated custom interfaces such as the sonar sensor utilised for distance-based user interactivity. Usability testing was utilised extensively during the content interaction stage to identify the most effective and least effective techniques in terms of the second research question, together with providing the basis for their potential improvement based on user feedback. This feedback formed an essential part of the overall methodology, providing the basis for iterative refinement to the techniques applied.

These four elements, and their iterative/cyclic nature in the overall process of the realisation of interactive digital compositions, are illustrated in overview below.

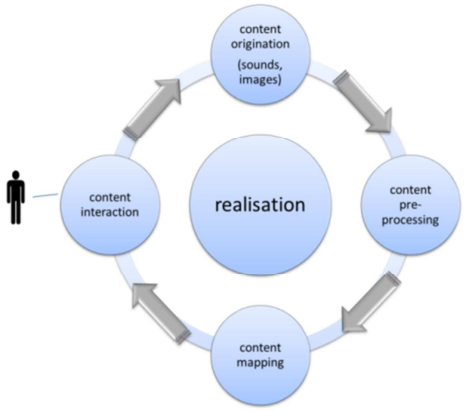

FIGURE 214: THE REALISATION PROCESS

This iterative realisation model is analogous to Schön's observations about how a designer engages in a process of "seeing-drawing-seeing", establishing the art of design as a reflective and iterative process (Schön, 1991). As well as the researcher utilising this reflective, iterative process for the initiation and development of works, it was enhanced through the deliberative inclusion of user experience testing, both online and in the IOCT's usability labs.

PALIMPSESTS AND N-TIER NAVIGATION

This research was particularly influenced by the block universe theory and the notion of the palimpsest (see Chapter 1). As Deutsch elaborates, the block universe theory represents the whole of physical reality – past, present and future – as frozen in a single four-dimensional block. Nothing ever moves and what we generally refer to as moments of time are but slices through space-time: when the contents of these slices differ from one another, we call it change or motion through space (Deutsch, 1998). This provided an important concept and inspiration in this research, with a parallel between slices through the block universe and layers of time (palimpsests).

Various techniques were explored for utilising a web browser-based system to enable a user to discover and navigate multi-dimensional layers of interactive visual and aural content modelled on the concept of the block universe. The primary conceptual model used to realise an artistic construct of the palimpsests is structured around *n*-tiers of visual and aural content beneath the surface level, illustrated in Figure 215, operating across the Cartesian co-ordinates for a three-dimensional space. Such content is typically related to visual images (still and moving) of the same place (such as a building) or other artefact (such as a map) over time and the use of both authentic and synthetic sound. The research interest centred on developing and identifying intuitive ways for users to

navigate and explore such multiple layers of content, as well as in finding methods that evoked stronger emotional connections with the past of place.

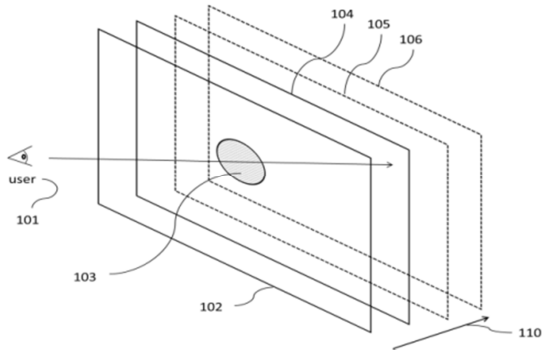

FIGURE 215: N-TIERED VISUAL CONTENT (LENS MODEL)

In common with the visual elements, the primary thematic basis for the aural elements of compositions was the concept of the palimpsest. The aural dimension of the approach is well described by the quotation from Charles Babbage:

> The air itself is one vast library, on whose pages are for ever written all that man has ever said or woman whispered. (Babbage, 1838, 2nd edition)

The *n*-tiered model described above was also applied to aural content in this research, which explored through works such as *TimeRadio* the ability to tune into previous soundscapes, based on a conceptual layered model of aural longevity (relative permanence) and aural transience (see Figure 216).

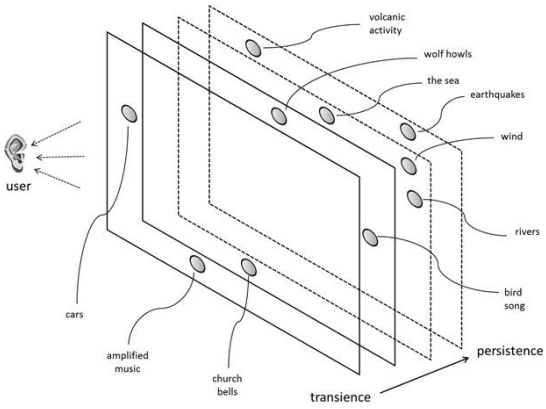

FIGURE 216: THE PERSISTENCE AND TRANSIENCE OF LAYERS OF THE AURAL SOUNDSCAPE

Those older, more persistent sounds that form the backdrop to our aural environment are often masked by the transient sounds of our age: such background aural palimpsests are as present as they have ever been, yet it becomes ever more difficult for us to perceive them since they are overwhelmed by the higher volume and prominence of contemporary sounds.

Research in this area included exploring the role of impulse responses (the acquisition of the acoustic characteristics of particular spatial environments) and convolution reverb (recreating the acoustic reverberation characteristics of a physical or synthetic space based on an associated impulse response). In terms of evocations of the past of place, the creative interest related to how sound behaves in different buildings and structures – architectural and vibration acoustics. In particular, how impulse responses may differ over time: for example, between period rooms spanning the late 1600's to the late 1990s. The research involved the capturing of impulse responses in a range of period environments at London's Geffrye Museum in order to enable their subsequent application within the composition portfolio and the evaluation of their impact on users. Aural content for the portfolio was influenced by several elements: authentic impulse responses of available original locations; synthetic (or imaginary) impulse responses; and the subsequent use of both in convolution reverb tools. Aural-related tests in the usability lab and online provided feedback on the impact of different impulse responses upon user perception and evocation.

USER EXPERIENCE TESTING

An integral element of the research methodology involved the techniques being subjected to extensive user experience testing both to assist with their further refinement and to assess their value in evoking an increased awareness of time and place. Online usability testing gathered 5,451 responses over three years of iterative cycles of composition development and refinement, with more detailed usability labs conducted involving eighteen participants. User experience testing involved four stages of online evaluation, and two formal usability labs each of which was spread over two days. A summary of the four online usability feedback stages is shown below.

Online iteration	Total responses	Number of works	Highest response rate
1	30	18	n/a
2	1,722	22	106
3	1,443	21	104
4	2,256	36	76
	5,451	**97**	

TABLE 50: ONLINE USABILITY FEEDBACK SUMMARY

The usability testing was framed within the context of spanning the two categories articulated by Buxton (2007): to explore both the essence of a single established trajectory (in terms of the intended design of a work), as well as helping establish the trajectory which the technique or composition should be on (such as comparisons, for example, between the lens and slider techniques, discussed in "Chapter 3: Design and Development").

Usability lab studies utilised in the course of this research enabled systematic observation (under controlled conditions in the IOCT usability lab) of users to assess how well they interact with and respond to compositional techniques, including alternative approaches to interacting with layers of images and sounds. These studies were complemented by online feedback mechanisms for internet users interacting with compositional elements and techniques over the web. Whilst online techniques lacked the systematic observation under controlled conditions achievable in the usability lab, they helped provide insight into the effectiveness of the compositional techniques and examples for a random, self-selecting sample of remote users encountering them on the internet. The usability lab, however, provided a more detailed data-gathering and analysis process better able to help determine *why* certain responses were being made. The use of both environments was important, however, since many of the works were intended for internet performance, therefore assessing online responses was of equal importance as the lab-based research.

Four generic usability areas were assessed in the usability lab stages of this research.

Usability Area	Description
Efficiency	the time taken to complete, and ease with which participants completed, relevant tasks (such as interacting with palimpsestic content, using the various techniques)
Accuracy	whether participants interacted in the expected way or deviated (that is, behaved in ways the composer did not intend or anticipate), indicating that the composition's presentation, design and associated techniques may not be optimal for the composer's intended purpose
Recall	how well the participant was able to recall content or elements of the composition afterwards, and to identify those elements, ideas (visual and/or aural) or techniques that were most, or least, significant for them
Emotional Response	how the participant felt about the compositions, with specific reference to whether they felt they evoked a sense of the past of place

TABLE 51: USABILITY AREAS

"Recall" elicited comments such as:

> "The ones that are more dynamic I enjoy, I feel like playing with, getting engaged with."

Emotional response elicited comments such as:

> "It made me consider the internal and external networks that exist in our everyday lives and made me consider not only your life but the passing of my own. It also made me consider the non-linearity of time and how memories work in clusters. Very powerful. The sound was driving the images in a very subtle way but allowed enough space for me to have these considerations".

The final usability lab's exploration of the impact of alternative HMI's and large screen projection and amplified sound produced the highest rated feedback of any techniques or compositions tested, and thus justified earlier feedback indications that they would prove more effective and engaging. This also highlights how the engagement of users in the

iterative design of IDT compositions through the application of the realisation methodology can help improve a final composition for both composer and audience alike in terms of maximising its intended artistic impact.

FINDINGS AND CONTRIBUTIONS

The research data, analyses and findings presented in this thesis, developed from the application of the realisation methodology and iterative series of usability feedback stages, demonstrate that interactive digital technology (IDT) compositions are able to evoke an enhanced user connection with the past of place through the use of a variety of aural and visual techniques. User experience testing helped identify those techniques that were most – and least – effective, both online for users accessing the works over the internet, and in the usability lab. User response data indicate that for some participants the works achieved a level of connection indicative of approaching the equivalence of Barthes' *punctum*. Examples from the research data that support these conclusions include:

- 96.6% of respondents online and 94% of lab respondents indicated that they found their experience with the compositions and techniques evocative of the past of place (OU1 and combined findings from UL1 and UL2)
- the techniques that "reveal the past hidden behind the present [slider and lens] are awesome!!" (OU2)
- "… the moving imagery and still images are both evocative. I feel the slider control is best" (OU2)
- "… beautiful, poetical" (UL1)
- "… poignant connections between past and present" (UL1)
- "It's intense, it's mind-blowing for me." (UL1)
- "Even the texture/tone of those images makes you feel nostalgic." (UL1)
- "[That's] so powerful." (UL1)
- "I like [the] fusion of time and space." (UL1)
- "…gives a sense of the past and future morphing together, or of one growing into/out of the other" (UL2)
- "This is the most engaging image that I've looked at. The sense of time. Yeah. It really is, it works well. It's about what's going on, not just the architecture." (UL1)
- "It's a non-space now ... but look at what used to take place" (UL1)
- "[Makes me think about] the whole notion of place, and how areas are given significance." (UL1)
- "… engaging … it made the experience very real" (UL2)

- "There is an element of the melancholic I think which is interesting. As we live in the present but also in the past we cannot exist, we could not exist, without our memories. And so it is quite an interesting bit of meandering through these spaces, through these places." (UL1)
- "... expansiveness, the kind of space it creates, not only where I'm sitting but a weird sense of space behind me" (UL1)
- "... takes me out, some notion of other" (UL1)
- "… an amazing experience … a sensation of being absorbed in time" (UL2)
- "Wonderful landscape of sounds and of images." (UL1)
- "Poetical and full of potential. So physical and metaphysical." (UL1)
- "I'm being watched. Looking back at the soul." (UL1)
- "A very real experience …. it is as if you are literally walking from present to past" (UL2)

Essential to these results was the application of the iterative realisation model, which enabled earlier works and techniques to be further developed, utilising user feedback to improve and strengthen their subsequent impact on users. For example, in UL1 (see Chapter 4) user feedback included the desire for "…large scale projection, surround sound and an alternative, more physical interface rather than the use of a mouse to heighten the visceral experience…" and "… I would like to see the work further developed into projections, installations, etc…". The subsequent development of prototype HMI controls later yielded amongst the highest rated techniques (UL2) and user responses. This active, participatory process of user engagement in earlier works, providing feedback on what worked most, and least, effectively, and their subsequent refinement, provides an important model for strengthening and building upon those techniques that impact most on users – in the example of the HMI and high definition, immersive projection used in UL2, producing the user response that it helps to create "A very real experience …. it is as if you are literally walking from present to past".

Later portfolio works such as *CCTV* and *Palimpsest Navigator* demonstrate the beneficial impact of the use of the methodology and the developmental influence of user feedback. Both of these works incorporate *n*-tier navigational techniques that were progressively improved based on multiple iterations of user feedback. For example, the slider technique, (which progressed through OU1, OU2, UL1, OU3, UL2 and OU4), was modified from an early on-screen slider control to an improved control (using movements of the mouse slider rather than requiring an on-screen representation/manipulation), to the prototype

HMI controller and the embedding of multiple elements utilising the technique within a multi-tiered, multi-window environment.

These developments illustrate both the practical implementation of the exploration of a single established trajectory (in terms of the intended design of the slider as a technique for *n*-dimensional navigation of the past of place), as well as the evaluation of alternative trajectories (such as the lens control, and later experimentation with pixel shader techniques, including the use of 3D anaglyphic realisations). This process of branching and exploration, both of improvements to existing techniques and of alternatives, forms an important part of the methodological approach – enabling the most effective techniques to be identified by users, and subsequently focused on and improved, with the aim of working ever more precisely towards the ideal of realising a *punctum*, a work or technique that so pierces the user.

User preferences with regard to the techniques developed and evaluated varied, with some users orientated towards those with greater granularity of control over the degree of interaction of the palimpsests (such as the palimpsest slider), and some more towards those with the ability to more directly create the illusion of "seeing through time" (such as the palimpsest lens). Providing alternative interaction mechanisms, all of which can themselves be refined and improved in parallel as a consequence of the integration of user feedback during development, also enables the final techniques and works to provide multiple ways in which users might interact with and explore them, potentially enabling more users to experience and enjoy the works in ways that provide most meaning and impact to them. This is a notable divergence from, for example, the use of cognitive techniques and heuristics in user experience testing since they are usually applied to help ensure conformity with a set of consistent processes and standards – the very opposite of what may be required in an interactive digital work to enable more users to experience it in a way that has most meaning to them.

Another consideration in this research was the extent to which sounds and images used in the compositions needed to be those that genuinely existed in the past, or ones that succeeded in evoking or recreating a sensation of the past: of sounding and looking as people *imagine* the past to be. The research explored these ideas through the deliberative inclusion and contrast of authentic and synthetic elements (both visual and aural) in compositions and techniques, with subsequent assessments of their impact on users. The results, which showed that both authentic and synthetic sources could be similarly highly (or lowly) rated by users, appear to confirm Barry Truax's observation (cf. p. 228).

The findings indicate that the nature of the content and the way it works for users in a specific context is as important as the nature of the technique involved. Both authentic and synthetic content may have a strong emotional impact on a user, but the key determinant is as much the context as the extent to which the element is authentic or synthetic. For example, both synthetic and authentic impulse responses were rated as broadly similar by users (OU3), with the issue of authenticity rarely raised in works that used mostly or exclusively synthetic content (such as the soundscapes of *CCTV* and *TimeRadio*). In the data gathered by this research, there is a marked user bias towards sounds of a more resonant and more complex nature and against those in a dry, unprocessed state.

This research also encountered technical issues and limitations. Some of the techniques and compositions developed in the portfolio pushed the design and realisation environment to the bounds of its current performance limits. This in part may be attributable to the use of the Silverlight environment for creative purposes perhaps not originally foreseen by the product design team, for whom the main focus appears to have been primarily business related. A wider comment on the potentiality and suitability of such development environments has been made by John Maeda with regard to visual design, but clearly with wider applicability to the type of IDTs on which this research has been based:

> The responsibility to make the computer a better space for visual thinkers is currently in the hands of large software companies with limited imaginations. (Maeda, 2000, p. 448)

Silverlight was selected for this research for two principal reasons: it provided a suitable platform for rapid prototyping and development of interactive works; and the researcher was already familiar with it as a development environment. It thus supported the focus of this research, the rapid and iterative development of the portfolio and the exploration of the user experience, rather than the technology used in its creation. The use of Silverlight enabled the researcher to maintain this focus rather than being distracted by acquiring the skills necessary to use an entirely new and unknown technical environment.

Towards the end of the research, as the open HTML5 standard matured, some of the techniques developed during this research were successfully ported from the proprietary Silverlight environment to open standards based HTML5, Javascript and Cascading Style Sheets (CSS). Future developments in this area would benefit from focusing on the use of open platforms, technologies and standards rather than proprietary approaches – which both prevent localised optimisation to overcome any technical issues encountered due to

the inaccessibility of the source code, and, even within the relatively short duration of this research, raise serious concerns about the long-term availability and durability of both the tools and the resulting works.

John Dewey comments that “The expressiveness, the esthetic meaning, is the picture itself.” (Dewey, 2005, p. 89). For this research, "the expressiveness, the aesthetic meaning” relates to the user’s experience and interaction with a work. It is in this context that the integration of user experience testing both online and in usability labs provides valuable insight into the ways in which users engage with IDTs.

This research demonstrates the essential role that users can play as a consequence of facilitating their interaction with the development of the portfolio, both online and in the usability labs. Their feedback, gathered by the iterative realisation methodology and the resulting feedback data from online and lab-based usability testing, enabled techniques and works to be refined and improved, progressively moving works towards a stronger evocation of the past of place. This was achieved through the use of parallel exploration of single established trajectories (such as a specific interactive technique) and alternative trajectories which the technique or composition should be on.

The implication for feedback received over the relatively uncontrolled channel of the internet is that the context in which users experience the work is an unknown (complicating consistency of interpretation), whereas in the controlled environment of the usability lab a greater consistency is achievable. This does not render internet-based feedback less relevant but its interpretation is less predictable due to the potentially arbitrary re-contextualisation of the works experienced: issues a composer must bear in mind if their artistic intent is to be successfully realised.

Underlying all of these findings is the iterative usability and feedback methodology. This provides a means of both developing interactive digital works, and analysing the emotive and experiential impact of various techniques and works on users in order to improve the works and incorporate those findings into their development. Whilst interactive digital technologies are at a stage in their evolution potentially analogous to the early days of film, when its techniques and vocabulary (and their familiarity with an audience) had yet to be established[59], the vocabulary and methods for interactive arts critical analysis and design have also yet to be formalised. The application of the iterative methodology, and the key role of usability testing and feedback – and its assessment and refinement of the

[59] See for example the BFI DVD Video. “Early Cinema : Primitives and Pioneers”, BFIVD643.

emotive impact of interactive techniques upon users – conducted during this research has, however, established an approach to the analysis of the interplay of interactivity in digital works and user response with potential wider value and significance.

The contributions of this research thus include the composition portfolio and the associated IDT techniques originated, developed, tested and refined in its research and creation; the research methodology developed and applied during this research, utilising iterative development of aspects of the portfolio informed by user feedback obtained both online and in usability labs; the findings from user experience testing, in particular the extent to which various visual and aural techniques help evoke a heightened sense of the past of place; an exploration of the extent to which the usability testing substantiates that user responses to the compositions have the potential to establish an evocative connection that communicates a sense close to that of Barthes' *punctum* rather than solely that of the *studium*; the role of synthetic and authentic content on user perception and appreciation of the techniques and compositions; and the emergence of an analytical framework with the potential for wider application to the development, analysis and design of IDT compositions.

FUTURE WORK

Whilst it was applied for a directed purpose within the confines of this particular research, the methodology has potential wider application in terms of its capacity to provide a formalised method for developing a better analysis of interactive digital compositions and the way in which users interact with, influence, and experience, the development and use of interactive digital technologies. Dewey's observation that

> The poetic as distinct from the prosaic, esthetic art as distinct from scientific, expression as distinct from statement, does something different from leading to an experience. It constitutes one. (Dewey, 2005, p. 88)

encapsulates the way in which the portfolio, and the iterative methodology utilised, have sought to create IDT compositions that likewise constitute an experience. It has helped both refine and improve the works evidenced in the portfolio, in terms of the evocation or experience that the researcher was seeking for an audience, and in the course of doing so provided extensive feedback on and insight into the way that users interact with visual and aural techniques. If the IDT composition is an experience – both what the composer experiences and seeks others to experience in their work, and the way in which an audience experiences it – then the methodology applied in this research provides the basis

of an analytical and contributory technique suitable for further application and exploration.

Additional work that could build upon and extend this research thus includes:

- Further refinement of the iterative methodology that has been applied, through its more widespread adoption in both the development and analysis of interactive digital art with relation to the nature of the user experience
- More detailed research into the specific question of how both synthetic and authentic content interact with context and the user experience
- Installations utilising surround sound and a more aesthetically produced version of the prototype alternative HMIs, perhaps manifested in a steampunk style cabinet of wood and brass
- Focused investigation of the nature of the user experience with random as opposed to author-led and user-led works to enable improved understanding of the lower ratings of the random work (notably the Old Guildhall School of Music)
- Negotiating access to original, vintage moving image content of locations (which feedback suggests is more evocative) and its use within enhanced or new compositions. Difficulties were encountered throughout this research in obtaining permission to use archive materials: for example the BFI indicated a charge of £10 a second with a minimum 60 seconds charge for providing moving footage of old London that the researcher had identified for use in this research
- Open sourcing the findings and techniques developed during this research to encourage their widespread adoption and further development. Providing the ability for users to load their own images and sounds online and to develop community-based versions (something that may be explored in the DMU Square Mile project) of various of the works and techniques
- Two techniques have already been migrated to HTML5 (lens and slider). Other techniques developed in the work could similarly be ported to non-proprietary models
- Curation of sound in historic contexts. Little evidence was found during this research of the research and curation of how the past may have

sounded in historic recreations. Whilst visual and constructural elements – furniture and furnishings and the use of building materials – is a well-developed area, there appears surprisingly little authenticity regarding the aural reconstruction of the past

- Potential use of fMRI (functional magnetic resonance imaging) to evaluate further the impact of certain works and techniques and their relationship with user emotion and memory; and to explore possible correlations with related cognitive states, such as memory and recognition, in participants relative to the claimed or observed states from both usability lab evaluation and self-evaluation
- Expanding the scope to works focused on more traditional gallery and public spaces rather than the internet as the realisation space to further analyse the impact of the context of the performance of the work

ASSOCIATED PUBLICATIONS AND RELATED WORKS

During the course of this research two papers were published and presented by the researcher. The first of these was *Palimpsests of Time and Place* (Fishenden & Hugill, 2011), presented at COMPSAC 2011, the IEEE Signature Conference on Computer Software and Applications held in Munich, Germany. The second was a paper and accompanying A1 poster, *Interactive Computer Visualisations of Time and Place* (Fishenden, 2011), presented at the Eurographics Association Ninth Theory and Practice of Computer Graphics 2011 Conference (TP.CG.11), held in Warwick, UK.

A mobile phone application, *sonic London*, based on aural and visual techniques developed and refined during this research, was released on the Windows Phone 7 platform in July 2011. To date it has been rated with 5 stars by those users who have downloaded and provided feedback, and has been downloaded 385 times[60]. Aspects of this research are also currently being used by the DMU Square Mile community-outreach project[61]. Together with an online site using HTML5 versions of the palimpsest slider and palimpsest lens techniques, a prototype application running on a high definition Android tablet has also been developed.

[60] As of 06.02.2013
[61] http://voetek.com/palimpsests/dmusquaremile/index.html. Retrieved 27.01.2012

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ANNEX 1: ACCOMPANYING RESOURCES

Several resources, provided on separate media, accompany this research thesis.

USABILITY LAB VIDEO AND AUDIO RECORDINGS (RESTRICTED ACCESS)

The contemporaneous video and audio recordings for the 18 usability lab sessions conducted during the course of this research are contained on a set of 19 DVDs. Each of these DVDs contains two files: the first is the front-on video view of the usability lab participant; the second, the 'over the shoulder' view, showing the works/screens that the user is interacting with. Both videos contain the same audio captured by the lab microphone. The one exception is that of Usability Lab 2 (UL2), Participant 6 (P6) which is spread over two DVDs due to the volume of data acquired. These DVDs of the 18 participants (P) in the usability labs (UL) are maintained under restricted access by the IOCT at De Montfort University in accordance with the agreed ethical approach, which guaranteed participant anonymity.

The DVD contents are as follows:

DVD1 – UL1, P1
DVD2 – UL1, P2
DVD3 – UL1, P3
DVD4 – UL1, P4
DVD5 – UL1, P5
DVD6 – UL1, P6
DVD7 – UL1, P7
DVD8 – UL1, P8
DVD9 – UL2, P9
DVD10 – UL2, P1
DVD11 – UL2, P2
DVD12 – UL2, P3
DVD13 – UL2, P4
DVD14 – UL2, P5
DVD15 – UL2, P6 – 1
DVD16 – UL2, P6 – 2
DVD17 – UL2, P7
DVD18 – UL2, P8
DVD19 – UL2, P9

COMPOSITION PORTFOLIO SOURCE CODE

The source code for all works within the composition portfolio is contained on this DVD. Except where otherwise indicated (please see "Acknowledgements", relevant footnotes throughout the thesis and embedded comments in the code), the code developed for this research is the work of Jerry Fishenden, undertaken between 2008-2012 at the Institute of Creative Technologies, De Montfort University, Leicester, UK. This code is provided "as is"

DATABASES AND OTHER MATERIALS

The databases from both online feedback and the two usability labs are contained on this DVD. The DVD also contains: the original impulse response recordings from the Geffrye Museum; the source code for the star-rating system used online; the source code and associated HTML pages use for presentation and data capture during the usability labs.

ANNEX 2: RESEARCH EQUIPMENT

FIELD RESEARCH

The following equipment was used to gather original aural and visual materials during the development of this research.

Name	Specification
Edirol R-09HR	24bit 96kHz WAVE/MP3 Recorder
Soundman Solo	In Ear Stereo (binaural) Microphones
Panasonic DMC-TZ3	Compact camera, 28mm 10x optical zoom Leica lens, 7 megapixels
Canon HV20	1080i HD Video Camcorder
Canon EOS 300D	Digital SLR Camera, 6 megapixels
Canon EOS 550D	Digital SLR Camera, 18 megapixels
Canon lens	EF 50mm 1:1.8
Sigma lens	28-300mm 1:3.5 – 6.3
Canon lens	EF-S 18-55mm 1:3.5 – 5.6
Opteka HD2	Semi Fisheye 0.35x Macro Lens adaptor

HOME STUDIO

The following equipment, and some earlier iterations of the software, were utilised in the production of audio for this research.

Name	Specification
Custom built Audio PC	Intel Core2 Quad CPU 2.66GHz. 4Gb RAM, 64-bit Windows 7 Home Premium.
Steinberg Cubase 6 (earlier Cubase 5 and 5.5)	Digital audio production software
Steinberg WaveLab 7 (earlier Wavelab 6)	Professional audio mastering software
Native Instruments	Battery 3; Absynth 5; Reaktor 5; FM8; Kontakt 4; Kore 2; Massive' Akoustik Piano; B4 II; Elektrik Piano 1.5; Vokator
East-West	Voices of Passion; Symphonic Choirs; Symphonic Orchestra; Fab Four; Gypsy; Goliath
Steinberg	HALion Sonic; Hypersonic
Yamaha	Vocaloid 2 - Prima
Voxengo	Impulse Modeller
M-Audio Firewire 410	Firewire audio interface
Roland HV-1080	64 Voice Synthesiser Module
Denon Amplifier	Surround sound amp, bi-speakered with both stereo pair (Bose) and 5.1 surround sound (Boston Acoustics)

DEVELOPMENT ENVIRONMENT

The following equipment was used during the design and programming of the various techniques and compositions.

Name	Specification
Sony VGN-Z11WN laptop	Intel Core2 Duo CPU 2.40GHz. 4Gb RAM, 32-bit Windows 7 Ultimate
Microsoft Visual Studio 2010	Silverlight development environment, utilising C# and Javascript
Microsoft Expression Studio 4	Silverlight design environment

Pinnacle Studio 14	Movie production software
Shazzam 1.3	Pixel Shader development environment
FXHome EffectsLab Pro	Visual Effects Software
Microsoft Windows Live Movie Maker	Simple video production environment
Microsoft Windows Performance Toolkit	For deep analysis of technical performance issues in Silverlight and other code
Phidgets	APIs and runtime tools for the use of the Phidgets prototyping environment (utilised with WPF rather than Silverlight)