Experiential Manufacturing: Designing Meaningful Relationships Between People, Data and Things

Mark Selby

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

SEPTEMBER 2014

Abstract

This thesis presents a practice-led research investigation into ways of designing more experiential and evocative interactions with data that relates to our experiences whereby less explicit, more intrinsic and aesthetic relationships are made between people, objects and data. I argue that the utilitarian values and instrumental approach behind the design of most systems that mediate our personal autobiographical data, while important, are not appropriate for more emotional forms of remembering. Therefore, systems are needed that cater specifically to modes of remembering such as reminiscence and reflection. By learning from our material encounters with memory, there are rich opportunities for design to uncover the latent values that might exist in biographical data.

To articulate the design rationale of the thesis, I describe two existing design projects: the Digital Slide Viewer and Photobox. These provide some design principles that offer guidance in making memory data physical so as to encourage meaningful material practices, and ways that interactions might be designed to promote reflection.

After exploratory interviews to gather insight into the ways people associate meaning with objects a set of designed provocations were produced. The Poker Chip sought to understand the ways that the material form of an object connects to its meaning, while The Bowl investigates how the actions we might use to make these meaningful objects might in themselves be meaningful.

The final designed provocation takes ideas from its predecessors, and puts them into practice with a data driven system. By responding to live data from real earthquakes, the Earthquake Shelf creates a tangible rendition that, by damaging objects, leaves behind material evidence of a remote event. During a long-term field deployment, connection between the objects on the shelf and the participant's memories proved illusive, but the shelf itself provided a viscerally real connection to a past experience.

The outcome of this thesis then is to articulate Experiential Manufacturing; a position on the design of technologies intended to mediate more emotional forms of memory, such that they can create more compelling relations between data, people, and things. It does this by first opening and exploring a design space based on alternative values for designing technologies of reminiscence that mediate our life experiences. By prioritizing the aesthetic elements of the experiences, rather than focusing on the data that describes it, this thesis explores the potential of material, liveness and slowness to create systems that mediate our experience data in more evocative and emotionally valuable ways. It then presents this position as a set of thematic values, or Strong Concepts at the heart of Experiential Manufacturing.

Acknowledgements

The completion of this thesis owes a debt of gratitude to many people. I would first like to thank my supervisors Dr. David Kirk and Professor Tom Rodden for their invaluable guidance and advice throughout the work of this thesis.

I am indebted to my participants for their generosity in sharing their personal experiences and memories with me when the reason for doing so was not always clear.

Throughout this research I had great discussions with many people, and am particularly grateful to colleagues at the MRL, Anab and Jon at Superflux, and Dr. Abigail Durrant for listening to half formed thoughts and offering fresh perspectives.

Thank you to Mat Jeff and Neil of IBI for your invaluable friendship and for making design fun.

I was also fortunate to be a part of a fantastic cohort at the Horizon CDT who provided interesting discussions, a supportive environment, and no small quantity of nonsense.

Thanks to my family for always asking me if it was finished yet.

Finally, thank you Annika for your honesty, encouragement and patience.

Table of Contents

1 Introduction

From natural disasters to holidays, people have always used technology to capture information about our experiences. Now, digital technologies can be used to do this to a far greater extent. The number of tools for capturing data, and the kinds of data we can collect are expanding all the time. Meanwhile exponentially increasing availability of accessible storage makes it easier and easier to create vast data sets that cover almost every aspect of human experience. The depth, breadth and texture of these records affords them the potential to provide us with much richer, more detailed, and potentially more human accounts of memorable events.

However, if this autobiographical data is to provide any value, it needs to be accessible and available. The records we are beginning to accumulate are not only huge and diverse, but are also fragmented, and distributed across various services, platforms, devices and locations, making them extremely difficult to navigate in meaningful ways. Because of the scale and importance of these challenges, many of the research technologies we have for accessing this data are geared to words more functional aspects of retrieving information such as efficient search and navigation.

But, data that describes our experiences is not just useful for being able to recall what happened and when. It has the opportunity to also provide highly emotionally valuable encounters with the past. While the ability to easily retrieve data from these archives, and to have them clearly presented is obviously important, there are other ways that people may find value in engaging with information that describes our past. Even within episodic, or autobiographical memory there are different kinds of remembering. Dubbed by some the "five R's" [7] these range from utilitarian remembering, to more emotional forms. Recollecting, Retrieving, and Remembering Intentions, may be focused on more practical considerations, such as remembering where you left your keys, or that you planned to do the food shopping later. Reminiscence is more emotionally motivated, while reflection may be for practical or emotional reasons, but involves re-examining past event in order to formulate new values. At the same time, autobiographical memory is constructive [3]. This means that our memories of past events are malleable and can be altered and reformulated over time so that they align with our current values and needs. While this might not be desirable in systems that present details of past business meetings so that they can be collaboratively acted upon, for example, it is an extremely valuable trait when remembering ones personal experiences for emotional reasons. Indeed, if depictions of events are encountered that do not align with current needs or values can be extremely unpleasant [54]. As such the direct and literal presentation of data about the past may not be conducive to providing meaningful engagement with personal memory. Or, at the very least, designers may be able to create systems that deal with this much better.

I argue that more emotional forms of memory, such as reminiscence and reflection are underrepresented in research into the design of technologies to support memory. Further than this though, I argue that where some of this existing research reports emotional response to technologies that prioritize utilitarian values, these affects are incidental, if not in-spite of, the design of these technologies. To be truly emotionally valuable, and to support emotional forms of remembering in meaningful ways, technologies that support memory need to be designed according to fundamentally different values than utilitarian systems.

At the same time though, developments like life-logging technologies have shown that new kinds of narrative construction are possible with large amounts of digital media. By virtue of the sheer quantity, and consequent mundaneity, of their images, tools like SenseCam [35] for example, have shown a shift from narratives based around the content of a single photograph, to sets of images. This allows for flexibility in the ways that narratives are constructed and maintained through this data. I argue here, that this digital content is now starting to behave much more like objects in the way that it supports memory, with ambiguity and importantly malleability over time.

Meanwhile, emerging technologies such as the Internet of Things, and rapid prototyping have precipitated an increased interest in systems that combine physical and digital matter in ways that aim to enable more meaningful interactions with both. Because of this there would seem to be new opportunities to think about the relationships between physical and digital things.

In this thesis then, I propose a different approach to the design of memory technologies that learns from the world of material objects. As well as in digital archives, data relating to our experiences is all around us, written through material and memory into the objects that we keep, collect and use. Physical objects are extremely good at supporting these more emotional forms of memory because the information they carry is predominantly implicit. The ways that we experience this object information are predominantly mnemonic rather than explicit, and are therefore more malleable and specific to our personal experiences. The meanings of valuable objects then are in flux, and their lack of explicit description of the events to which they are associated allows us to reformulate and reconstruct these memories in line the constructive nature of autobiographical memory.

But the relationship between objects and memory is complex. The way that a person might associate meaning to an object is very personal, and the meaning itself in constant flux. Simple representation of information does not do justice to this complexity, or the strengths of the ways objects connect to meaning. Digital and physical things have different affordances and properties. If the two are to be combined to their full potential, these need to be considered in the design.

Broadly speaking, existing approaches to the physical manifestation of data into physical form, either into an object, or through the behavior of a device, do not pay sufficient attention to what

it is that make objects good at supporting meaning. That is, often these experiments gain nothing from making the output physical.

Many, for example, seem to represent the data in readable ways that become essentially a physical graph. While these maybe compelling in certain ways, I argue that this sort of conversion from digital to physical ignores the strengths of each format, and so does little to create aesthetic relationships between people, data and things. This thesis then is an investigation into how we might design the relations between data, things and people, in ways that better support emotional forms of autobiographical memory.

1.1 The Research Question

The problem space outlined above, and articulated in detail throughout the literature review is based on the following research question:

How do we encourage memory and meaning with a lifetime's worth of data and the things around us?

This question is extremely broad, but was useful in articulating the goals of the thesis, and opening up the design space for going beyond the functional support of memory to prioritize more emotional aspects, and to explore a broader range of possibilities of value from digital archives.

The work of this thesis then seeks to build on the problem space, as stated in the Literature Review, to explore new possibilities for designing relationships between objects and memory data in ways that better support emotional and aesthetic forms of constructive remembering. To do this it will concentrate on details of aesthetic relations between people, objects and memory such as how the material of objects, and the interactions that they afford, link to the act of remembering. Taking this approach, rather than starting with a particular type of data and thinking about how that might be manifested physically, it avoids placing structure on sets of memory data, and instead concentrates on aesthetic relationships to data through memory. This thesis then contributes to the field of HCI a set of practical investigations within the design space, that provide examples of how these aesthetic relations can be designed for more appropriately. These will then be used as a basis to articulate a design position that can be used and expanded upon by the community. This position will emphasise aspects of material and experiential aesthetic, and the importance of slowness and liveness.

Additionally this thesis contributes to the increasing body of work, both in HCI and design more generally, that explores the relationship between data and material. Although the particular focus is on technology and memory, there I hope to establish design principles that help more generally with the design of compelling aesthetic interplay between digital and physical in order to contribute to the emergence of new kinds of meaningful experience with data.

1.2 Research Approach

In order to achieve this, I have conducted a programme of empirical and practice-led research. Due to the thesis' focus on investigating ways of designing new relationships between data, material, and memory, centering the research on purposefully designed objects and devices was extremely important. This allowed any discussion on the research question to be grounded in material and experiential terms, rather than hypothetical questions.

In order to better articulate the design approach, and therefore reasons for using design as a research tool, during this thesis, I give examples of 3 existing design genres that have been influential. These are not presented in order to state that I am 'doing' these kinds of design, but that they each present ideas and methods that have influenced my approach to design and research.

First, Speculative Design is an approach that uses designed objects, and the narratives they embody as a mechanism for provoking questions about the social and cultural implications of new technologies. While people may be able to have discussions about the possible consequences of the internet-of-things upon privacy, for example, speculative design seeks to ground these in everyday experience. By designing a fictional product to exist within the techno-social conditions under discussion, something esoteric and abstract is made more tangible. As a result the audience is arguably more able to get to grips with the subject, or rather to ground esoteric ideas in the everyday, and therefore to reflect on it in more relevant ways.

Although the research questions of this thesis are grounded in small details of, and responses to, interaction rather than larger scale socio-cultural speculations, this is still a useful approach for this thesis. The idea of making memory data material, and its potential aesthetic experience is a somewhat abstract idea that may be difficult to imagine. Further, this thesis is concerned with the detailed interactions between material and it's meaning, and so a less tangible, more abstract approach to the research question may not be as effective.

Secondly, Critical Design is a genre of design that is explicitly intended to explore alternative values to those that are predominant in the word of products. Initially proposed by Anthony Dunne it seeks to use "speculative design proposals to challenge narrow assumptions, preconceptions and givens about the role products play in everyday life" [19]. In doing so it, acknowledges a diverse range of human need beyond utility, and rejects the techno-utopian ideals of commercial technology.

However, Critical Design is a term that describes a very particular approach to critique through design [19] that will not be taken in the design work that informs this research. But, for my purposes it adequately describes ideas of using designed prototypes to critique predominant technological values.

Finally, designing for 'Ludic Engagement' was proposed by Gaver et al. [26] in describing an approach to design that investigates, "how technologies for the home could support ludic activities—that is, activities motivated by curiosity, exploration, and reflection rather than

externally defined tasks" [26, p.1]. This is also design to explore alternative values, but perhaps with a softer and less confrontational approach than direct critiques. In offering alternatives that explore these more human values, it emphasises their importance, and the unsuitability if others. The values behind ludic design are obviously relevant to this thesis, but it also offers useful approaches to designing for them. In particular, Ludic design utilises ambiguity in ways that allows users the opportunity for reflection, and "allows designers to engage users with issues without constraining how they respond." [24, p.233]

Although the three genres of design mentioned above have some influence on the design work of this thesis, they also offer some resource in terms of research methods. Critical design for example, borrows from modes of critique and discourse found in the fine arts. Its primary arena is the gallery, where is used as a sight to provoke questions, and discussion among an audience. This works because it relies on high-level discourse, and so is not normally concerned with users, and the detail of use. However, critical design also contributes to design practice by employing reflective practices that advance design methods and practice. Speculative design does have some history of deployment with users, where the designed objects form the basis of a prop in a structured conversation about research themes. It can also be used in a reflective design exercise, where the production objects and narratives allows the designers and researchers to formulate research contributions, and develop their thinking [91].

Ludic design is often concerned with people's responses to the prototypes in real life situations. Because of this, its approach borrows from ethnography, both in the formation of design concepts and in their evaluation. Here the designers use tools such as cultural probes to gather inspiration for design, and later work with ethnographers to deploy technologies with real users, in their homes, or the given context under investigation.

Like this thesis though, all these approaches are concerned with producing knowledge that contributes to and supports design practice. They do not use scientific methods to create generalizable knowledge, but instead create instances of an 'ultimate particular' [82]. These can then be analysed through varying levels of abstraction [51] in order to offer intermediate level knowledge in the form of a set of Strong Concepts [36], that as inspiration or resource for the production of new design artefacts by other designers.

While not identical, the approach to evaluation in this thesis tends more towards the design ethnography methodologies used in Ludic Design, and is comprised of interviews with participants and deployments of prototypes of varying standard of finish and complexity dependant on their proposed research use.

Interviews are used in various ways throughout the research process, ranging from more general inquiry, to more specific subjects matters. The research activities begin with a series of exploratory interviews in order to gather empirical examples of ways that people associate meaning to things, and how they remember through or with the object. These interviews were a good way of informally gathering inspiration for design activities. The lack of strict focus allowed

participants to discuss what they felt was important about the objects and express their relationships with them.

Following the exploratory interviews, the next step was a series of design provocations. These were a series of simple, low fidelity prototypes that were intended as a relatively quick way to respond to, and expand upon interesting elements of the interviews, by helping to ask further questions about the relations between the objects and their value. This was achieved in two ways; first as a prop to elicit discussion with a participant, and later as a reflective design exercise.

In the first, my interest was primarily in investigating the role of tactile perception in linking objects to a memory and asking of it was possible to create an object that, through its materiality could be associated to an existing memory? To investigate this I made six replica's of the participants object, the first one being identical to it, and each one thereafter losing a feature until the final replica which was blank. The ability to touch the replica's and reflect on them allowed the participant to consider the relationship between the materiality of their meaningful object, and the experiences to which it was associated more deeply, and gave rise to some useful discussion about the ways that objects can evoke meaning, that would inform the next research activity.

The second design response was used as a reflective design exercise. The act of creating prototypes and reflecting on their aesthetic and interaction allowed me to think through ideas from the exploratory interviews more deeply. These concerned ways that actions, or the act of affecting the materiality of objects could be used in creating not just evocative objects, but more evocative interactions through the aesthetic experience of creating those objects.

The Final research activity was a field deployment of a higher fidelity prototype. This followed a fairly traditional field deployment pattern, as exemplified by Ludic design in HCI.

To begin this investigation a research participant was recruited, and the information from their in-depth interview, as well as the findings of the previous activity, were used to develop the Earthquake Shelf. This prototype is a shelf that monitored live earthquake data feeds online. Whenever there was an earthquake in Christchurch, New Zealand the shelf would shake and, if strong enough, the objects placed on the shelf would be damaged. This took ideas from the previous research activities about the ways that material can represent meaning through damage, but also that material features that represent meaning may be manufactured. It also took ideas of the use of evocative actions, as well as objects, For example, the shaking action of the shelf is evocative of the participant's original experience, and it was hoped that the resulting damage to the object would also be evocative.

The prototype was then installed in the participant's office for a period of 6 weeks. During this time the participant was asked to complete a sort of diary study by making private blog entries on the project website. This helped them to document feelings and reactions as and when the Earthquake shelf was active. When the deployment period was over a final interview was

conducted in whivh the participant was asked questions about their blog entries, and invited to reflect more deeply on their time with the Earthquake Shelf.

1.3 Contributions

The contributions of this thesis, summarised below, are intended to support design practice. In particular, they are applicable to designers of technological systems that support reminiscence and reflection. As such they are in two sections that concern both the design of systems, and methodological issues that might arise from their study, respectively. The first is an articulation of a design position based on design values that have emerged from the design elements of the thesis, and the second is a set of methodological lessons that come from the deployment of these designed provocations.

1.3.1 Design Position

These contributions are derived from the practice-based research that comprises much of this thesis, and take the form of a set of values within an overall design position called Experiential Manufacturing. This is intended as a contribution of generative intermediate-level knowledge, that will initiate a new design space for designing technologies for reminiscence and reflection that can be used, further explored or adapted by other designers.

These values that comprise Experiential Manufacturing are based around the main points of interaction that were seen to be influential in the production of the design work within this thesis, and the role these design decisions played in the resulting prototypes' ability to relate to the memories and experiences of the research participants.

The design-focused contributions are grouped in to 3 themes: Designing for Physical and Digital, Designing for Then and Now, Designing for Personal-ness.

This first theme, Designing for Physical and Digital, reflects upon the design decisions that mediate the relationship between the data, and the physical object.

Material Supports Meaning over Time: The physicality of objects affords them a flexibility of interpretation that allows them to adapt to the addition and layering of new meaning over time, where we reshape it according to our current needs and values.

As such, their interactions in the present relate to and build upon the past, and physical objects that are connected to memory exist both in the past and present. Consequently, from a design point of view there is a need to balance the tension between interaction in the present and reflection on the past.

Making the Digital Feel real through Physical Interaction: Physical manifestations of digital data can create very 'visceral' and 'real' interactions that encourage reflection on the meaning of data in relation to the user's, or viewer's, own experiences and memories.

The Object and its Interaction Must Fit with the Experiential Aesthetic. However, simply representing data physically is not necessarily enough to achieve this visceral, real, or deep connection to the past. Instead, the physical design of objects that represent data, and devices

that mediate data must be related to, and evocative of, the aesthetic of the experience they represent if they are to support aesthetic and emotional forms of memory.

The next theme, Designing for Then and Now, follows the idea that when designing technologies that support reminiscence and reflection, the past is overlaid onto the present. In this way our memory is reconstituted through our current actions and feelings, but also through the functionality of the system. As such, systems need to be aware of the constructive nature of memory and to allow the user the freedom to construct memory according to their reflections on the present.

Reflection is Embedded in Everyday Practices. Many objects through which we remember are part of the practices of everyday life. Sometimes we are engaged with the memories, meanings and values that they are associated with, and sometimes they may be an unnoticed part of the background.

It is important to consider both the aesthetic relations to the systems and how it might support the ability to become part of the aesthetic relations that make up the home and everyday life when in use or not.

Interaction and Reflection: Any direct interaction with the system forces the user to concentrate on what they are doing and what is happening now. Designers of devices that support reminiscence and reflection need to pay attention to the balance between attention and reflection, allowing for both evocative and aesthetic interactions in the present to trigger reminiscence, but also how the device then retreats from attention, or supports reflection thereafter.

Reflection is Slow: Reflection on the past is a slow process that requires time and space to think. Here, the focus of the interaction is not upon completing a task, but on the aesthetic relation to the activity.

The reflective time and space within the interaction was heavily dependant on the balance between the pace and mode of interaction. If the mode of interaction is extremely emotional or visceral, then the frequency of interaction may need to be low, while an increased frequency may lead to dissonance between user and system that negates the affect that it was meant to achieve. Importantly though the mode and frequency of interaction should reflect the activity that is being evoked. Designing this balance is a matter of sensitivity to the aesthetic of the memories being referenced, and to the affect of the device's aesthetic interaction through a process of experimentation.

The third theme of design contributions is about 'Designing for Personal-ness'. It is important when designing for personal experience to emphasise evocation of aesthetic rather than description of the event. This allows the users to perceive the data in terms of personal experience, but with an ambiguity that allows people to formulate the meanings and according their current values.

This requires an experientially focussed bespoke approach to the design of the device and interactions. This allows the prototype to evoke deep levels of reflection through the provision of visceral interactions despite using non-personal data.

This highlights an important distinction between *personal*, and *personalised*. Many systems that support remembering start life as general technical systems that are then adapted to their users, or personalised, through the inclusion of the users personal digital archives for example. I argue that this approach does not fully engage users, as it does not relate to their experiences in any other way than through the data being used.

1.3.2 Methodological Lessons

In addition to the design considerations described above, there were methodological lessons to be learned from the research conducted in this thesis. These apply principally to challenges around the deployment and assessment of the prototypes, but these challenges also arise from the approach taken in their design.

For instance one methodological problem presented during the discussion was the difficulty of deploying slow technologies over the relatively short time frames achievable in research projects. This can mean that participants do not get sufficient opportunity to engage with prototypes, and therefore little opportunity to reflect on their meaning and impact. Alterations made to a device's behaviour to overcome this can disrupt other elements of the prototypes design such that it is no longer addressing the intended research themes appropriately.

Ideally slow technologies could be deployed for many months, possibly over a year, but this is not always possible, and alternative methodologies may need to be conceived to address these problems.

One potential technique might be to deliberately disrupt deployments. Deliberately changing design features to afford contrasting interactions, midway through a deployment could allow participant's to formulate reflections based on less engagement. Further, deliberately changing interactions to disrupt participants' relationships to, and experience of, the device could reveal interesting elements of interaction that might have not been so easy to identify otherwise.

Finally, designing prototypes for engagement with specific people, about specific experiences necessitated a very bespoke approach to design, which in turn meant that participant numbers were very low. The various research activities were very discursive and interview data was used to gather insight form the participants, which was combined with extensive reflection on the design of the prototypes, from a design perspective.

2 Literature Review

2.1 Introduction

This chapter will review the relevant literature, and design led research work surrounding the subjects of memory, and memory support in HCI. The purpose of this is to gain an understanding of the themes that inform this thesis, to define the problem space and to define a program of further work, and situate the eventual contributions.

Each section of this chapter will address a different aspect of the relationship between data, memory, objects and people.

Personal Digital Records of the Past will look at how new technologies have allowed us to record our experiences and create vast archives of data that describe our past. From the rise of digital recording technologies to the inexorable increase in personal storage capacity and distribution through social media, the ways we record, share, and remember our experiences are changing. These are often disorganized and unmanageable, making them ineffective as mementos, but by looking towards research into life logging systems that seek to understand how best to organize these archives, we can begin to think about solutions to this problem.

What kind of Remembering then seeks to clarify which type of remembering we are interested in. Researchers have investigated technological support for many types of remembering from the functional to the emotional, and support for each requires a very different approach to design. This section will outline an idea of emotional and aesthetic forms of reminiscence, and then address the suitability of various different design approaches to this type of remembering.

Making Sense of the Records then continues with the life logging analogy, by taking the example of an existing technology to see how our digital records might be used to support our desired type of remembering. It looks at the affects these records have had on the ways that we construct narratives, and therefore the stories that we produce using our memory data and consequently the affects that this has on the ways in which we engage with and remember the past.

Incorporating Artifacts concludes the literature review by considering the role of physical objects in remembering, and their use in the design of digital memory systems to help construct narrative and meaning, through their shaping of our interaction with memory data. It gives a review of various examples that show different ways that this might be achieved, and uses them to discuss some important aesthetic and design considerations that need to be accounted for when designing to support aesthetic and emotional forms of remembering.

2.2 Personal Digital Records of the Past

We have always used technology to record the things we do and think, from writing about them to capturing them on film. For a long time these technologies were not widely available, and only

in the latter part of the 20th century did they begin to become accessible. More recently, digital recording technologies accelerated this trend to become relatively ubiquitous, and available among far greater numbers of people. As such they offered the means to create ever richer, and more personal records of our experiences. Now, the proliferation of web technologies, web-connected products, mobile computing and ubiquitous computing, offers an increasingly diverse and complex means by which we can capture, store, share, and access data about our experiences. As a result, this data has become richer and more diverse. As well as capturing images and video, or storing text, for example, we might also record GPS data, weather data, sound files, the number calories we burned, and our altitude or compass direction. All this data can also be cross-referenced with that recorded by others, or freely available on the web. Now these extensive data sets offer exhaustive records of the things we do, beyond those that we can remember ourselves [54].

In addition, the inclusion of meta-data, or related contextual information such as time, location, etc., means that records of our experiences are becoming more and more complete:

> The types, quantity and value of personal data being collected are vast: our profiles and demographic data from bank accounts to medical records to employment data. Our Web searches and sites visited, including our likes and dislikes and purchase histories. Our tweets, texts, emails, phone calls, photos and videos as well as the coordinates of our real-world locations. The list continues to grow. [96, p.5]

While I might be hesitant to read too much into statistics gathered from the internet, a quick web search suggests that, at the time of writing, the average Flickr[1] user has 2118 photos in their account[2], while Instagram[3] claims 55 million photos are uploaded each day[4]. This tells us little about individual users habits, but does give some idea as to the quantity of information we are talking about, especially when we consider that many people use several such online accounts that deal in various types of data, from self-written text, to details about the books we read. These personal digital records then, in their detail and scope, have great implications for remembering the past and it is these that this literature review is especially interested and, in particular, the ways we document our own experiences - and how they are used in memory of personal experience. For this discussion I exclude those records of events curated by professional archiving and record keeping organizations such as The National Archives[5] or the

---

[1] Flickr is an online photo sharing and storage service. See: http://www.flickr.com/

[2] See: http://statsr.net/flickr-stats/

[3] Instagram is a photo sharing based social network that connects to other services such as Flickr, Twitter and Facebook. The latter are also its current owner. See: http://instagram.com/

[4] See: http://instagram.com/press/

[5] http://www.nationalarchives.gov.uk/

The Met Office[6]. However, I do acknowledge, and include the growing possibility, supported through open data initiatives[7], to include data from public archives within personal archives. For example, we might think about the possibilities of augmenting personal records with associated data collected by these professional bodies, such as weather, climate, or news, for example, in order to give richer pictures of the past through provision of detailed contextual information.

In order to discuss the affects that these combinations of data might have on the ways we remember our past, this part of the literature review will look towards research into life logging technologies. In their depth of recording, and resultant dissemination and review of the information captured, these studies offer a comparative point of discussion for the concerns addressed here.

Often taking inspiration from Vanevar Bush's Memex machine [14], the implementation of a system that keeps track of everything you do such that it can easily be recalled has been a popular pursuit in HCI research. For example, MyLifeBits was "a project to fulfill the Memex vision first posited by Vannevar Bush in 1945. It is a system for storing all of one's digital media, including documents, images, sounds, and videos" [30, p.235]. So while the idea to create a comprehensive personal archive predates digital technology, let alone HCI research, the emergence of the necessary technologies has finally allowed researchers and technologists to make serious and viable attempts at realizing such a system. As well as the increase of networked products that log interaction data and allow documentation of experiences, one aspect of this is the simple matter of storage capacity:

> Yet if the user inserted 5000 pages of material a day it would take him hundreds of years to fill the repository, so that he can be profligate and enter material freely." In 2002, such abundant storage is finally on the horizon. Within five years, terabyte hard drives will be common and inexpensive (<$300). Thus, purchasing an additional terabyte of personal storage every year will be feasible for the average computer user. It turns out that filling a terabyte is not easy. [30, p.235]

The sheer quantity of recordable and recorded data raises several challenges for both those designing and those using these technological systems. MyLifeBits is largely concerned with the technical challenges of creating huge data repositories that could both be owned and maintained by a user, and also be used in any sort of coherent way.

This challenge is more significant than it may seem, and research into current domestic digital archiving practices has revealed that people already struggle to construct digital archives in meaningful ways:

---

[6] http://www.metoffice.gov.uk/learning/library

[7] Many organizations such as the Met Office for example now make the data they collect freely available

But in general, studies of purely digital archives show that people's attempts to collect *meaningful* digital memorabilia are often unsuccessful: people tend to produce large, unplanned, and poorly organized accumulations of digital objects that are seldom re-accessed and gradually become forgotten [43, p.3]

This is perhaps due to a lack of suitable mechanisms for archiving and review [43], making it reasonable to suspect that this affect is magnified as the quantity of data being captured and stored increases. To think about how this effect might be exacerbated we can look toward current research into life logging technologies. Life logging research has parallels with the kinds of extensive digital records we are talking about, because they are generally geared towards accumulating an extensive picture of a persons activities though digital capture and storage. They do this, generally, within a purpose built technological system, rather than the amalgamation of social networks, or personal collection, but there is also a body of research working to understand how people use the resulting data archives, and how they understand them. To illustrate with an example, we will look at SenseCam:

SenseCam is a wearable digital camera which captures an electronic record of the wearer's day. It does this by automatically recording a series of still images through its wide-angle lens, and simultaneously capturing a log of data from a number of built-in electronic sensors [75, p1].

At the time of its development SenseCam, as a wearable device for automatic image capture, might have been viewed as being quite radical, but we now see an increasing number of parallel devices released onto the commercial market. Mobile devices like smartphones and tablets, or wearable computing devices such as Google Glass[8], and various smart watches[9], are all commercially available, and capable of recording our activities and experiences in various ways. In this light, there are now more real opportunities for capturing data at the kinds of resolution and scale as these research based life logging technologies.

Importantly, research around SenseCam has raised questions over the suitability of capturing data indiscriminately [74], and the affects that profuse and automatic capture might have on memory [35, 50, 54, 74].

Although it is not possible to record absolutely everything, the aim of life logging systems is to capture data continuously and in great quantities. This creates large archives full of data that the user then needs to curate or organize in some way:

---

[8] http://www.google.co.uk/glass/start/
[9] For example: http://www.sonymobile.com/gb/products/accessories/smartwatch/

First, we can never capture absolutely everything, so choices must indeed be made when designing and building systems; for example, different kinds of data require different kinds of sensors or capture devices, adding complexity for the people using and building the systems. Second, capturing vast arrays of data might overwhelm end users maintaining and retrieving valuable information from large archives [74, p.75]

Despite design decisions over what to capture and when, and user choices over which tools to use, that may influence the kinds of data and events being recorded up to a point, there will still be large amounts of data captured. There is also an emphasis on automatic capture. For example, the device might repeatedly capture images according to a sensor input, rather than the user deciding to take an image, and constructing that image according to their wants. The automaticity of these devices removes the 'decisive moment' [50] from each instance of capture, thereby creating a set of images that the user has not linked to specific experience, and that seemingly lack any kind of underpinning narrative that might make them valuable in reminiscing.

2.3 What kind of Remembering?

Before further exploring ways that technologies can better support people in remembering their past through digital records, we must clarify what kind of remembering we are addressing. Autobiographical data, or data that represents our experiences, pertain most directly to the episodic memory system. This is the neurological system that deals with details of our personal experiences such as places, people, and associated emotions. This is distinct from procedural and semantic memory systems that deal with remembering how to perform actions, and remembering meanings of things, respectively [3].
Within this category, HCI research has explored many possibilities for the ways that technology, and the digital records that we create might support people in remembering past experiences. Research into Life logging technologies, for example, has been conducted, designed and used to support many different forms of memory, in various contexts. In Things We've Learned About Memory, Banks et al describe five ways that technology can support remembering [7]:

- Recollecting – Re-living past experiences for practical reasons, for example in order to recall people, locations of objects, or perhaps details of a meeting.
- Reminiscing – Re-living past experiences for emotional and sentimental reasons.
- Retrieving – Finding and recovering information from the past, such as work documents and may include key word searches for example. This can, but does not necessarily involve recollection.
- Reflecting – Reviewing data in order to learn about ones past, or frame it differently. This is more about identity and learning than memory as such.

- Remembering Intentions: This might include remembering things you intended to do, such as daily tasks, or plans for the future.

These 5 themes are not distinct categories, and any act of remembering may involve more than one of them simultaneously. For example, in wishing to *reminisce* over an old family photo, one must *retrieve* it from the archive, and subsequently *reflect* upon the meaning of the image in one's current situation. Similarly, others such as retrieval and recollection may often go hand in hand.

The purpose of identifying these themes is to enable the designers of systems to think more clearly about the different ways that their system might address specific aspects of remembering and in doing so provide the kind of support needed more effectively.

> "These 5 R's can help us define the end user experience we are trying to achieve. Here we need to bear in mind that they may represent very different design goals. In other words, a system optimised for reminiscing may be quite different from one optimised for retrieval." [7, p.7]

This thesis focuses mostly on reminiscence and reflection; the more emotional and aesthetic forms of remembering which I would argue are underrepresented in HCI research, or at least often approached in misguided ways. The majority of research projects seeking to support memory emphasize the more functional aspects of remembering [67] such as efficient navigation of archives for recall of information [E.g. 30], as well as medical applications that seek to help people with memory impairments such as Alzheimer's. These rightly prioritize efficiency of navigation and access to data within the archive according the functional and interactional requirements of its users, but at the same time, descriptions of many of these systems regularly list multiple purposes [35]. As a result the interface of these systems tend to be tailored towards different modes of remembering, and often these less 'practical' applications to memory are something of an afterthought.

This presents problems because, as described above, the ways that these types of memory work, and their requirements, are fundamentally different. For example, if before reminiscing on a family photograph, you must first retrieve it, a system that properly supports its retrieval, may not necessarily provide the best support for reminiscence and reflection. As a result I argue for research into systems that are tailored *entirely and specifically* to the support reminiscence and reflection. Designing for these more emotional and aesthetic modes of remembering seems to be quite difficult, because the requirements of people reminiscing are ambiguous, fluid and varied, while the interactions involved, or needed are perhaps less apparent, identifiable, or rational. For example, because episodic memory concerns one's personal experiences and feelings, it is very often emotional and personal in nature. Therefore, any system designed to

support episodic reminiscence needs to be sensitive to these emotions and the ways they might change over time.

This brings us to another aspect to this form of remembering which potentially makes designing to support it more difficult:

> Our memory of events, then, involves reconstruction – we artificially extract or dissociate past events from the otherwise interconnected tissue of duration in order that they can be reinserted into the demands of current circumstances (this is what Bergson means by 'actualisation'). [56, p.141]

Remembering is a constructive act, and our memory of an event is influenced and constantly reshaped by our needs and circumstances in the present (at the time of the act of remembering). This is important because it allows us to forget aspects of events that are no longer relevant to our needs:

> (Re)construction is not so much a deficiency as a benefit. Using generalizations, relying on conjecture, emphasizing the present, and respecting subsequent experiences, helps us to reason swiftly and economically, to abstract and to generalize, and to act in time rather than remain caught up in conflicting recollections. [54, p.21]

Many systems that intend to aid the recall of information do so by preserving and representing that information literally, which may limit both their malleability in constructive remembering and their ability to be forgotten [54].

> First of all, presenting 'the' memories is not possible, since they are in the owner's head and can change. But if there would be a way of presenting the original memory this could have the same effect as the finding of Conway and Pleydell-Pearce (p. 266, 2000): 'recall of memories that were inconsistent or dissonant with a lifetime period caused strong cognitive reactions'. [38, p.2]

Although it may not be possible to depict *the* memory, presenting too literal a depiction that no longer aligns with the persons understanding or needs may be detrimental and even unpleasant. Memory triggers on the other hand may allow for more constructive remembering in that they provoke remembering rather than depict memories. Triggers can also take other forms and stimulate other senses that the visual dependency of photographs cannot, such as smell, touch, taste and sound. By suggesting the past more obscurely, but by provoking memory through the perception of a related artifact, be it physical or digital, the person is able to reconstruct their memories as needed:

For example, Cohen (1989) describes how sharing autobiographical memories serves as a mechanism for self-disclosure developing or deepening social bonds. And Tversky (2004) documents how people's narratives of their lives often contain distortions that are made to support the goals of telling the story. The same work also shows how memories are changed by retellings of experiences: so that deliberate omissions or elaborations of the original event become confused with the original memory after repeated retellings. " [67, p.2]

All of this is indicative of a tendency to conflate the data with the memory. We can see however, that they are not the same thing. A photograph, or whatever kind of data we may deal with, is not *the memory*; it is rather an index to it. In recognition of this, we might look beyond systems that record and represent content directly and look more towards the aesthetic experiences that memory data might be able to provide. More will be discussed about what this means for the design of systems later in the chapter.

2.4 Making Sense of the Records

If we are concerned with more aesthetic, and less descriptive representations of data, we are confronted with a problem in how to present this data in ways that enable people to construct stories and memories that suit their changing needs. To continue with our example it is useful to look at the ways that people are able to construct and perceive meaning in archives of memory data created by SenseCam, and the effects that the systems that present and mediate this data have on this remembering. Specifically, the characteristics that these new data archives have upon how we are able to construct narrative.

2.4.1 New Kinds of Narrative

Creation of narrative in memory data can be "understood as a set of choices around whether, when and how to construct a story" [50, p.1]. One consequence of the shift of authorial responsibility (as described earlier) from user to device with technologies like SenseCam is a disruption of the ways that users construct narratives and representations of their experiences. Images are information rich and, traditionally, taken intentionally by the camera user. Deciding what to capture, how, when, and what to keep and where to keep it were all things that forced people to make editorial decisions about the kinds of stories they wanted their data to tell up front, at the moment of capture. Technologies that capture automatically, like SenseCam, remove many of these choices [50] with the possibility of resulting in images that the user is not easily able to decipher, let alone attribute meaning and value too. This is important to people because "stories about our past serve to cement social bonds, define identity and engender emotions" [67, p.3]. However, further than this they "can also engender immersive remembering by directly evoking past events, places and people" [67, p.4]. Technologies that take away the

'decisive moment' [50] of capture that allows users to construct narrative around their memories would seem to threaten the evocative power of the recorded material.

However, rather than simply robbing users of the chance to construct the data into meaningful narratives, tools like SenseCam create opportunity for new forms of narrative construction. Lindley et al. discuss the implications that these modes of capture have for how personal voice and identity are maintained in digital content, and the ways that we use that data to tell stories about our past [50]. For instance, one of the findings from their study concerned how the functionality of the mode of capture, specifically the design decisions that went into the production of SenseCam, and the parameters by which it took photographs, affected the ways that images are captured and consequently the ways that people are able to use those images to create narratives and stories.

> In reconstructing narratives then, it is left to the narrator to ascertain unifying themes and to identify the relevant image sequences. Thus, when devices capture data automatically, an obvious need for flexibility in dealing with the resultant data set arises. [50, p.6]

Here the decisions that go into making the narrative are moved from the moment of capture, to the review and editing of content captured automatically. This need for flexibility in dealing with the images is so that users can more effectively, and freely, shape their own narratives and meaning from the data after the fact. This would seemingly require a lot of time and effort on their part to wade through the stream of photographs. Interestingly though, the nature of SenseCam images provides an alternative:

> We have seen also how participants used SenseCam images not to give a blow-by-blow account of events as they unfolded, but to focus on what was interesting or important to them. Indeed, in some of the narratives reported above, there is little sense of what did actually happen; a sense of routine or playfulness emerges as an overarching theme, derived from insights taken from the SenseCam image stream as a whole. [50, p.6]

The quantity of these photographs, along with the automaticity of capture and consequent lack of intent each change the way that users of SenseCam relate to the images. These images were often representative of more mundane aspects of everyday life, lending them an ambiguous meaning that can provide scope for constructive remembering and reflection. At the same time, or possibly as a result, when reviewing photographs users no longer looked to specific images for meaning or inspiration for reflection and memory, but to the *set* of images. Rather than each photograph provoking a memory, or forming a story, they do so collectively, giving a sense or

impression of meaning rather than describing it. In combination, these characteristics give users the ability to focus on what they found most meaningful now, as opposed to what may have seemed meaningful in the past:

> It is clearly evident that one's identity and sense of self will change over the course of a lifetime, and that narratives pertaining to the same set of images might be realised through different sites of expression at different points in time. Thus, in the design of lifelogging technologies, it is important to recognise that what seemed relevant at the time of image capture might be overshadowed by different topics at a later date; the ways in which images are interpreted and repurposed will alter. Indeed, it seems extremely likely that as children grow, their take on SenseCam data streams as uninteresting may become considerably different. [50, p.7]

The ambiguity of meaning caters to multiple 'sites of expression' by allowing flexibility in interpreting images that would allow for constructive remembering throughout the users life, as their needs and values change. As Lindley et al point out; any attempt to provide a system or interface for retrieving and viewing these images through software should then be sensitive to this need for flexibility by not imposing rigid meanings and structures onto the data. Instead, systems need to be sensitive to the context, intention and practice of use:

> Trying to understand better why the technology is sometimes used and sometimes not, and why it is appropriated in the various ways we refer to, means placing usage in this context of narrative, memory and practice. We suggested a need to pay attention both to the 'site of expression' (which has to do with what aspect of our lives we are looking at) and to 'performativity' (which has to do with the occasions upon which we construct narratives and the identity work that we do around it). [50, p.7]

This suggests a very delicate balance between supporting the user in their ability to navigate the archive and find what they are looking for, and not imposing unwanted structure:

> Systems for *reflection* might be different still where abstraction is important, offering flexible and novel methods for viewing personal data in ways that might surprise, provoke, or educate users. [74, p.76]

So, in its ambiguity, data captured in profuse quantities potentially affords greater opportunities for reminiscence and reflection. In order to fulfill this potential, systems that support reminiscence and reflection might need to break away from the purely archive and retrieval

driven model of data management, and focus their attentions away from reviewing such data through traditional utilitarian instrumental means.

2.4.2 Affect on Remembering

The potential, discussed in the previous section, of large and ambiguous autobiographical data sets to support new forms of narrative construction is especially important where reminiscence and reflection are concerned. These qualities allow space for constructive remembering and therefore for users to reconstruct their memories according to their present values and needs. But to what extent is this possible using current systems that mediate between people and data? The previous section concluded that systems for reminiscence and reflection need to break away from common utilitarian and instrumental ways of engaging with memory data, but before we review some examples of how this can work we will look at how systems and data currently relate to reminiscence and reflection.

Here we argue that because emotional memory is not explicitly designed for, nor it's meaning considered, digital systems could support this form of remembering much more effectively.

In the wake of SenseCam's development, several research efforts have emerged to investigate the extent to which the data captured by SenseCam, and the way it is accessed and organized by users, is supportive of various types of remembering. According to Sellen et al., there are 3 ways that the SenseCam images are able to elicit memory; 'True remembering' whereby the viewer of the image is able to "mentally re-experience that event" [75, p88]; Secondly, that the viewer is able to use knowledge about their own activities, routines, people they know etc. in order to "identify images as their own, and lace them in a sequence" [75, p88]; and finally that viewers could gather semantic information contained within the image "such as lighting, geographical information (such as an office versus a town centre) or something more specific such as images of people eating" [75, p88] to place them in order.

While the device is principally aimed at more functional forms of memory support, it was also found to be able to support more emotional, and reflective forms of remembering, like reminiscence:

> Anecdotally, both healthy users and memory impaired patients have experienced so-called "Proustian" moments of recall when viewing SenseCam images of personally experienced events. Particular images often trigger an autobiographical recollection, where the thoughts, feelings and emotions at the time the event was experienced come "flooding back". [35, p10]

In this instance the application of the term 'Proustian'[10] refers to the way in which a sensory experience of an object provokes a powerfully evocative and cascading reminiscence of

---

[10] This term refers to the novel 'Swann's Way', by Marcel Proust

interwoven memories. This act of remembering is made more powerful for its evasiveness, and the mental work that must be done to recover of the past.

Where previously we might have seen that photographs are descriptive, and have boundaries that restrict the scope of remembering, images like those produced by SenseCam are ambiguous and mundane enough that they allow for broader, and constructive remembering. But, while the images themselves may be evocative, we must also ask questions of the system through which these images are reviewed:

> Supporting the reliving of or reminiscing about personal events, to more specific functional support for memory including finding lost objects or documents, remembering names, remembering whom you met, details of conversations, and remembering past actions or events [75, p81].

While SenseCam may be usable for the support of reminiscence and reflection, it does so through an incidental quality in the images, rather than any specific intentionality in its design. With this in mind me must ask what might be achievable when aesthetic and emotional approaches to constructive remembering are purposefully designed for?

The presence of archiving and organizational systems that impose structure on the content undoubtedly effect how the photos are viewed, and the users' motivations for doing so. Technological infrastructures of such systems tend towards functional memory support, in the organization of an archive that can be efficiently navigated, and don't seem to differ too much when being applied to reminiscence or reflection [43]. Any system that aims for the veridical recall of facts or events misunderstands the nature of this form of remembering and therefore is detrimental to that which it is trying to support and to the ability of the images to achieve these Proustian moments of reminiscence:

> The time that is 'lost', is not, for Proust, recovered by means of improved literal recall or a more accurate chronological record. In fact, one might say that these practices militate against the sort of recovery of the past that Marcel, the protagonist, finds so elusive. The past that is sought exists outside of historical record. What Marcel seeks is the *potency* of the past, not a mere recalling of 'what happened' or 'who said what'. [56, p.138]

In imposing order on the way the data is reviewed, restrictions are placed on the way that a user might wish to review their memory data and remember their experiences. For example, popular photo sharing platforms like Flickr, Facebook and Instagram organize photographs by timeline. While they each offer varying levels of flexibility and navigation, they immediately require that users review their content in a linear temporal format. Further than this, each of these archiving

sites can carry different associations for the user. One, such as Facebook, might be informal, for sharing and engaging in social interactions, while another like Flickr might be more concerned with the sharing and review of well-crafted images. In influencing the kinds of material that are uploaded to these archives, "the meanings that become associated with those sites then impact the ways in which the content in itself is perceived." [48, p,759]

While Lindley et al [48] found that, because "Content on different sites is thus associated with different core values" [48, p.759], people used these values to curate different types of archive; we might question the flexibility of this approach allow for changing values over time.

Clearly it is very difficult to design a system to support memory that does not impose its utility onto the user, but finding ways to do this might uncover alternative routes to supporting reminiscence through autobiographical data.

Other research studies investigating the use of SenseCam images have integrated location data [42] in order to gauge the affect upon the evocative power of the content:

> Images promote more genuine, detailed recall, whereas locational information promotes inferencing. While we lack clear data on this point, there is some suggestion too that images may also be more evocative than locational data - presumably because they are associated with authentic recall. [42, p2053]

This is understandable, because photographs have long been recognized as powerfully emotional mementos [17]. In the passage above though, the values placed upon the act of remembering still sound decidedly utilitarian, with the amount of detail enabled in remembering determining the evocative power of the data, rather than its emotional impact, for example. Further, evaluation of these modes of image review tend to rely on the image as a memory cue, which can be problematic. Middleton and Brown discuss the constraints that images can put on the interpretation of images:

> Memory springs into being from the cup of tea, not the 'dark region'. Perhaps the teacup is acting as a contextual cue for the activation of a set of associations stored as mental representations in long-term memory? This explanation, though – couched in the terms of experimental psychology – is problematic on a number of grounds. First of all, it ignores Bergson's crucial distinction between *perception* and *memory*. If the two are conflated in this way, we will be forced to attempt to explain how a perceptual event – the taste of the tea – can be transformed into a kind of protomemory in such a way that it can be compared to other past representations with which it is somehow associated, begging the further question of how such association occurs. [56, p.140]

Here the idea of memory based purely on the perception of a cue is problematic. Photographs, because of the richness of information they contain, are heavily reliant on perception. Of course, the meaning of a photograph is open to interpretation, and may be interpreted differently by different individuals, or by the same individual over time. However, we could also argue that the descriptive content of photographs somewhat limits the malleability of their interpretation, and places a boundary on the scope of remembering. Consequently the ability of the mind to wonder, and reconstruct meanings according to current circumstance is affected. Presenting an example of a mother and son discussing a family photo, Middleton and Brown discuss the constraints that images can put on interpretation of images:

> In the present example, we may interpret some of the difficulties the mother experiences in recruiting Paul to her version of past events as due to 'irreducible tension' that exists between the photograph as a useful way of occasioning talk of past family experience and the photograph as a direct visual record of the occurrence of some event ... The irreducible tension here is that the photograph affords collective remembering, but does not capture sufficient detail to allow for consensus to be reached about the recollected events. To put this slightly differently, the past that the photograph makes visible is a past that was not and could not have been experienced as such by all the family members. [56, p.144]

This of course applies to a photograph being reflected on collectively, rather than individually, but we may still learn from it. While the photograph affords the ability to remember, it also constrains that remembering to the content of the photograph when interpreted collectively as it is the only common ground available. This highlights how an image of one event can be read differently depending on individual perspective, but also that the descriptive content of the image prevents common consensus between differing memories. This is the same constraint that would restrict the remembering of the individual viewer to the immediate context of the depicted event, rather than encouraging reflection beyond the scope of the image. In this way, images might not be the most suitable media for investigation of the kinds of constructive remembering that we are interested in.

So although it is possible for technologies like Sensecam to support this form of memory, the fact that it does so is arguably an incidental side affect of the desire for prolific capture in supporting functional memory. But, in their symbolic ambiguity through a lack of predetermined or prescribed description of events, the way that SenseCam images relate to memory is arguably more like a material object than a traditional photograph. Perhaps then any system that seeks to provide access to these data, and in doing so provide effective support for emotional and aesthetic reminiscence, could learn more from the ways that we deal with objects when remembering, rather than systems that organize and recall data.

2.5 Incorporating Artifacts

Digital artifacts, or content can clearly comprise extremely rich records of experience. But while they can also provide extremely evocative interactions with the past [66], the design of systems that mediate this data tend towards the descriptive which, as we have seen, may not be the most appropriate for reminiscence and reflection. While it is no doubt possible to design more evocative, less descriptive interaction with data through digital modes [for example see 79], it is the interest of this thesis to explore the opportunities presented by material objects. Here, I believe, in the role that objects might play in mediating the relationships between data, memory and people are rich possibilities for the design of memory technologies that can offer new ways of addressing the issues raised throughout this literature review. Indeed, many of the research efforts that seek to support the emotional and aesthetic aspects of memory have taken artifacts as inspiration in investigating how such data can be mediated in ways that meaningfully evoke reminiscence. However, the relationship between objects and memory is still a complex one, and so it is pertinent that we "we consider how to make the most of physical affordances" [45, p.38] in the design of systems that mediate digital memory data to support reminiscence. The question then becomes over how to do that effectively, and in a way that respects and preserves the affordances and attributes of both physical and digital, while addressing the concerns detailed above.

In order to gain inspiration for designing systems that use memory data to support reminiscence and reflection, some researchers have sought to understand existing practices of archiving valued objects in the domestic environment [e.g. 45]. This provides insight into the relationships between people, memory and things that is useful in designing the interactions of these digital systems.

These studies show some contrast between the ways that physical and digital mementos are archived. This is largely due to "the different ways in which digital and physical content can be stored and how they are then encountered." [48] While digital objects are often lost, or neglected, the valuable items discussed in these investigations are predominantly physical. Here we might argue that objects' physicality is a fundamental aspect of their value in allowing them to become part of the fabric of the home [45], while the design of the devices that mediate these digital artifacts does not do allow them the same level of curatorial possibility in the home [66]. Physical objects have various properties that encourage the attachment of meaning such as the ability to move and position them in space [61], or the suggestion of provenance through patina [204], and so on. More importantly physical objects are able to support a broad range of meanings, with the ways in which they do so being equally diverse. This diversity of scope is also clearly demonstrated by Csikszentmihalyi and Rochberg-Halton [17] who, in a study of

meaningful objects in the home[11], found that from the 1,694 objects discussed, 41 type categories were derived (TV, furniture, visual art, photos etc. from these a total of 37 categories of meaning were established (For example 'memento', 'heirloom', 'gift' etc.):

> By using these criteria, we coded 7,875 different reasons that the objects were special; in other words, on the average, each object was coded as having four separate meanings [17, p.57]

They then go on to discuss the ten most common objects to which meaning is attached[12], from furniture, to plants, musical instruments and books. These categories might not be surprising, but they show the diversity and flexibility with which meaning can be attributed to things. Meanwhile the passage above illustrates the ability of these objects to carry multiple meanings and therefore multiple interpretations. The ways in which objects support diverse and multiple meanings, and the ways in which designers and researchers have attempted to digitally augment things with stories, is one characteristic of great interest to this research.

2.5.1.1 Supporting Stories

Physical objects to which we have associated memory are laden with rich meanings and stories. These stories and memories are an important part of our interaction with objects and the past:

> The first observation to make, highlighted by the findings of this study, is the importance of stories. The objects that people showed us usually sparked a story about why the object was important, how it came to be, or why it was kept where it was. [45, p.39]

The perceived problem here though is that these stories are implicit, and so only apparent to the person who has attributed meaning to the object. A new visitor to your home, for example, will likely not be able to guess the stories behind an object on display in any meaningful detail [37]. Of course, these stories can be shared, often verbally, and the objects themselves act as good props to remembering and communicating these stories. This has inspired researchers to investigate technological ways of augmenting this practice by attaching stories, in the form of memory data, to objects so that their stories can be shared in richer and more diverse ways. This also has the effect of allowing specific narrative construction of otherwise dispersed or unstructured data through interaction with an object.

One of the earliest examples of this kind of work is perhaps Memory Box by Frohlich and Murphy [22]. It is a system for attaching, and crucially playing back, verbal stories associated to objects.

---

[11] This study was conducted in the USA in 1977, across a range of social and cultural groups
[12] 1:Furniture. 2: Visual art. 3: Photographs. 4: Books. 5: Stereo. 6: Musical instrument. 7: TV. 8: Sculpture. 9: Plants. 10: Plates

This was an 8 x 5 x 3in box lined with fur, containing a pair of earrings, a necklace, a pebble, a matchbox and a photograph. The lid of the box contained a loudspeaker, and the box itself was plugged into a Sony minidisc player. Example stories were recorded in an interview with a colleague who commented on the contents of her jewellery box. [22, p.238]

This approach is slightly misaligned from our questions about how objects might provide meaningful interaction with memory data, in that it involves the creation of new content through recorded stories, rather than association to an existing set of data. The study method further contributes to this because the research prototype was exposed to participants in a lab setting, where the stories and objects were not their own, but examples recorded by someone else. However, as an exploratory study, it was effective in gaining some insight into the possibilities of such systems. For instance, one key finding concerns participant's anticipated motivations for using the system. Many believed that they would not need such a device to aid personal reminiscence because the object is evocative enough. Instead they saw that it could be well suited to remote sharing of stories and memories with others, to whom the meanings of the object might not be apparent, for example when gifting or passing on an object. Subsequently, other researchers have devised various systems that work to investigate more directly the ways that such interactions might work using existing objects and sets of memory data. Van den Hoven et al. conducted more explicit research into the roles of personal souvenirs as triggers in remembering experience. They did this with a view to creating a system that would use people's souvenirs as elements in a Tangible User Interface (TUI) by linking the objects to digital photographs using RFID tags. The photos, related to the meaning of the object, could then be retrieved via an RFID tag reader. This system aimed to address the esoteric and implicit nature of these objects stories, along with the malleability of the story to its audience. Similarly, in attaching sets of photos to related physical souvenirs, Nunes et al. created 'Souvenirs' [61] an RFID based system that allows people to link physical souvenirs in their home with digital photo collections on their computer. This combined physical objects' ability to be located and positioned throughout the home, with the digital photographs' ability to aid sharing and discussion of experiences. The result was intended to create more meaningful and enriched interactions with the past through story telling:

The person would (as normal) position the keepsake at a meaningful location within the home, which would in turn present opportunities for social engagement. From these opportunities, any household member could bring the keepsake near a large display (e.g., a Plasma television screen), which would automatically start a slide show of those related photos. [61, p2]

This addresses one key difference between storing and accessing paper versus digital photos. Because paper photos are objects, and so occupy space, they can be curated and located around the home to achieve various ends. Digital photos, on the other hand, tend to exist in the same Operating System file structure as countless other documents. Unless they are printed, or 'promoted' [4] into the physical world, they are not generally subject to any mechanisms that support their potential value. For instance, it is common for people to simply use their OS file system to store and view photos, while relatively few use dedicated software or online platforms [61]. As with the discussion of life logging above, we might consider that a large quantity of digital images means that they are valued collectively rather than individually, in which case printing one and putting it somewhere in the home would be pointless. However, Souvenirs attempts to give these photographs a meaningful physical presence without the need to print hundreds of photographs.

One immediate problem with such systems concerns the differing spatiality of the valued object versus the location at which the photographs can be viewed. Because the souvenirs were generally kept in different places than the home computer, the objects had to be removed from their places of display and reflection where they had been purposefully placed, and moved to a scanning device attached to a PC and display; a site of utility. So while this may make the viewing of relevant photo sets far easier, and also act as a more easily remembered 'location' of the photos, the qualities of the object become secondary, acting as little more than a conduit to the digital photos. The object's position in the home, and the values associated with that location, is not utilized at all in the interaction with the photos, and there is now a technology-based interaction (usually software) between the objects and the memory data. As a result these systems draw focus away from the experience of the object or data and onto the interface, or technological interaction. Again, while these systems show value in the act of remembering, we might ask whether the removal, or perhaps more subtle integration of these interfaces might provide further benefit.

The tensions around location and presence made evident in these studies demonstrate one difference between physical and digital, and the consequent difficulty in designing relationships between them. Imposing physical properties onto digital content, and vice-versa, is problematic and a large archive of digital photos has requirements and values that cannot be easily achieved through physicality. For instance, while entire photo sets are linked to single objects, there may still be too many of these that are considered valuable, and therefore worthy of display, to realistically link to individual objects. While other considerations, such as personal tastes in home decoration, or the availability of space come into play, we can also see that the data and the object need to share a common meaning and association in order for there to be a meaningful link between the two. As such the relationship between data and material must be more carefully considered.

Related to this is the nature of the interaction with the data through the object. The interactions through which people retrieved the digital photos related to the object had little relation to the experience that they represents, or the people involved in looking at the photos. Instead a technological system was designed, possibly based on generalized findings from a field study of many people, and inserted into peoples' homes. Later in the study, the design of the system was changed in ways that meant people could avoid the main features of the system. This indicates strongly that the way the system was initially designed, and the intended interactions between people things and digital photos, did not fulfill the users needs.

However there is another possible approach to tagging objects with data. The work discussed so far has taken place in a domestic and personal context, where the need for augmenting personal objects and data is unclear, with infinite interactional and conceptual possibilities. Tales Of Things[13] is another example of a project that explores some of the possibilities for linking objects with data, but in a very different context.

> Tales of Things is a tagging system which, based on two-dimensional barcodes (also called Quick Response or QR codes) and Radio Frequency Identification (RFID) technology, enables the capturing and sharing of object stories and the physical linking to objects via read and writable tags. Within the context of our study, it has functioned as a technology probe which we employed with the aim to stimulate discussion and identify desire lines that point to novel design opportunities for the engagement with personal and social memories linked to everyday objects. [9, p.1]

TOTeM (Tales Of Things and Electronic Memory) endeavored to explore opportunities for the attachment of narrative to objects in meaningful ways but does so in a much more specific setting. For example, during the Future Everything[14] festival, Tales of Things was deployed in an Oxfam charity shop[15].

> The RememberMe artwork was a collaborative project with the Oxfam shop charity shop, in Manchester. During FutureEverything 2010, a research assistant based in the shop, asked people who dropped things off to tell a brief story about one of the objects into a microphone: where they acquired it, what memories it brings back and any associated stories. These audio clips were then linked to an RFID tag and QR code and attached to the items as they joined the shop's stock. [78]

---

[13] The TOTeM project is an EPSRC funded project to explore social memory in the emerging culture of the Internet of Things: http://www.talesofthings.com/

[14] http://futureeverything.org/

[15] http://2010.futureeverything.org/festival2010/rememberme

While the setting of the shop is also a complex one, the expected interactions of potential customers within it was important in providing a clear context for design where interaction with the artifact was placed at the forefront. Attaching stories to items of clothing on sale in Oxfam Charity shops represent a particular kind of object and context that makes the attachment of stories particularly compelling, and frames the interaction with the stories and objects in meaningful ways.

This material 'turn' in the life of the project readdressed the balance of where the immaterial data was located. Instead of being accessed through a web interface, the RememberMe work explored the potential of the TalesofThings project to manifest a social Internet of Things that is situated in the event based context of exchange. [78]

Being inside the shop meant that the best way for people to access the story of an object was by inspecting the objects much in they same way they would expect, scanning the tag, and listening to the story all in the same place, rather than exploring the website to look at stories, or removing the objects from their context. In this way the objects was able to give structure and meaning to content like audio records that, if encountered separately, might have suffered from a lack of context. This engendered the interactions that lead to meaningful encounters between people things and data.

The buyer can now chose items of clothing based on values in addition to their function or style, while listening to the stories attached to items gives them a new experience of, and information with which to select items.

Through this mechanism the shopper is given new ways to respond to the materiality of the object. Once someone buying a jumper, for example, from an the Oxfam store listened to it's story the were compelled to read the material characteristics of object in a whole new way. Perhaps a loose thread, a patched elbow, or a slightly faded area became more than 'wear and tear' and became an ongoing narrative wrapped up in physical form.

These types of object – no longer wanted, but valuable enough for resale rather than disposal – may sometimes have stories associated with them, where the sentiment attached to the thing also increases the perceived value, both emotional and monetary, in the eyes of the potential buyer:

> Scanning an object replays its past, its associations, its locations and the memories of its owners. Consequently, the ability to tag, provide and embed objects with memory has potential to change the social and economic value of real-world objects. [9, p.2]

Aside from potential economic benefit, the fact that people were willing to pay more for items with stories connected [9] shows the value that people place on stories and meaning, and that there is great potential in terms of personal emotional value (not just monetary) in finding meaningful ways to connect objects and digital stories.

The context provided by the choice of location also helps from a design point of view.

We have shown that, for the participants in our case studies, literally any object could potentially become a source for a story of significance for their owner. The ability to tag any object and to involve these in the storytelling process is thus important for an augmented memory system. [9p.10]

This range of possible objects and interactions makes for a very broad design space that can be difficult to design for. Focusing on specific contexts and interactions in this kind of work allows the designers of the system to tailor details and interactions of the system to more detailed user scenarios, and therefore to create more compelling experiences of the objects, place, and digital stories.

Attaching data to objects in the ways discussed above is an attempt to make the stories behind objects more accessible, and all are examples of the ways that material objects can frame digital narrative. However, this also seems somewhat antithetical to the ways that objects support personal memory. The stories behind personally meaningful objects are implicit, and individualistic, which lends them the flexibility and interpretability to support emotional and aesthetic engagement. It is therefore arguable that while attempts to attach explicit stories to them may help share those stories and establish social memory that are valuable in particular contexts, they are also detrimental to what it is that makes *personally* meaningful objects powerful. Much as we saw earlier with Middleton and Brown's examples of the mother and son discussing a photograph, in ascribing set meanings to objects, there is little scope later for reconciliation between that meaning and the users current perception of it.

Tales of Things' Remember Me, on the other hand provided a good example of when this kind of augmentation works. Its rich and specific context provided compelling interactions with both data and object that aligned with users expectations and values. The domestic examples on the other hand would seem to suffer from the complexity, or ambiguity of the context. Outside of an appropriate context, perhaps the very characteristics (pre existing mental models) that are supposed to let objects structure interactions with data, are those that prohibit the integration with unfamiliar systems. There seems then to be a need to design sensitively to, and specifically for those values and associations.

This explicit connection of data with object also seems better suited to sharing stories where the meaning of either is not immediately evident to the receiver. This then becomes a mechanism for helping others 'know about' a story, rather than a person remembering and reflecting upon their own experiences.

Two ways to overcome this would seem to be to create either very bespoke systems that are tailored to the specific need of each study participant, or to make new systems and devices that are not fighting against the pre-established mental models and associations of artifacts.

A more bespoke approach will allow designers to take into account the specifics of the context in which they are operating. Then, rather than examining the link between data and object in an

abstract sense they can look at the specific relationships between *this object* and *this story*, and how they relate to these people in this place. This approach perhaps allows for the design of more compelling interactions between people, things and data.

2.5.1.2   Objects Support Multiple Interpretations and Aesthetic engagement

Significantly in the case of personal reminiscence, physical mementos, especially those found in the home, are not just good at supporting meaning, but they are good at supporting multiple meanings at once, both to one individual and across social groups. Like the disagreement over the photograph in Middleton and Brown's example, different people can interpret an object in different ways. However, unlike the photo, the object visually depicts nothing of the related experience that might constrain the viewer to the scope of its content. So, in their lack of explicitly descriptive data, objects are able to support and provoke multitudes of meanings and interpretations.

After studying the importance of physical objects in home archives, Kirk et al. found the following:

> Furthermore, many such objects revealed, as we have discussed, how the meanings of objects and the stories associated with them can become part of a shared family history or can be quite different for different members of a household. [45, p39]

This not only allows multiple interpretations by different people, but also by the same person over time.

Their ambiguous, or flexible meaning is a characteristic that allows for the constructive remembering and narrative formation that we have discussed previously. This of course makes the design of any connection between objects and data even more complex, especially when the introduction of descriptive data threatens to dilute this ambiguity. One potential answer to this lies in designing with sensitivity to the values and expectations entailed with the domestic context.

In their paper *Designing Web-Connected Physical Artefacts for the 'Aesthetic' of the Home* [99], Ylirisku et al. provide an extensive overview of the ways that objects fall within and create the aesthetic of the home. They take the view that the current push towards technological mobility, while it has obvious benefits, has engendered the creation and prioritization of devices that are not aligned to, and therefore do not support these domestic values.

> The benefits of this flexibility, fluidity, and portability are obvious, yet a design process that places access anywhere at its centre misses the opportunity to build upon an alternative set of values: those associated with designing for a *particular place*. [99, p.909]

I might go further than this and say that digital devices have long been sold on task oriented values, and the prioritization of technological features. Fundamentally the home is a place of alternative values to most other sites of technology, and one that requires a wider scope of values than those that drive the majority of technological innovation. These include reflection, memory, personal taste and experience [17].

Taking after Miller [57], we might agree with Ylirisku et al. that the 'aesthetic' of the home can be viewed as "the ordering of the patterns of the relations of people and materials" [99, p.909]. This is important because newly designed technologies need to be able to find their place amongst these relations, and to form their own. By the sensitive design of both the physical material aspects of devices, and the ways it mediates interaction with memory data, such systems should "enable digital media *to find its place* in the domestic environment; to be at home" [99, p.910].

Here Miller also sees the power of objects as resulting of their shifting role in the microcosm of the home and their fluid relations with people. Their power is in their ability to occupy the background of attention [58], a mode of interaction distinct from being 'off', and one not usually present in technological devices. Given the complexity and individuality of people's home aesthetics, designing for them surely demands a specificity and individuality in design?

> The central dilemma that Postrel and Miller both bring forward is the interplay between the universal and the particular. The problem is to bring the details of the everyday into dialogue with generic forms, and to be committed to both extremes: the universal and the particular. [99, p912]

This is a significant design problem that, I would argue, is much easier to understand in theory than it is to put into practice. However, one tactic is to learn from specific aspects of the domestic aesthetic, drawing upon relations engendered by physical objects, and to design interactions that support the same dynamics using digital content.

For example, Swann and Taylor drew inspiration from the practices, and social mechanics around the organization of paper photographs in the home [88], to inform the design of devices that might support these same dynamics, relationships and narrative and storytelling in collections of abundant digital photographs [90]. Digital photos are also a conveniently ubiquitous form of memory data, and are somewhat typical in the aesthetic and emotional shortcomings of technologies that provide access to them once archived. Again this is not to say that the digital objects themselves are less emotionally valuable as a result of being digital, but that the technologies we have available to mediate this content do not do justice to their value.

Research into Technology Heirlooms [e.g. 63], also seeks to play with these aesthetic relations in order to create new interactions with digital and physical material, and in doing so attempts to

reconcile the distance between what are commonly observed as meaningful objects, and our digital archives. This builds on several strands of research, such as those above, that, "have made important contributions to understanding how interactive technologies could better support digitally capturing family memories and revisiting them" [63 p.338].

By observing how material objects are attributed value, and passed down to subsequent generations with the affect of "sustaining social relationships and bolstering ideas of shared heritage, history and values" [63, 337], researchers have transferred these lessons to the design of physical devices that support remembering in various forms. In doing so they have shown the value of designing for this particular aspect of domestic aesthetic, and further demonstrated "the value of being able to position digital content amongst other material things in the home." [99, p.910]

> Collectively, this sample of reflections helps illustrate how giving digital collections physical properties might better support the dynamics of living with them over time, from intentional engagement to simply letting them persist among other significant domestic possessions and spaces. [63, p.343]

One major aspect of this aesthetic sensibility are the material choices that allow the technology heirlooms to suggest their prospective value, and take place amongst the other heirlooms and meaningful objects in the home. Many domestic objects that mediate with memory data are designed in ways that emphasize technological properties or aesthetic rather than those of the proposed context. A classic example is that of the digital photo frame, a device that does little to communicate the value of its contents [4]. For example, these tend to be made out materials borrowed from the world of gadgets rather than those of meaningful objects. Instead, materials that are more sympathetic to the domestic environment can be used:

> How the qualities of certain materials, such as wood, can inspire a perceived sense of durability; and how the invocation, experience and putting away of inherited objects— digital and physical—appears central in supporting meaningful, self-determined interactions with them. [63p.339]

However the use of a material is only half the story. The forms it has been made into, and the interactions with it also play a vital role in how the user will relate to the device. For example, many digital photo frames are now made of wood, but with barely any affect on their aesthetic relation to the domestic. Similarly, there are many research projects that site the use of wood as a mechanism to increase perceived value and notions of longevity, while very few discuss exactly how their use of material supports their intended interactions. In other words, although materials do communicate certain values, their use in itself does not equate to, or successfully

create an aesthetic, and the ways that those materials are used to construct forms and interactions are just as important in the communication of aesthetic values.

A good design example to emphasis this point is the Prayer Companion by Gaver et al. of the Interaction Research Studio at Goldsmiths. The object itself is constructed out of plastic, rather than any material that might theoretically suggest preciousness. However, there is detailed discussion in the accompanying paper [25] about how the device fit well with, and became a valuable part of the aesthetic of its setting, because of the interactions that the form and function of the device engendered.

This indicates that in addition to materials and form, the ways that the objects interactions and behaviours influence the relations that construct the aesthetic are also important factors in allowing the device to fit with the domestic aesthetic. The use of ambiguity in the design of the device is another tactic to achieve this. Ambiguity has been described before, perhaps originally by Gaver et al [24], as a means of allowing users of digital systems to form there own interpretations of the devices meanings and their subsequent relationship to it. For example, when discussing the different ways that ambiguity can be designed into a digital device, they discuss tactics for enhancing ambiguity of information:

> Focus on creating or reflecting uncertainties about information that are in some way significant. The purpose may be merely to make the system make the system seem more mysterious and thus attractive, but more importantly it can also compel people to join in the work of making sense of a system and its context. [24, p.237]

This use of, "*imprecise representations to emphasis uncertainty*" [24, p.237] is intended as a way of "crafting interactive designs that are engaging and thought-provoking" [24, p.240] and thereby enabling deeper attachment to devices, through more compelling interactions and personal meaning. This then seems to be a useful tool in designing systems to support constructive and aesthetic forms of remembering.

Existing design work that uses ambiguity in the design of technologies for reminiscence does so through this ambiguity of information. However, the 'imprecise representation' of this might take a couple of forms. Broken Stories is a design project by Miwa Ikemiya[16] that uses familiar domestic objects and tropes of patina to create subtle relationships between objects and data. The system requires users to damage a piece of ceramic tableware, and then to colour the resulting cracks. They then decide a meaning for the pattern, and use a smartphone application to record, and attach their story to this unique object. This is an example of the ability to attach meaning to any object through the ambiguity of the material features. As such, the user is able to construct meaning freely. However, again, this system involves the tagging of data to physical features, and so the possibility for that meaning to adapt later is potentially restricted.

---

[16] For more information, visit: http://miwaikemiya.com/BROKEN-STORIES

On the other hand, although this uses quite clear information through the use of digital photographs, the form of the object that it is linked to, and the way they are is linked to the object, is ambiguous enough that the meaning attributed to the form are left entirely up to the user.

Photobox [64] is another example of the use of ambiguity in the design of memory technologies[17]. It is, "a device intended to be used over many years, which occasionally prints a randomly selected photo from the owner's Flickr collection inside of a wooden chest" [64, p.665].

Unlike the example above, Photobox presents the information fairly clearly, in the form of a photograph, however what is unclear are the reasons for presenting *this* information at *this* time. The function of the device is extremely simple, but ambiguous, and in the presentation of a random image the user is invited to reflect more upon what this means *now*. This then allows them to reframe and reconstruct their ideas around the meaning of the image and the device according to their current needs and circumstances.

Both of these are also very observant of the domestic aesthetic, not only in their appearance, materials and forms, but also in their acknowledgement of the rituals and relations that construct domestic experience.

Unlike Banks' digital photo frames, both of these prototypes use the associations and languages of familiar objects, and appear un-technological in appearance, and so are more easily able to disappear into the fabric of most homes.

2.6 Conclusion

This chapter has given an overview of existing research and literature relevant to the themes of this thesis, namely ways that we can create more engaging interactions with the digital information that describes our past. In doing so it has delineated the current landscape of the research and identified an avenue for further investigation into the design of digital and material systems that support reminiscence.

We have seen that an increase in the accessibility of digital recording technologies, such as cameras and mobile devices, and a parallel increase in the capacity and availability of personal and online digital storage have resulted, for many people, in the accumulation of huge archives of personal data [54]. Much of this data describes our past experiences and memories, and so offers extremely rich opportunities for reminiscence and reflection.

However, because of the quantity of this memory data, and despite the organizational mechanisms (like tags) of archiving systems, this data is often dispersed across various locations and poorly organized. As a consequence it is rarely accessed or engaged with.

As such, the main design and HCI challenges in dealing with this memory data are the ways that this data can be structured into meaningful stories that allow us to engage more meaningfully

---

[17] See section 4.2 for more detail on this project

with the past. Our accumulation of digital memory data can be compared to life logging research, which looks to find ways of recording and giving access to vast amounts of autobiographical data. This has shown how the quantity, and consequent mundanity of much of this data has lead to new ways of building narrative structure and alternative ideas about how value might be placed on digital things. Rather than using specific pieces of data, like a single photograph, to tell stories, users of life logging tools constructed narrative from sets of data, like such as a collection of many photographs, to get a sense of a time, place or experience.

While there are many ways of remembering our past experiences, this work is primarily concerned with reminiscence and reflection. Reminiscence is an engagement with the past for emotional and sentimental reasons, while reflection involves the review of data in order to learn about the past, or restructure their memory of it according to current values.

Here the emotional evocativeness and aesthetic experience of engaging with memory take precedent over the ability to recall and act upon information.

But these forms of remembering, and these values, are not usually well catered for in the design of systems that support remembering through digital content. Such systems tend to focus around utilitarian goals that prioritize the retrieval and recall of facts, and so do not best suit the type of remembering we are interested in, and so fail to do justice to the emotional and mnemonic value of our memory data.

Because reminiscence of episodic memory is constructive, organizational structures imposed by digital archive and retrieval systems unavoidably place an overall structure on that data that affects the way it recalled, sorted and used in remembering. At the same time they tend to present the data literally, which again may be poorly suited to the aesthetic qualities of the data, while also restricting our ability reconstruct memory.

Although the design of such interpretable systems with aesthetic and evocative qualities is extremely difficult, I investigate one approach to overcoming this challenge by combining memory data with physical artifacts. By virtue of their material and aesthetic qualities, objects have always been effective at supporting meaning and remembering of the past. Now, these same qualities can offer inspiration for the design of technologies that mediate relationships and interactions with memory data to help construct it into ambiguous but meaningful narratives. At the same time they can shape interactions with data that fit with aesthetic requirements of context, and of constructive emotional memory.

Various approaches have been taken to this, from connection of physical and digital through tagging technologies, to the creation of devices that allow physical interaction with memory data. As well as providing valuable insight into possible meaningful relations between objects, data and people, these projects also highlight yet more challenges.

For a start, physical and digital things are different mediums with different properties, affordances and constraints meaning that they do not mix so easily or directly. Combining physical and digital objects to access and browse memory data may not necessarily add much

to the experience as it is possible that their respective properties and aesthetics are negated, and so experience of each. Careful design of this relation is required so that the system fits into the aesthetic - defined as the values and expectations that arise from the relations between objects and people – of the place, be it domestic or otherwise.

Meanwhile in the domestic context, augmenting an object in a literal way with descriptive information restricts the ambiguity of the object, and its ability to evoke emotional reminiscence. Ambiguity of information must be used so that the interaction with memory is more about emotional aesthetic forms of remembering than recall of information.

The work of this thesis then seeks to build on this discussion to explore new possibilities for designing the relationship between objects and memory data in ways that better support emotional and aesthetic forms of constructive remembering. To do this it will begin by excluding digital data, and concentrating on details of aesthetic relations between people objects and memory such as how the material of objects, and the interactions that they encourage link to the act of remembering. Taking this stance, rather than starting with a particular type of data and thinking about how that might be manifested physically, it avoids placing structure on sets of memory data, and instead concentrating on the aesthetic relationship to memory. In this way, data can later be included in ways that are more appropriate to its meaning and value.

By taking a design led approach to exploring these themes through material and aesthetic means, I hope to establish ways of designing a symbiotic relationship between material and digital in more natural and emotionally valuable ways.

3 Methodology

3.1 Introduction

Because the objective of this thesis is to contribute to the design of systems that mediate data that relates to experiences for the purpose of reminiscence and reflection, it makes sense to do research through design. Engaging in the design of objects and devices that explore these relationships, and learning from that process, seemed the best way to do discover new design opportunities, and to establish a design space.

These practical elements constituted a mixture of empirical and design led research. Designed objects were made to various degrees of fidelity and functionality in response to empirical explorations of people's relationships with objects and data, and again used as probes or provocations to form the basis of further discussion and empirical study.

The purpose of this chapter is to outline my approach to 'design led research', and go on to describe and discuss the methods used throughout the thesis, justifying the reasons for choosing them. However, more detailed accounts of the particular process and methods applied will be individually described in later chapters that describe specific projects. This chapter begins by discussing why I might want to use design led research to explore the research question, and how it will benefit the themes of this thesis. Then, in order to further contextualize the methods chosen throughout this chapter, it will continue by giving an overview of the style of design used in the practical elements of the thesis. By providing examples from disciplines that have influenced this approach such as Speculative, Critical and Ludic Design, this will give an idea of the kind of work being conducted and the suitability of these approaches.

3.2 Why Do Research Through Design?

The primary reason for choosing a design led approach for this thesis, is that it is fundamentally an investigation into *new* kinds of objects and interactions that might be made possible by new technologies that allow the combination of physical and digital matter. Any exploration of the new inevitably benefits from the design and creation of new things.

This approach also allows you to gain specific insights into the ways that a technology will affect people. Objects are an integral part of the enactment of everyday life. As such these artefacts convey a language of use [84] that is familiar, but implicit, to many people. This affords design led research a unique benefit in that the designer can leverage this familiar and legible language of everyday artefacts to ground research explorations in the everyday experience of the audience. This in turn allows the researcher to elicit meaningful responses from people about what it might be like to live with the new technologies under question. Therefore, through a carefully designed object that involves real interactions, the design researcher can gain insight into esoteric or abstract questions about future technologies. The details of these interactions

and how they work is at the heart of this thesis, and so a research strategy led by the design of prototypes that provoke engagement and discussion with hybrid digital physical interactions is a natural choice.

Design led approaches to research are many and varied, a symptom, some argue, of a lack of clear definition and structure reflected by the many different terms used to describe exactly what is being done and how these processes contribute to knowledge [60]. Researchers from more scientific disciplines consider this troublesome because it can be difficult to demonstrate and articulate the contribution of creative practice to knowledge, but also the logic of the process. Despite this, the act of design, and of making itself is increasingly recognised as a form of knowledge production in its own right, where designerly, rather than scientific modes of inquiry are better positioned to support design practice [82]. One might also consider this lack of easy definition and codification to be encouraging. The subjectivity and creativity involved in creative practice afford it a malleability and agility that is particularly useful when the topic of research is not so hypothesis driven, but more exploratory. This approach is exploratory in the sense that although a prototype might be designed to address a specific research question, deploying a new technology or object into an everyday setting fundamentally disrupts that setting in complex ways that you might not have predicted [92]. This disruptive characteristic is what allows a designed prototype to uncover much more than it was intended to, and for the intervention to reveal surprising details about the interaction:

> *When researchers actually construct something, they find problems and discover things that would otherwise go unnoticed. These observations unleash wisdom, countering a typical academic tendency to value thinking and discourse over doing. A PowerPoint presentation or a CAD rendering would not have had this power [46, p.2].*

The power of this approach then is in its ability to engage people on an everyday level. The constructed object is rooted in everyday practices and perceptions in order to provide detailed insights about what it might be like to experience a technology. Crucially though, the complexity and multitude of these potential practices and perceptions gives scope for responses and offer insights on subjects beyond the immediate scope of the research activity. These are invaluable in providing the rich details of interaction that make research contributions, particularly concerning the affective impacts of interactive technologies, of great value. However, such value is also dependent on the style of design being used. What follows will give details of the design approach, and the research methods that will be used to make these kinds of deep, experientially grounded and exploratory responses possible.

3.3   Design

In order to give context to the research methods chosen in this thesis, and detailed throughout this chapter, it is necessary to describe the approach to design used in this research. This will

also give insight into the nature and intentions of the objects being produced, and the ways in which they are exposed to project participants and audiences.

Despite the prevalence of design led research, the genre or style of 'Design' is rarely defined, with a few exceptions [see for example: 26]. This is problematic because 'Design' is perhaps as broad a term as 'Science', and could encompass anything from product design to usability, fashion or service design. The majority of practical work in the projects that make up this research will be conducted from a product design point of view. However, it is also not satisfactory to simply define these disciplines through their chosen mode of output, and while the practical outputs here will primarily be designed objects and prototypes that are positioned as speculative 'products', they are nonetheless research prototypes, and as such a particular approach is taken to their design.

The style of design used in this work, although heavily influenced by product design, might best be described as Speculative Design, but there are three influencing genres. The following will give a brief summary of each.

3.3.1 Speculative Design

Speculative design does not define a discipline or modality, but rather an approach to design that seeks "to provoke questions about the social implications of new technologies." [10, p.62] It does this by building an understanding of a particular science or technology and using this knowledge to develop scenarios that suggest ways the technology might affect society, culture, politics and economics etc. The role of design in this is crucial. The design of objects that might exist under the proposed techno-social conditions provides not only an illustration of the concept, but also grounds the proposal in the reality of everyday life. The way that it does this is derived from the legibility of objects and their impact on everyday life discussed earlier. This further illustrates design's usefulness in research. By logically extrapolating potential applications and implications of emerging technologies, and the language of objects, speculative design can offer examples of the kinds of devices and interactions that might exist. In this way, something esoteric and fictional is made to seem real to the extent that one could imagine its affect on their life:

> *By regarding a design prototype as if it were an actual product or system, you receive a glimpse of a potential world: the world in which such a thing could exist. It's like a small moment of future shock, except that, instead of the future overtaking you, it is you that overtakes the future.* [10, p62]

Then, the esoteric questions over advanced technologies mean something to the audience. The goal is not to create products, but to provide space and opportunity for people to discuss what products could, or should be, and the desirability or otherwise of the techno-social conditions that might lead to such an object.

The efficacy of this approach is further demonstrated by its application to, and adoption by other disciplines. For example Design Fiction, a method often used in speculative design, is increasingly employed by technology and futures researchers to create future techno-cultural scenarios. In his short essay of the same title, technologist Julian Bleeker describes Design Fiction as:

> *Design fiction as I am discussing it here is a conflation of design, science fact, and science fiction. It is an amalgamation of practices that together bends the expectations as to what each does on its own and ties them together into something new. It is a way of materializing ideas and speculations without the pragmatic curtailing that often happens when dead weights are fastened to the imagination.* [11, p.8]

As a method or approach within Speculative design then, Design Fiction combines a set of disciplines that allows the imaginative exploration of ideas that are free from the practical limitations that can be afflicted by market driven aspects of the product lifecycle like supply chain or manufacturing. The fiction and speculation can then suspend disbelief and allow ideas to be positioned as though they were products, and take advantage of that context of audience interpretation, while being free from the constraints that tie products to the traditional market values that we are trying to escape.

> *Design fiction is the cousin of science fiction. It is concerned more about exploring multiple potential futures rather than filling out the world with uninspired sameness. Design fiction creates opportunities for reflection as well as active making. [11p.8.]*

This emphasis on fictitious scenarios, and building the materials to furnish them affords a few opportunities that may not be possible through traditional design approaches. Primarily, it allows the designer to craft techno-social scenarios around technologies that are not yet possible to build. Further than that, it allows you to investigate the implications of technologies that it is not practical to build in terms of time and cost effectiveness.

For instance, Song of the Machine [Figure 1], by London based design studio Superflux [86] is based on research into ocular implants that use a combination electrical stimulus and light responsive proteins to restore sight to the blind.

> *What if we could change our view of the world with the flick of a switch? The emerging field of optogenetics combines genetic engineering and electronics to manipulate individual nerve cells with light. With this technology, scientists are developing a new form of retinal prostheses. Using a virus to infect the degenerate eye with a light-sensitive protein, wearable optoelectronics can establish a direct optical link with the brain* [87].

The designed objects act as props in the accompanying film, and together they explore the possibilities of such prostheses, including the idea that it could potentially provide superhuman sight through engineered perception of additional light spectrums, and digitally augmented vision. However, the objects they made are not real functional prostheses and the film not a document of actual interactions. Although the technology is real, it is still restricted to the confines of the lab, and some years away from application. Instead, the speculated object and scenarios developed by the designers are suggestion of things that could exist, and what they might do.

This is not just matter of pragmatism. Building working prototypes with experimental technologies, or in experimental ways, inevitably involves the retention of software or hardware bugs or compromises on form and materials that disrupt the user's experience, removing them from the conceit of the fiction. Instead of mitigating these foibles, the designer can concentrate on the aesthetics and experiential elements of the design in order to achieve much more vivid results:

> *Most design futures strive to create a rich, textured, often first person immersion in a credible alternate world through the use of multiple media and storytelling techniques. The best examples also seek to evoke the everyday richness of life in a 'thick' way, going beyond the obvious layers to explore more subtle 'scents and sounds' of an alternative future in more emotional, evocative ways.* [72, p.1]

This use of objects and multimedia materials like film provide an experiential and evocative richness that is not achievable with simpler forms of communication:

> *Highly visual, often emotional, and ethnographically infused, their approach brings the future alive through videos, objects, and print media. The result, they argue, is a*

profoundly engaging experience that goes beyond technical reports and PowerPoint presentations towards a different form of engagement. [72, p.1]

Although the design work within this thesis will be speculative in nature, the intention of the research activity is to ground research activities within, and to explore, specific details of direct interaction with objects. So although the context of this thesis is a speculative one, the objects and research activities are grounded in small details of and responses to, interaction rather than larger scale socio-cultural speculations.

This might make the use of some speculative design methodologies seem an uneasy fit. However the approaches oriented around objects are suitable for the design work that will compose this thesis in that they will allow for the investigation of technologies designed according to alternative values. Further, this thesis is concerned with the ways that people might experientially and emotionally engage with proposed technological systems, rather than the practical details of their use. This makes a speculative design approach a very fitting design approach to employ. Likewise, these props can simultaneously be used to provoke and support discussion around the larger, more speculative themes of the project.

3.3.2 Critical Design

Most product design, particularly in the commercial sector, might be described as affirmative design. This is the design of products that follow market trends, and consequently reinforce the values by which products are made and sold. Under this condition technical improvement takes precedent and we see the constant release and marketing of products that are thinner, lighter, faster, with more pixels, more disposable etc.

Meanwhile, the majority of speculative design is used as a mode of critique whereby the designs are intended to explore and question the values and motivation that underpin technological development and future application. However it is important to note, that speculative design is not necessarily critical in intent, and can in certain cases be little more than a marketing tool for large corporations to reinforce affirmative values in creating 'seamless' techno-utopian visions to help them sell products. An often-cited example of this is critiqued by Raford for its compelling presentation, but lack of rigour in creating a design future:

> *Design futures are often at risk of producing visually rich, but analytically impoverished, outputs. Corning, the industrial glass manufacturer responsible for the wildly successful "A Day Made of Glass" videos, is a case in point. Although it is a beautifully made video and a masterpiece of public relations, critics point out that it lacks the most basic considerations of causal relationships and interactive effects. As a piece of film-making, it is engaging. As a piece of scenarios work, however, it falls below the mark.*
> [72, p1(35)]

This is not to say that technical innovation is bad, more that design has a responsibility to explore the many alternative and diverse aspects of human experience. There are alternative strands of design that pursue this and seek to explore alternative values in design, to create new things that contribute to culture and society in more diverse ways. Critical Design, an approach to design pioneered by design studio Dunne and Raby, and first coined as a term by Anthony Dunne in his 1999 book Hertzian Tales [20], describes an approach to design that, "uses speculative design proposals to challenge narrow assumptions, preconceptions and givens about the role products play in everyday life"[19]. This acknowledges that the scope and range of human needs are diverse beyond the desire to achieve tasks, and rejects techno-utopian ideas to pursue the notion of the post-optimal object [19].

Figure 2: Placebo Project, by Dunne and Raby

An early, perhaps formative or archetypical example of critical design is the Placebo Project, by Dunne and Raby. The project explores our relationship to the electronic devices and infrastructures that surround everyday life. They do this by revealing the invisible electromagnetic field emitted by electronic things:

> *We devised and made eight prototype objects to investigate peoples' attitudes to and experiences of electromagnetic fields in the home, and placed them with volunteers. The objects are designed to elicit stories about the secret life of electronic objects -- both factual and imagined. They are purposely diagrammatic and vaguely familiar. They are open-ended enough to prompt stories but not so open as to bewilder. [21]*

The objects that make up the Placebo Project are, technologically speaking, very simple. The table in Figure 2 for example is embedded with simple compasses that, when an electronic device is placed upon it, respond by pointing in different directions as determined by the field, rather than compass direction. They do not utilise advanced technologies to make their point. Instead they are designed in ways that draw attention to a technological condition - the ubiquitous presence of invisible radio waves - in order to enable simple but poetic forms of interaction with these new objects, but also with the existing electronic devices. As such they offer glimpses of new kinds of everyday experience.

Critical Design is a term that describes a very particular approach to critique through design [19] that will not necessarily be adhered to in the design work that informs this research. However, for our purposes it adequately describes ideas of using designed prototypes to critique current products by illuminating or provoking thought around their values. This approach to design is important here as this thesis seeks to question many of the ways that digital and physical things are combined in the design of technologies that support reminiscence and reflection by exploring alternatives values around what those things might be.

3.3.3   Ludic design

Designing for 'Ludic Engagement' was proposed by Gaver et al. [26] in describing an approach to design that investigates, "how technologies for the home could support ludic activities—that is, activities motivated by curiosity, exploration, and reflection rather than externally defined tasks" [26, p.1]. Here, the researchers spotted new opportunities for design in domestic contexts that went beyond the performance of tasks, or even entertainment, and instead acknowledge the home as a place of alternative values. Rather than see these activities as boring, or wasted time, they are often unnoticed, but nonetheless extremely valuable aspects of everyday domestic life that, "can be a mechanism for developing new values and goals, for learning new things, and for achieving new understandings." [26, p.2]

This approach is less overtly critical than the examples described previously, but still offers critiques of prevalent values in that it is a non-affirmative approach to design whose values are starkly different to those we might find on the shelves of our local department store. Instead of gadget-like priorities, they pursue playfulness, intrigue and speculation on the part of the user. This is a softer, but no less compelling, form of critique. Rather than challenge current values directly, it offers alternatives, and explores new possibilities:

> *From a cultural perspective, supporting ludic pursuits may counterbalance tendencies for domestic technologies to portray the home as little more than a site for work, consumption, and relaxation* [26, p.2]

An early example of this Ludic approach to design is Drift Table (Figure 3), developed by Gaver et al as part of the Equator project.

Figure 3: The Drift Table, by the Interaction Research Studio, Goldsmiths

In search of a way to explore their ideas of ludic engagement, the designers were inspired by the technical development of load sensors by one of the project partners. This technical element gave them something to grasp which lead to a set of prototypes, one of which was the Drift Table:

> *The Drift Table is an electronic coffee table that displays slowly moving aerial photography controlled by the distribution of weight on its surface. It was designed to investigate our ideas about how technologies for the home could support ludic activities—that is, activities motivated by curiosity, exploration, and reflection rather than externally defined tasks* [26, p1]

Designing for 'curiosity, exploration, and reflection' requires a certain amount of ambiguity of information, context or relationship.

In order to allow users the cognitive room to interpret the device, and their interactions with it, on a deeper and more personal level, such devices should be "open-ended or ambiguous in terms of their cultural interpretation and the meanings—including personal and ethical ones—people ascribe to them" [26, p.4]. This allows users to think more carefully about how the device fits into their life, and decide what it means to them:

> *By impelling people to interpret situations for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and more personal relations with the meanings offered by those systems.* [24, p.233]

Designing ambiguity into the system looks useful in a number of ways. Firstly, because this thesis involves designing systems for personal reflection, the flexibility for people to interpret them in personal ways and establish 'more personal relations' makes the use of ambiguity of information an extremely useful tool. They are able to perceive and make sense of the technology outside of the practical and cultural constraints embedded in the design, as well as the social or political contexts of the object.

As well as an effective design strategy for user engagement, it is also a useful tool for researchers that offers several advantages:

> *Allowing this ambiguity to be reflected in design has several advantages. Most importantly, it allows designers to engage users with issues without constraining how they respond. In addition, it allows the designer's point of view to be expressed while enabling users of different sociocultural backgrounds to find their own interpretations. Finally, ambiguity can make a virtue out of technical limitations by providing the grounds for people's interpretations to supplement them. [24, p233]*

Flexibility in interpretation seems to be particularly useful in design lead research as it forms a basis on which people can respond more personally and diversely to speculative uses of technology. In doing so may give researchers access to a more diverse set of resultant themes as they can "raise topics for consideration without imposing their views" [25p.2056]. It also encourages participants to keep their mind on their relationship with the technology rather than the device. For instance, in the case of the Drift Table, "We resolved to keep the table simple and restrained, to encourage people to explore the situation it created rather than the mechanisms used to create it." [26, p.6].

Such openness does not imply a lack of design. A prototype designed to be open to interpretation is more complex than one might imagine. Successful ambiguous designs are not "free of any hint about where and how they could be used" [25 p.2056] and still address specific scenarios or situations. Ambiguity in some areas must be matched by clear design and attention to detail in others. In the example of the Drift Table, the designers and researchers report that leaving out certain details that one would assume 'useful' was not easy. This passage demonstrates the difficulty, and intention to detail involved in keeping a design simple:

> We resisted the temptation to add new functionality for several reasons. First, most attempts to make the table more interesting also implied creating a clearer narrative of use, which opposed our notions of open- ended design. Second, many of the proposed

functions seemed too useful, liable to encourage a focus on task performance rather than creative exploration. Others seemed to require focused interaction, whereas we also wanted the table to afford occasional or peripheral engagement. Finally, many proposed functions would make the Drift Table 'seem like a computer'. People would be led to expect a complex set of interaction possibilities, to approach the Drift Table as a utilitarian design, and to focus on interacting with the Drift Table as a computational device. We resolved to keep the table simple and restrained, to encourage people to explore the situation it created rather than the mechanisms used to create it. [26, p6]

There is evidently still fine judgement in balancing the features that will make the design behave in the way you want it to, whether that is open ended or prescribed functionality. Similarly, using ambiguity does not absolve the designer from responsibility for the success of the prototype. One could assume that the ambiguity of a design, and the reflective nature of its analysis mean that no matter what happens, there will be interesting discussion. But, these prototypes can still fail based on the ways that participants engage with prototypes, comparing them to other technologies, accommodate them into their homes, and express insight and reflection.

This approach is an important influence for two reasons. First, its capacity for encouraging deeper engagement and personal or emotional reflection on objects by participant is important to the aspects of this thesis that examine the nature of personal meaningful objects and engagement with memory.

Secondly, the focus on balanced ambiguity involved in this approach is particularly good for use in more exploratory discursive research activities that use discussion as key tool.

3.4 Research Through Design

Now that we have reviewed the design ideologies that inform the design work in this thesis, it is also worth noting that they may often be seen as somewhat incompatible. Critical and Ludic Design in particular have significant differences that make them uncomfortable allies. Deeper than their differing approaches to exploring alternative values mentioned above, they are opposed in their approach to evaluation. On one hand critical design borrows from modes of critique and discourse found in the arts, such as using the gallery as a sight to provoke questions, and discussion among an audience. On the other, it is a highly reflective practice where a significant element of its contribution is to advance design as a practice through developing new thinking and methodologies. Ludic design also has this reflective element, but this is usually based on a combination of the practice of design and people's responses to the prototypes in real life situations. To do this Ludic design uses an ethnographic approach to design, both in the formation of design concepts and in their evaluation. In this approach designers use tools such as cultural probes to gather inspiration for design, or work with

ethnographers, and later deploy technologies with real users, in their homes, or the given context under investigation.

The approach to evaluation in this thesis, as will be described shortly, tends more towards the design ethnography methodologies used in Ludic Design. Because of this, I do not offer critical design as an example to describe a design approach being employed here directly, but one that is more of an ambient influence to my design practice. Indeed, despite your chosen methodology, when discussing design according to alternative values it would be remiss not to mention critical design.

Speculative and Ludic approaches to design, on the other hand, have had a significant impact on HCI research since their introduction, and have consequently come to offer interesting alternative perspectives on the interactions between people and things.

This section will consider how research using these approaches to design works, and how they will be used in this thesis. First though, it will start by looking at what I might mean by design research, and why it is suitable for use in this research.

3.4.1 What is Research Through Design?

Exactly what constitutes research through design, and more particularly the role of creative practice in research is a still a matter of some debate. Some argue this is both reflected in and compounded by the lack of clear terminology to describe it [60]. This amorphous relationship between practice, particularly of the kind discussed so far, and research is perhaps because of the subjective nature of creative practice and anything that we might learn from engagement with its outputs. There is also an 'unknown' element to design practice, and the problems tackled throughout the design process:

> *Problem understanding evolves in parallel with the problem solution, and many components of the design problem cannot be expected to emerge until some attempt has been made at generating solutions. Simon, in what he calls "designing without final goals," wrote that a goal of design may actually be understanding the problem and generating new goals, elaborating that the idea of final goals and a static problem definition is inconsistent with our limited ability to foretell or determine the future.[62 p.57]*

To research peers that are used to a more scientific approach this is often regarded as problematic because it defies many aspects of the scientific method that are considered important such as hypothesis driven investigation, and replication.

So what role can creative practice play in research, where can it contributes, and what form can its contribution take? The following is not intended to clarify this matter on the whole, but instead to state clearly what role design practice plays in the research that makes up this thesis.

To begin we can look to some existing definitions. For example, Niedderer et al [60] define research and researchers as, "systematic inquiry to the end of gaining new knowledge, and a researcher is a person who pursues research" [60, p3]. Creative practice and creative practitioners on the other hand are defined as:

> *Professional practice (in art, design etc.) or to processes usually used in professional and creative practice to produce work for any purpose other than the (deliberate) acquisition of knowledge. 'Practitioner' accordingly refers to anyone who pursues professional /creative practice.* [60, p.3]

These definitions do little to describe what either researchers or creative practitioners actually do, but they place a clear and useful distinction between activity whose sole purpose is the creation of new knowledge, and that in which it might be seen as a by product of creating a piece of creative work.

Koskinen et al. follow this distinction to discuss the ways that the outcomes of creative practice engaged in for research can fit into the creation of knowledge:

> *Design research in which construction — be it product, system, space, or media — takes center place and becomes the key means in constructing knowledge. Typically, this "thing" in the middle is a prototype like iFloor. However, it can be also be a scenario, a mock-up, or just a detailed concept that could be constructed. [46, pp.5-6]*

The notion of 'constructive design research' seems to sit comfortably with Niedderer's definition of research, whilst acknowledging that creative practice can legitimately be a method of conducting research, without compromising the acquisition of knowledge.

This term seems to best describe the approach taken in this thesis where in designed prototypes are used as the "key means in constructing knowledge" [60].

But how do we construct knowledge from a piece of design? Another way to look at the above is to say that In order for design to be a research activity it needs to move beyond refining practice to address theoretical issues and where "Design-based research extends ordinary design activity with the goal of developing generalizable knowledge" [62, p.57].

But, generalising knowledge seems at odds with the nature of design practice:

> *In design practice, the goal is all about creating something non-universal. It is about creating something in the world with a specific purpose, for a specific situation, for a specific client and user, with specific functions and characteristics, and done within a limited time and with limited resources. Design is about the unique, the particular, or even the ultimate particular [82, p.59]*

For Stolterman, design in opposed to science in that where science searches for generalizable truths that can be replicated in any context, design is necessarily concerned with very particular and unique circumstances. This resonates with Obrenovic's assertion that "the design solution evolves over the design process as designers deepen their understanding about the design context and problem." [62 p.57] But, if the peculiarities of a design context mean that, unlike science, design cannot rely on reproducible methods that can be transposed to other contexts [82], how then can knowledge generated in the design of an 'ultimate particular' be of use to others?

To do this design research must produce knowledge that expands "beyond the current design situation, viewing the design problem, solutions, and procedures as instances of more general classes" [62p.57]. While this is where knowledge is generated that is specific to this design context and problem, analysis of what makes this solution successful can also be generalised to form a 'design framework':

> *Design frameworks describe the characteristics that a design solution should have to achieve a particular set of goals in a particular context. In other words, a design framework represents a collection of coherent design guidelines for a particular class of design.* [62 p.57]

The extent to which a framework of recommendations created by a design researcher might apply to other designers is also a complex issue. For Storlterman, "this fundamental idea can be condensed into the notion that designers can be prepared- for-action" [82, p.61] by being immersed in, and engaged with the complexity of a design context, "but not guided-in-action by detailed prescriptive procedures"[82, p.61] that may be entirely inappropriate to deal with a different context.

In order to think in more detail about the kind of knowledge we might generate from research through design, we can compare the production of design frameworks to Höök and Löwgren's idea of Strong Concepts [36]. These offer a form of "intermediate-level knowledge" [36p. 2], positioned somewhere between and Ultimate Particular, or 'Instance' [36] as a specific instance of a response to specific design space, and a generalised theory.

This intermediate-level knowledge is a common output from design research practices [36], perhaps because general theories are of limited use to design practitioners. For Gaver [23] theory and design have a mutually deficient relationship where, "theory underspecifies design, so that practitioners will be faced by innumerable decisions whatever theory they use"[23 p.994], and "theory is underspecified by design, in the sense that many aspects of a successful design will not be captured by a given theory" [23 p.944].

This is not to say that theory is not useful to design, or vice-versa, but that design researchers need to be aware of the ways that they relate to each other best. Here, intermediate-level

knowledge sets a happy medium derived from a relationship between ultimate particulars and theory that can be generative for design [23, 36].

Here we see the importance of specific designed artefacts as instances, where, "the choices made by designers reveal both the issues they think are important, and their beliefs about the right way to address those issues"[23, p944]. But, these philosophical, functional, social and aesthetic values are implicit [23], and so according to Gaver, theory can be used to annotate the design instances in order to articulate those values and therefore make available to other designers and researchers. Here the design artefact takes precedence, rather than serving as an illustration of a theory, while the theoretical annotation serves "to explain and point to features of 'ultimate particulars', the truths of design" [23, p.944].

Importantly, these forms of intermediate-level design knowledge can be generative [23, 36], meaning that it "plays a direct role in the creation of new designs" [36p.2]. To this end Höök and Löwgren introduce the idea of Strong Concepts:

> Strong concepts are design elements abstracted beyond particular instances which have the potential to be appropriated by designers and researchers to extend their repertoires and enable new particular instantiations [36, p.5]

While objects are specific instances only applicable to a specific purpose in a specific context, Strong concepts are formed from selected elements of the artefact or its interaction, be they philosophical, functional, social or aesthetic. These can then "be isolated and abstracted to the level that they are applicable in a whole class of applications, a whole range of use situations, or a whole genre of designs" [36, p. 5]. They are though, more specific than theories, and do not aim to be universally appropriate, but can be added to a designers "repertoire" [73] of methods, processes, and values.

However, it seems that there are different ways that intermediate-level knowledge can be derived from these instances. On one hand we might learn from what people do with an object, such as the ways they interact with it, or their reflective responses to it. On the other, we might learn from the act of designing or making itself.

The former has a strong tradition on HCI research, of which I will describe more later, but even then may present difficulties given the emphasis on interpretation and ambiguity that the design work of this thesis aims towards. This is a question over, "how design and evaluation strategies shift when we abandon the presumption that a specific, authoritative interpretation of the systems we build is necessary, possible or desirable" [76. p.99].

Clearly this has implications upon how the design work in this thesis will be evaluated. While these prototypes might not be evaluated in tradition measures, each can be evaluated against the aims set out in the design space. That is, each prototype can be judged by its ability, or the

efficacy with which it allowed the research question to be investigated, and the values that inform the design space.

However, Obrenovic's assertion that knowledge production is an essential part of the design process, wherein the solution is inseparable from the knowledge produced in achieving it, reminds us that this distinction between knowledge produced in the evaluation of a design, and knowledge produced by doing design also seems troublesome. Because of this we might more easily imagine a combination of approaches where the designers values, and the participants' reflections melt together to form a resource for deriving the intermediate-level knowledge. Further, the prototypes are designed to provoke discussion between researcher and participant about the research themes as experienced through the designed object. As a result, the values of the designer, and the experience of the participant are not easily separable, nor is it meaningful to do so.

The conclusions of this thesis will be based around reflections upon all these modes of inquiry. The methodology of this research will be a process of research through design that uses a mixture of reflective design practice, and reflections from participants. Insight from this mixture of sources will be used to produce intermediate-level knowledge, in the form of a set of Strong Concepts.

The remainder of this chapter will examine in more detail the methods by which this will be achieved.

3.4.2 Research Through Design Methods

There are currently several established ways of approaching research through design practice that set precedents for using designed prototypes to gain knowledge. According to Koskinen et al. these can be broadly categorized into 3 areas; lab, field and Showroom [46].

In lab based research participants are brought into a lab, or other controlled environment, and asked to perform a predetermined set of tasks in using a prototype. Their performance is monitored and measured so that metrics can be gathered from these activities. This approach is well suited to usability studies, or psychology research, but is of little use in more exploratory, discursive research agendas.

In Showroom based research, prototypes are exhibited in a gallery or other public venue where they are exposed to media and public audiences. The main strength of using showroom or gallery based research activities is that you are able to expose the research provocations to a large and diverse number of people. This is suitable for discursive activities that focus on broad concepts such as climate change or the ethical implications of synthetic biology, rather than specific details of interaction.

Field based design research is used in design research in two ways. In the first sense empirical data is gathered from the field in order to inform and inspire design work. Alternatively, designed prototypes are deployed with people in a real word environment, at home for example, where they live with them for a period of time.

This is useful in design research as it represents more of a natural 'everyday' setting for interaction with technology, and allows participants to form more detailed responses through connections and relations established with a prototype over longer periods of time.

For this research, I chose predominantly to conduct design led research in the field. The following will give an overview of the methods used throughout the course of the research, although specific details of how these were conducted will be given alongside project write-ups in the relevant chapters.

3.4.2.1   Exploratory Interviews

To begin the program of research for the thesis, a series of exploratory interviews were conducted. A call for participants was disseminated that invited interested people to bring along objects that they considered to be of emotional significance. At interview they were asked to tell the story of the objects, and then were asked questions about various aspects the story, or aspects of their current use.

These were conducted as an entirely exploratory exercise intended to gather inspiration and empirical examples of ways in which the people related to objects and memory.

Tools like cultural probes were not used, as there was already a focus on precious objects. In other words the research activity was not so open ended at this point that inquiries needed structuring through designed probes, but was instead already focused to the point that a simple discussion seemed appropriate.

Interviews were audio recorded, and analysed for interesting themes. Again this was a relatively informal process because it was not aimed at uncovering trends of interaction with objects, but as a mechanism for uncovering interesting details, thoughts and behaviours. Where possible, objects were brought along to the interview. This was to allow me to see how the participants interacted with the objects during the process of remembering and reflection. To this end, in a couple of cases, where participants were willing, the interviews were video recorded to give a better document of their interaction during the interview. However, some participants were uncomfortable with being filmed.

Objects present at interview were photographed, or if not present, photos were provided by the participants. In hindsight some additional documentation would have useful, such as photographs of where the objects were kept in the home.

These interviews were a good way of informally gathering inspiration for design activities. The lack of strict focus allowed participants to discuss what they felt was important about the objects and express their relationships with them.

In order to derive inspirational details and themes for use in later design work, the interview transcripts were analysed using simple qualitative thematic analysis. Importantly, this was a good way of getting real empirical examples of the ways that people interact with objects they consider meaningful to them. There are many examples available in literature [e.g. 32], but

seeking out my own allowed the collection of cases that are not edited by, or filtered through the interests and agendas of other authors.

3.4.2.2   Design Provocations

Following the exploratory interviews, two studies were undertaken to investigate particular areas of interest from the interviews. For this process, objects were made and presented to the participants. The interaction between objects and participant were prescribed by both the design of the objects, but also the task they were given to undertake with the objects. In this way the objects acted as provocations to frame discussion around the particular topic. During the study itself, the objects were presented to the relevant interview participants, followed by a semi structured interview and further discussions intended again to direct discussion of the objects towards the themes of the study. These interviews and discussions were audio recorded, transcribed and analysed to gather reflections and comments relevant to the research question of each study.

This is a similar approach to a method often used in speculative design and design lead research that involves the use of objects as props to frame discussion around certain topics. Although speculative design practice often makes use of these artistic outlets, it can also be suitably adapted to more personal scales of reflection.

Figure 4: Mimi, one of the Domestic Gubbins, by Superflux

For example, Domestic Gubbins [Figure 4] was a research project and collaboration between the design studio Superflux, and Microsoft Research Cambridge [85]. The project explored ideas of machine intelligence, and how such intelligence might affect domestic life. Once they had arrived at the idea of small intelligent objects, their research approach involved fabricating simple non functioning models of the objects, and using them as the basis for visual materials including photos and films that illustrate the potential scenarios of the objects behaviours:

> *The functions of the Gubbins can never really 'work', hence we built them as props and situated them in an everyday context, to show how they might work and have a certain amount of agency. In this way, we were able to let people imagine how it might be to*

62

live with them, and further, what might intelligence mean in an everyday mundane domestic context. [91]

In order to gain further understanding of the benefits of this approach, I spoke with Superflux directors Anab Jain and Jon Ardern about its advantages and disadvantages[18]. One immediate benefit is that of pragmatically balancing the needs of the research question, and the resources that would be required to make the prototypes:

> Jon: And you also wouldn't know whether it would be successful. You could put a lot of resources into something that...
>
> Anab: It would have cost more money and more time and we would have had to give, we would have had to put in 2 months of, like give the prototype to people, 5 families for 2 months. And then what? But we were, there's a lot of things; what are the research questions? What is the best way to address them? What is an inventive method? What are the responses you want to elicit out of it? It's a whole load of things and I think, its ok to have new method each time, to do that method informed by desired outcome - most appropriate, tailored (designed) to fit the needs of the project.

However, this method has benefits beyond simple resource management:

> Anab: So how do you... so there's an ethnographic design approach where if you go by the strict academic rules, can be very useful, but can be very long and may not necessarily give you the best or most inspiring results. So how do you design from that? That's why Gubbins, because I was in an environment where they were doing more of the academic sort of, while we were interested in ... I mean the question I had to ask was; what is intelligence? And what does 'smart' mean? And if you do that and if you ask those questions you can get into a semantic, discourse for hours with people, and so the idea was that if you design something to get people talking around it, that helps to kind of bring the conversation down to objects and stuff.

In this case, the designed object can act as a lens through which to focus the research question. By positioning a difficult and esoteric question like 'what does smart mean?' in the tangible and relatable experience of an object – by simply providing a compelling example of what smart might mean, there is a greater possibility for meaningful and 'useful' discussion and reaction. This method is extremely useful in addressing esoteric questions, that are more about discussion around broad questions on the implications of an object, rather than specific

---

[18] Superflux are an industry leading design practice specializing in design research strategy and foresight. The interview was conducted on 17.11.2012, at their studio in London.

questions about usability or performance. This process was extremely useful in this stage of the thesis as a means of pushing quite loose, or esoteric empirical inspiration into more specific points for reflection on the nature of the link between objects and memory through particular perceptions and interactions. Doing this with objects allowed these responses to questions to be experientially and empirically rooted rather than purely discursive or reflective which, while interesting, may lead to more ambiguous responses that are difficult to use as the inspiration for design. Instead it allowed more focussed and useful discussions around esoteric questions that might otherwise be difficult to imagine, while at the same time framing these discussions in ways where further inspiration, and more pragmatic tactics for design can be gathered.

However in the case of this thesis, the objects being used as props in this phase were simple objects in themselves, and so could be made 'functional'. Being able to interact with the objects in simple ways prompted the participants to focus in on the research questions in much the same ways as the films were, and engage with more expansive questions that might result. As an example, when discussing their reactions to the prototypes based on the interactions with it, and their knowledge of the experiences and memories from which it was derived, they were better able to imagine more speculative scenarios implicated in the design of the prototypes, that could not be built. This could be about potential systems that might enable their prototype to exist, and whether that would be desirable.

3.4.2.3   In-depth interview

To begin the second phase of research, an in-depth interview was conducted with a participant. Unlike the previous round of interviews that were focussed on relationships with objects, this was intended to gather detailed information about a particular experience, ranging from places, people and objects to emotions and times of day.

This information would form the basis for the design of a bespoke prototype that explores possible relationships between data, their experience and objects.

The interview was conducted face to face at the participant's office – the requested location of the study. This helped gain a sense of the location, and how the prototype might fit into it during the deployment.

The interview was audio recorded, transcribed and analysed for details about the experience that the participant felt were particularly important, such as repeated statements and descriptions of events, and detailed descriptions of places and objects. Because the study revolved around the personal experience of one person, there was considered no need to formally code the interview data, instead interesting passages of the transcription were selected and isolated as resources for design. This was primarily done by hand, printing the transcript onto paper, then cutting out and reorganising interesting snippets in order to form highlights of the account.

3.4.2.4   Field Deployment

Another method used in this thesis was field deployment. This is a method often used in design led research for gathering responses and reactions to prototypes that have been designed to investigate a research question.

Whereas short term engagements which, "are only catching a single snapshot of the many interpretations users may develop across time using the system" [76, p.106], longer-term deployments on the other hand strive to overcome this, by taking place over weeks or months.

> *Users' interpretations of systems can shift substantially over time. Longitudinal studies may therefore also be invaluable in understanding such changes in interpretation.* [76, p.106]

This durational affect on the ways that participants engage with the technology demonstrates the greater depth of reaction and interpretation that a longer-term deployment can provide. The snap shot, is replaced with a much more detailed temporal account. Because of this, longer-term field deployments are seen as a more effective way to address the deeper questions implicated in the design of the prototype:

> *But for high-level interpretation issues, such as "what implications does this system have for how I want to lead life?" it is likely that long-term studies will be necessary in order to formulate comprehensive accounts* [76, p.106]

However, this deeper engagement with prototypes over longer periods of time is not a foregone conclusion. With potential for deeper engagement comes a greater need for the design of the prototype to be executed well. In short, prototypes put into a field deployment are immediately at a disadvantage because "their role as part of a research endeavour also creates a misalignment with the ordinary ways in which technology is made at home" [92, p8]. Whereas a short term provocation allows participants to temporarily suspend their disbelief and consider alternative context that might surround the prototype, the way that a field deployment situates prototypes in a familiar, already established, context over a longer period of time necessitates that the design of it make some effort to become part of that context [92].

> *Furthermore, and insofar as elements of it may be treated as Stuff, its very existence as a device of research as opposed to an ordinary household product means that the Video Window challenges the ordinary ways in which new Stuff is situated in the home environment, is made sense of and accounted for by household members, and is thus incorporated by them into the home.* [92, p5]

Disruption of this context is to some extent valuable. Deploying technologies that subvert values or preconceptions of what an object or technology is, provokes comparison to 'normal' domesticated things and forces a questioning of values and relationships to these things. This is where deeper / unexpected insights come to the fore. As always, however, exploiting this tension requires a delicate balance, and in order for this provocation to succeed, some level of acceptance is required. This can best be achieved through careful, and diligent design of the prototype's aesthetic language and interactional affordances.

Any design led study that requires the prototype to achieve a high level of acceptance and engagement in its deployment is reliant on a certain standard of finish. Of course, the prototype must be technically and materially robust enough to endure the duration of the research period, and all the unpredictable things that people might do with them. But more than that, the design aesthetic and interaction of the device has a strong influence on way that the prototype will be accepted in to its setting, and engaged with by the participants.

Firstly, because "materiality can play a fundamental role in defining the meaning and identity of technological devices"[25 p.2063], the aesthetic of the prototypes reflect the kind of engagement you wish to engender.

Figure 5: The Prayer Companion. Image courtesy of http://www.moma.org/

This idea is well demonstrated by The Prayer Companion [Figure 5], a research prototype developed by the Interaction Research Studio at Goldsmiths [40]. The material design of the device offers implicit clues that affect how the participants read, interpret, and engage with the device. In this case, the device was designed specifically for a very specific context and user group. The design of the Prayer Companion reflects this through both its visual appearance and the ways that its display must be read. Visually the device fits well into its surrounding

environment [25], while being different enough to draw attention. This, combined with its location, ensures that it does not go ignored.

At the same time the device's upturned display requires the reader to bow their head in a prayer like posture, encouraging a contemplative form of engagement that is both familiar to the nuns and that suits the intention of the device. These details are not secondary to the function; indeed both aspects are integral to the success of the prototype:

> *Beyond any direct functional effect on, for instance, readability or obtrusiveness, the way the Prayer Companion fits with the convent's ambience was a significant source of the specificity that encouraged the nuns to interpret it as a resource for prayer. What this suggests is that we separate the functionality and materiality of our prototypes at our peril. By definition, of course, prototypes do not resolve all issues relevant for a final product. Commonly there is a temptation to focus on technical functionality while sidelining materiality to be dealt with later. Our work suggests this may be problematic, however, because materiality can play a fundamental role in defining the meaning and identity of technological devices.* [25 p.2063]

These details of material design are vital to the success of the prototype. Of course, the success of the prototype also has serious consequences for the success of the research study. Acceptance of and engagement with prototypes is a key factor in the success of a deployment [27], and the aesthetic design of the prototype can have significant consequences for this acceptance:

> *Their role in encouraging volunteers to view the devices as potential products and - to a lesser degree - in allowing us to exhibit the prototypes. Here we suggest that the Prayer Companions materiality has been pivotal to its appropriation by the nuns, and thus to highlight this is a worthy subject for empirical research and reflection.* [25 p.2056]

By sharing the language of products – materials, appearance etc. – encourages acceptance, because it lends the device a level of familiarity that gives the participants ways to engage with it and begin to approach it.

3.4.2.5   Diary Study and Follow-up Interview

In order to collect response data for analysis and evaluation of the prototype, the field deployment was accompanied by a diary study, and completed with a follow-up interview. Diary studies are a common HCI method for collecting data in long-term field trials [see for example: 13, 16]. For the diary study, an account was made for the participant on the project website where they could easily write blog entries detailing their reflections and publish to a private blog. This blog is only accessible to members of the website, and was originally intended

to act as a community portal for participants in the project. This was considered to be a suitable approach as it allowed the participant to record and reflect on their thoughts as and when they happened. Because the prototype was designed to act infrequently and unpredictably in a way that reflected the participant's experience, it was considered important that they could reflect on their reactions while 'in the moment'. Otherwise it was considered that they might forget aspects of their reactions after time.

Because the diary blog was accessible by me, via the login, these periodic reflections also acted as a reliable way to gauge the users engagement with the prototype as the study progressed. This theoretically afforded me the ability to adjust the prototype's function and behaviour in order to encourage optimal engagement from the participant.

The third benefit of the online diary study was that the recorded responses to prototype activity could be used as points or discussion in the follow up interview, which expands on 'in the moment' responses to inform more in depth, detailed analysis of the relationship between the prototype and the participant's reactions.

3.4.2.6   Research through Reflective Design

The final way that the designed artefacts will be used to contribute knowledge, and respond to the research question is through the design of the objects itself.

Critical and speculative design practice uses the design process as a reflective tool to learn more about research questions. In creating a scenario, and then having to make the world (or part of it) of that scenario tangible, and believable there are numerous problems to be solved and questions to be answered.

Now, HCI researchers conducting design led research are also coming to regard the act of engaging in the design of prototypes as a method to generate and contribute useful knowledge around a research theme.

By way of example, Sengers and Gaver [76] write about the usefulness of ambiguity as potentially valuable resource for design; an idea and methodological framework they would not have been able to arrive at had they not engaged in the design of such a device. Similarly Odom et al discuss the design of a research prototype, that act of which allowed them to reflect on the details of creating slow technologies, and therefore concept of slow computing:

> *Our experience of implementing (and living with) Photobox highlighted deeper challenges bound to designing and investigating slow technologies—the long time periods implicated in this design space raise complex practical, technical, and methodological issues that are arguably atypical in HCI research when taken as a whole. What new knowledge can we uncover about slow technologies used over longer time periods when we cannot test for or anticipate critical challenges that could, for example, complicate a field deployment study?* [64, p668]

This particular example indicates that a reflective approach to the design of research prototype, and the difficulties encountered therein can allow researchers to imagine and discuss issues that would otherwise not be picked up on. The last sentence of the above passage also hints at the inadequacies of the time scales involved in research studies in investigating slow technologies, and therefore that diligent and reflective design of research technologies might be the only way to tackle, or even become aware of issues that might arise. A point backed up by Obrenovic:

> *Design-based research, however, can produce knowledge that normally could not be generated by isolated analysis or traditional empirical approaches.* [62 p.57]

Until recently reflective design practice as research was not regarded as being able to stand alone in HCI, due to its inability to stand against principles of the scientific method:

> *Design-based research facilitates disciplined, systematic inquiry into a real-world context while simultaneously doing justice to its complexity. It is conducted in messy, but entirely realistic, situations and while it produces claims with less certainty and replicability than other research methods, it can extend our area of inquiry beyond the scope of these methods.* [62 p.57]

However, it strength is in dealing with the complexity of everyday practices and real interactions. And as discussed earlier, research through design, where the act of design creates is particularly effective in producing generative intermediate level knowledge that can lead to new design, and new possibilities in design.

4 Design Rationale

This chapter will provide some background context to underpin the conceptual approach taken in the design work of this thesis. I will present some design work undertaken prior to this PhD in order to clarify the design rationale, and in doing so demonstrate more clearly the motivation behind the research.

The two projects that will be discussed in this chapter, Digital Slide Viewer and Photobox, were designed as part of the Technology Heirlooms[19] research project during an internship at Microsoft Research Cambridge in 2009. They were developed in collaboration with Richard Banks, principal designer in the Socio-Digital Systems group, and several others who will be referenced throughout this chapter.

The Technology Heirlooms research project looked at our ever growing digital personal autobiographical records, and asked what it would be like to own and engage with such an archive over an entire lifetime. How might we search and excavate such a huge and diverse archive in meaningful ways? How might we pass them on to others, or inherit them ourselves? The two prototypes I will discuss here were initially developed as conceptual prototypes that articulated responses to these questions through the design of a physical device, and allowed further thought and discussion about what living with such technologies over a lifetime and beyond might be like.

As discussed in detail in the Literature Review chapter of this thesis, the majority of technology design and research focuses on productivity, and while there are exceptions that concentrate very effectively on values like playfulness, curiosity and reflection few of these directly address ways that remember our pasts through engagement with our digital archives. We would argue that many research projects and studies that do address personal memory do not pay enough attention to these values and instead concentrate on technological experiences.

From a design point of view the projects discussed here seek to apply values found in ludic design approaches [see Section 3.3.3] to the design of technologies that support personal memory, reminiscence and reflection. In particular, they concentrate on values of slowness and reflection, that are beneficial in better supporting the ways that people find value in remembering their past experiences.

These projects have since been used in research studies, or written about by others, all of whom will be referenced throughout this chapter.

---

[19] http://research.microsoft.com/en-us/projects/heirlooms/default.aspx

4.1 Digital Slide Viewer

Figure 6: The Digital Slide Viewer [20]

The Digital Slide Viewer [Figure 6] is a physical memorial of a Flickr account. It provides a physical manifestation of, and interaction with an inherited photographic archive. The prototype is based on research into the ways that people inherit objects from relatives.

> *Imagine you have a relative who uses Flickr for much of their life. One day they pass away. Would you want to inherit their account, with all of its responsibilities, or do you really just want the content to be able to use for reminiscing about the person? I think I might want the latter.*
> *With the Digital Slide Viewer we imagine that I'm able to pay a service to back up that account into a device which can then live on my bookshelf at home. Like a photo album, I can just pull it down and use it to browse through shots of this person's life. Those shots just happened to have originated on a web service. [5]*

We saw that while these heirlooms can be extremely emotionally valuable, they also come with a degree of obligation that can be something of a burden. For instance, if the objects that have been inherited take up a lot of space, they can be difficult to manage in the home. We imagined how this might transfer to someone inheriting tens, or even hundreds of thousand of digital photographs. The obligation to pay subscription fees to online services, or server bills may be unwanted responsibilities. At the same time, in this situation, potentially meaningful photos

---

[20] Image Courtesy of Richard Banks: http://www.richardbanks.com/2010/03/16/techfest-2010-some-technology-heirlooms/

would live hidden away on a server, and if you wanted to print any, you would potentially need to spend a lot of time browsing through photographs.

The Digital Slide Viewer then suggests that instead of inheriting someone's Flickr account, you might actually just want the photos. And the ability to have these in a physical space, without having to have hundreds of thousands of photographs in you attic, or living room, may be a potentially valuable thing. Further, this physical presence, and materiality of the device may help better structure the construction of value around the archive through being integrated into the aesthetic of the home.

4.1.1   Digital Slide Viewer: Prototype

Because the Digital Slide Viewer was designed as a conceptual prototype, it was initially developed with partial functionality, sufficient that it could be demonstrated to researchers and therefore used for discussion and reflection around the research theme. The initial prototype used blank plastic slides to press simple switches within the body of the slide viewer that triggered a small key-ring sized digital slide viewer to scroll through pre loaded photos [Figure 7].
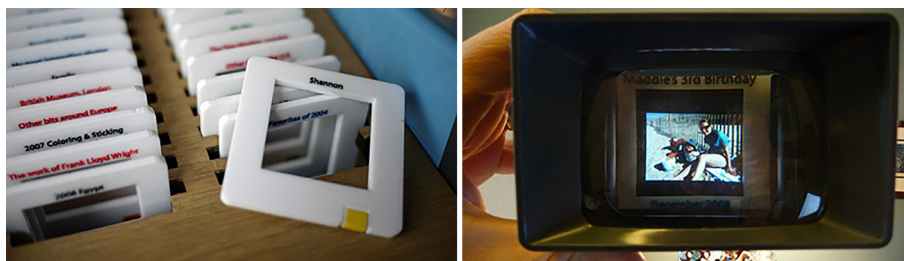

Figure 7: The 'blank' slides stored in the presentation box (left), and an image being shown in the viewer (right)[20]

While this was enough to demonstrate the concept of the slide viewer, the interaction involved in using it did not reflect what we wanted to achieve in the device. Because of this, the second version was later developed by Richard Banks and Nicholas Villar (both of MSRC), using Microsoft's own Gadgeteer prototyping platform. This version embedded coloured tabs into the faces of the plastic slides that could be read by an RGB sensor to pull down associated sets of photographs from a given Flicker account over Wi-Fi. The viewer could then be tilted from side to side to move between photos in a set.

4.1.2   Digital Slide Viewer: Reflections

The primary purpose behind the Digital Slide Viewer was to reintroduce rituals and practices that exist around precious material objects to interactions with personal digital content:

> *The goal of this device is to think of alternatives to the slightly awkward process of showing photos on a PC. It provides an approach that is more elegant than going*

through folder hierarchies on a laptop. It provides a form that is more socially intimate for the act of reminiscing than the current digital methods. [4, P.39]

As such the Digital Slide Viewer uses the legible affordances of physical objects and devices to structure interaction with digital content in a particular way. Affordances encourage a ritual of use that put the user in a frame of mind to engage with the content. For instance, in removing the box from its place of display, and perhaps sitting own with it, the user prepares to engage with the archive. Then they must select slides, taking them form their storage place in the box, and inserting them into the viewer, and in doing so they experience the feel of the slides, and the sounds of placing them into the box and viewer; sensory experiences that apply only to the act of looking at images on the viewer.

This selected set of images can then be scrolled through, before being physically removed, and the slide located back in its box. All this is intended as a mechanism to promote the more emotional and reflective aspects of looking at photos as manifested through deliberate practices based on interactions with particular objects. A slide viewer was chosen as the medium for this because it provided a legible, and somewhat familiar form in which multiple images can be viewed. The form and scale of the viewer also affords individual viewing and private reflection, with its handheld form and small display affording a more private or individual way of looking at content. Similarly, looking at an image on a device dedicated to that purpose, and whose small screen and lens require concentration also encourage focus and reflection on the content. At the same time however, because the slide viewer is a hand held device, it can easily be passed around a group of people. This offers an alternative way of sharing, based on the passing of an object, which opposes the ways that people might usually stand around a screen.

All this plays on the rituals of interaction that allow for the collaboration in construction of value both as a group and individually around the viewing of analogues photographic slides, but in a device that be placed as a visible container of an archive. Similarly, although each slide does not link to a single image they do link to related sets of images. Again, this association of digital things with a physical object that has a physical and ambient presence when not in use potentially has value in affording more reflective interactions through engagement with a tangible and identifiable material device.

4.2 Photobox

Photobox is a wooden box that searches its owners Flickr account every so often, maybe 3-4 times a month, to select a photograph at random and print it out inside the closed lid.

It was designed to explore how more compelling and emotionally valuable aspects of traditional practices of storing and encountering meaningful objects in the home might be applied to digital content.

In particular it was inspired by the serendipitous encounters with the past we can have when searching among things that have been put away, and forgotten about. Many people store things in spare rooms, attics or basements, and these are things that we may not want to throw away, but also do not need, or want to engage with everyday. Perhaps while searching through the attic we may come across a box of old photos, or a childhood toy that we were not expecting to find, and have a moment of reflection as we reminisce on the memories associated with that object. Photobox explores how this mode of discovery, and the aesthetic and value that can result from this interaction, might be applied to the archives of personal photos that we keep online. Digital archives can often serve a similar purpose to the attic, albeit for slightly different reasons. Availability of storage means that digital files can be easily kept out of sight online or on local hard drives at very little cost. Due to the sheer quantity of images that can be kept in this way, and their relative invisibility, digital photo archives have a great opportunity for serendipitous rediscovery of, and engagement with memories of the past experiences. The size of a digital photo collection that spans many years, and the difficulty of looking back through such an archive means that the collection will undoubtedly contain many images that their owner has forgotten about. Another consequence of this is that the original meanings associated with many of those photos may have faded, or become slightly more ambiguous.

Photobox then identifies that there are many opportunities for exploring alternative ways of engaging with these archives that may be better suited to emotionally and personally meaning of its contents. As such Photobox acts differently to many domestic technologies, and its interaction is designed to explore different values in the design of technologies that mediate personally meaningful content:

> *We designed the Photobox to critically explore potential future interactions surrounding domestic technologies aimed at slowing down consumption of digital photos, and supporting experiences of reflection. We wanted to create a technology that might contrast the always-on-and-available qualities of many contemporary domestic consumer devices. We also intended to create a design artifact, which had a form that did not demand attention from its owner(s) nor require active participation to enact its function. [64, p.666]*

This recognizes that many technologies that are produced to mediate our personal content are not designed to support the ways that we might engage with the past through that content, but are more often designed to optimize its organization and recall. Photobox then removes all decision-making and control from this process for the owner, in order to focus attention on their relationship to the content, and the values and meanings it embodies.

In order to examine how this was achieved through the physical and behavioral design on the device the following section will describe the design decisions behind the prototypes interaction in more detail.

4.2.1 Photobox: Prototype

Figure 8: An old wooden writing slope that would become the first Photobox prototype.

Initially created as a partially functioning conceptual prototype, Photobox was first developed to the point that it could be demonstrated. However, its potential to form the basis of an interesting user study meant that I was then asked to develop a further two Photoboxes that could be deployed in households for an extended period of time. These prototypes, including the original were updated with much more robust and reproducible physical design, electronics, and software. While I developed the physical devices and electronic elements, Tim Regan[21], a computer scientist at MSRC, developed the software.

The main body of Photobox is made using an old wooden writing slope [Figure 8]. Usually made in oak, or rosewood, with brass and leather fittings, these are boxes that open up to reveal an inclined surface for writing, and storage for stationary. We bought well used ones with lots of wear and patina to communicate qualities that we might associate with something that inherited or handed down to us over generations of a family. While this choice might seem to prioritize nostalgia over the use of materials more suitable for a technological device, we wanted to exploit cultural affordances to create a prototype that projected a sense of endurance over time, and

---

[21] http://research.microsoft.com/en-us/people/timregan/

that it might contain precious things. These writing slopes, when closed, were also a similar size and shape to a large shoebox – a place where research had shown many people keep collections of photographs [6].

Figure 9: The new interior panels [Left]. The small photo printer hidden in the lid of the box [Right]

To make the Photoboxes, the insides of the writing slopes were removed, and new ones made that maintained the aesthetic of the originals, but that better suited the functionality and aesthetic of Photobox [Figure 9]. These were laser-cut MDF panels that fit in the boxes, and featured the necessary slots and recesses to achieve their functionality. They were then veneered with woods, such as oak, to fit visually with the rest of the box, and to hide wires embedded into the panels. Each Photobox contained a small Bluetooth enabled photo printer [Figure 9]. The small size of the printers allowed them to be discretely hidden within the box behind a wooden panel in the lid, while its Bluetooth connection meant that there were no wires running into the box other than a single power cable. This allows the box itself to look as un-technological as possible. These design decisions were all important in making Photobox something that did not demand too much attention:

> *This choice helped integrate all technology used to print photos into a form that enabled it to be fluidly opened up and put away. This choice was influenced by prior work describing how supporting the range of practices associated with use and non-use of sentimental objects appears central in supporting meaningful interactions with them over time [10]. For example, the occasional ritual use of an heirloom object, and subsequently putting it on display or putting it away. [64, p.667]*

With many valued objects, the ability to not use them is arguably just as important as using them [58]. The ability to not occupy attention is a quality that we wanted to design into the Photoboxes.

Another aspect to these design choices is the lack of control the user has over what the Photobox prints, and when. With this we wanted to see what the affects might be of interacting with a device over which the participant has little control, *"How would people react to a device*

that did not attract nor require the owner's attention to carry out its function and, on that basis, acted very infrequently?" [64, p.667].

This automaticity and randomness was designed as a mechanism to provoke reflection on content, but also on relationships with technology. By disrupting normal usage behaviours that we have learned through the use of archival and review technologies that prioritize more functional aspects of memory, we aimed to find ways of designing interaction qualities that promote more emotional and reflective engagement with content. However, because the user has no control over Photobox, it is important that the device is engaged with at the discretion of the user, not when the device decides it wants to print something.

Another aspect of Photobox's interaction that sought to differentiate it from more commonplace technological interactions was that it only prints pictures out inside the box when the lid is closed. This meant that there were no visual signs that the Photobox was doing anything to attract attention, and so interaction is left entirely up to the impetus of the user.

Figure 10: The magnetic connections in the lid and base of Photobox mean that it can only print when closed. These also connect the printers 'out of paper' light.

This was achieved by effectively turning the lid of the box into the on/off switch for the printer. The box's latch was replaced with a set of magnets, attached by wires embedded in the box's internal panels that connected to the pogo printer's on/off switch [Figure 10]. If the box's lid was opened, the printer tuned off, and so the Photobox could not be left open in order to more easily see when photos were being printed.

However, some small elements of functional interaction were unavoidable. The small size of the printers meant that they could only hold 10 sheets of paper at a time, and despite Photobox's slow rate of printing, it would eventually need replacing. By the same mechanism as above, the printers 'out of paper' light was moved to the front of the box, where the lock would have been, and placed behind an opaque acrylic inlay. When the pogo printer was out paper, this inlay would glow gently.

The reason for printing the photos as opposed to using a screen inside the box was to further exploit the affordances of physical things:

> *To this end, we wanted to use a printer to explore the value of making digital photos*
> *material, particularly in terms of the potential durability a paper print might offer in*
> *contrast to digital files. [64, p.666]*

As well as cultural ideas around value, making a photograph physical forces whoever finds it to decide what to do with it, and in doing so they may think more deeply about what the image may mean to them or others.

Figure 11: Photobox has a hidden internal compartment for storing private photo's

When the participant finds an image, they can take it and place it somewhere around the home, or perhaps throw it away, or it can be placed in a storage compartment found hidden in the base of the box [Figure 11]. This compartment offered a more private, hidden space where photos could be kept, without needing to be visible. Showing an image on a screen does not convey the same sense of presence, or of value, as a physical photograph, and would of course not afford the same ability to be placed around the home.

The Photobox itself has no computational power, but is connected via Bluetooth to a laptop computer also installed in the participants' home. Again this Bluetooth connection meant that there were no wires, so the laptop could effectively be stored separately, within a certain distance, hidden away and forgotten. The laptop ran a custom software application that largely determined the interaction behaviors of the device.

A few times a month, at random intervals, this application searches the participants' Flickr[22] account, and randomly selects a single image that it prints out inside the box. The slow pace and irregularity of activity was deliberately intended:

> *[…] to invert the 'always on, updating and available' qualities of many contemporary consumer electronics. This choice was also influenced by prior work describing how ceding autonomy to a system can open up new opportunities for people to actively create meaningful experiences with digital content [65].*

Similarly, the choice to select random images was deliberately intended to disrupt the preconceptions people might have about technologies that mediate their personal content, and to get them to reflect more on their relationships with such technologies, and more generally their photographic practices and archiving as a whole.

> *We could have curated a special selection of photos from a person's collection to appear in their Photobox over time. However, we selected randomness to introduce an unfamiliar and potentially disruptive machine behavior.*

In this way the photographs are presented without judgment about their emotional or mnemonic value, or a predetermined meaning. The meanings and values that the participant may find in them are entirely up to them in the moment of discovery. In the design approach to this work then, systems making judgment on the importance of content was seen as being at odds with people's ability and desire to create their own value and meaning in photographs and indeed memories.

The following section will briefly describe the user study that was later conducted with Photobox, and go on to discuss some of the finding that relate to the design features detailed above.

4.2.2 Photobox: Study

Will Odom, a PhD student at the HCI Institute, Carnegie Mellon, who was an intern at MSRC around the same time, later conducted the user study. Full details of the study are available in the resulting CHI paper [65], but by way of summary, the three prototypes were deployed in 3 households simultaneously for a period of 14 months [65]. Following existing research on trajectories of appreciation [29], this relatively long study duration was deemed necessary to get a sense of what the Photoboxes would be like to live with over a longer period of time. It was felt that because of the slow pace of interaction, a more typical study duration of 3-4 months would not give sufficient time for the study participants to fully engage with the devices.

---

[22] Flickr is an online Photo archive and community: www.flickr.com

Households were selected based on the size of members' Flickr archives, so as to allow the ideas of randomness and serendipity inherent to Photobox's design to play out [65]. Throughout the deployment, Odom conducted Bi –monthly semi structured interviews [65] to discuss the thoughts and experiences of the participant's time with Photobox.

Over such a long time period there was of course discussion around a great many themes. However, after analyzing the interview data, Odom derived a set of outcomes based around general themes. To inform the rest if this chapter, I have re-analyzed and reinterpreted Odom's findings and themes to more specifically address the role of making the digital physical in supporting interaction with personal memory data.

4.2.2.1 Material Practices

As discussed above, Photobox was designed in reference to various existing material practices that exist around valued objects with the aim of re-introducing some of those practices to people's interaction with their digital photographs. The study showed that this was a valued element of Photobox's design, and that people found value in this materiality in two broad areas.

4.2.2.1.1 Making Photos Physical

Firstly, making the pictures themselves physical prompted the re-emergence of practices that exploited their physicality and ability to be located in place. This allowed people to put photographs in places were they could be seen and discussed with others publicly or privately:

> *The study has also highlighted how making digital photos materially present in the home played an important role in supporting re-visitation and reflection around this personal content. Printing the photos enabled participants to better incorporate material versions of their digital photos into their everyday lives. In some cases, this led to ritualized uses of the print outs (e.g., Heather putting 'good omen' photos under her pillow at night) as well as the re- emergence of prior practices of curating photos in the home (e.g., Tim and Britt's refrigerator). [65, p.8]*

Here, printing the photo affords the possibility to put the images in places around the home, either for personal reflection and memento, or to share with certain people depending on place. It is also notable that the scale of the pictures made them easily shareable. The image print outs were smaller than a traditional photograph, at two by three inches. They were also not of a high image quality. These material qualities meant that the photos could be informally shared, and that the users attention was perhaps more focused on the meaning of the images, rather than its content.

Such located sharing or reflection would not be possible with an image shown digitally. Indeed, as with the Digital Slide Viewer, this materialization offers a more aesthetic alternative to sharing digital photos, which can otherwise be something of an awkward process [4].

4.2.2.1.2   The Archive Made Physical

While the archive may not be made physical in a literal sense, the Photobox is a proxy, or interface that represents and manifests the digital archive. The implications of the box itself being a physical presence is perhaps less striking than that of the images themselves, however it is also made the rest of the interaction with the Photobox possible. In other words, it was vital in giving the photo archive a physical presence in the home, but in a way that was not overbearing, and importantly, was sensitive to the aesthetic of the homes, as well as practices around memory, reflection and sharing. This means that the archive now had a location of its own, rather than sharing one with countless other things on the PC.

> However, as the study progressed, we observed these tensions began to fade across households in different ways. During the final interview, Britt and Tim (H1) reflect on an important decision they made in month six: "Britt: *At first we were excited to show it to people and get the photos. Then, it became kind of a drag because, you know, we want to use it, but we can't do anything. I'd be walking through into the kitchen and be thinking 'When is the next one coming?' ...Then we moved the computer under a [living room] couch. ...That made it [Photobox] less like a focal point in the dining room. ...it became a lot easier to not worry about it but also not forget about it. Tim: Yea after the laptop was gone I didn't have to come and see the little lights on it and wonder what it's doing. ...It eased things up. It became a lot more comfortable for us.*" [65, p6]

The important thing about this ability to have its own location is again it can be placed somewhere that communicates its value, or it can be placed somewhere that it can be forgotten about. This affords it similar properties and interactions to the physical heirlooms and mementos that inspired the design to begin with. There is also a clear link between the object and the meaning of its contents. Unlike that of a general-purpose device, this can lead to a stronger, more direct engagement for the user.

4.2.2.2   *Slowness*

Various findings from Odom's study relate the affects of Photobox's design to the Slow Technology movement. Slow Technology does not necessarily refer to the pace of interaction, although this is undoubtedly a part of it, but rather to design interactions that create space for reflection rather than prioritizing efficiency and moving quickly from task to task.
Odom's study showed that while one effective aspect of Photobox's design in prompting reflection was slowing down the pace of interaction, it was its combination with "layered randomness" [65] that really allowed participants the space for interpreting and reflecting upon the images they received, through both temporal space and ambiguity of meaning. As such the two are discussed together here.

It appeared the combined design choices of slow pacing and layered randomness were effective. Participants could not easily develop expectations about how many photos the device would print each month, when they would print, and what glimpses into their life they might provide. [65, p.8]

Initially, this led to a lot of confusion while participants tried to work out what the Photobox was 'doing', producing some weird and wonderful speculations about its intentions [65]. However later, as they began to accept it, participants began to discuss their interaction with Photobox more in terms of its slowness and randomness. This is exemplified by one participant, when they describe their early reactions to Photobox:

Britt-H1 reflects on her experience during this period of the study: "It's this new thing here [points to dining room]. It looks interesting, kind of antique. It's lovely. And, the photos it's popping out, we haven't seen most of them in so long. ...it's intriguing when we get one. But, it does make me want to have another one and another one. ...I guess I don't mind too much not being able to push a button and make it pop another one out. I am peeking in on it all the time. Sometimes there won't be one for a week! Or longer!" [65, p.5]

Another participant describes how the pace, and randomness combined to make them feel variously tense and excited:

Samuel (H3) reflects on his experience in month four: "At the time I think I didn't even realize how many images wash over me everyday. I'm so used to seeing photos on the internet, just clicking through them rapid fire [makes rapid clicking sound], it became hard to wait. ...When it did [print] I'd get excited but also well I'd get kind of tense. I'd be like 'When's the next one coming? What's it gonna be? When should I look next? Why is it doing this to me?!" [65, p5]

These emotions stem largely from that fact that Photobox behaves unlike any technology that the participants were used to. They therefore have expectations of what a technology should be like that Photobox does not fulfill. However, after time the participants began to see the value in this kind of interaction. Here, the same participant discusses the way that the randomness allowed him to enjoy meaningful encounters with images:

Samuel later compared his experiences with the Photobox and his photo albums: "I think I started to understand why it didn't print many [photos]. ...Made them more special but also more easy to take in, in passing. ...[It's] kinda similar and kinda different to [looking at] a photo album. ...With [my photo albums], I have to make time and get

absorbed in them. I get a lot out of it. But, realistically I don't do it much. ...The box created that same sort of feeling but without having to prepare to get too deep. I could look in, think for a minute then go about my day. ...since I never knew what was coming, there's no way I could prepare and now that I think about it, that's one reason it kept being exciting. ...It has certainly reinvigorated my [Flickr] account." [65, P5]

As well as provoking reflection on the meanings of the images, photobox prompted people to think more deeply about their photographic practices. These encounters with random images made them think about what they took photos of, and how they were using their archives. Beyond this, it also prompted participants to reflection on their relationship with technology more generally. The unusual and disruptive interactions engendered by Photobox caused them to think about issues of control, and the 'always on' nature if most technologies.

These reflections are all related. While the slowness and randomness of the Photobox often meant that people were initially frustrated that they could not choose what was printed, and when, they eventually 'understood' Photobox. In this understanding they reframed their relationship with the images, and the device, and ultimately began to experience the "enjoyment that can emerge if control is ceded to the system in a meaningful way" [65, p8]

Odom describes how one household experience this shift in perception:

> *Samuel describes how returning from a two week vacation in month seven caused him to critically rethink his perspective: "The surprise of getting a photo was great but I had this, I don't know, sense that I should have some ability to make it print. ...Sometimes I'd have these thoughts like why am I not telling it when to? I guess it's what I'm used to doing. ...When we got back [from vacation]. ...I opened it up and found three photos, one was of a different trip, [from] back when we first met. That's when I felt like I 'got it.' It's going to do its thing. It can take care of itself. That way of thinking about it changed things for me. I don't have other things that do stuff on their own. From then on, it started to take on a personality. It's independent and takes its time, but it's going to print something for me."* [65, p6]

Here the participant recognizes that the device will 'do its thing' and begins to recognize that there is value in this lack of direct control. This is echoed by another case:

> *Somewhat similarly, Heather (H2) discusses how her perception of Photobox as a "technology" had to change before it could be completely integrated into her life: "Even though it's using a laptop and getting on my Flickr, I had to let go of any idea that it's like our other gadgets. ...[laughs] it's not too typical that I have to wait for technology. That took time to get used to. Zack: But it's also not asking you for anything. Heather:*

Yes you're exactly right and I think that's one reason why it's cool. ...why I want to keep it." [65, p6]

Generally we can see that the elements of Photobox's interaction that were intended to create emotionally meaningful interactions with personal autobiographical content also, in being antithetical to what one might expect of a technology, caused the participants to reflect upon their more general technological practices, values and relationships.

Collectively, these reflections help illustrate how the Photobox provoked some participants to critically consider the role of technology in their everyday lives and, in Heather's case, make a subtle change to her routine. They also highlight how participants, such as Samuel and Britt, drew on experiences and metaphors in which digital technology was conspicuously absent to describe their interactions with and perceptions of Photobox. [65, p9]

These reflections demonstrate the value that can be found in these kinds of interactions, and also the effects of the kind of reflections and reactions such a disruptive technology provoked from them.
However, this is a very difficult set of relations to design for, and people's dominant practices and perceptions cannot simply be disrupted without returning some value if these kinds of values are to take hold in the design of future technologies.

4.3 Conclusion: Re-experiencing the Past

Describing these projects was intended to demonstrate some of the motivations behind this research, and to offer examples where the design work could be related to the research findings in detail. This helped to discuss peoples responses to living with technologies in terms of specific elements of the prototype's design, and therefore to understand the affects of different affordances, constraints and interactions. Several themes derived from the study of these prototypes, and consequent reflection upon their design, were carried forward as starting points for the design work. However, these projects also motivated to some extent the move away from using personal photographs as the subject matter.
As well as presenting people's photographs (personal autobiographical data) directly for reflection, the prototypes described in this chapter made use of materiality and slowness to encourage deeper reflection on the past, beyond the scope of the content itself. This is different to how people might normally reflect through a technology, most of which tend to prioritize the direct presentation of content. In part the conditions that encourage this were created by the slow interaction and randomness designed into Photobox's interaction. Slowness and randomness made Photobox's function and meaning ambiguous, which prompted users to

reflect on the meanings of the photographs, and their significance. In particular, these create opportunity for the participants to reflect on the content, and its appearance in this time and place, in relation to their current identity, needs and values of the user.

At the same time, the physicality of both the digital Slide Viewer, and Photobox provide more of an 'experience' of looking back than just the provision of information about the past. The physicality and materiality of the devices become integral to the aesthetic experience of reflection and remembering, and work to help users engage in particular ways. Fundamentally then, this is not just about designing systems to help people view information about their past, but to investigate ways of structuring interaction with that data through material such that it provides a much more aesthetic and experiential interaction that evokes the past more fundamentally. Achieving this is of course extremely complex, and these projects show that there are many factors in the design of such technologies aside from the data itself that are also extremely important in determining the effectiveness. My argument states that these factors are largely underexplored, and so this thesis will contribute to existing research by examining these material interactions more closely. The remainder of this conclusion will describe the key factors that will be taken forward, and that form the basis of the design approach of this research.

4.3.1   Physical Manifestation of Digital Data

The experiential benefits of making digital things material was a significant lesson learned from these projects. Materiality affords the ability to be located in space in ways that allow the construction and communication of value, both privately and communally. It also affords a presence that makes it both available for attention, but that can also be hidden from attention, allowing for a variety of intensities of interaction.

Data manifested physically also has more opportunity for Sensory (e.g. the slides in slide viewer) engagement than traditional visual displays. Of course these may not be as effective in communicating detailed information, but for the more subtle and emotional purpose of this thesis, these may make for interesting interactions.

Designing these affordances for digital things, by giving some means of physical manifestation has great potential for rich interactions, especially with personal autobiographical digital content. However, it is not as simple as simply making something physical. As discussed in the literature review, there are many current and recent research initiatives that investigate ways of making the digital physical, but many neglect very important aspects of materiality. Once something is made physical it becomes an object, and as such it both creates, and is subject to material practices and culture. Many research and design project stop at the point where the data is made physical, and do not consider the life of the objects after it is made.

There are two particularly important aspects of this, that will be described below, and that inform the design rationale of this research.

4.3.1.1 Material Practices

With both the Digital Slide Viewer and Photobox, we saw that giving digital images a physical form gave them a presence in the home that allowed for the reemergence of material practices. With the Digital Slide Viewer, these practices involved what we might refer to as the 'ritual' of reviewing content, where this ritual is a materially informed process of preparing, both privately, or communally, to engage with the past. The slide viewer does this by leveraging the affordances and constraints of an analogue slide viewer. The ways in which particular curated sets of content (photo sets) are associated to specific physical objects (the slides) means that they must be physical managed, and manipulated in certain ways as defined by their function. Similarly the form of the viewer, with its small screen and lens affords both private viewing and concentration o the image and there fore its content and meaning, but also has the ability to be handed around.

Photobox on the other hand saw the reemergence of forms of sharing photographs that are only possible with a printed image. The ways that people to could place, or hide these images in certain places where certain people would find them creates a very different form of sharing than emailing a photo to a friend, for example. In the case of the former, the recipients experience of discovering the images, and is enhanced by its location. Other participants hid photographs in locations that were private or meaningful to them, where they could be encountered without the need for a premeditated, or distracted session on the computer.

It is also notable that the different physical forms of the images in each project afforded different material practices. This shows that these practices need to be designed for carefully, and that simply making physical representations of data is not enough to position them within material practices or cultures.

If it is to be successful, the design work of this thesis will have to pay careful consideration to meaningful material practices that relate to the experiences described by the data, and that add value to the act of reflection and reminiscence.

4.3.1.2 Aesthetic and Experience

Another important aspect of the way that the digital is made physical is the aesthetic experience of the resulting artifact. In the literature review [2.5.1.2], I discussed how the aesthetic of the home, and by extension any context in which design is to be placed, is extremely important. Many research projects that seek to design new technologies either ignore, or do not pay sufficient attention to this aesthetic and instead produce prototypes that do not sufficiently integrate or engage their participants [99]. This does not just mean the that the prototype should be visually styled to suite a home, although that is part of it, but that its interaction, and the experience of using or living with it, should fit as far as possible into the home's aesthetic, as constructed by the relations between people and things.

The interactions that result from the materiality of the photographs, the materiality of the devices and their behaviours in these cases are derived from research into the ways that people organize

meaningful things in the home. As a result they fit with the aesthetic of the home, and allowed for the prototype to be integrated into people behaviours and social relations. This is not to say that the device will be seamlessly assimilated. Any new technology would, and arguably should, be disruptive, but I would argue that in order to be disruptive in any meaningful way, the prototype must be part of the contextual aesthetic.

There is another aspect to the aesthetic experience of interaction with technologies that support memory. As well as paying attention to the domestic aesthetic, designers of these technologies need to pay attention to the experiential aesthetics of looking back at the past, whether that's intimate sharing with those close to us, or serendipitous discovery. A large part of this means adhering to non-technological values which as we have seen with the projects shown hear, means creating temporal and cognitive space for people to reflect on the past when reviewing data, but also paying attention to the ways in which people find value in looking back, and being sensitive to appropriate opportunities to engage with the past.

Although Photobox and the Digital Slide Viewer did not address or reveal this directly, we might also extrapolate that the aesthetic of the event being remembered is also important. How a device might be designed to t reflect the values inherent in the data being remembered on, and consequently the event they represent, while allowing space for the reformulation and reflection is a very interesting design space that should be carried forward for investigation.

4.3.2   Slowness

In the Photobox study, we saw that slow paces of interaction and randomness simultaneously helped to disrupt peoples predominant expectations of technology being always available and controllable, and allowed space from interpretation through ambiguity of meaning, in order to create new forms of value not previously experienced in interaction with digital technologies. These ideas will be taken forward to investigate in more detail how frequency, and mode of interaction relate to each other, and how these affect the aesthetic experience of engagement with autobiographical data.

4.3.2.1   Living with things over time

Living with things for long periods of time creates very different relationships between people and objects than with things that are more quickly discarded. This engagement over long time periods is part of what allows stories and memories to be associated with the objects, and can (but does not necessarily) increase their value. However, designing for this kind of temporal engagement requires a very different approach to designing their interaction.

The research that informed the design work discussed above showed that material things are good at supporting this long-term engagement. Materializing digital autobiographical data then arguably allows for more temporal forms of engagement, by allowing things to occupy space over long periods of time. However, this has consequences for how we design the interactions of the technologies that mediate this process. As mentioned, physical objects occupy, at various

times, varying positions in the ecology of objects situated within a context. As such they demand varying amount of attention at various times. The ability to be interacted with directly, but also to fade into the background of our attention is an extremely important aspect of their value, and power as things. Digital technologies are not always sensitive to this, and often draw attention to them selves by demanding interaction, or by needing direct interaction to function. At the same time however, by virtue of being digital, or rather not physically present in space, they can be quickly ignored. Were they physical, this might not be the case, and a system with physical presence that demands the same level of attention would be extremely intrusive. As such if we are to design ways of making the digital things physical, they need to be able to fade into the background of attention.

Any digital systems that supports reminiscence and reflection should therefore pay attention to the ways that people interact with physical objects not just in the moment of interaction, but over time, including when they are not being directly used or paid attention.

4.3.2.2 Randomness and Control

As well as acting infrequently, Photobox printed photographs randomly. This randomness was double layered in that it printed randomly selected photographs, but also at random time intervals. The study participants had no control over what was printed and when. Odom et al found that this was a valuable mechanism in prompting users to reflect on both the meanings of the content, and their present circumstances. In trying to work out why this photograph had been printed now, or why it followed the previous one, they reflected on the memories of the past, but also their current values. This reflection was accompanied somewhat by an anticipation for what might come next, which was again a reflective mechanism as well as one of looking forward.

This surrender of control to the system is an interesting tool in designing technologies that support reflection, and one that fits well with the aesthetics of remembering through objects, and so would be another interesting design approach to carry forward.

4.4 Summary

Listed above in section 4.3 are the key design considerations that should be applied, and taken forward for further investigation onto the rest of the thesis. *Physical Manifestation of Digital Data*, is one of the main drivers of this thesis, and the forthcoming design work will focus on making biographical data physical, and the benefits that this might have for the technologies that mediate our experiences of remembering. In particular though, the forthcoming design and research will focus on how this might be done effectively. Making the digital physical in meaningful ways is not a simple exercise, and so the analysis offered above provides some broad principles that can be used to negotiate the design of such systems.

Slowness, *Material Practices*, *Aesthetic and Experience*, *Living with Things over Time*, and

Randomness and Control, are based on ways that research has shown people engage
meaningfully with physical objects. They then offer examples, and possibilities for applying these
to the design of digital systems without losing the benefits of either physical or digital.

5 Material and Memory

5.1 Introduction

This chapter gives details of the first empirical investigation of this thesis, and comprises reports of exploratory interviews followed by two design responses. The purpose of these investigations was to gain empirical insight into ways that people connect memories with objects, and then to explore these further by creating prototypes that ask questions about particular aspects of these relationships. These activities were conducted in order to gather inspiration and insight with which to develop another, more in depth design investigation.

While the design space as expressed in this literature review is concerned with how we design meaningful interactions with digital data through physical objects, the work that makes up this first chapter leaves data to one side. This purpose of this is to concentrate on the relationships between objects and the memories associated to them, and to therefore build a detailed understanding of how meaning, memory and narrative are associated with, and accessed through material objects. This understanding will form the basis of later activities that will start to integrate data into these relations in more aesthetically appropriate ways.

The first activity was a series of exploratory interviews wherein participants were asked to bring and discuss objects that they considered to be personally meaningful. This was used to gather empirical examples of the ways that people connect memories and objects, or more accurately, the relationships between people, objects and a memory. A few examples of these interviews will be presented in this chapter. Although not all of these would go on to be directly involved in the rest of this chapter, their inclusion here will give an idea of the kinds of themes that informed the design direction of this thesis.

The next stage was to develop two design-led investigations that took themes from the exploratory interviews and investigated them more deeply. The objects and interviews chosen for design response were considered to exemplify most strongly the themes taken from the interviews.

These investigations will be presented separately. The first, 'The Poker Chip', is an investigation of the way that the object in question - and replacement of the original object from the story - is able to link to a memory in part through its tactile similarity, and in part through its implication in a personal relationship. It will start by discussing these themes, and then give details of the design work involved in creating the investigative 'props' and the investigation that they were used in. Finally it will give the finding and implications of the investigation, and formulate directions for further inquiry.

The second design response, 'The Bowl', is an exercise in research by reflective design[23] that uses designed objects as props to think about the role of the signs of wear that are maintained in the materiality of objects, particularly where they are relatable directly to memories and experiences. The investigation looks at how these signs and affordances of memory are both the result of, and situated in, action. As such it seeks to explore not only material characteristics but also the potential of the actions that create them to be evocative. Again, this section will start with a discussion of the themes that make up the design space, before giving details of the design work involved in creating the props and how they helped address the research question. It will then go on to discuss the observations and reflections that resulted form this exercise. Finally, this chapter will conclude with a discussion of all the observations from all three research activities. The conclusion will also identify further avenues for work by beginning to consider what role digital artefact and data might have in these object / human / experience relationships.

5.2 The Interviews

To begin the research process for this first set of design led investigations, a series of exploratory interviews were conducted. The purpose of these was to find empirical examples of objects that people considered meaningful, and to see how these objects connected to memory. Although such examples are well covered in literature [See for example: 32, 93], gathering them for myself was a good opportunity to see first hand the way people respond to objects while they remember and tell stories. It was also a good way to gather examples that are not filtered through the interests of others' research, allowing me to ask specific questions and guide discussion of the artifacts.

To recruit volunteers, a call for participants was circulated on email lists and using social media. The call asked:

I am a PhD student at Nottingham University's Mixed Reality Lab and Horizon DTC. As part of my research into the relationships between our personal memories and our possessions, I would like to speak to people about the objects they own that hold particular significance.

If you would like to participate you will be asked to select between 1 and 3 objects (or sets of related objects, like a collection) that fit one or all the following criteria:

1 - Something given to you by someone else

2 - Something that would like to pass on to someone else

3 - Something that represents a shared memory (but that doesn't fit either of the above)

An 'object' can be anything from toys and ornaments to photos, songs and bits of text, physical or digital. The interview will be recorded, but very informal, and although you

---

[23] See Methodology chapter

will need to provide your reasons for selecting each object, you will not be required to disclose any private information, anecdotal or otherwise, unless you are comfortable to do so. Ideally I would like to see these objects in the place where they are normally kept (at home, work or wherever), and to take photos of them in-situ. However if it is more convenient you could bring them to another location, or provide photos.

All information you provide will be completely anonymised, and only used for public display following provision of consent

The three Options were provided partly as a way for people to think about what a 'meaningful object' might mean, and to aid their selection process. Based on conversations leading up to the issue of this call it was apparent that the idea of a meaningful object could often seem quite obtuse to people, making it difficult to choose objects. At the same time, these selection criteria were a mechanism to get exposure to different ways that objects can become meaningful as determined by the literature, such as those that represent personal relationships.
There were seven respondents in total, each of whom bought between one and three objects.
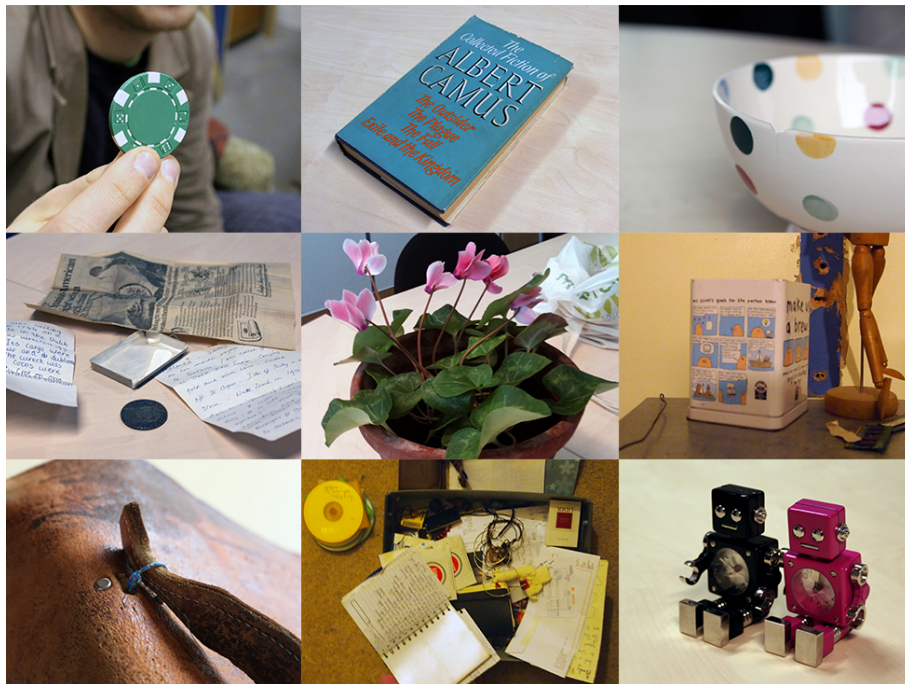

Figure 12: Some of the objects from the exploratory interviews

As can be seen in Figure 12, the objects brought along were diverse, ranging from new to old, made of all sorts of materials and dimensions, and comprised both individual items and collections.

Interviews generally lasted from 30 minutes to an hour. Participants were invited to tell the story behind their object, and were then asked a combination of a standard, and case specific questions. These questions, such as "where do you keep it?" and "how often do you look at it, or use it?" were intended to gather more information about the participants' interaction with the object. Interviews were audio recorded, and later transcribed for analysis. Some interviews were also video recorded as a way to better document people's physical interactions with the objects while they remembered and told their stories. However, not all participants were comfortable with being filmed.

Interviews were analyzed thematically for interesting themes that might provide good opportunities for future design work, and that were not already well covered by literature or existing work.

This chapter will not cover all the interviews and objects, but will offer a set of vignettes of those that helped inform the direction of the coming design work.

5.2.1 Interview 1: The poker Chip

Figure 13: The Poker Chip

During a trip to New York, the participant had been particularly excited to visit a jazz club that, despite ill health, he managed to find the evening before returning home. Upon paying entry to the club he was given two poker chips to be used as drinks tokens at the bar. Due to feeling unwell he opted to keep the second chip as a souvenir. Interestingly though, the chip in the interview was not the chip from this story, but a replacement:

But anyway, so I got this chip and I kept it, and then I had my wallet stolen. Erm, and I got it back but it didn't have the chip in it, so er, so when my girlfriend went back a couple of years ago to New York, erm, I couldn't go, but yeah she went back and I asked her to go and er, try and find the place and to see if she could get me a replacement. And she actually, she managed to, she managed to track it down, and they'd stopped the whole chip thing quite a long time ago, at that point 'cause this was like three years after I'd been. And erm, but they went like out behind the bar and dug out a box with some of the old chips in.

This replacement object (Figure 13) then not only takes the place of another object in a story, but also brings with it a new layer of meaning through the girlfriend's retrieval of another chip, from the same place, having gone on a similar journey.

Erm, but yeah, no I really like, I treasure it because, erm because it has a kind of narrative attached to it I think. And it's also a memory of this really nice place that I went to. Erm, and that I really enjoyed despite being, like, full of snot and really not very happy in general. And, er, and then yeah, like the fact that, I lost it I was really gutted, but then to get a replacement was, y'know it still has like, quite a strong like, signification to me so yeah I suppose in that respect the, definitely the y'know, the losing it and sort of, having it replaced has added to its relevance I suppose.

This layering of meaning through the additional narrative and involvement in a social relationship, becomes an important aspect of the memory, and through the replacement object, the two narratives are combined.
Considering the way that one object can stand in for another, it is interesting to compare the materiality of the two chips:

Like the other one, the first one that I had [picks up chip from table] was, looked exactly the same, but it was black and white not green and white and it had the, it had the club name printed on it. But other than that it's identical, like physically, to the sort of shape and size. And the design with like the dice, erm, like images of the sides of dice on, around the edge.
...Erm, like the last one had like, their logo on it: [picks up chip and examines it], and their web address and things, like on one side, and their actual address, so I did quite like that it was, that was why I kept it the first time around was because it wasn't just a chip it was a nice thing and it had a particular connection to that place because it had like, their logo and all the rest of it on. And, whereas, like this one only has that connection to the place because I remember the first one. And yeah because it has this other, like story attached to it. I don't think, if they'd have given me that [shows chip in

> *his hand] I probably wouldn't have kept it. Erm, I'd have just had another whiskey instead. 'Cause yeah, it's just, y'know it's just a chip, even though it's quite a nice chip, it's ... it is just a chip so...*

The first chip's materiality was an influential factor in it being retained as a souvenir, but the participant clearly states if they had originally been given the replacement chip they would likely not have opted to keep it because it did not have any special features related to the place. Clearly then, the replacement chip connects to the original story only because it replaces, and therefore refers to the original. Being a mass-produced object, they are materially identical, despite their visual differences. What role then does physicality of the replacement chip play in this association?

> *I think, erm ... yeah it has more of a, it's quite a tactile object as well I think. Y'know cause it's ... it has some, like grooves in it, and y'know has a few wear marks and things, um, and it has quite a nice weight to it as well.*
> *Erm, it is quite a tactile thing, and I think that's probably one of the reasons why I kept it in the first place.*

The objects tactility is clearly something that the participant values, and as suggested earlier this is a characteristic that forms part of the connection to the previous lost chip. This is exemplified again by the fact that the participant keeps the chip in a place where he is likely to stumble across it occasionally:

> *And also it's quite nice that every now and then, y'know like I'll go through to find some money or a card or whatever and, like find it, and have that little remembrance of it and. Y'know, it's quite nice I suppose.*
> *Yeah I think like if it, if I had put it in a draw or a box somewhere, I, that I'd just never get it out because [shrugs], yeah like, if I wanted...if I actively wanted to remember it, I'd just remember it and I wouldn't necessarily need to get it out the box to look at it. But, yeah, like having somewhere where I sort of incidentally, kind of stumble across it.*

In 'stumbling across it', he is confronted with the object's tactility, rather than engaging with it first on a visual basis.
The way that this replacement poker chip and its tactility link to memory represents an interesting angle for a design led investigation into the link between objects and memory. On one hand it is a new object, with its own associated narrative. On the other hand though it is a physical reference to another object, and as such refers to the memory associated to that other while augmenting it with its new meaning, creating an amalgam of objects and narratives.

5.2.2 Interview 2: The Bowl

Figure 14: The chipped cereal bowl

The cereal bowl was given to the participant by his partner, and again stood out because of the strong importance of tactility in its emotional value. On a general level, the shape and weight are distinctive and memorable to the participant. These characteristics contribute to his desire to use and engage with the object:

> *I'm always, I mean not consciously, but I'm always aware of it. And it's kind of, its a very kind of big and round bowl, y'know it fits nicely in your hand and so on, and its kind of stable on the base and so just the kind of qualities of it seem to have y'know, it has that connection as I use it.*

There are also instances of more specific tactile connections between material characteristics and events that symbolize familial relations.

> *Yeah I use it every day which is how, erm, how it gets to have this chip in it which I kind of, and a little crack which I kind of quite like because that came, erm, came from - we were at a music festival actually and it was pretty much the first time that Fiona, my partner had been erm around with my kids. And of course there's all sorts of y'know, tensions to figure out there and erm, and it sort of got broken as Sammy and I were sorting the kind of washing up in the camper van and so it just kind of y'know kind of represents just a little bit of that complexity in life.*

In this case, the material characteristic is both directly created by and representative of social relationships and tensions.

While the damage inflicted on the bowl would usually be seen as a negative, in this case it is a valued reminder of a significant episode in a persons life.

Despite the damage, was still very much a functional object, and in fact derives much of its value from this fact.

> *No, I, I'm pretty sure not. Erm, when that chipped, y'know I was, it had an impact but I was just kind of- that's just life. Y'know I would rather, 'cause there isn't really much choice. I would rather use it and y'know have it exposed to that risk of getting broken as crockery sometimes does, er, than. Because If I were to go and lock it away, then y'know, it loses its meaning almost, because ... Yeah, I mean it would just be a sort of abstract thing, erm. Yeah, just like the relationship to it would be less alive I suppose.*

This notion of the relationship with the object being 'less alive' if it were not in use shows an interesting combination of its importance as a functional item, its tactile value which can be experienced through use, and the performance of engagement with meaning provided by using the bowl on a daily basis. Its value is in its everydayness. The characteristics that encourage the participant's engagement with the object therefore maintain the object's perceived emotional value through regular use.

Despite this, the bowl is not considered indispensible, although the participant admits that disposing of it would be regrettable:

> *Yeah, erm, and y'know, if it should break then it would break and it would just then become a bit of broken crockery it would go in the bin. But, y'know, I hope it doesn't for a while.*

The consideration that it would be disposed of comes from the objects everyday functionality. If it can't function, and cannot be engaged with everyday the relationship with it is, as the participant says, 'less alive', so why keep it?

5.2.3 Interview 3: The Frisbee

The subject of this interview is a Frisbee, retained from the participant's days playing for the university team. It is also another example of a replacement object.

> *So, it's slightly complex in that, the original Frisbee I had came out of the Oxford v Cambridge varsity match in 1999, looked identical to this one, and I think, I just got given that after the match, 'cause I think I scored the most points in the match or*

something so I got the match Frisbee, so lots of good memories with that one of,
y'know playing in that match.
But that one actually, I think we were playing on Jesus Green in Cambridge one
December and it was so cold that actually it snapped in half when we threw it, the cold
had just got to it. So I bought this one, but in my mind it's almost the same thing
because it looks identical and, the second one was definitely bought as a replacement
for the first one for the memories to kind of get attached to it.

Like the poker chip, the Frisbee is also a direct replacement of a meaningful object and in it's intention as a replacement and material similarity, a meaningful thing. Here the familiarity of the form and the satisfaction gained from it are significant to the participant:

Erm, and part of the, part of this is just the feel of it as well. So you have, I guess the
competition Frisbee and stuff, y'know a very specific weight and shape. So y'know
every one I've ever played with in a match is this size and this shape, so it just kind of
falls into your hands in a natural way and, kind of, all the kind of ways you hold it just
come very naturally. And probably, I once worked out at one point that I probably spent
a thousand hours playing ultimate Frisbee over, over four years, I must have thrown this
tens-of-thousands of times, so it's that kind of, what I really like about this is that [grips
Frisbee] tactile.

Here too, the replacement object brings it own set of meanings and associations that blend with those of its predecessor:

And then also, again it's been very much, like, played with by lots of people. And it got
stuck up a tree in Newhall College once, and I had to borrow a ladder to go and get it
down, so I guess that's, yeah and it was very, I just had an amazing time for three years.
And it was my kind of, y'know I trained four times a week and pretty much spent every
day with that team, so it just, I guess it represents all the good memories of that time.

As with many objects of reflection, it's functionality it key to its mnemonic value and emotional meaning:

It gets used very regularly. Yeah, so it's not a kind of, it's not a museum piece at all it's,
y'know if it breaks one day then it breaks. Yeah it's very much used and dug out during
the summer to play with.

This emphasis on functionality means that the object's meaning is also tied into the action of its use:

Yeah it's one of those things that I did so intensely that it just becomes a kind of motor memory really. So I can still, y'know if I go and throw a Frisbee in a park I can still throw backhands, because it just becomes part, part of your motor memory really.

The gestures and movements that the user must perform to throw the frisbee are in themselves mnemonic actions. The motor memory is tied up with the autobiographical memory, and te object is the thing that links them.

5.2.4 Interview Discussion

Each of these interviews featured objects whose tactility was an important aspect of the objects meaning, and link to the memories it was embroiled within. As well as their visual characteristics, the materiality of these objects - texture, weight and shape - are important aspects of the ways that we engage with the stories they embody.

Some interviews featured objects that were replacements of the original artefact from the story. In these cases the object's apparent lack of authenticity, or originality, does not dilute the mnemonic association in any way, but instead add new layers of meaning and complexity to the objects story, and therefore the owner's memory of the event.

The poker chip discussed in the first interview was visually different than the object it replaced, but the owner commented on its tactile similarity, framing encounters with the object as predominantly tactile. The material characteristics of the objects connected the participant to a valued memory, whilst adding new value by representing additional meanings and relationships. The Frisbee was also a replacement for an original that in this case was damaged to the point whereby it could no longer perform its function, but this time it was materially and visually identical. The Frisbee's value was also dependant on it use, and the gestures and bodily actions required to use it also became important aspects of its ability to connect its use to their past.

The bowl discussed in another interview, was described in terms of the satisfaction bought by its form, and the way it felt in the hand. The curvature of it sides, its size, and weight, were all factors that made it satisfying to use. Its functionality, as with the Frisbee, is a big part of its success as a meaningful object. The acts of use are enacted everyday and so keep the meaning of the object. It is its embedded-ness in everyday life that contributes to its value.

Tactile similarity seems to work well when the object is a functional one, as attested by the descriptions of the bowl and Frisbee. The poker chip, on the other hand, is not strictly a functional item in the sense that it is used to accomplish tasks on a daily basis. Its function, or purpose is a purely mnemonic one. This makes it an intriguing object in terms of the role it plays in everyday life. Whereas the other objects' tactile value is rooted in their everyday utility, the Poker Chip is instead inserted into the everyday by being kept in a place where it might be serendipitously discovered.
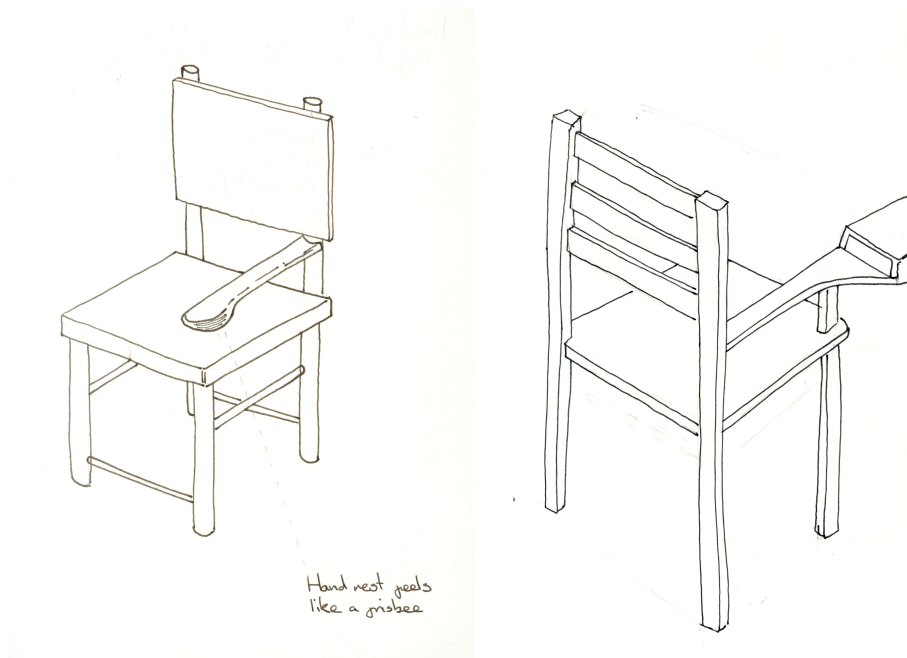
Figure 15: An early sketch exploring applications of tactile memory triggers in everyday objects

The relationship between tactility and memory is an interesting starting point for this research. In, particular how these tactile 'hints' of meaning might be encountered in other ways beyond the object to which they belong. For example, Figure 15 shows an early sketch to think about ways meaning might be 'borrowed' from objects and transplanted into new ones to give unexpected flashes of memory throughout the day. In the sketch, the armrest of a chair has been shaped to the exact form of the edge of the Frisbee. Would sitting in the chair and grabbing the arm rest give the Frisbee's owner a flash of memory, and thereby create a meaningful encounter through an unrelated object, or is the remembrance this form brings entirely bound up in the act of using the Frisbee? This particular idea was not followed through in this research, but the idea that gesture and bodily action can be evocative is investigated later in the chapter.

These interviews, and initial design ideas all reflect the role of the objects' role in memory as a result of their relationship to the body, rather than relying on visual senses.

5.3 Design Investigation: The Poker Chip

5.3.1 Introduction

This report provides an account of a design investigation that aims to explore aspects of the relationship between personal memory and the materiality of objects. In order to do this it directly addresses the poker chip brought to the exploratory interviews, as detailed in section 5.2.1. In that interview the participant discussed their attachment to the poker chip and

described the role of the object's tactile qualities in that value. This also explained why a replacement of an original object was able to hold personal significance.

Being a mass-produced object, the chip seems to represent an interesting aspect of how material can attach to memory. Except for in the eyes of its owner, nothing about its materiality appears unique, and as a form it has been duplicated millions of times. Despite this, it is 'this' chip, as opposed to the multitude of others, that is important, however this duplication of form makes it possible for other similar objects to become entangled the relationships between object, experience and memory. In response, this investigation was conducted to further investigate the nature of this relationship by using specially designed objects that enable deeper discussion of these issues between the researcher and participant. Specifically, it seeks to explore ways that the material characteristics of the object in question might be replicated, and used to make a new object meaningful by reference to its predecessor. In this way, is it possible to make a new object that become part of this material / mnemonic relation.

To begin, this report will set out a design brief [5.3.2] that will state the aims and intent of the design work. This is followed by a review of the design process [5.3.3] and production of the objects that were made, and how these design decisions relate to the research being conducted.

Next, 'The Deployment' [5.3.4] details the way that the prototypes were presented to, and interacted with, by the participant while 'The Analysis' [5.3.5] reviews the interview data resulting from the investigation, and 'Reflections and Conclusion' will follow this by articulating their significance and implications for further work.

Throughout this section, various other terms will be used to describe the object being discussed. 'Original' refers to the poker chip first acquired by the participant himself, but that was later lost. 'Replacement' refers to the poker chip brought for discussion by the participant in the initial exploratory interview that inspired this experiment. 'Replica' describes any of the artefacts that were created for the experiment, and are numbered 1-6.

5.3.2 Design Brief

What the original interview does not tell us is whether tactile properties alone are enough to connect objects to meanings. Similarly, it cannot offer any insight into how this link to the other object and narratives might work or how it might be designed for. The role of the objects discussed here in memory seems more complex than simply providing tactile memory triggers. For example, the replacement chip has also been attributed meaning because its acquisition resulted from sharing that original story with a friend, and so it also representative of that personal relationship. In this way it is not a copy or an imitation of the original, but a new object that adds new layers of meaning to the object and memory. It is itself a memory object, but also a mnemonic for an event that it is not directly connected to.

Using objects designed to provoke discussion around these questions, this investigation should seek to determine how far the material characteristics of an object alone could be used to

associate a new, meaningless object to a memorable experience, through association to an existing meaningful object. The design provocations should use these ideas to explore ways that objects might be designed to recreate the tactile material characteristics of existing meaningful objects in such a way that allows them to be effectively associated to the same experience and memory. At the same time, they should be used to ascertain what level of tactile similarity might be enough to achieve this.

5.3.3   The Prototypes

In order to address the brief, a set of 6 replicas was made of the poker chip. These were later to be used as points for discussion with the participant.
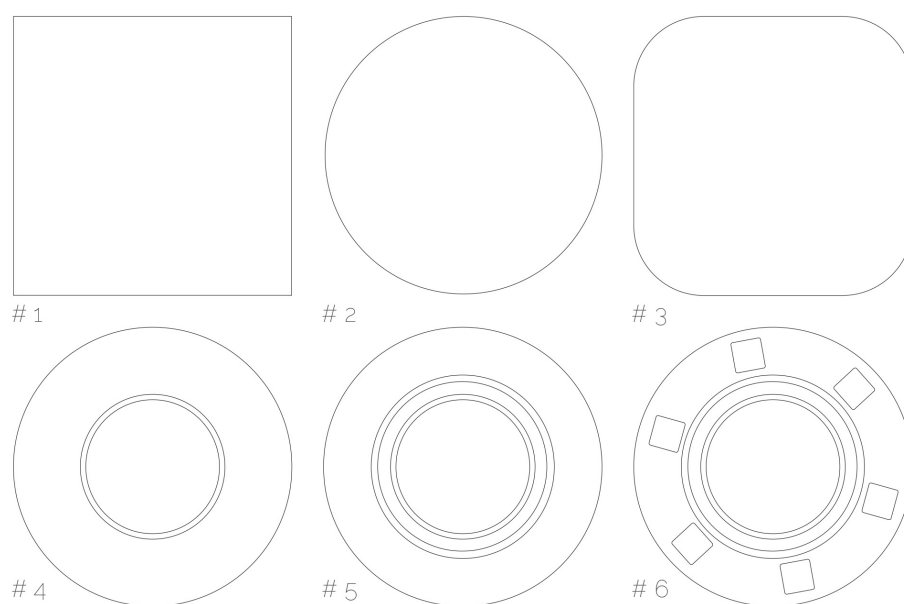

Figure 16: Illustrations of the replicas 1-6

The final replica chip (Figure 16, #6) is a direct material copy of the replacement chip, while each of its predecessors loses a physical feature until all characteristics, other than the material, have changed completely. Because I was interested in how the *tactile* characteristics of the new replicas might relate to the original object and associated memory, all visual characteristics that are not also perceivable through touch, such as colour and pattern, have been ignored. All iterations were left the same off-white colour of the ABS plastic that they are made from.

The first, most similar replica will allow comparison between the two objects directly, and therefore to discuss whether or not it is able to evoke memories of the associated story through touch.

The purpose of creating the series of forms is to help discover what level of similarity is needed to remind the participant of the original. For example, will the square replica have any

characteristics, such as texture or thickness that remind the participant of the original, and therefore evoke the related memory?

After taking measurements from the poker chip, 3D CAD drawings of the replicas were made using Solidworks[24]. These were then fabricated using a 3D printer, which deposits layers of ABS plastic to create a physical version of the digital model.

Each replica was then finished by hand so that their texture was smooth, and closer to matching that of the original. This is a significant part of the objects tactility, so it was extremely important that the texture was as similar as possible to that of the replacement chip.

Figure 17: The replicas in their presentation box

In order to store the replicas, and present them to the participant, a presentation box was made (Figure 17). Although they were handed to the participant by the researcher, rather than the participant taking them from the box themselves, the box helped in a couple of ways. Firstly, just as a convenient way to store and display the replica chips in the intended order, rather than them being loose in a bag or in hand. It also helped prevent unwanted abrasions and damage that might alter to the surface's texture. Being stored in this way also acknowledges, respects and enhances the replicas' potential meaning and value.

---

[24] 3D CAD drawing software commonly used in the product design industry to create virtual 3d models of objects that can be used as templates for manufacture. Available at: http://www.solidworks.com/

5.3.4 The Deployment

In order to discuss the research questions with the participant, the prototypes were presented to them during a controlled deployment. This was a short-term provocation in which the replicas acted as props that could be examined and discussed. This gave the participant a more tangible grasp on the research questions rather than abstract speculation, which was especially important given that this was an investigation into ideas of material perception.

The replacement poker chip that the replicas were modelled after was not present during the deployment. This was so that any associations were not through direct comparison, but through memory only, thereby asking if the replicas were reminiscent of the replacement chip rather than being descriptive of it. The deployment was done in the participant's home, and was conducted in two parts.

5.3.4.1 Deployment Part 1

First the replica chips were presented one by one to the participant starting with #1, through to #6 (see Figure 16). It was done in this order under the assumption that out of all the replica's, the least similar was least likely to be recognized as being a derivation of their poker chip, but that the final, most similar replica would be instantly recognizable.

Figure 18: The participant inspects the first replica using touch only

If this is true, presenting them in this order would allow us to find out at which point in the evolution of the replicas there was enough tactile similarity for the participant to be reminded of the replacement chip and its associated narrative.

The participant was asked to keep their eyes shut throughout this first part of the experiment so as to only concentrate on the tactile qualities of the object at hand, and eliminate visual recognition. The chips were placed in the participant's hand one at a time, and upon receiving each chip, he was invited to respond to the object.

Figure 19: the participant holding their favorite replica during the discussion

Although this part of the deployment was conducted in a way that attempted to prevent the participant guessing the subject matter too early, the very fact that they had been invited back, after previously discussed the poker chip in the preliminary interview meant that they already had a sense of what this activity might be about. Consequently, it was much easier for the participant to guess what the objects were. Despite this, rather than thinking about what the experiment was about overall, the participant was asked to concentrate on the object at hand, and to reflect upon how it felt, what he thought it was and what it made him think about.

5.3.4.2   Deployment Part 2

The second part of the deployment was an unstructured discussion on the themes raised during the first section, and of any other reflections or insights the participant might have about the objects both individually and collectively. During this stage, the participant was allowed to see the chips as a set, and to interact with them as he pleased.

This second part of the deployment was intended to gather deeper insight into the participant's responses to the chips, and to give them further chance to reflect on them individually, collectively, and on the research questions.

5.3.5 Analysis

The interview and discussion were audio recorded and later transcribed. Transcriptions were then analysed to derive themes that related to the research question.
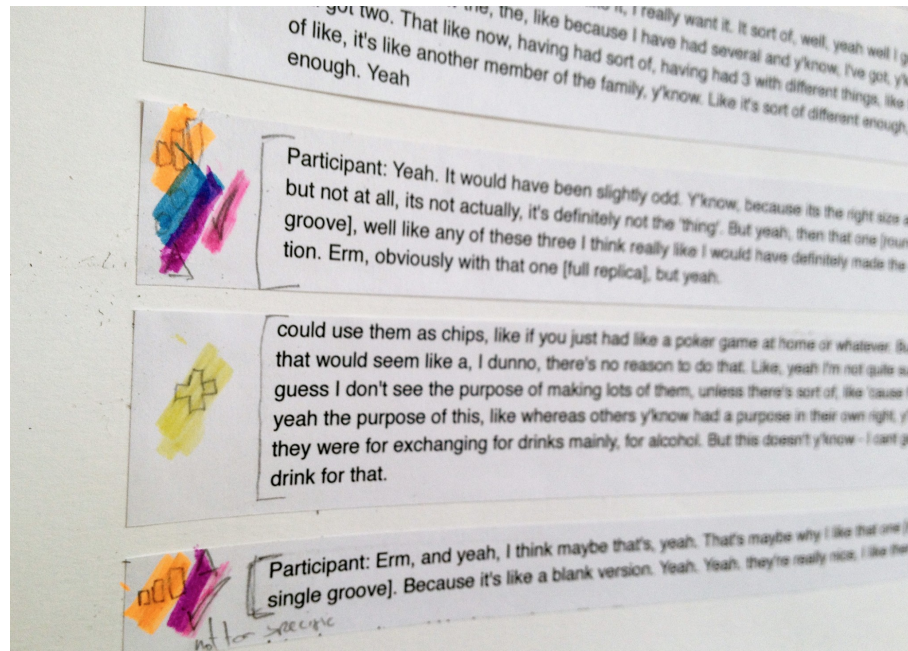

Figure 20: Analyzing the interview

Three key themes were derived from the participant's reactions to and discussions about the replica chips. These all described distinct but related, and sometimes reliant, ways in which they attribute meaning to the object: Recognition, Sharing and Uniqueness.

5.3.5.1 Recognition

Having been asked to come for a second interview, and therefore having an idea of the subject of this research activity, the participant was able to guess what the objects were aiming to reproduce upon encountering the first (least similar) replica. Even so, it wasn't until several iterations later that they were confident that they recognized the object they were holding as being related to the poker chip. As predicted, this recognition seemed to come in stages as the objects became more and more familiar:

> *Well in relation, because we've been talking in relation to the project I guess it does remind me of the chip a little bit because it's sort of similar proportions and er, its quite slim and a similar sort of size. But, and it also er, makes me think of a scrabble, a giant scrabble piece.*

106

From this excerpt we can see that although the participant can already associate the first replica with his poker chip, they are far from confident in the connection. The important distinctions seems to be that they can also easily imagine the early replica's to be other unrelated objects such as "a giant scrabble piece". This is reinforced again in their reaction to the second replica:

> It's like a token or something. Like at a coat check, or something like that. Like a stand in, or something to hold. Yeah, like at a coat check, or a bag check or, yeh. Something you exchange for something else.

This ability to see the object at hand as something other than the chip shows that it's tactile differences to the replacement chip create a week link to the replacement chip, and associated memory. It may be comparable to it, but it is not equated with it. An interesting aspect of this is the participant's inability to recognise the material that the chip is made from.

> I can't quite work out what it's made of. Like, if it's wood or plastic [taps object]. It's really hard to not open my eyes. It's maybe plastic. Maybe.

This arguably demonstrates a perceptive confusion whereby there are not yet enough familiar features for the participant to build a complete picture of the object, and fully connect it to the replacement. Their ability to recognise the object increases again with the third chip:

> "Yep, that's definitely - that's the chip. Yep. Yeah it's sort of, probably slightly thinner. Like really, I don't know maybe I'm, maybe fractionally thinner. Like maybe half a mill [millimetre] or something. And obviously there's no indentation, so there isn't the texture to it. But it's definitely the right size and the right shape."

From this point the replicas are never discussed in terms of any other objects. Any ambiguity in their form is reduced to the point that they are only considered as replicas of the poker chip. Now the object at hand is unavoidably related to the chip, but there are still some shortcomings with regard to those features that are still missing.
The participant's recognition appears to get stronger again with the next replica, which adds an intended circle on the face of the chip:

> Participant: That's right yeah. The thickness seems much better, and yeah it has the groove in the right place. There's still not the, there's not the indentations around the edge where, like, that delineate the, like the edge of the dice symbols that were on it. But then like the dashed line sort of groove is there.

> *Interviewer: Ok so you can kind of, without looking at it you can picture which bits are which*

> *Participant: Yeah definitely, I can see, yeah I can see it exactly. Like y'know, there's no, it's just missing these bits like around the edge*

This replica is also not considered in relation to any other type of object. This iteration is detailed enough that the link to the replacement chip is complete, and the participant is prompted to recall details of his poker chip not yet present in this replica. At this stage, the participant is also able to recognise the material that the replicas are made from:

> *It definitely, it feels more, the thickness feels even actually, like better. I think, I don't know if it, maybe they're the same but I don't know, this feels sort of slightly like, more substantial in a way. Slightly thicker maybe, I don't know if it's, my hands are playing tricks on me, or something. But it definitely feels more like plastic.*

Here it is arguable that their ability to recognise the material, is somewhat dependent on the presence and perception of other physical characteristics. Because of the inclusion of more physical features, the object is familiar enough that he can 'fill in the blanks' and recognise characteristics which were previously elusive. In the later discussion the participant is clear that the 4th replica was the point where all these characteristics combined to allow full recognition of the original object:

> *Like, and, y'know like, I wasn't sure with these if they were, like I said I didn't know if it was plastic or wood, I couldn't quite be sure. But then like, as soon is it got to this one [round with single groove] it sort of felt more like familiar, and I sort of knew that it was a plastic thing*

At this stage the assumption was that each subsequent replica would increase this feeling of familiarity. However, while they did indeed become more and more materially similar, in the later discussion the participant remarked that they did little more to evoke the chip, or the memory.

> *Participant: this [replica #4] kind of, like because the thickness is right, and it had that groove in it, like that's when it, it felt almost like, it felt more like I was holding the 'thing', like whereas this one felt like I was holding something that was, similar, but definitely not the 'thing'. I felt more like I'd sort of, like connected to the memory, I think.*

> *Interviewer: Yeah, That's the one with the single groove on it?*

> *Participant: Yeah, the single groove. Like I think I don't, I don't know that I got that much more out of that one [replica #6] than I did out of that one [replica #4]*

This replica then provided the most complete link to the replacement chip, and associated memory. In fact, after this point the more similar replicas were detrimental to the original memory.

> *But, this one [replica #4], I know its definitely not that, it's not the real thing, but it's, it's close enough to be a memory without it being an imitation.*
> *I mean obviously it is an imitation, but y'know like it's not trying to be the thing, whereas that feels like it's trying to be the thing.*

From this we can clearly see that as far as this participant is concerned, the 4th replica benefits from not being too similar to the replacement chip. The use the word 'imitation' describes replica #6 negatively as something that is trying to *be* the genuine artefact; something that it can never achieve. In being somewhat dissimilar, replica #4 avoids this trap and becomes a new, but related object.

5.3.5.2 Sharing

Having identified the 4th replica as their favourite, the participant discussed the significance of its creation. Much as they received the replacement chip as a result of sharing that story, the participant valued the fact that this replica existed as a direct result of sharing his story with me:

> *I mean maybe it's sort of a bit anomalous in, as an example of like, a singular thing that has a memory connected to it because, like, because I had y'know I had the original one, and then I had the replacement of the original one that my friend gave me. And, like, that felt like a replacement in a way although it was really nice that it was really nice to have it and it had an extra memory 'cause it was a gift from like, from my ex-girlfriend who had been over there, and she's made the trip to go and get it and like, it was a really nice thing to, like that extra sort of story to the memory is really nice. But, it still always felt like a replacement. But now that I've like, I've now got a third one, its almost like with another, with a totally different story attached to it, it's, yeah, it feels that, yeah I don't know it feels odd that, like now, more of them isn't a problem now*

This is later echoed in a discussion about another chip that they had recently acquired from a trip to Korea. However, this time they also describe how these new additions are valuable because they help reinforce the memory and make it stronger by adding new layers:

So the only other sort of original experience is the one I just had when I went to Korea, but like it's sort of, yeah, like I like that it has this sort of, I shared this memory and every time I share it the memory sort of gets stronger and y'know more vivid, like y'know. If i didn't tell anybody about it, i might have already forgotten about it, but erm, i don't know. But yeah, like, it's a story that kind of kept coming with me, like as I've got older and gone though my life and y'know, it's probably changed in my memory as well, like originally it was about that experience in that jazz club. And that's still there, but its sort of not, prominent, its maybe not so prominent

As such, the replica was produced directly because of, and in relation to his experience, and is not something that was 'left over' from an 'original experience'. In this way it seems that the object is no longer a copy or replacement but a new entity:

It's produced from this discussion and me telling you about it and showing it to you, and you having looked at it and seen it yourself and it sort of like, it's a product of the memory and its not a product of the thing. Like I think like a direct copy would be in some way, wrong. Whereas I like that all of these have been produced sort of, afterwards

This is also linked to the reason that they preferred the 4th replica as opposed to the 6th, most similar replica. While the 6th replica was more materially similar, it was not part of an 'original experience', but produced purposefully to connect to the other chips and so is seen as an imitation. Thanks to it dissimilarities, the new chip is no longer a copied object, or a replica, it is a 'product of the memory'.

And that felt like a replacement in a way although it was really nice that erm, it was really nice to have it and it had an extra memory 'cause it was sort of, y'know it was a gift from like, from my ex-girlfriend who had been over there, and she's made the trip to go and get it and like, it was a really nice thing to, like that extra sort of story to the memory is really nice. But, it still always felt like a replacement. But now that I've like, I've now got a third one, its almost like, er, with another, with a totally different story attached to it, it's, yeah, it feels that, yeah I dunno it feels odd that, like now, more of them isn't a problem now.
Like that form [picks up chip] it pulls all of those memories together a little bit. And all of those little stories. And, yeah like I have a very sort of strong memory of that shape. And the idea of it, I mean its a reproduced item anyway, obviously 'cause I wouldn't have found it in two countries. But despite that I can still remember the original, like, the very first one, and then the second one, and then the third one.

In this case, the circumstances in which the object is acquired have consequences for it form. Objects that are gathered from original experiences are able to be materially identical because they have a separate meaning, but are linked to the others' meanings through material similarity. However, where the object is not part of an original experience, but produced in order to connect to another original experience as a result of sharing a story, being materially identical is detrimental to its ability to connect to those other objects and meanings. As such an object that aims to connect to existing memories and meanings should to be different enough that it does encroach on the relationships between original story object and story.

5.3.5.3 Uniqueness

Linked to the circumstances of its production, or acquisition is the idea that the replica chip has value through being a unique object. While the others chips were mass produced objects, this one was made bespoke for the participant and the experiment, and as such is a one of a kind object.

> But, it's still like, its really nice because it's kind of, it exists because I've talked to you about this memory, and you've gone away and made this sort of, specially, kind of, so like as a replica, its still, its still a special thing. I mean in some senses this [round, one groove] is probably more special than like the original because, in the original one there were, I don't know how many, but like, there is only one that's like that, and that's really nice

This hints at the idea that a one off, unique object might carry more potential significance than a mass-produced one. This is of course also linked to the idea that the 4th replica is not an exact copy of the replacement chip.

> It kind of, that only exists because of the memory and because of the experience that I had. And that's a really nice thought, like, that y'know, that experience has created that object, actually, like rather than being something that's left over from it. It's really nice

5.3.6 Reflections

Due to individualistic nature of the experiment, the observations gathered from it are not presented as generalizable findings. They do however allow us to discuss the relationship between this participant and their meaningful object, and do so in relation to the design brief posted earlier this section. This discussion will be based on interview data, but also in terms of the appropriateness of the design perspective, and the design process.

This investigation demonstrated that it is possible to fabricate a new object in such a way that it evokes an experience via reference to an existing meaningful object. In this deployment the participant found that the 4th replica was evocative of their original object and experience, but

also appreciated it as an artefact in its own right. Figure 21 shows the 4th replica alongside one of the other chips in the participant's collection after they had asked to take it home.

Figure 21: Image sent by the participant after the deployment. It shows the recently acquired chip from Korea next to the 4th replica that they asked to keep

However, this perceived value appears to rely heavily on the context of the replica chip, such as the nature of its production, and the relationships involved in its acquisition. The observations detailed begin to offer some ways of explaining how these contexts play into the production of the seemingly valuable object. 'Recognition' offers an explanation for how the chip was able to be evocative of the participants experiences through tactile perception, while these in combination with 'Sharing' and 'Uniqueness' give an idea of how this new object might hold some significance to the participant through relation to social relationships.

The following then are a set of design principles derived from these themes that are intended as stand alone approaches to the design of meaningful things, and points to be taken forward into the design work for the next chapter in an attempt to put them into practice.

5.3.6.1   Optimal Tactile Similarity

'Recognition' [section 5.3.5.1] describes one way that replica #4 was able to evoke memories for the participant, as well as what allowed it to become meaningful to the participant. In many ways, this appears to be the simple application of a tactile memory trigger. However, through their comments we are able to see a more complex relationship between the participant, their memories, and materiality's of the various iterations of the chip.

These two observations are related in that it is the combination, or accumulation of features that allows for the different scales of recognition. However, rather than simply being a case of more features equalling greater recognition, it seems that there is an optimal level of similarity. After a strong association to the original object has been made by replica #4, the perception of its form can no longer be related to other objects and experiences, and so recognition through further features does not get any stronger. Instead, as physical similarity increases thereafter the participant begins to see the replicas as imitations of the original. This is seen to be negative because they are trying to mimic an existing object and meaning, and are therefore encroaching on that relationship. No matter how accurate a replica might be it is not, and cannot *be the thing*.

A further reflection here, combined with the observation that the participant was often unsure about materials and dimensions, might be that any accurate replica of an objects can never be exact, especially in the view of a person for whom it is a memory object. The experiment asked the participant to remember the original object rather than having a direct comparison between objects, the comparison is subject to the distortions of their memory, such as prioritising or emphasising certain physical features over others. Because of this any exact physical replica may only ever fall short of their idea of the original, presenting an uncanny and disappointing imitation. An inexact replica on the other hand can effectively evoke the object, but has enough associative ambiguity to allow the person to create the links that they find meaningful without trying and failing to become another thing.

The 4th replica then is similar enough to evoke many of the same associations and memories, but importantly it is dissimilar enough to allow some degree of ambiguity and freedom of interpretation. This allows the participant freedom to read new meaning into the object, and consequently for it to be seen as a new, and valid addition to the collection.

In this instance, an object was broken down into a set of physical features that combine to construct a memory object. Enough of these features were combined to make the replica evocative of, but not an imitation of the original. An obvious question here might be over which features are chosen to achieve this. If you are not recreating every material feature, which one do you create? None of the features of the chip are meaningful in and of themselves, it is their combination that it meaningful in making a recognisable object. From the discussion we can speculate that these feature are arranged hierarchically from those that are more immediate to perceive, such as the thickness of the chip, or the fact that it is round, to those that are more subtle, such as the finer indented patterns on it surface.

5.3.6.2   Context of Acquisition

Clearly in this case there is more to the relationship between the physical objects and their meaning than just their material characteristics. The methods and contexts of their production and acquisition are also significant aspects of this attribution.

Indeed, there is an interesting link between the idea of optimal similarity and the ways in which these memory objects are acquired. This distinction is related to the differences between the replica and replacement chips' modes of production and acquisition, and there is an interesting point here about the difference between a mass produced object being appropriated as a memory object, and an object that is produced *to be* a memory object. The replacement chip is a mass produced object with a function. It was a token that could be exchanged for drinks, and was retained as a souvenir. The replica however, has no other function than to evoke the experience. It is a unique object made specifically in response to the telling of the original story; it exists because of the story, rather than being "left over from it". Its similarity, and bespoke-ness to the experience allows the replica chip to take on some value to the participant. If this investigation had simply involved a real 'functional' poker chip it is doubtful that it would have taken this value, as it would not have been implicated in any new experiences, nor would its production have been linked to the sharing of the story. For example, the participant had acquired a new chip during a trip to Korea to visit a sibling. This was an object of the correct type that was appropriated in the course of a new and memorable experience, the sharing of an old experience, and a personal relationship. As such it was included in the collection, an act that also associates it to the other experiences.

In the case of a mass-produced and commonplace object such as this, the chip owned by the participant (itself a replacement) may be an index to the owner's very unique experience, but we can see it as part of an ecology of related objects that, although distinct, are bound together by their tactile similarity. The properties that make it a tactile memory trigger are therefore reproducible. Furthermore we have seen that this set of material properties can be distilled, and separated from 'the object'. In other words, it is not necessary, or even desirable to reproduce an object in full, but rather particular sets of characteristics that are able, as a group, to index these associated meanings and trigger the memory. This seems to be particularly important in the process of making a new object, as opposed to appropriating an existing one during the enactment of new memorable experience.

The replica chip on the other hand, does not so strongly fulfil these requirements. It represents the sharing and reliving of the memory, and the experience of taking part in the investigation. However, because its material form leaves enough, but not too much, room for ambiguity, and freedom for interpretation, it can more easily be associated with the other objects and experiences. Similarly, its physical differences from the mass-produced chips and its uniqueness reflect the experience associated with it and enable it to be included in the collection.

Another aspect of the context of acquisitions is that the objects that come to be considered meaningful, not only have the appropriate tactile properties and are gathered from experiences, but are also implicated in a personal relationship of some kind.

The chip from the interview comes from the participant sharing the experience with his girlfriend. The chip from Korea is from a visit with his sister, who also retained the chip for him, and the

replica from this investigation was made directly as a result of his sharing the story with me. These then are not just references to past experiences, but also to people.

5.4 Design Investigation 2: The Bowl

5.4.1 Introduction

The basis of this investigation is the chipped cereal bowl discussed in section 5.2.2. Again the participant described the object's physical characteristics and tactile qualities as components of the objects meaningful status. Importantly the participant was even able to recall the circumstances in which the bowl was damaged. It is perhaps unusual that a specific material characteristic caused by damage acts as an index to a specific memory, as opposed to a general sense of history, so this investigation asks if what might otherwise be a negative feature is instead valuable or even desirable? Rather than recreating an object, as in the previous investigation, this exploration began by attempting to reproduce this damage as a way of embedding meaning into a new object.

To achieve this, a set of tools was designed that would allow the user to chip a new cereal bowl in a way similar to that on their original. This allows not only reflection upon whether the material damage and associated meaning itself transferable to a new object, but also upon whether the *act* of damaging the bowl could itself be evocative of the original experience.

In order to relate the details of this experiment, section 5.4.2 will start by setting a design brief for the creation of a prototype that will allow this investigation to expand upon some of the observations taken from that interview. Section 5.4.3, 'The Prototypes' will then give details about the material responses to this brief and the various design decisions involved in the production of the objects and devices produced to inform this work. Next, section 5.4.4, 'Reflections', will reflect on the design process and resulting objects before offering some analysis, and concluding with a discussion of the outcomes.

5.4.2 Design Brief

The damaged cereal bowl is another example of an object whose material characteristics play a significant role in its meaning. In this case, one of these characteristics acts as direct references to an event and the entailing relationships between people.

Designers and researchers have long been aware that objects record and exhibit their histories through patina and wear [4]. But these histories are often vague or obtuse, even to their owners. They give a sense of the objects life but rarely any reference to specific events. However, in this case the participant was able to tell the story of how the bowl had been chipped along its rim. They also indicated that they were somewhat fond of this feature because of it link to a time, and to people that were close to them. At the same time, they were aware of its fragility, and the fact that one-day it would break. This object's meaning is also tied to its functionality. That is, a big

part of its value comes from its role and use in everyday life. When it no longer functions, the meaning is diluted, and the participant will dispose of it.

This begs the question of whether such features, in as much as they are direct links to memories, are worth persisting across functional objects? In other words can signs of provenance be created, and is it valuable to do so?

There is another aspect to this though, in that the significant feature – the damage to the bowl - is the result of an action. Although the action in the original event was not deliberate, it is worthwhile asking if the act of deliberately breaking a bowl to recreate the original feature can be evocative of the original act.

The design work in this this investigation should explore these ideas by creating prototypes that allow the participant to damage bowls as an act of replicating a meaningful material characteristic.

5.4.3 The Prototypes

To begin the design work, material experiments were carried out to investigate ways of making chips in cereal bowls that were similar to the one on the bowl in the interview (Figure 22). For example, from which direction was the impact made, how much force is required, and what shaped implement is needed?

Figure 22: Two experiments in chipping cereal bowls

Once the most similar result was achieved, the next step was to create tools that could be used to achieve this same result with relative consistency. Because of variations in the material the bowls are made from, it is not possible to get identical results and the quality of result will vary, but it is possible achieve something similar enough that it is hopefully evocative of the original without imitating it.

Figure 23: 2 punches designed to chip the bowl

A set of punches were made (Figure 23) that could be used to achieve the desired affect. This was the first step in beginning to translate the idea of chipping the bowl in predictable ways from simple manual experiments, into a device that would perform the task more reliably.

Figure 24: The first version of the Bowl Chipper

Next a sort of jig[25] was made to hold the punches in a position that would best allow them to chip the bowl in the desired way (Figure 24). The bowl is placed on the platform of the wooden frame where the punch is held close to the rim of the bowl. The punch is sprung, so that it can be pulled back and released, thereby chipping the rim of the bowl.

This device was more of a sketch than a working prototype, designed and made to show what kind of interaction and the aesthetic experience the gestures involved in using the device lent to the act of breaking the bowl. Despite not being functional, this initial idea for a device was finished to a relatively high standard and designed in such a way that, save for it being an unusual object, it did not look too out of place in a kitchen. This allowed me to reflect more deeply upon these aesthetics and interactions, as it could be imagined in its intended context of use.

The decision to make it a kitchen appliance was based on the fact that it is for breaking cereal bowls. Although it seemed to fit well in this context aesthetically and in terms of function, it took up a lot of space for something that would be rarely used. The most significant observation made from this physical sketch though, was that the form of the device and the interactions involved in using it created a very different aesthetic of experience to that originally described by the participant. Simply, the gestures involved in using it did not seem to suit the emotions and events described in the participant's story. Breaking something, even accidently, is a violent and unpredictable act. In its endeavour to make the action controllable through the Bowl Chipper these qualities were eradicated and so were the emotional thoughts, and responses that would otherwise make the act an affective one. In order to reinstate these aesthetic qualities to the interaction, the bowl-chipping device was reconsidered.

---

[25] A jig is a custom-made tool used to control the action of another tool

Figure 25: The finished hammers in use

A set of hammers were designed as a way to allow more force, but also because of the gesture allowed by the act of using a hammer against an object (See Figure 25). Unlike the jig discussed above, hitting a breakable object with a hammer is a consciously destructive, and affective act. The heads of the hammers are designed to mimic either the punches shown above, or to mimic the surface form and material of another bowl, each of which may achieve the desired effect. Again, aesthetically these are designed to reference the design language of both tools and kitchen apparatus.

5.4.4   Reflections

Findings from this research activity are derived from reflection on the design process. Rather than attempting to recreate an action from a story, and test its efficacy as a memory trigger, the design, making, and use of the prototypes were used as a way to think through the role of material and gesture in the act of changing objects characteristics to represent memory. Specifically, these reflections focused on how a deliberate gesture could be designed to align with the participant's description of the emotional aesthetic of an experience in which the original bowl became damaged. These reflections are discussed below.

5.4.4.1   Evocative Gestures

The design of these artefacts was inspired by the idea that specific material marks on an object could be indexical to specific meanings or values. At the same time the object's meaning was tied strongly to its function and the participant's ability to use the bowl was essential to its mnemonic value. The damage to the bowl also means that it may one day brake to the point that it could no longer be used, and therefore would longer be able to maintain any mnemonic

value. In that case, is it desirable to persist these marks beyond the life of the original object so that that some material link to a memory can be maintained in other usable objects? If so, how might this be done best? Digitally scanning an object to make a 3d replica that could later be manufactured, while replicating the material form of the bowl and its damage ignores the aesthetic of the situation in which the bowl was damaged and the physical action or gesture that caused it. The project here attempts to find ways that an object could, through the enactment of a gesture, recreate this damage in a meaningful way. However rather than recreate the exact gesture that broke the bowl – the details of which I do not know – the prototypes instead aim to encourage an action from the user, that may be evocative of the aesthetic of the original.

The first prototype sought to do this through mechanical means, but in doing so seemed to rob the user not of the intent, but of the evocative gesture. Using a hammer seems a much more purposeful and intentional action. To strike something is to intentionally damage it by hand, an aggressive and destructive act that implicates the user more fully in the material of the object being affected, rather than distancing the user through automation. This may be comparable to the act of craft, as opposed to manufacture.

5.4.4.2   Intent

The focus on evocative gestures also raises the issue of intent. The original bowl was not damaged intentionally, however this investigation considers that using an intentional gesture could evoke the conditions in which the gesture took place. By intentionally breaking the bowl to recreate a material feature from a meaningful event, albeit using a different action to enact the damage, would you remember the way, and reason, that it was broken originally?

In any case it is clear that material signs of provenance are the results of action upon them, from a person or other object. Making these purposefully, with a method that evokes a memory of a meaningful experience, may result in the embedding of meaning into that object.

It is interesting to also consider how this process might work with digital systems where the action of the object can be driven data from an actual event, and therefore be more thoroughly linked to the memorable experience. This may seem like a long shot until we consider the ways that the Poker Chip and the Frisbee were intentionally replaces with new, materially identical objects. The intent behind their acquisition as a replacement, as well as their material and semantic similarity to the original objects, effectively relates them not only to the original object but also to the original experiences. They then represent all these meanings as well as any new ones picked up in the process. This proposition draws on intention to replace, as exemplified in the interviews about the Poker Chip and the Frisbee, but where it is not possible to find a materially identical object thanks to the uniqueness granted by the physical signs of memory. Further, the fact that those objects can be replaced suggests that a memory is not limited to a single object, and can instead be represented by several, or several objects can provoke a memory even, evidently, if they were not implicated in the actual enactment of the original experience from which the memory is derived. The Poker Chip is a perfect example of this, as

more and more objects are added to the collection if the circumstances of their acquisition are correct.

Clearly there is some value in the intent behind acquiring a replacement, so maybe there is also some value in the act of intentionally affecting an object in order to have it replace and represent previous objects and experiences?

5.5 Conclusion

This chapter documents a series of exploratory interviews around empirical examples of meaningful objects, and their roles in the experiences and memories of their owners, and uncovered interesting details about the role of the objects' materiality in this relationship.

Next, two design responses were undertaken that would form the basis of two further studies, one design provocation, and one a reflective design process, that further investigating two of the objects from the interviews. In doing so, they set out to discover ways that their material links to memory might be manipulated and leveraged in the design of objects that combine digital and physical matter. The reflections from these studies were aimed at uncovering strategies for the design of more meaningful objects and interactions.

The first investigation looked at the way a poker chip's tactile properties and physical uniformity allowed it to simultaneously represent and refer to two different experiences, and the way that these same properties allowed for the connection of new, similar objects to connect to it through shared experiences and social relations.

The second investigation investigated an objects signs of wear to find out which types of these affordances are valuable, and explored ways that such meaningful marks might be persisted and maintained beyond the life of the object, and into the life on the memory.

To build upon and make sense of the reflections and discussions made throughout this chapter there are a number of key lessons that can be derived, and taken forward into further work. These concern what the research objects in this chapter showed us about the relationships between material and memory, but more particularly act as starting points to ways that we might approach the combination of physical and digital matter in order to make more meaningful things.

5.5.1.1 *Objects Should Evoke*

It is well known that objects can be powerfully evocative of memories, people, places and events [93]. The ways they do this are as multifarious as the things themselves and what they represent. Evocation in this sense is important in its distinction from description. That is, even those objects that index to a specific experience do not describe or illustrate the thing they represent explicitly, but instead provoke the act of remembering through the intrinsic meaning represented by their material. An important aspect of an objects ability to evoke is that by offering clues and hints to memory, they allow space to remember and to add, forget, and construct the meaning of that object.

The research activities in this chapter also suggest that there is another dimension to the importance of evocation that is especially significant when we consider designing for meaning by combining physical and digital things. When supporting meaning by integrating data into a physical object, it is often hard to move beyond the data's illustrative properties. In this case, the object becomes little more than three-dimensional data visualization, achieving neither emotional impact, nor effective communication of information.

Accurate imitation or descriptions of information was undesirable, or at least inappropriate in a physical object. It is therefore recommended that when attempting to link to a memory through the design of an object that combines digital and physical materials, these are combined in a way that references, and links to some emotionally significant aspect of that experience, rather than providing details about it.

This may also be related to the apparent contrast between the uniqueness of physical things, and the duplicability of things [4]. The earlier research activities found that even mass-produced objects can comfortably be called unique, both materially and semantically. Although they are arguably unique in being an individual instantiation of a physical form [4], their uniqueness is enhanced throughout their life by the addition of meaningful physical features (the bowl), or their involvement in and representation of specific experiences (the chip). Digital objects on the other hand – imagine a text file, or digital photograph – are infinitely duplicable. Exact copies can be made and shared with little effort or consequence.

We clearly saw in the case of the poker chip that duplicating a physical object, and thereby the memory 'data' attached to it seemed to impinge on that objects uniqueness. It could obviously never 'be' the object, so trying to physically replicate it when the original still exists was not regarded as a desirable. Instead, a similar object allowed for association to the existing meaningful object and memory data, while adding new meaning. In this way a new meaningful object must respect what is already there, but also contribute to the network of objects and meanings. One opportunity for further work here is to combine physical and digital in ways that evoke rather than describe data, but also to do so in ways that does not imitate and impinge on existing meaningful objects and data.

5.5.1.2   Evocative Actions

One of the ways that an object's materiality can evoke memories is through patina. These physical signs of provenance are the marks of use, wear, damage and repair that give subtle clues as to the events of their life and longevity, but often give little more than a 'sense' of history. For example, the armrests of an old leather chair may have become polished or threadbare, indicating that a specific person, or people used it regularly for many years. Of course, to the right person there can be an immense amount of value to this ambiguous patina, but sometimes signs of wear can also represent a specific event. In this case they are a link to a particular story or memory, and as such are valuable features of an object because they have a direct relatable meaning.

These could be described as affordances of memory in that they are a feature of physical objects that encourage and allow a specific act of reminiscence. These affordances result from actions and gestures made by people, other objects, or external forces in the practice and enactment of experiences, and so act as indexes to the memory of those experiences. We might then consider the actions and gestures that created the marks to be a valuable part of the process of embedding meaning into an object.

5.5.1.3   Intent

Intentional creation of a memory object through a specific action or gesture is an interesting route for further design consideration. Earlier I discussed the ways that participants in the interviews purposefully sought out objects to replace lost memory objects, and in doing so attributed meaning to these new artifacts in a very robust way. Then, borrowing also the notion of the evocative action or gesture that can be used to affect an object we formulated the idea that a new object could be intentionally marked, damaged or altered in some way that would associated it with a memorable experience. Intentionally affecting an object, either directly, or by placing it in a situation where it might be affected materially in order create a meaningful object by to associating it to a meaningful event is a n approach that would make from an interesting aspect of further design work.

5.5.1.4   Objects as Personal Connection

This might go some way to addressing our other theme concerning how objects are produced and acquired. Following the example above, the participant re-enacting an aspect of their experience in order to affect an object has a greater level of involvement in the reproduction of the object, much as their involvement in the original experience lead to the acquisition of the original object. Thinking more deeply about this more active role would advance the idea of creating meaningful objects, and hopefully begin to explore ways that this might be valuable to the participant.

As well as tactile properties, the way in which the person comes to acquire an object has also been shown to be valuable here. This includes the experience from which the artefact is gathered, or the social relationships that are implicated in that acquisition. This connection to people, places and events, is rarely something directly addressed or leveraged in HCI projects relating to memory, and could represent an interesting route for investigation in this thesis. These ideas outlined above will all be carried forward into the next chapter, where they will be implemented in the design of a new system that attempts to combine objects and data in emotionally meaningful ways.

6 Experiential Manufacturing

6.1 Introduction

This chapter provides details of the third and final design investigation of this thesis. It follows on from the previous chapter by putting into practice the lessons derived from those design investigations, in an attempt to create a system that combines data about experiences and physical objects. The intention of this is to simultaneously make the data meaningful and evocative while and the object more meaningful.

Up until this point in the thesis, the design work has not combined digital and physical together. Rather, the studies so far have been used to think about new ways that this combination might be achieved by investigating in detail how physical objects relate to memory through tangible evocation. In this way, the design investigations have been used to create generative intermediate-level knowledge, that will now be used to create new design, that investigates new possibilities for the design of technologies that mediate memory data for reminiscence and reflection. The approach now takes this knowledge about the ways that objects relate to memory as inspiration to design relationships between data and objects. To do this, the design will include four key values, derived from the lessons of previous chapter:

- Objects should evoke
- Evocative Gestures
- Intent
- Objects as Personal Connection.

These values are considered important in this approach to the research agenda of using the properties of physical and digital to create more meaningful interactions with both. The question here is over whether or not an object, in bearing the material scars of an action caused by data relating to a persons experience, is therefore evocative of that event. Further, whether the system is evocative in the performance of these actions?

This chapter will give an account of this design investigation by starting with details about the recruitment of the participant. Then, the section about Design [6.4] will cover everything from the interviews that informed the design space and initial design ideas, to the chosen design, early prototypes and the final design. Next, The Deployment [6.5] will report on the design and logistical aspects of the deployment, before offering an analysis and discussion of the findings. Finally the Conclusion [6.8] will then summarise the main lessons learned from the investigation, and how they will be taken forward into the next chapter.

First though, it would be useful to introduce the idea of Experiential Manufacturing, a term derived from both the background literature and studies so far in this thesis, and that describes

the context of the design work in this chapter, and the approach taken to combining digital and physical objects to make meaning.

6.2 Experiential Manufacturing

From natural disasters to holidays, we have always used technology to measure and capture information about extraordinary events. Now, embedded technologies can be used to do this to a far greater extent, creating vast data sets that cover almost every aspect of our experience. Increasingly these exist alongside a proliferation of personal subjective accounts created through personal networked devices and social media tools that apply equally to more everyday, or private occurrences. The depth, breadth and texture of these records could provide us with much richer, more detailed, and potentially more human accounts of memorable events. But how can these vast data sets be used in ways beyond the veridical recall of facts, to better support the ways we remember personally emotionally meaningful experiences?

Meanwhile, data relating to our experiences is all around us, written through material and memory into the objects that we keep, collect and use. The ways that we experience this object information is predominantly mnemonic rather than explicit, and is therefore more malleable and specific to our personal experiences. However we might also imagine that thanks to advances in digital manufacture and the subsequent decrease in the cost, speed and ease with which objects can be created and replaced, these object-stories are becoming shorter and less significant.

These meaningful objects can be particularly potent in the wake of disasters. In these extreme circumstances meaning can be attributed to even the least likely of objects; a Biro may become an evocative reminder of an air crash, or a broken vase a relic of an earthquake. In any case these objects bear the material scars of these events, and in doing so act as visual and tactile indexes to the narratives they embody, and the memories of their owner. Far from being unwelcome reminders of traumatic events, these objects can become treasured connections to another time, to people and places, or even of triumph over adversity.

Experiential Manufacturing is a design project that will explore possibilities for the design and manufacturing of services and systems that use data gathered during events to affect the material of otherwise meaningless objects. By giving these 'blanks' unique material characteristics that betray the narratives of our experiences provided by their digital records, can we deliberately produce objects that better reflect our experiences and in doing so create more personally meaningful material surroundings?

6.3 Participant

Following ethical approval for the project a call for participants was released that asked for people who had experienced an earthquake. The following text was posted on the project website:

As part of a research project from the Mixed Reality Lab at the University of Nottingham, Experiential Manufacturing investigates ways of using digital data to make more personal, meaningful records of our experiences.

To inform this research, we are currently looking for people to take part by sharing a story about an experience. Your story can be about anything, be it positive or negative, from the extraordinary to the mundane. We are especially interested in those that are not well documented already, but as long as it is of personal significance, and you are happy to tell the story, we would be really interested to hear it.

If you're interested in taking part, please contact us using the Take Part form. Or if you have any questions about the project, feel free to get in touch.

The link to this page was disseminated via email lists, and through social networks with the following request, "Have you ever been affected by an earthquake? We'd like to talk to you for a new research project. See here for details: http://experientialmanufacturing.com/take-part/". After extensive circulation three potential respondents came forward and of these, one was chosen to participate in the project.

The participant was a male in his 30's working as a researcher in Geo-Sciences at Edinburgh University. He was present in the 2010 Christchurch, New Zealand earthquakes both in September of 2010, and February of 2011. Although his experience of the earthquake was clearly traumatic, he was made fully aware of what would happen throughout the investigation, and so was willing to discuss it and to engage in the research project.

This is perhaps also partly due to his relocation to the UK, making it extremely unlikely that he would go through a similar experience again. Indeed, this was a key aspect in gaining ethical approval.

6.4 Design

This section will give details of the design process. Starting with an overview and discussion of the initial interview with the participant, conducted to gather inspiration for the design work, I will describe the decision-making that went into creating the prototype used in this part of the research. This will address the ways that the prototype was designed to help pursue the various strands of the research agenda set out in this chapter.

6.4.1 Initial Interview

To begin the design process for this project, the participant was interviewed about his earthquake experience so as to get details about the nature of their experience. The informal interview took place in his office, and started with him describing his experience. This included showing photos and video that he had taken, as well as websites he frequently visited that gave

information about New Zealand earthquake activity. After that, some further questions were asked in order to get more details about particular aspects of their story.

The purpose of this interview was to gather insight into the experience that could be used in the design of the research prototype. In particular I was looking for details about objects, emotions, immediate reaction to the earthquake, people and places. The following offers an overview and analysis of the interview.

6.4.1.1   Analysis

The interview began with the participant describing an upcoming earthquake preparedness campaign that a friend, still living in New Zealand, had told him about. This was a government organised mass earthquake drill [See: 59] Reading from the website, he states:

> 'New Zealand Shakeout' is a national earthquake preparedness campaign that will lead up to a public national earthquake drill at 9.26 on the 26th September. We aim to have 1 million people participate in the drill. It will be the first shakeout drill held anywhere in the world and the biggest earthquake public education campaign ever staged in New Zealand. Drop Cover Hold.

He discussed the benefits of such a campaign to people like himself and his friend who had moved to New Zealand from places where earthquakes were not common, and that for these people not knowing what to do in the event of an earthquake is a major worry. For those that had now experienced perhaps their first earthquake in 2010, this was not a simple matter of going through a drill:

> Actually they were all quite nervous, even though they were just doing a rehearsal. Because I think they are, perhaps as like you were saying, because the emotional connection is so much more real

Straight away this hinted at the, evocativeness and emotional impact of performing an action that is derived from an affecting experience.

The participant continued by describing his earthquake experience with the first event that took place at 4:35 am on 4th September, with a magnitude of 7.1:

> And of course at 4 am you're in bed and its dark, and then the shake was so violent that it knocked all the power grid out because they've got these safety accelerometers. So they switch off to save, so then of course there's no power so it's completely dark and you've just had this violent shake for 40 seconds and then you're like 'what happened there?' It was obviously a quake but like we all thought it was the alpine fault, this really big thing and we were like 'well, we've survived it, that was alright'. And it was really

cold in the house so we all, we piled into the car and turned the heater on, and the car radio on…

We just sat in the car and it just like kept on going, like more and more aftershocks. And obviously at the beginning they're quite close together, but random. So you're sitting in the car and the car's quite good because of the suspension and everything.

…

Yeah, so everyone was at home sleeping pretty much. I think there was one person who dies later on from a heart attack, but effectively there was no fatalities, so we kind of just thought 'oh well' its pretty crazy. Our house had a few, kind of tiny broken things but, nothing structural. And then the whole of the CBD was shut down, so they got the army and kind of taped it all up to stop people going in because it was just too dangerous. But, it was, our chimney looked alright but later on we had to get it removed as a kind of preventative measure

Despite being scary, this first event had relatively light consequences. The participant later discussed the second event, on 22 February 2011 with a magnitude of 6.3. Despite being of a smaller magnitude, this was a much more destructive event due to the depth and location of the tremor, but also the time of day that it occurred.

And I was at home just finishing off my phd, about to go and submit it. And I had my laptop, and like, I was just copying the pdf onto a usb stick to go into uni to print it off, and there was this huge earthquake shaking event that was just like, "oh my god!"
It was pretty dramatic yeah. Like I said the light, y'know just the normal light hanging from the ceiling was swinging so violently that the erm, it was smacking into the ceiling. And because it was a wooden house, it was on concrete piles, so it like 'that far' off the actual ground, the whole house is just shaking – you can't stand up in it. I mean, I was in my chair typing, and I just kind of held on like that [grips edges of desk] while it was going on. And then afterwards, like I say I went out in the back garden, and walked through all the glass in the kitchen and stuff from the, that had been ejected out of the cupboards.

This passage, like much of the description of the brief period around the actual shaking event describes many of the affects on objects, as well as the sounds that the house was making.

We got a brick chimney here, and the rest of the house is wooden, so wood flexes quite nicely but it sounds really loud and all the wood slats just banging against each other were just incredibly loud and we thought that was things falling off the, y'know like the bricks falling off the, bouncing off the roof

These objects are notable for their being damaged, or for their sounds they make during the destruction of the house. However, others are notable for their involvement in the more emotional aspects of the event, particularly when trying to contact friends and loved ones:

> *But then, during this one my wife was at work and she worked right in town, so there was this whole kind of thing of like, "is she alright?" and she was thinking "am I alright?"*

> *"I tried phoning Nora, my wife, and couldn't get hold of her but left an answer message. Because the mobile network was still running on batteries but it was obviously at limited capability. Erm, and I tried texting her as well, and I, sent them off but of course you don't know if they get or not."*

> *"And then Nora turned up and it was an incredible relief, and then Eli was like, "I'm trying to find my wife, Estelle, I don't know where she is", and everyone was trying to find everyone it was this whole kind of.*

There are several technological objects implicated in these emotionally stressful situations. For instance, the sudden obsolescence of mobile and digital telephones due to the failure of their electricity dependent infrastructures left the participant cut off from his loved ones:

> *And then, when it really got kind of emotional was when Nora came home and we turned on the radio, we had like a little battery radio. We turned it on, we bought that after the first one and we had to sit in the car. So we bought this little battery radio, and in fact the local electricity company started giving them out, they just posted them to people, tiny radios. So we turned on the radio and were listening to this report and they were saying, yeah one of the buildings has collapsed; I think it was the CTV building, which was like the local Christchurch Television. Erm, and it literally completely crashed killing everyone in it pretty much*

Meanwhile, the battery powered radio grows significantly in importance, as a means of gaining access to information about what has happened, even bad news.
These play an important role of in the dissemination and communication of information, an extremely important resource in these situations.
Although objects and their roles in the experience are mentioned, the purpose of doing so seems more to provide rich descriptions of their experience rather than to emphasise any specific damage and loss of objects, which did not seem particularly important:

> *Yeah [laughs], some stuff in our house fell over, like draws and things like that and just got, everything got kind of, a bit trashed - TV got trashed, and then just everything fell*

off the shelves. Our new printer fell on the floor [laughs]. Erm, yeh filing cabinets just sort of, fall over. Then like, all the contents of cupboards just like go ejected onto the floor so there was glass everywhere and that kind of thing

This may prove useful in any design response, as there is no 'significant' object to reference. Instead there is a set of perceptions and interactions based around objects that can be referenced.

Another significant aspect of the participant's earthquake experience was that of the aftershock sequences:

But the thing that was really weird that happened in the Christchurch one was just that whole aftershock sequence. Because I had no comprehension at all of the fact that there would be so many of them. That was what was kind of weird.

Often, we tend to focus of the earthquake as a single finite event, but the series of aftershocks, some of them sizeable quakes in their own right, can continue for months. One particularly memorable characteristic of these was the sound that triggered sudden apprehension:

Oh, the other thing that happened was, you could always hear the sound of the quake. You know how you get lightening and the thunder? It's kind of the opposite way round with quakes, you get the thunder then you get the shake. Because you can hear it coming through the ground, so you get like the different waves, like the primary and secondary waves or whatever.
And they wouldn't always be correlated. So sometimes you get this incredibly loud roar coming and you think, "here's a really big one" and there'll just be a tiny little wave and you think, "oh is that it?" And other times it'll be quite a small thunder before and then the whole thing will shake like crazy.

Possibly a result of being interested in geography and geology, the participant seemed particularly interested in one particular consequence of the earthquakes called liquefaction:

Erm, and so there's this layer of really sort of, soft soil and underneath it is like huge aquifers, and with all the shaking basically the soil and aquifers mixed into kind of like just jelly and mud, and the pushing effect from underneath and the kind of harder rock basically pushes that water through so the ground water just comes up bringing with it all the silts and lighter, smaller, sandy particles. Erm and then as the water goes back down again it leaves all that sandy stuff on top. So you end up with just like these huge areas of like beach, that's just this grey beach that stinks, sometimes because it's mixed

with wastewater. And then of course the houses and the heavy things sink, and the light things like the drain covers in the street rise, so suddenly you've got all the drain covers sort of sticking up that much in the road, and all the roads are broken, and then you've got like the heavy land that's sunk and sometimes y'know they didn't sink at the same rate, so suddenly houses have all got leans on them of a couple of meters and stuff and people are still living in them 2 years later like that.

Beside descriptions of the actual earthquake, the participant also described the various social developments that occurred, that both affected them personally and Christchurch society as a whole. Aside from the very occasional theft, the overwhelming majority of these were positive.

Er, I dunno, the main thing is just that it was an incredibly, frightening, emotional event. And then on the other side was this kind of, I dunno I guess a kind of warmth from the fact there was this community spirit that wanted to get together and sort stuff out, and that was really nice to see. That's the stuff that should be celebrated from it really.

Clearly these things do not make up for the trauma of the earthquake, or mean that it was a good thing, simply that people did good things in the face of adversity, and that as a consequence, the outcomes of the earthquake are not solely negative. These acts also form valuable, but positive, memories of an otherwise traumatic occasion.

The social initiative talked about most, and participated in, was a voluntary service organised through Facebook called the Student Volunteer Army [83], which is now an international volunteer service, and was started to help clear up liquefaction residue:

There was all this silt that had come up in the liquefaction process, and there was kind of really amazing guy at the uni who said, "why don't we set up a, an army, like a student army?" And he used Facebook to organize it and he got like, I don't know, 50,000 or 70,000 people top 'like' it. And then he got all the provisions from Mitre10, which is like B&Q. So we got all these barriers and spades, so we all just went and volunteered, and we just went round digging it up from old people's houses who couldn't do it themselves. And there was like hundred and thousands of tons of this stuff, it's really heavy, it's all filled with water as well, and it starts to really stink.

There were also a number of ad-hoc social spaces throughout the city that attempted to fill the gaps, literally and figuratively left in the city and the social lives of its inhabitants:

Yeah so there's this thing called 'gapfiller'. I don't know who thought of it but they just said, "there's these building which have been taken out and there's now gaps in the city, and we're missing cinema's, and we're missing nightclubs, and we're missing all these other

things; why don't we use these gaps as something?" So they got like a, little cheap generator or something and then, like a cheap projector, and then like late at night they'd just show really old films on the wall of like the next building and stuff like that.

I think yeah, they were trying to make spaces where people could meet again. Because before that you would go to a cafe or a pub, or whatever, or go and see a film together. And suddenly you've got no cinemas, you've got very few restaurants open, you've got no real public spaces. So I think we're trying to create these kind of public spaces again, so people were trying to have some new normality, its not going to be the old normality, but at least try. And I think they got some piano's, like old piano's had had been thrown away, cleaned them up and then just stuck them in these public places. So you could just roll up and have a go on this piano or whatever. They're still there now; I think they'll be there for years.

There were also some far more local and personal social consequences, wherein the need for resources like water, and the lack of things to do meant that there was now time and opportunities to socialize with neighbours:

And I think just that whole kind of social barrier of the niceties was just like, throw that out, lets just get on with it. We'd moved into this house and then like chatting to the neighbours and stuff but not really got to know them that well, but after the quake like, they were coming round to ours, we were going round there's and drinking wine and chatting and stuff. I think the community that was there integrated a lot more. They had like this common shared experience I guess. So that was quite a positive thing from it yeah.

It is these social initiatives and relationships that lend a positive aspect to the participant's memories of the earthquake, and as such are valuable aspect of that experience.

6.4.2   Initial ideas

Following the interview several initial ideas for design were explored that would potentially use data to affect or create an object using data (see Figure 26).
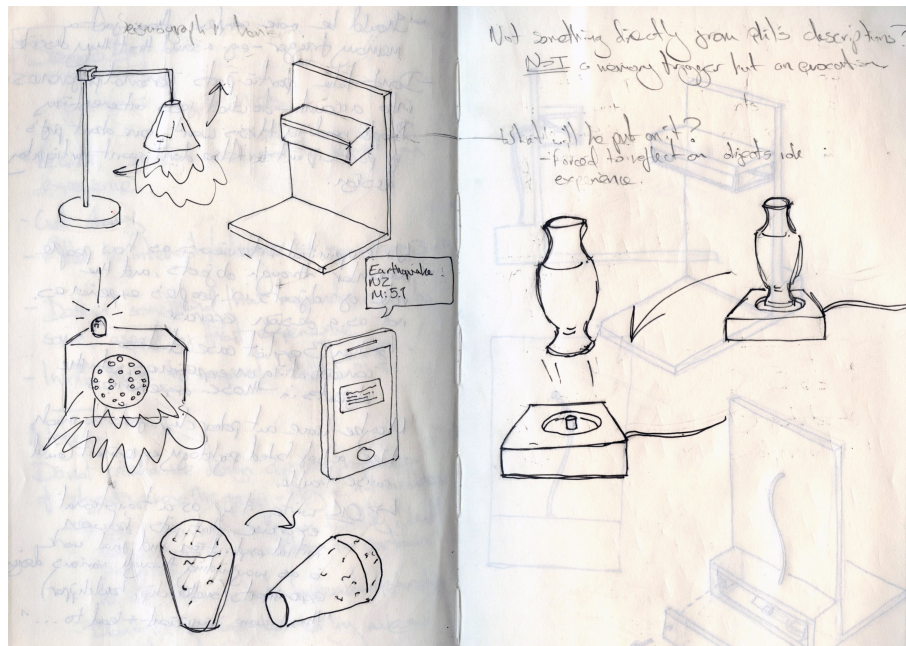
Figure 26: Some Initial Ideas

All used the event of an earthquake in New Zealand as a trigger for some sort of action. This was intended to reference the recurrent aftershocks that followed the earthquake, and reflect the relative regularity of such events in New Zealand.

All of these were based to greater and lesser extents on the descriptions of objects, architecture and environment given during the participants interview. Initial Ideas included a lamp that shook when there was an earthquake in New Zealand, a radio that read out live earthquake data, simple text alerts, and objects that would fall over as earthquakes happened.

Two more of these will be reviewed here in order to contextualize and explain the selection of the eventual chosen design.

6.4.2.1   Additive Seismometer

The participant was interested in the liquefaction that occurred during the earthquake, and also volunteered to help clear up the sands that were deposited as a result. In response to this, ideas were developed for devices that used such sand in order to create an object.
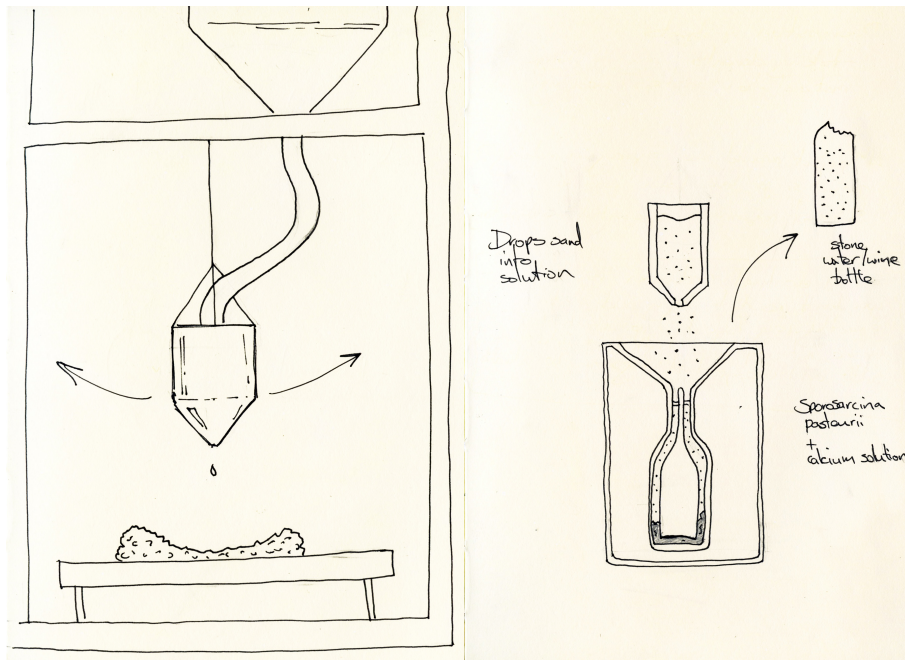
Figure 27: Sketches for the Additive Seismometer.

The first idea was a manufacturing device influenced by additive manufacturing (3d printing), and rudimentary seismometers. A shaking platform would respond to live earthquake data causing the pendulum to move and deposit a mixture of sand and resin in patterns determined by the pattern of the shaking, eventually building an object. This is an additive manufacturing process similar to the way to a 3d printer deposits plastic material, but that would use the peculiarities of each earthquake to create individual unique shapes, rather than the formation of a digital file. After exploring this idea through sketches and researching relevant technologies a few problems were raised. Firstly, this depositing and setting of material would be an extremely slow process, and because earthquakes themselves are relatively brief only a very small amount of material would be deposited.

Although this could be overcome through further iteration, the main problem with this idea was a conceptual one. Fundamentally, the object produced as a result of this system would be little more than a 3-Dimensional visualisation of the earthquake data, which contradicts the goals of this thesis. In depositing material in relation to the pattern of the moving platform, the resulting form would 'describe' a pattern of movement. Because this is legible, anyone encountering the object must then assume that the shape of the object represents the actual earthquake. Firstly, this would be impossible to achieve, because that kind of data is not available to me. But secondly, this idea would result in a form that is (or attempts to be) too descriptive of a *current* event. As discussed in the literature review, and Section 5.5.1.1, this may inhibit its ability to be evocative of a previous one.

6.4.2.2 Earthquake Shelf

Another idea was for a shelf that would shake according to real time earthquakes in the Christchurch area.
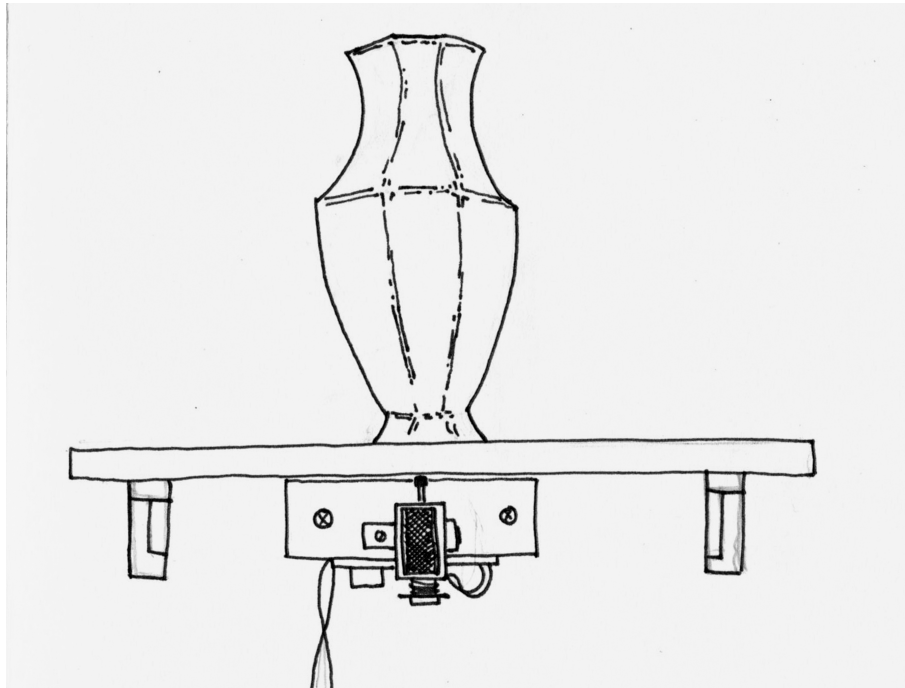

Figure 28: An early sketch of the earthquake shelf

This references the simple idea that things fall off shelves during earthquakes as an opportunity to materially embed data into an object through a simple mechanism. This changes the shelf from a sight of display to a sight of uncertainty and potential. Making use of the regularity of earthquakes and aftershocks occurring in New Zealand, this offers a connection to meaningful place and experience by using real time data to echo familiar and recognisable conditions of that place and characteristics of the experience. Further, any objects placed on top of the shelf would be remotely affected, via data and mechanism, by the earthquake. This is then a way of using data that relates to someone's personal experience, and a familiar act or action that is part of that experience, to affect the materiality of an object.

This idea was eventually selected for development as it was considered to best fulfil the requirement from the previous chapter, whilst still relating to the experience of the participants as determined by the interview. Rather than creating an object based on data, and risk becoming a visualisation tool, the shelf instead uses data to affect an object. This object is intended to be evocative in the sense that its form does not describe any readable information. In this way, using contextually relevant data to affect its material form a mechanism adds provenance to an object.

Similarly, the shelf's behaviour is also evocative rather than descriptive. While it recreates a physical action from the participant's experience, it is a generic enough action that it does not attempt to recreate or describe it explicitly. At the same time, the use of live data simultaneously detaches the shelf from describing the participants past experience, and potentially provides a meaningful link to a place, by connecting the user to the events occurring in that location. Importantly though, there is not enough there is not descriptive information available in the shaking of a shelf to associate the action explicitly to a specific current event, thereby allowing the participant to reflect on their own experiences.

6.4.3 First prototype: Testing the Concept

The development of the Earthquake shelf followed an iterative process, in order to get a sense of what the shelf could and should be like, before refining the concept and physical design.

Figure 29: An early test of the shelf concept

The first test (Figure 29) was more a physical sketch than it was a prototype. A hinged shelf was attached to a wall, with a solenoid mounted underneath that would push the shelf up and down. Eventually, and depending on the strength of the movement this would cause the vase on top to wobble and fall. In this case the movement of the shelf did not respond to any earthquake data, but was programmed automatically using an Arduino.

This test showed that the movement of the shelf, the noises produced, and the movement of the vase was satisfactory in comparison to videos of the earthquakes provided by the participant. In order to push the test further, another version was created (Figure 30).

Figure 30: Test 2, before and after

This version saw two changes. First, the shelf was made much smaller, so that only one object – the vase – could be comfortably placed on it at a time, elevating the given objects perceived importance. Secondly, the shelf was programmed to recreate an actual earthquake – the great San Francisco earthquake of 1906. The behaviours of the shelf were modelled on a written description, based on estimates of the earthquake activity:

> *At almost precisely 5:12 a.m., local time, a foreshock occurred with sufficient force to be felt widely throughout the San Francisco Bay area. The great earthquake broke loose some 20 to 25 seconds later, with an epicentre near San Francisco. Violent shocks punctuated the strong shaking which lasted some 45 to 60 seconds. [95]*

An eyewitness description found online was also used as reference to make an approximation of the event:

> *It seemed as if I had scarcely been asleep when I was awakened by a terrifying sound– the Chinese porcelains that I had been collecting in the last years had crashed to the floor. (My interest in Chinese porcelains ever since then has been purely platonic.) The whole house was creaking and shaking, the chandelier was swinging like a pendulum, and I felt as if I were on a ship tossed about by a rough sea. "This can't go on much longer," I said to myself. "When a house shakes like this, the ceiling is bound to collapse. As soon as the plaster begins to fall, I'll cover my head and accept what comes."*
> *- Earthquake and Fire by Arnold Genthe [95]*

The idea behind this was to attempt to create a prototype that followed the behaviours of a real, known event, and so to embed data from it into an object that would then represent a historical event. The clock in the image was added to indicate that the shelf starts shaking at the same time the San Francisco earthquake started. The vase placed on the shelf roughly matches the types of objects from the description, while the duration and timing of the shaking also matches

the description. This material experiment was filmed[26] to document the interaction, and illustrate the proposed scenario so that it could be reflected on to further the design process.

This test worked well in giving the sense of a specific event, but it felt like too much of an attempted recreation of event that could only ever be insufficient in describing it effectively. At the same time it felt too literal a description of the event, as opposed to an evocation. This is particularly important given that use of eye-witness data in the experiment, was intended to mirror a design that might use data gathered from a participant personal archive. Therefore the system that might eventually be given to the participant would not fulfil the design goals.

Using live data as an alternative, allows for the systems aesthetic connection to the participants experience to be gained through the action of the physical object. Crucially though, using live data of course means that the shelf will respond to real earthquakes as and when they happen. Following the varying strengths and timings of real events, as well as connection to a real event in a meaningful location adds another layer of aesthetic connection to the memory.

6.4.4 Final Prototype

Following the initial concept tests, and being happy with earthquake shelf as the most suitable prototype for use in the study, a final version was built for the deployment.

This brought with it a number of changes that were necessary both for it to fit into its intended deployment environment (the participant's office) and to ensure the desired modes and depths of interaction. Although the shelf concept was selected because it represented the best fit with the brief and requirements derived from the previous chapter, these changes were also instrumental in making sure that those requirements were followed effectively. The following description of the final design iteration will explain the changes made in terms of how they helped the prototype best address the overall brief.

6.4.4.1 Live Data

Because the decision was made to return to the idea of responding to Christchurch earthquakes in real time, a source of live data was needed. This was easily found through several sources, from the US Geological Survey [94], to New Zealand's own Geonet [31]. The decision to go with the latter was made easy as the participant also referenced it during the interview. The GeoNet sight offers a data feed of earthquakes that are 'felt'. Although these are not earthquakes reported as being felt by other people, they are described as being those earthquakes above a magnitude of 2.0, which are likely o be felt by people. Using earthquakes that have been experienced by someone else adds a nice subjective aspect to the design in connection to others.

Using live data was intended as a mechanism to connect the participant to the place of their experience, therefore evoking memories of it, rather than explicitly recreating aspects of it.

---

[26] Film available at: https://vimeo.com/43677262

6.4.4.2   Shelf Movement

First, it was decided to change the way the shelf moved. In previous versions the shelf moved up and down only, while in reality earthquakes can follow different planes of movement, both horizontal and vertical.

Figure 31: The floating frame mechanism and motor

To achieve this, a new mechanism was needed. This comprised of an aluminium frame attached to the box of the shelf via four springs (See Figure 31). A vibration motor mounted to this frame at 45 degrees using a custom 3D printed mount allowed the platform to shake in both horizontal and vertical directions. Because of the movement of the vibration motor though, this shaking can be quite uniform in direction and strength, causing the shelf top to simply move in a circular motion. The Arduino code that controlled the motor compensated for this by triggering the motor at various frequencies, durations and intervals in order to achieve a less uniform shaking affect.

This shaking motion does not realistically replicate the motion of an actual earthquake, it is more an alert or notification of the kind of event that is happening elsewhere, without trying to replicate or describe the affects of any one particular event. This is intended to make the shelf evocative of a remembered event rather than descriptive of a past or current event.

6.4.4.3   Designing to Fit Location

Because the shelf was to be installed in the participant's office, I wanted it to feel like an item of furniture so that it would fit into its surroundings better. Although it would clearly still stand out as a new and unusual presence in the office, I wanted to minimize that affect.

To begin, because the shelf was being installed in a university building, it was not possible to mount it on a wall. This, along with limited space in the office itself meant that it needed to be a freestanding structure that could be placed on an existing surface.
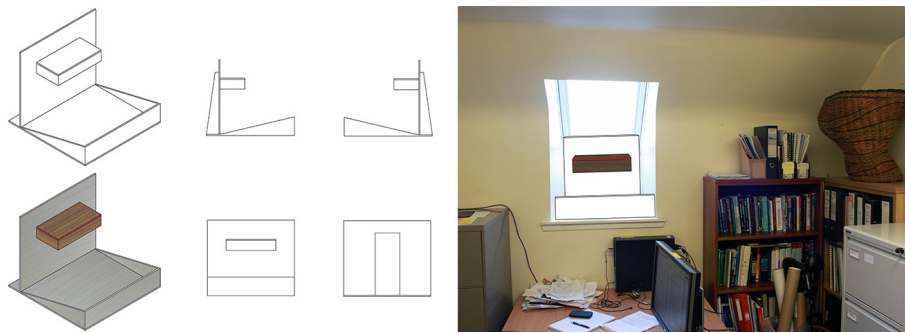
Figure 32: Final designs for shelf unit (left), and sketch of shelf in the office (right)

The place chosen by the participant was a recessed window ledge to the side of his desk (See Figure 32). A stand for the shelf was made that would fill this recess in order to make it seem more like a part of the room. This stand needed to be stable when the shelf was shaking, and to be small enough not to block the window. Because the shelf would also be quite close to the participant's desk, the design shown in Figure 32 also incorporates a raised edge around the base to catch any objects that might fall from the shelf.

This all made the shelf unit a very unusual structure, detracting somewhat from its ability to blend in and be forgotten. In order to compensate for this to some degree, the shelf's stand was painted the same colour as the walls in the office. Similarly, the mechanism was hidden from sight in a floating shelf style construction that hid the mechanisms, while the electronics were hidden behind the shelf's stand.

6.4.4.4   The Earthquake Shelf System

There are several constituent parts of the shelf system that were decided upon and developed during this final stage of the design process. From the source of the data, to the method of connectivity and distribution of software, many of these were changed in order to make the prototype as robust as possible in its ability to function for the duration of the deployment. For example a previous system configuration, that was abandoned, involved an Arduino [1] connected to the Geonet server over wifi, requesting and parsing the data itself. However, over the university network this was at best temperamental, and would often need to be restarted. For a field deployment, the system needed to be as robust as possible, so the final system split this process into two separate parts with dedicated machines, and pieces of software.

Figure 33: The earthquake data feed on geonet.org.nz

First, an application written in Processing [71] running on a local machine in the research lab makes an http request to geonet.org.nz (Figure 33), in order to retrieve data about the most recent earthquake associated to Christchurch. From this data it extracts the magnitude, and uploads that number to a data feed on the cloud based data streaming service Xively [98]. This fata feed acts as a mediator between the local machine and the shelf, and because it is easily accessible online, allows the shelf to be monitored from anywhere.

Figure 34: The Xively data feed used by the earthquake shelf

Next, the Arduino board [1] that controls the shelf makes a simple request to the Xively data feed [Figure 34] to retrieve the magnitude of the most recent Christchurch earthquake. If there has been a new earthquake, the Arduino code maps the magnitude number to an integer in the usable range for the motor, and calculates how long the shelf should shake for. Then, the motor is triggered and controlled to shake the shelf according to the strength of the latest earthquake.

This was a much more robust system configuration than the previous versions, which relied solely on an Arduino to retrieve data over Wi-Fi, and lasted for the duration of the deployment.

6.4.4.5   Mapping Shelf Movement to Earthquakes

Although the shelf uses very descriptive earthquake data containing information about location, magnitude and depth for example, these details are only used for loosely determining the shelf's behaviours. None of that information is available to the participant through the shelf. This provides a level of ambiguity that aims to prevent the participant from thinking too much about the details of a recent earthquake, and instead to reflect on a more personal basis.

To begin, the shelf only responds to earthquakes that are felt in the Christchurch area. That is, felt earthquake events of any size that include the word 'Christchurch' in the XML description. The magnitude determines the extent to which, and the duration for which the shelf shakes, but these behaviours are not reflective of how a actual shelf might shake in that particular earthquake.

6.4.4.6   Object on the Shelf

While previous versions focused on the ways that the shelf, and earthquake data might affect an unassociated object, in this deployment the participant was asked to choose what to put on the shelf.

This requires the participant to deliberately select something to go on the shelf and so promotes the intent behind choosing objects to be affected by the data.

This is also a way to promote freedom of interpretation of the meanings and associations that might come from experiencing shaking events, and to ask the participant to engage with it on a more personal level from the outset.

6.5 The Deployment

The deployment of the Earthquake shelf followed a typical field trial template as set out in the Methodology chapter [Section 3.4.2.4]. While that chapter discussed the purposes and benefits of using such deployments, this section will report on the more specific details.

6.5.1 Setup

Although it was originally intended as a domestic device, the participant required that the shelf be installed in his office at work [Figure 35].

Figure 35: The Earthquake Shelf installed in the participant's office

During the interview about their experience, a good place for the shelf was agreed, along with gathering any technical requirements of the room, such as power and wired Internet access. The office was shared with one other person, who had also previously lived in New Zealand, but was not there during the earthquakes.

An approximate 5-week deployment was agreed upon but it transpired that the participant was away from the office for much of the first week. The deployment period was lengthened by one week, beginning on 13.06.2013 and ending on 26.07.2013, with the shelf being collected 2 days later. Because the software that retrieves earthquake data was located on a local machine at another location, the shelf was activated the day after installation, and deactivated on the day the deployment was scheduled to end.

6.5.2 Adjustments

Part way through the deployment the catchment area of the shelf was widened. Initially it was designed to respond only to earthquakes in the Christchurch region. However, after three weeks of the living with the shelf, earthquake events in the area were uncharacteristically infrequent, while the most of the events that did occur did so when the participant was not in the office. Although the shelf was intended to act infrequently in mimicking the frequency of local earthquakes, this lack of activity was problematic because, given the limited duration of the deployment, there might be little opportunity for the participant to engage with the shelf. The Earthquake Shelf's focus on using physicality to evoke memories of an experience meant that actually experiencing the shelf during a shaking event was vital to the participants ability to reflect upon its meaning. They may be aware of what the shelf does theoretically, but there is no replacement for actually experiencing the physicality of the shaking. As a result, we decided that

it would be beneficial to increase the frequency of the shelf's activity, or the likelihood that it would discover real earthquakes. In order to achieve this, the software that retrieved earthquake data for the shelf was re-programmed to respond to any earthquake in the whole of New Zealand. That is, every 'felt' earthquake provided by the geonet.org.nz data feed. The affects of this change will be discussed later in the chapter.

6.5.3   Diary study

During the deployment there were two main ways of collecting the participant's reactions to, and reflections upon living with the earthquake shelf. The first of these was a diary study run during the deployment so that the participant could record their reflections on the shelf as and when they occurred, or whenever the shelf did something. This method id perhaps better suited to recording their more immediate and 'in the moment' responses to the shelf actions.
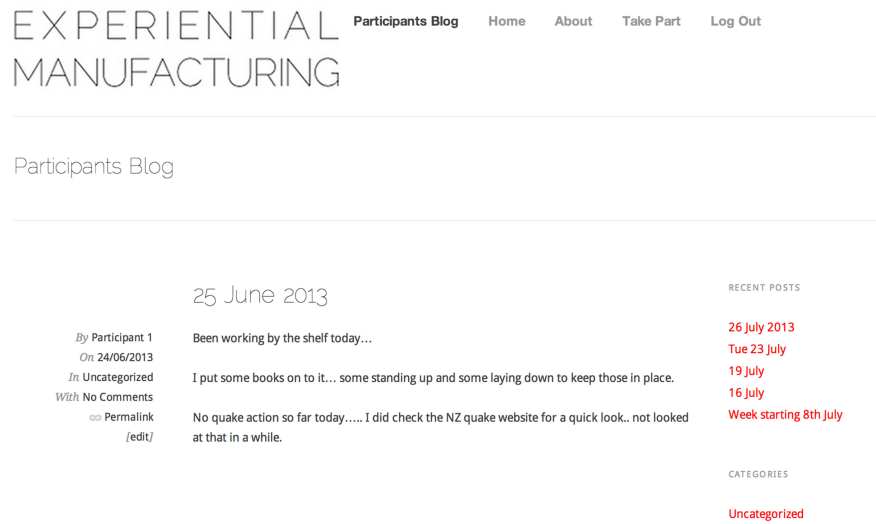
Figure 36: An entry in the participant's blog

Prior to the physical installation of the earthquake shelf, a user account was created for the participant on the project website, and they were given their password and username at the end of the installation. They were able to make blog posts that were automatically categorised into a private blog (See Figure 36) only accessible when logged into the site. As such, these entries are not publicly viewable, and the participant and myself were the only people able to see them. The participant was also asked to take photos of the objects that they had decided to put on the shelf, and if possible after having fallen, but these were instead provided via email, rather than in the blog posts. The participant posted to the blog regularly, completing 13 entries in total.

6.5.4   Follow-up interview

The second method for collecting responses from the participant was a follow up interview that took place after the shelf had been uninstalled. This was supposed to take place on the same

day, so that the shelf, and the objects placed on it could be directly referred to and discussed. Unfortunately, due to the personal circumstances of the participant, this interview was delayed and conducted over Skype on 27.08.2013.

This interview was based around a discussion of the participant's blog posts, using themes from them as talking points for further discussion, and to elaborate on points that may have been made briefly, or only suggested. This was intended as a more reflective method of data collection, wherein we could discuss the deployment, and the participant could reflect more deeply on the experiences.

6.6   Analysis

Given the individualistic and personal nature of this investigation, formal coding methods were not used to analyse the interview data. Instead the transcripts of the interview were subjected to a simple thematic analysis to find themes that related to the research questions. These are addressed directly below.

6.6.1   Findings

The findings from the interview can be divided into three main sections that represent three distinct phases in the deployment of the earthquake shelf. In the first phase, the Earthquake Shelf represented and created a strong reflective emotional connection to the participant's own experience of the earthquake in Christchurch. In the second phase, the meaning of the shelf changed, instead providing an empathetic emotional connection to people that the participant knew. The third phase on the other hand leads up to the end of the deployment and involves a 'wearing off' of these emotional values and reflective qualities established during the earlier phases.

These sections will be discussed in terms of the themes that constructed these phases, and that caused the change between them. First though, it is necessary to discuss the objects that the participant chose to put on the shelf.

6.6.1.1   Objects on the Shelf

The first thing discussed during the interview were the objects that the participant had chosen to place upon the shelf:

I put books in the end just because they were less destruct-able than china and glass. And really I was just thinking the things in New Zealand that fell over were, well obviously lots of breakable things which weren't really appropriate, things like a TV which would be difficult to fit on the shelf, and the other things on shelves were really CD's and books. So I just thought why not get books because they are easy to re-stack and they don't get broken. They're just old, scuffed books

Books were selected because they were the most practical choice out of those possibilities that could be connected to the original experience, but were not selected because they, as individual objects had any significant connection to the participant's experience. However they also served a more functional purpose:

> *And obviously it is good to have something there because if a quake happened at night when you're not there, or a day you weren't in there a visual indicator that something had happened. If it was significant enough to chuck the items off the shelf.*

Having something on the shelf that could also fall off provided a form of notification that a strong earthquake had happened while the participant was absent. This also indicates that the objects on the shelf were not the main focus for the participant. They served a functional purpose, but were not seen as particularly significant beyond that.

6.6.1.2　*Phase 1: Emotional Connection to Christchurch Experience*

In the first 3-4 weeks of the deployment the participant felt that the Earthquake Shelf provided a strong emotional connection to the memory of their previous earthquake experience in Christchurch, New Zealand. This connection was the result of a number of interactions elicited by aspects of the shelf's design as detailed below.

6.6.1.2.1　'Real-ness'

One of the key aspects of this emotional connection had to do with the physicality of the shelf, but also to the interactions that were enabled by the inclusion of data. These physical and digital factors are included together here, because as far as the participant's responses are concerned, the two are not cleanly separable and contribute equally to their emotional connection to the memory of their experience. The most immediate value in the shelf's physicality was brought about buy the physical presence that it exhibited:

> *I think at the start there was an incredible novelty to it and I felt actually there was an emotional link. It felt like this is a real thing in the office that's vibrating because something real is happening on the other side of the world, and that whole reality was quite different to what I expected. Because looking at quake net [website], or whatever and looking at graphs, just becomes somehow scientific study of it rather than the real thing. I think making it a real object does definitely create a stronger link to New Zealand, and I think that's actually why my friends who came in and saw it were like, "oh, this is like a bonding across the planet to something", and it seems much stronger than just looking at a chart.*

The physicality of the shelf then, combined with its connection to real events created an "emotional link" by evoking memories of experience, but also by connecting them very directly to a meaningful place. As hinted at in this excerpt, this significance of the physical experience provided by the shelf was later exemplified further by the reaction of visitors to the office who had heard about the shelf:

> *Participant: But some other Kiwi's who were there who were also working in the geography department were kind of interested in what it was doing, and especially because I think one of them is from Blenheim, that second series of events round Wellington were all kind of affecting Blenheim so she was interested in how her family were doing there, and if her Mum and Dad were ok, and that kind of stuff, so for her there was suddenly quite a lot of interest. Rather than having to go back and forth to the Geonet site to see if anything is happening or checking in the news pages, there was kind of an alarm for her. So I think that's why she suddenly became quite interested in it. And she was like, "where can I get one", and I was like, "sorry you've missed your chance, I did ask you"*

> *Interviewer: So I guess that shows an interesting difference between seeing it, experiencing it and being told about it*

> *Participant: Yeah, I'd say so. Again though a demo button would be quite handy. Like if you wanted to persuade more people to take part in the experiment, some kind of demo facility or whatever.*
> *I know you had some stuff on your webpage, with the vase and stuff but again it's the difference between a picture and a real object.*

For these visitors, experiencing the shelf as a physical manifestation of data emphasised the tangible and visceral connection to events and places, therefore changing their perception of the shelf from that which they had formed given just a description.
The participant was adamant that the physicality of the shelf provided a very different, and more emotional experience than looking up earthquake information online:

> *I think it's because when it's going off and you're there it's sort of impossible to ignore it. I think William made a comment about, initially he said, "just a pop-up on my computer screen would have done the same job", but I very much disagree because my computer screen pop's up things saying you've got new email and you need to update your antivirus and all sorts of stuff, which I can quite happily ignore for a long time. But there's no way you can ignore this thing violently shaking in the corner of the room, so it was an immediate attention grabber. And because it was a real object that was sitting in*

a room all the time, and not something you had to turn on, it was just always on, it made it quite different. So there was a lot of difference between a pop-up on a screen and a real object.

Here, the Earthquake Shelf's physicality makes it un-ignorable. In responding to an earthquake by mimicking aspects of that event, it demands attention, and this is in part where its emotional impact begins.

6.6.1.2.2 Single Function

Another aspect of the design of the shelf that enhanced the participant's emotional connection to their experiences was that it had a single purpose:

Oh yeh, and the other thing is - it only has one function doesn't it? It's a shelf that vibrates when there's an earthquake, and that's it. It's a very simple function. Whereas if it's something like a computer or an iPad or a computer or a phone app or something, you can do so many other things with your phone that you can quite easily be distracted by all the other things you can do with it and therefore not look at the quake link thing. So I think the fact that it was just one function, makes a more direct link and a much simpler link.

The single purpose allows clarity of engagement, and here the participant values the direct link to the place and events of his experience through the action of the shelf. By making as direct a connection as possible to real events elsewhere, there is no misinterpretation:

Also it doesn't require any training at all does it, you set it up and then all I have to do is sit there and notice if it did anything or not. Whereas with any other device, you need some kind of, y'know, how do I get the information out of it? Even if its something fairly simple like a TV, you know, its fairly simple, but you still have to know, "how do I turn it on and where's the remote and how do I change channels", and stuff like that. But this required literally no instructions.

In this simplicity, there is nothing to interrupt engagement with the information, and therefore nothing to disrupt or detract from any reading of, or reaction to it. To further contextualize his point, the participant then likened this singular functionality of the shelf to a smartphone app:

Yeah I quite like that. I guess in a way, that's what apps have become on phones, like you can get most of the same information from web pages, but people just want to push the button that says 'BBC news', and it instantly has one job of showing you the

news. So in a way I guess the app phenomena on the phone is sort of trying to do the
same thing.

In being limited to a single function the shelf also has clarity of engagement and meaning in that it represents one event, and therefore a direct association to the participant's experience. The comparison to apps is an interesting illustration of this idea. Apps, to greater or lesser extents, are distinct units of software dedicated toward a single purpose, or to providing access to information of a specific kind. We might use an app dedicated to the weather forecast, news, or for sharing our personal photos with friends for example. While many of these will involve greater or lesser complexity, depending on the detail, or different uses of the data being used, their dedication to a single task allows more direct, and clearer engagement with that data. These app-like characteristics, combined with the visceral properties of the physical action, is a seemingly powerful combination in directly and clearly engaging the participant with the data, connecting the participant to their experience, and therefore in provoking an emotional response to the data and object.

6.6.1.2.3   Live-ness

The Earthquake Shelf's use of live data was an aspect of the design that played an important role. Firstly, it was vital to the participant's engagement with the prototype:

> *I think that was crucial actually. I think if it was historical events, I wouldn't have been*
> *that interested, because I wouldn't know 'when and what'. So I know there have been*
> *earthquakes, what's the reason to have something that's vibrating now from some*
> *historic event but I don't know where or when it was. So I think it being live was actually*
> *a critical part of the whole thing.*

As well as influencing the participant's interest and engagement with the Earthquake Shelf, it was also a significant influence on his construction of emotional meaning in the data, and the object. Live-ness, and the knowledge that something was happening now, supported this through the connection to other places and real events that held emotional significance for them.. This was also a powerful link to the memory of his experiences, and to the predicaments of other people they knew.

> *So there's a little bit of delay, but I think the more live the better actually, the more real-*
> *time the better. From a kind of, feeling that this is a real event. I think it would be so hard*
> *to recreate the whole emotion and feeling of the original event, it's such a large scale*
> *and everything around you is moving and vibrating and you're kind of worrying about*
> *your life and your loved ones lives and stuff that it wouldn't be possible to replay that on*
> *a single thing like a shelf, y'know, you'd need to do the whole building to actually be*

able to replay the Christchurch thing. I think in a way this is a sort of a surrogate, but it's more of an informative thing than a recreation thing for me. Or maybe a trigger rather than an informative thing. Yeah, its maybe a trigger to go and look up more information, so its more of an alarm for raising awareness. And for that reason I think it has to be live.

Here the participant discusses the idea that, because it is impossible for the shelf to effectively recreate any aspect of his experience, it acts instead as a sort of experience specific alarm, or "trigger", that notifies him in a very 'real' and evocative way that an event he is interested in, and has emotional investment in, is happening across the planet. This compels him to seek out more information, and to engage further, and reflect deeper on the events.

6.6.1.3   Phase 2: Emotional connection to People

The second phase of the participant's engagement with the Earthquake Shelf saw it shift from a device through which he remembered and connected with his experience, to one that connected him more to people that he knew. This followed the adjustment of the shelf's function from responding to earthquakes felt only in the Christchurch area, to those that were felt anywhere in New Zealand. As further explained in section: 6.5.2, this change was made following correspondence with the participant and although it was conceptually important that the shelf be linked to Christchurch, it was also important that in the relatively short period of the deployment, he should be able to engage with and respond to the shelf. This was echoed by a comment made during the interview:

I think partly because the experiment was to do with the emotional connection to this, and if nothing happens there would be very little to talk about. And also because I wasn't entirely sure if it was working. So y'know it would be good to, because we'd had that issue with the ethernet connection in the office, so I guess it was also the reassurance that it was connected up and functioning as it should. And i guess its just always more interesting to involved in something where something does happen, rather than an experiment where nothing happens.

There seemed to be a general confusion about how to respond to or engage with the object. This was in part because he had not yet had enough opportunity to do so, but also because he was unsure that it was even working, and had no way to check due to the limited interaction. These are characteristics that are extremely uncommon in normal life with electronic devices and so may have caused uncertainty or confusion. Once this alteration had been made, however, the participant's reading of the device was changed significantly. Changing the data that the shelf represented also changed the object's meaning:

I think it was necessary to change it otherwise I think there would have been very little to talk about. But I think it was interesting to change it after a couple of weeks because the first bit was much more about the links to our experience, and the second bit was much more about New Zealand as a whole and that people were going through something similar to what we had been through.

So, while his experience started as one of reflection on their memories, in breaking the explicit link to the location of their own experience, the participant's engagement with the shelf became more about empathy for the current experiences of others. This was still engagement on an emotional and reflective basis, but now their refection was less direction towards reminiscence of their own experience, and more onto the current experiences of others.

6.6.1.3.1   Supplementary Information

Because the Earthquake Shelf provided no actual data about the earthquakes it was responding to, the participant sought out the detailed information online as a way to check on the seriousness of the event and supplement the more visceral response connection that the shelf provided. The frequency with which they did this, and their motivations for doing so, seemed to change with the adjustment of the shelf's purpose, and so supports the observation that their engagement shifted from personal experience to empathy for others:

I think initially it was curiosity with the Christchurch ones, in that sort of first phase. But then the second one was probably more of an emotional link, because with Wellington I was thinking, there's always been this, "the big quakes going to happen in wellington, it's overdue", so I was kind of expecting there to be a major catastrophic event there, and I was thinking "is this it?" So there was probably more of an emotional connection to those events because it felt more serious. Whereas I think the Christchurch ones, I'd be quite surprised if there was a really big one for quite a while. I imagine there'll be aftershocks of fairly decent size, but hopefully nothing as big as the original ones. Not a new event. And the Wellington thing was a new event, so I probably looked more at the news for the wellington ones as well, like stiff.co.nz, quite a good news gathering site for new Zealand, so I kept looking at that.

So, after having been notified of an event by the shelf by this information combined with his own knowledge of earthquakes (resulting from his experience) allowed him to get an idea of the severity of an event. This also allowed him in turn to curate his own data sources, looking up the information that he thought was valuable, rather than having it decided for him through the design of the shelf.

Although the participant felt emotionally connected to this series of events due to empathy resulting from his own experience, he went on to discuss this in terms of emotional connection

to particular people too. The supplementary information became a way to check up on friends, and get an idea of how they might be doing:

> *And of course with the Wellington set of events, when it became a New Zealand wide experiment, and thinking about Wellington, like I said we've got friends there and I saw on Facebook, one friend was actually watching The World's End, film with Simon Pegg, and they all kind of left the cinema screaming, which was a bit ironic. So there's an interest in how they're getting on. So when the device vibrates we're like, "I wonder how Gregg's getting on", or whatever, in New Zealand at the moment and go and look the details up. So at that point I guess it's more of a connection of people that we know in Wellington, rather than our experience of Christchurch.*

In this sense, the activity of the shelf connected the participant to specific people that he knew, by triggering him to think how they might be being affected by the current earthquake, or aftershock.

Here, more detailed information helped him to know more about what others were going through, and so to form more empathetic connections. Previously, on the other hand, more detailed information added little to his reflection, as detailed information about current events, had little impact on his personal past experiences. The temporal location of his engagement was now in the present as opposed to the past.

6.6.1.4   Phase 3: 'Wearing Off'

At around 1-2 weeks from the scheduled end of the deployment, a third phase of the participant's engagement with the Earthquake Shelf began. During this time, various factors conspired to turn the shelf into an intrusive and annoying device where it had once been a valued source of emotional connection to the past, or people.

6.6.1.4.1   Too Much too Often

In the final few weeks of the deployment, shortly after the change of the shelf's catchment area, there was a major earthquake and series of aftershocks that affected Wellington and the surrounding area. These were consequently picked up by the Earthquake Shelf, which caused a dramatic increase in its activity during the final weeks, shaking as many as ten times in a 24hour period. The Earthquake shelf was to designed to have quite a violent and affecting action, but also, crucially, to act only very occasionally; a behaviour that relied on its relation to a relatively small geographic area. Understandably then, this increase in activity had adverse consequences:

> *But I think also later on that started to wear off and maybe with the Wellington sequence when it was going off quite a lot it more became a little bit frustrating maybe. This thing*

is just going off and its like, yeah I know there's a quake - I don't need to have this violent shake along side me.

Although this 'wearing off' of the emotional connection felt through the shelf is partly due to the sheer frequency of action in the latter half of the deployment, this is also combined with the participant's prior knowledge of the quakes that were happening through news and social media outlets to make the notification that the shelf provided unnecessary:

But then that whole sequence of - and then you expanded it to look for quakes across the whole of New Zealand - and there was that whole sequence of events going on in wellington. Well, in the cook straight between wellington and the South Island. And from Facebook and other things, I knew that was going off, so it almost then became a case of being in the office thinking, "I wonder when the shelf's gonna go?" Because I kind of knew there was going to be a whole aftershock sequence and it would be quite active for a while. In which case I was thinking about New Zealand anyway, and I'm wondering when this is going to tell me something happened there.

This also indicates that the 'realness' bought about by the shelf's physicality that had been so important earlier in the deployment, had now become a drawback:

I think I made a comment somewhere that maybe, because its quite destructive, or quite violent, then in that respect it was quite a distraction from my work or whatever, whereas if it was something perhaps more artistic then it wouldn't have mattered. So if it was something quiet like a fountain or a light that glowed or something. But then I guess you would miss lots of stuff because you wouldn't be looking at it. Yeah. Yeah I think maybe because it's so loud, it just became intrusive.

The frequency of action, combined with the 'violence' of the action prevented the shelf from effectively moving to the background of attention when not active, and so it very quickly became disruptive and annoying.

6.6.1.4.2   Location of the Shelf

This overbearing interaction was exacerbated by the location of the shelf. The participant considered the suitability of having the shelf in the office as opposed to the home:

I think it would have been interesting for my wife Nora to see it as well, because obviously we experienced the quakes together. And just coming home and talking about it is not quite the same, as opposed to seeing it. I guess also, at home you're probably walking around more, because there's more rooms, rather than just having the one

office room. So it might be that you hear it in the distance, and go to have a look as opposed to being alongside it or not being alongside it. Whereas at home it might be on the lounge and you might be in the bedroom or the bathroom and you hear it and you can go and have a look. It might be a slightly different experience for that I guess.

Clearly he considered that the location of the shelf had a huge affect on the attention it demanded from him. He considered that the home might offer a more casual, and occasionally distant relationship with the device. Its presence in the office was also at odds with the practices that one would be engaged in there:

Also I guess at home be relaxing or watching TV whereas at work you tend to be, you're working. At work, if you're trying to focus on something it can be quite a distraction. "Oh, it's going off, what's going on? Oh yeah I was doing something else over here", whereas at home maybe you're not so deep in concentration on something else that it becomes a massive distraction, its just sort of a side thing, a sideshow.

Simply, it proved largely distracting in these later stages, in a setting where distractions were not always welcome. Where once it's being un-ignorable was a part of its value, the enforced close proximity of the office, and its frequency of action made it a negative presence. This further suggests that the Earthquake shelf would have been much more effective as a domestic technology, as was originally intended.

6.6.1.4.3 Simplistic functionality

Distinct from, but related to the idea that a singular function was valuable in providing a direct link to an event, is the observation that although the shelf provided an emotional and visceral connection, it did so in too simplistic a way to remain engaging. After the period of intense activity discussed above, this meant that the shelf's affects became overfamiliar and became mundane.

Actually I don't know if it would be relevant or not, the vibration was its only way of indicating an event. I wonder if it had multiple ways of triggering something that you go, "oh, something's happened." So like if maybe it didn't just vibrate, but could do other things, like the lights or whatever, or if it could ooze out wet sand or something like that, and then there'd be many different things that could make me more interested in which one of those it had used and why?
So like, if it was a big quake, in Christchurch and there was some liquefaction reported somewhere, in that respect it may be more emotional because it's using different ways of communicating instead of repeating the same thing.

In this simplicity the shelf's behaviors and interactions became repetitive:

> *So I think you become used to it quite quickly. Like, its vibrating - there's a quake.*
> *Whereas if it used multiple ways of communicating you might look at it and go, "oh,*
> *hang on, tis is a different kind of event". I know it had the duration and magnitude but,*
> *yeah, rather than just vibrating if it could do some other things, like the sounds and*
> *smells, so triggering different sense maybe.*

So while this simplicity was an intentional characteristic of the design, that initially gave the participant a clear and direct emotional connection to memories of their past, it was possibly too simple to remain engaging for long.

6.6.1.4.4   Negative Associations

Another factor that possibly contributed to the 'wearing off' of shelf's value was that the shaking action used by the shelf – a destructive action that caused objects placed on it to fall - tended to remind the participant more of the negative aspects of his experience.

> *Yeah I think perhaps because of the destructive side of it but then, I think I mentioned it*
> *to you, there's this whole kind of camaraderie that came out if it as well, there's the*
> *student army that formed where people dig out all the liquefaction residues form*
> *gardens, and food drops. All that kind of thing went on. There was no electricity or gas,*
> *so people were dropping off food, and getting to know neighbours and things. So there*
> *were lots of positive things that came out of it as well. Mainly to do with community I*
> *guess, and the way the community responded and got closer as a result. But the shelf*
> *really does kind of, due to its violence, as you were saying earlier there was no warning*
> *it was going to happen it just sort of goes off, so a result, you end up with a sort of a*
> *violent reminder, and that connects to the more violent aspects of earthquakes rather*
> *than the kind of cleanup phase*

While the shaking action was intended to remind the participant of their experience, it was abstracted to the point where it was hoped that the resulting ambiguity would allow them to remember events as they wished – good or bad. Clearly though, this was not the case, and because the evocation of the shelf hinges around a physical action, it had mainly negative connotations:

> *It's hard to think of what would recreate the positive things because they're sort of*
> *people based, whereas the shelf thing is really more to do with the physical activity of*
> *the earthquake.*

6.7 Discussion

The prototype deployed in this chapter was designed to investigate the evocative possibilities of combining physical interaction with secondary digital data that relates to a person's previous experiences. This investigation was a mechanism for interactions that encouraged emotional engagement with and reflection upon a previous experience, and also to result in the creation of an object that would in turn be embedded with meaning, acting as a longer lasting focal point for such reflection.

In order to achieve this the design of the research prototype followed 4 principles derived from the previous chapter:

- Objects should evoke
- Evocative Actions
- Intent
- Objects as Personal Connection.

The ways that these were used in the design process are detailed in the design section (6.4) of this chapter. The purpose of this section though, is to establish the extent to which the ways these were used in design were effective in achieving the goals of the prototype, and which other factors contributed to the construction of value through interaction.

6.7.1 Making a Meaningful Object

According to the research question, the first question we must ask is over whether the shelf was able to embed personal meaning into an object by using data relating to a previous experience to affect the object in an evocative way.

In this regard the Earthquake Shelf, as used in this research activity, must be considered unsuccessful. Throughout the interview the participant gave no indication or mention of the objects upon the shelf other that their practical use in signifying that there had been an earthquake when the participant was absent. At the beginning of the interview, the participant stated explicitly that the books on the shelf had not changed in his perception of their meaning as objects during the course of the deployment. This is in spite of the fact that he purposefully chose the books because they related to his original experience. During that event, many objects were ejected from shelves, and books were the least breakable or dangerous items he could choose, and so any association to, or significance within the original experience was extremely loose. The lack of meaning, or change of meaning attributed to the books may be because of several reasons. Firstly they were objects that the participant already owned, and therefore had preconceived ideas about. They were already familiar to him, and as a result they already had meanings associated with them that disrupted the addition of any new meanings. Secondly, there was little value already associated with the books. The marks of use they bore were not affordances of memory but simply the signs of an old, worn book. As a result, any further damage or change of state was not seen as remarkable or significant.

Thirdly, while the books placed on the Earthquake Shelf bore physical and visual marks from being shaken off multiple times, these were lost amongst existing scuffs and marks. As a result they were not perceived as really being marked or affected by the earthquake. In other words, the material affects of being on the shelf were not significant enough to be noticed, or considered as being related to a specific event.

To overcome these issues, it may have been more effective in the case of this investigation to supply the participant with a new object. This object would therefore carry no preconceived meanings or associations and could be associated primarily with the shelf. Similarly a new object would show the signs of wear and damage more prominently, and it is then possible that these marks would be more noticeable and therefore significant to the participant and attached to the event. This could be taken further by designing the object to get damaged, or broken safely, and in certain ways. It could then easily be reassembled into a functioning object, the only material damage on which was inflicted by the shelf.

This echoes the sentiment of the singular functionality that the participant valued in the shelf. One device affects one object, which in turn has one meaning.

6.7.2   Emotional connections to previous experiences

The next question then is whether or not the Earthquake Shelf was successful in connecting the participant to their previous experience in an emotionally meaningful way?

The participant spoke definitely of the real, and visceral connection to the memory of their experiences, and of an empathetic connection to people experiencing current earthquakes as a result of the Earthquake Shelf. In creating a bespoke system that reflected a previously lived experience, the shelf was able to use data and a physical device to evoke memories and elicit emotive responses. It was able to evoke memories of past earthquake experiences by physically manifesting live earthquake data in ways that related to aspects of those previous experiences; the connection to Christchurch, the shaking of a shelf, the sounds of wood knocking etc. At the same time it reflected current events of a remote location such that the participant felt (via memory of their own experience) connected to other people currently going through a similar experience.

However, this was not without problems, and during later stages of the deployment, those things that created these meaningful interactions also became detrimental to the value the participant gained from the shelf. These changes are presented here as a balance of tensions that relate to the combination of physical object and data, and how these balances changed, or might be changed, to negotiate different from of engagement and interaction.

6.7.2.1   Reflection and Utility

The physical manifestation of online earthquake data created a visceral and 'real' connection to the participant's past experiences and in doing so strongly evoked memories of these experiences, causing an emotional response. That is, the shelf encouraged them, through its

'real' connection to events in Christchurch, to reflect on these events and their experiences in a much more emotional way than a purely digital interaction might have done. This is demonstrated by the participant's comments that contrast the difference they observed between looking up earthquake data online, which became something of a scientific exercise, as opposed the purely emotional affect of data experienced through the shelf.

To emphasise this difference between the emotional and knowledge based presentations of data, the shelf would often leave the participant wanting to find out more about the events that had occurred. To begin with the main focus of reflection was their own experiences, and so the purpose of the supplementary data was simply to satisfy curiosity. Later though, when the data that the shelf used was changed, and the implicit link to Christchurch was broken, the participant's interpretation of the shelf changed. He was no longer exclusively focussed on his own experiences, but instead became about empathetic connection to other people experiencing the current earthquakes. In this case the interaction with the shelf was still reflective and emotional, but the purpose of seeking out supplementary information became about getting a clearer sense of what others were going through. So while the shelf's purely evocative (as opposed to illustrative) use of data was satisfactory for more personal reflection and a purely emotional response, as soon as a need for some form of utility was introduced it became deficient. We know from existing research, as well as the exploratory interviews conducted at the beginning of this thesis that utility and emotional affect are not mutually exclusive, and can in fact be reliant on one another [4]. However in the case of the shelf we are talking about function of the data as manifested in the device, as opposed to the function of the device itself. For instance it is feasible that the shelf, if adopted long-term into a domestic setting could provoke emotional reflection through its simple display of an object, even when not reacting to earthquakes because it has the latent potential to do so. But, as soon as another requirement is placed on the data, and the need of it changes from emotional reaction to a need for practical and measureable information, the purely evocative output is no longer satisfactory. Therefore the exact role of the data, and any potential demands that might be put upon it should be considered when designing such technologies or experiences.

In using online data sources to connect a device to a specific place that was meaningful to the participant, and doing so by referencing an experience that they had there, the participant was able to reflect on their own past experiences. However in this sense the shelf also provided a realistic empathetic connection to friends in those locations.

These affects seem to support the idea that, when properly designed, the combination of physical and digital can create emotionally engaging interaction and reflection on the past and empathy with the present.

6.7.2.2   Live-ness

In this investigation, the use of live data was vital in creating the emotional responses, and reflections on the past elicited by the Earthquake Shelf. The knowledge that they were remotely

experiencing these events more-or-less as they happened was vital to the participant's engagement with the prototype, but also in encouraging them to reflect upon their own experiences.

This live data, and more specifically the knowledge that something is happening in a place *now*, connects the user to that place very directly. By allowing them to effectively share an experience – albeit remotely - they can reflect upon it, and also gain an empathetic connection with that place and with the experiences of others. This is further emphasized by the physicality of the shelf, where the very tangible and evocative interaction makes a seemingly more real connection to an event. Other researchers have also found value in using live data. For example, in evaluating a data driven artwork that connected to location, Jacob's et al also found live-ness to be a vital aspect of peoples' experience if the work:

> *In contrast to slowness, the artists also emphasized how it was vital that the work should make a live connection between two remote forests in order to support a localized and viscerally real experience.* [41, p7]

This works because the participant, or audience in this case, can relate what they see in the manifestation of the data to their own experiences and thereby create an empathetic connection with the other place. For example, in this investigation the 'viscerally real experience' of the shelf is created by the combination of empathetic connection to place, the direct reference to one of the participant's previous experiences (both in the data being used and the device used to output it), and the physicality of the device.

It also this connection to experience that allows live data to be a material for reflection on one's past, as well as reflection on the present thereby creating a potentially more complex relationship with the digital and physical material.

However, responding to live data can cause difficulty, especially when the device has very limited functional interaction, and the source of that data is as unpredictable and uncontrollable as the occurrence of an earthquake. This occasionally lead to frustration for the participant who could not interact with or control the shelf more directly in order to test it, or demonstrate it to visitors. The relationship to this form of interaction then is a difficult one to balance. A large part of the emotional effect comes from a direct and live connection to the data, but that to some extent requires the user to relinquish control of the device – a form of interaction that can be uncomfortable.

6.7.2.3   Functionality and Interaction

The shelf's only function was to shake whenever there was an earthquake in New Zealand, and as such there was very little to distract from the shelf's meaning. The participant appreciated this simplicity, saying that it created a more direct connection to their experience. However, eventually these effects began to "wear off", instead becoming that eventually became familiar

and boring. One reason stated for this, in addition to the increased frequency of interaction, was that the Earthquake Shelf had only one mode of interaction - shaking - the simplicity of which did not reflect the complexity of real earthquake events. This was reflected by the participants suggestions for how the shelf might reflect a larger variety of earthquake affects such as sounds, liquefaction or smells, perhaps depending on the actual consequences, or strength of the earthquake.

This presents a few complications from a design point of view. Firstly, the aim of this design investigation was to evoke memories of earthquakes, rather than describe the effects of current ones. It is possible that any attempts to include more descriptive forms of outputs may have diluted the emotional impact of the shelf by being too representative of present events. Evidently there is then a difficult balance between emotional affect and utility where neither is dispensable, but must each be weighed dependent on the goals of the system.

More fundamentally though, the Earthquake Shelf was designed to be a shelf because it is a type of object, and action upon the object, that is implicated in the participant's original experience as part of their domestic environment at the time. It shakes because that is what happens to shelves in earthquakes and objects fall off, becoming damaged. These relationships between objects and events create a set of associations, interactions and meanings that contribute to the visceral and real experience of the Earthquake Shelf. So if a device portrayed various different earthquake affects, what kind of device is it? And, how would an object portray various aspects of earthquakes that are not necessarily related to it?

This "wearing off" of affect also coincided with the latter part of the deployment where not only were events much more frequent, but the explicit link to personal experience was broken, and so the shelf took on a slightly more utilitarian function. In this case a more diverse set of outputs may have benefited. However before that it may have encouraged the participant to seek or interpret particular meanings rather than pursue their own paths of reflection.

6.7.2.4   Balancing Slowness

Designing for reflection through 'Slow Technology', is a design ethos put forward by Hallnas and Redstrom [33] that favours alternative values to efficiency and function. However, rather than being about literal, temporal slowness, 'slow technology' refers to designing technology that provides time and space for reflection and contemplation:

> *A key issue in slow technology, as a design philosophy, is that we should use slowness in learning, understanding and presence to give people time to think and reflect. Using such an object should not be time consuming but time productive; we should get time for new reflective activities. It is not technology for compressing time to do given tasks, but technology supplying time for doing new things. It is technology that is useless for fast and impressive demos; to see what it is takes time. [33, p.167]*

Establishing time to think and reflect through design has also been noted by other researchers describing the ways that 'slowness' can give pause for reflection in artworks that use data [41] and in doing so creates deeper interpretation of the data, and therefore a closer relationship with the subject of the data. This was also true to some extent with the earthquake shelf, where the subject of the data was the participant's previous experience. In this case though, the nature of the interaction and context of the device highlight some interesting issues with such an approach.

As discussed in the previous section, the 'meaning' that the participant perceived in the shelf changed part way through the deployment from a reflection on their own past, to providing an emotional empathetic connection to other people. In this way the shelf seemed to take on a utility, as opposed to purely creating space for reflection. Under these circumstances, many of the features that created the opportunity for reflection became annoying, as they were no longer able to support the participant's perceived value in the device. In particular, the lack of information that the shelf gave, while previously intended to encourage reflection by not providing distracting technical details about the earthquakes, became frustrating.

Similarly, the lack of direct interaction with the device became frustrating because the participant began to have their own demands of the device that they could not meet through it.

Perhaps more subtly, this investigation highlighted another difficulty in designing slow technologies that relates to the duration of the deployment and to technology domestication. To begin with, the participant found the shelf's lack of activity frustrating. Although, in reality his use of the diary study blog show that he was still able to reflect on the shelf, these were limited in scope and he felt that the lack of activity robbed him of the opportunity to really experience and reflect upon the shelf's interaction. This highlights a problem when deploying such 'slow' research technologies over relatively short periods of time often available to researchers. Alongside missing potential technical complications that might occur over longer periods [65], there are also potential limitations to the participant's level of engagement with the prototype. How can we evaluate ways that a person would engage with technology over the years if we can only study it for a couple of months? This realistically gives little idea as to the efficacy of the technologies we might design to act slowly, over long time periods.

Although the earthquake shelf is not explicitly designed to last a lifetime, it is a slow acting technology that require would require a long time period to assimilate into the lives of its users. As such the deployment period of 6 weeks may not have been anywhere near long enough. The result of this is the participant's frustration that they are not able to engage with the device to extent that they would like.

Shortly after this frustration lead to the change in the shelf's catchment area, there was a major earthquake event and aftershock sequence in Wellington, causing the shelf to act much more frequently. However, the shelf was designed to act infrequently so that the violence of the shaking action in response potentially traumatic experience would cause emotive reflection

rather than annoyance or trauma. In acting more frequently, the shelf quickly became annoying and intrusive. This highlights the balance of mode and frequency of interaction in relation to the deployment period. If frequency of interaction (especially for such a strong mode if interaction) is too little, engagement with the prototype will suffer. On the other hand too much may cause the kinds of frustration due to overexposure exhibited here. Infrequent interaction may be more suited to longer-term deployments of many months [See for example: 65], while a shorter-term deployment may have to take into account how a potential need for increased frequency of action affects the participants relationship with the prototype when designing the experience and aesthetic of the interaction.

Another factor for design consideration in the balance of slowness and action during a deployment is the situation in which the prototype is placed. The requirements of the participant meant that the shelf needed to be installed in his office at work, and it seems that the later frustration he experienced was exacerbated by the shelf's location. While the home can be a place of reflection [26], where distractions may be tolerated, and even valued, the workplace is predominantly a place of concentration and application to given tasks, where frequent distraction and contemplation of other contexts may be extremely unwelcome. The participant spoke explicitly about the ways they thought that, despite their requirements, the Earthquake shelf would have been more suitable in their home. The reasons for this were related to the idea of attention, in particular the idea that when at home, it is more likely that you have time and cognitive capacity to pay attention to the device, but also that if necessary you can escape it. Similarly, in the home there is opportunity for a variety of nuanced interactions because of different proximities. For example, the participant spoke about how, at home, they may be in a different room when the shelf shakes and so either miss it to discover it later, or hear it and rush to the other room to see it. At the office on the other hand, they are either there or they are not. If they are there, they are right next it and so have very little variation, control, or space for serendipity in the way that they experience it.

6.8 Conclusions

This chapter has given an account of a design led investigation based around a prototype shelf that shakes whenever there is an earthquake in Christchurch, New Zealand. The design of the shelf was based on the experiences of a recruited participant, and designed to create an emotional connection to their past experiences as a way of creating a meaningful, emotionally engaging interaction. At the same time, this evocative interaction was intended as a process that would add meaning associated with that memory to an object through material damage.

The prototype was deployed with a participant for a six-week field trial, and was installed in their workplace office. Throughout the deployment the participant undertook a diary study by writing private blog posts, and it culminated in an interview about their experience using the blog entries as discussion points.

It was established that the Earthquake Shelf was unsuccessful in embedding meaning into an artefact by using data to affect its materiality, and several potential reasons for this were discussed with suggestions to overcome them. After that, the key outcomes from this investigation revolved around the ways that the shelf as able to elicit meaningful emotional reactions to the data through both the affordances of that data and the design of the physical object. While the principles derived from the previous chapter were utilised in the design of a system that has emotional affect, this investigation also highlighted ways that a system geared entirely towards this purpose might easily fail because of the design, the setting, and the changing expectations of the participant in relation to external factors. These factors became evident in the investigation as a series of tensions between aspects of the physical and digital design of the prototypes.

The physicality of the shelf provoked an emotional response but was not good for providing information. Instead information was sought elsewhere to supplement the emotional reactions. However when the participant placed a more utilitarian demand on the shelf, the purely physical output did not provide them with the information they wanted, and instead the supplementary information they sought online increased in prominence.

Having a single function also allowed the shelf to create a direct connection to the participant's experience. In responding to one kind of data, using one physical action afforded by that object, the shelf directly related to the participants experience. However, this later became confused as the data being used was changed, and with it the participant's requirements of, and relationship too the shelf changed.

Live-ness was shown to be important element of the shelf's design because, for the participant, it created a very real connection to another place and the events happening there. Further, because the data and design related to the participant's own experience, it also created a very real and emotional connection to their own experiences and memories creating a potentially more complex set of associations and interactions than purely reminiscing.

Slowness was also shown to be important because it allowed space for reflection upon the meanings and memories evoked by the Earthquake Shelf. However, the success of this slowness was heavily dependant on various factors, from the physicality and 'violence' of the shelf action to the frequency of events that occurred. As the number of earthquakes increased, the physicality of the shelf changed from being a key factor in the emotional impact of the shelf, to an annoyance because when removed from their intended temporal structure, the physical actions became inappropriate.

These lessons all demonstrate the advantages of combining physical and digital material for creating more meaningful reflections of the past, and more meaningful interactions on the present. However, they also demonstrate the complexity of balancing these properties when designing a system that is to achieve emotional affect, but also to fit into the life of the user.

These lessons will be taken forward into the next chapter and discussed in terms of their implications for the design of more meaningful physical digital systems.

7 Discussion

The design investigations detailed in the previous chapters have all been geared towards addressing the research question at the heart of this thesis:

> *How might we use the language and properties of objects to structure data in ways that enable more meaningful interactions with our past experiences?*

In the literature review we saw many of the challenges faced in the design of systems that use data related to people's experiences to support meaningful interactions with, and reflection on the past. Most significant is the difficulty of presenting digital records of people's experiences back to them in meaningful ways, that appropriately support them in their reflection on the past. I argued that many interactive systems fail to do justice to the emotional or mnemonic potential of this data this by paying insufficient attention to the constructive nature of remembering. I then offered up physical objects as a potential source of inspiration for addressing this. Although material objects are not inherently better at supporting memory than digital ones, they are very good at providing and supporting meaning over time and in providing these aesthetic interactions with both past and present. The combination of physical and digital then seems to have significant benefits for creating technologies that mediate reminiscence. This is not to denigrate the object to the role of a mere conduit, but to create a mutually beneficial symbiosis where the combination of experience data and designed objects and systems create richer, more rewarding interactions in the present, and with the past.

This is not straightforward though, and although there is now significant precedent in HCI research and the commercial sector for designing such systems, there are still many challenges. HCI research into tangible interactions, for example, uses tangible objects to introduce some of the richness and subtlety of physical objects into using computers [39]. In many cases though the benefits of these are purely utilitarian, in that physical objects constrain and afford various gestures and actions that can be achieved with the screen based system. I would argue that while this may have benefits for the functional interaction with the system, the tangible elements of these do little to exploit the aesthetic and experiential possibilities of combining data and objects. Even when valued artefacts are used, they are used as little more than means of manipulating, or connecting to, digital content that takes focal precedence [37]. Similarly, research into various techniques of generative design and manufacture, some based on user input, and some based on data from experiences, offer ways of creating highly personalised objects [52]. These reflect either one's role in the making process, or various aspects of one's experience. In general, however such 3d printed objects tend towards representing data, and so have a particular kind of aesthetic shared by very few of the material, aesthetic and experiential

qualities that we see evident in meaningful objects. That is, they tend to be more concerned with representing information than they do with reflecting the aesthetic and emotional values integral to the experience that they aim to represent. The material emotional and aesthetic aspects of experience, those things that form the heart of our personal memories are paid little attention in these modes of retelling.

It is notable at this point that while the design space established in the literature review was based on the example of life logging data, the data used in the final investigation of the Earthquake Shelf uses 'secondary data' gathered from the a public online resource. Initially life logging data, and personal photos were used as example to discuss ways that technology commonly deals with large data sets that are difficult to manifest in ways that make them meaningful to a person. Then, as a result of the literature review, I argued that in order to discover truly new opportunities for design designing relationships between objects and memory data, it was necessary to first identify, and develop a deep understanding of some particular ways that people attach and access meaning to and through objects. As a result, data took a back seat for the first set of design investigations. After reflecting on these, I saw the value and design potential in ways that objects could evoke rather describe memory through their materiality. This was influential in the Earthquake Shelf, the physical interaction took the lead in connecting the data to the aesthetic of the participants experience in an evocative way. At this point, it was considered that using data recorded by the participant, or more common forms of memory data, such as photos, or videos, would in fact be detrimental in evoking memory, due to being to descriptive. In other word, any way of presenting the participant's own memory data would be to literal a connection their experience to be evocative. This development is not considered problematic, primarily because this thesis is primarily concerned with exploring the possibilities for objects to engender reminiscence and reflection through aesthetic interactions with objects. The fact that it has dome this with such seemingly unrelated data adds to the ability of the Earthquake Shelf to do so, and goes some way to demonstrating the pertinence of the design position that will result from the discussion below.

Similarly, the aim of this thesis so far has been to open a new design space, rather than to prove universal design principle about designing objects that mediate memory data. It has done this by practically exploring new ways that data and material might interact in order to prioritise the aesthetic and experiential qualities of experience and memory, in the design of technologies for memory and reflection. ,

The below discussion then seeks to explore aspects of this new design space in order to articulate a design position. The intention is that this position, as an articulation of investigations within a design space can be shared with and expanded upon by other designers of technologies for remembering and reflection. They are not however intended as recommendations that provide a set of rules or guides for 'good' design of such systems.

7.1 Design Position

The following develops the key reflections from the previous two chapters, and in doing so seeks to develop a position on the design of technologies for memory and reflection. This is intended as an example of an alternative approach that presents new opportunities for the design of meaningful interactions with autobiographical data rather than a set of recommendations or guidelines. As a result it is heavily shaped by the values that I consider to be important in designing more meaningful technological interactions.

Before we discuss these recommendations though, we must define the terms and perspectives on which they rely. First, and perhaps most fundamentally, is the idea of 'interaction'. In HCI 'Interaction' typically refers to the physical and practical manipulation of interface elements as a process in the completion of tasks [15]. Conversely the design approach used in this thesis (See section 3.3) is focussed on the aesthetic experience of using technology as promoted Dunne [20] and Wright et al. that entails "not just the cognitive but the sensual and emotional threads of experience situated in time and place" [97, p.18].

Emotional affect is a significant aspect of the aesthetic interactions prioritised in this thesis. And although emotional affect has also been shown to be important in undertaking rational cognitive tasks [12], I deal with it here as an important element of human experience in-and-of itself. So, in the sense that emotions are "culturally grounded, dynamically experienced, and to some degree constructed in action and interaction." [12, p.59], an emotional response to the shelf's shaking is just as much a form of interaction as the act of putting books on it. By the same token then, reflection on memory and on the past is also seen as an interaction with these objects, as they too are dynamically experienced through the actions of the device.

To differentiate between these forms of engagement with the prototypes I will use the terms 'aesthetic interaction' to describe aesthetic emotional responses to and reflective interpretations of systems, and 'functional interaction' to describe the task oriented manipulation of interfaces. However, this is further complicated by the temporality of these forms of interaction. While memory may be regarded as being purely about the past, the process of remembering and reflection on the past are fundamentally, and simultaneously situated in both the past and the present. Whether provoked by an object, smell, or some other sensory encounter, reflection on the past is the result of an interaction in the present. At this point attention shifts from the present, and the past take precedence. This is equally true of interactive digital systems, and although they often utilise interaction in order to engage with materials of memory, there is little regard for the interplay between the past and present. This interplay is a critical factor in enabling technologically mediated reflection on the past to be valuable. As a result, one of our key design challenges is in allowing our system, and our interaction with them, to take a back seat for a while.

To fully articulate the design position, the rest of this chapter draws upon examples from this thesis, and some other sources, and breaks the discussion into thematic sections. Each of these

represents one aspect the ways in which devices can be designed to relate to aesthetic of personal experiences, thereby evoking the past rather than describing it.

7.1.1 Memory and Material

Although understandings of memory have in the past treated it as a purely cognitive process, it is now widely understand to be embodied. That is, memory, or the act of remembering, is a practice that occurs in response to the sensory perception of the world. Be it visual, aural, tangible, or olfactory, it is closely related to the world of things and our perception and interpretation of their properties [4, 12]. As such the physicality of objects allows us to design interactions that may not be possible through purely digital means. While physical things are not better or more evocative than purely digital means, exploring the opportunities that come with materiality was a central part of both the motivation for this this thesis, and the design approach used within it.

This work showed two main ways in which designing with physicality supported meaning and reminiscence.

7.1.1.1 *Material Supports Meaning over Time*

Researchers have found that physical paper photographs, for example, that are meaningful to people go beyond simple representation of events, and instead offer complex sets of meanings that are available through the photograph as an object, rather than the simply the subject of its content [67]. This is partially explained by the recognition that in this type of remembering, objects are not just sensory memory cues. In analysing passages from Proust's *Swan's Way* from a Social Psychology perspective, Middleton and Brown [56] discuss ways that objects relate to memory:

> How is it possible that the initial recollection of Aunt Léonie gives way to the whole of Marcel's childhood? If the cup of tea really did act as a discrete contextual cue that was capable of triggering off other associations, then we would expect specific, discrete 'episodic' memories to result, not a sense of the entirety of Marcel's past. [56 p.140]

Instead of relating only to discrete episodes however, objects allow for the addition and subtraction of associations and meanings that are dependent on the present circumstances in which they are being reflected upon:

> Our memory of events, then, involves reconstruction – we artificially extract or dissociate past events from the otherwise interconnected tissue of duration in order that they can be reinserted into the demands of current circumstances. [56 p.141]

Because of this, reflections on the past are a combination of past and present, where each is altered according to the person's current needs and circumstances. Objects in particular are good at supporting this layering and combination of temporal periods. They are relevant to the present circumstances of the person through their interaction and engagement with it, while also contextualizing and evoking the past.

Another way that objects support memory is, if we maintain our Social Psychology perspective for a moment, through their 'stability':

> Now, in the case of remembering, we may begin to reconstruct past experience by using the apparent stability of an object as the basis for unfolding our recollections of people and events. By describing the supposedly unchanging character of the object, we gain a foothold on the activities that this object – such as the sack apron – previously mediated. These activities then also appear to gain a kind of durability by virtue of the relationship that they have to the object as described. In other words, the object lends something of its material durability to the people we wish to recall – it projects something of its stability into the fluidity of our past experience. [56]

Although this idea is applied here to the social sharing of memories, this 'stable' base on which to build recollection also applies to personal reflection. The object is a site around which "the repetition of 'intelligently coordinated movements' prolongs the past into the present". [56 p.138] In other words the way it is experienced and interacted with persists through time in a way that allows us to recall the experiences, people and places associated to it.

This in turn supports the constructive layering of multiple interpretations over time, as opposed to a complete change in meaning, as was exemplified by the Poker Chip, Bowl, and Frisbee discussed in *Chapter 5*.

Because of this we might say physical objects that represent memory support multiple time frames, existing both in the past and the present in ways that digital objects do not. In being stable, but malleable across time their interactions in the present relate to and build upon the past, while a purely digital format may represent different or layered time frames very descriptively and linearly. Encounters with data, especially in the kinds of ways used in this research are necessarily in-and-of the present whether or not that data happens to reflect the past or the present. For example, the Earthquake shelf uses live data as a provocation to reflect on the past, and while this can add new layers of meaning to the interpretation of the system with each engagement, there is a need to balance the inherent tension here between the interaction in the present and reflection on the past through the physical and digital elements of the system.

When designing this balance, an extremely important consideration is *why* the user is interested in the data that the system will mediate. Although the focus of this thesis is in personal reflection,

the Earthquake Shelf deployment gave a serendipitous example of a case where the participant's interest in, or requirements of, the data changed part way through their time with it. This had very evident consequences for elements of the physical design. To begin with the participant's response to the shelf was more one of personal reflection on the past and curiosity triggered by the knowledge that something was happening now. Later however, they became more interested in the data and in gathering information about these current earthquakes. The catalysts of this change give us some ideas for design recommendations that relate to the how the physical design can influence the systems ability to provoke reflection, or provide detailed information. More specifically, the users requirements of the data have important consequences for the mix of physical and digital elements, and their emphasis in the design of the system.

For example, the Earthquake Shelf was designed to give an entirely emotional response to the data, and to encourage reflection on the past. It did this by providing a purely physical output of the data that allowed a more visceral response, but also obfuscated the data about present earthquakes to the extent that it was not readable in any practical way. Although the participant was able to look up supplementary details online, during the initial period of the deployment this was not their main focus. The purely physical manifestation of the data prevented the participant from focusing too much on what was happening now and allowed them to reminisce on their own past experiences. Later though, the link to the participant's specific experiences was diluted by broadening the location of the data, at which point they began to focus much more on the present out of empathy for others. Now the purely physical output of the shelf did not meet their needs, and quickly became frustrating. In this case the participant would have preferred to have more actual information about the earthquakes as they were happening such as magnitude, exact location and perhaps details about urban damage. They discussed ways that this could have been achieved using small discreet screens, or perhaps paper printouts. While both states achieved emotional affect, it is important to consider exactly what the requirements are of the data, and consequently where the user's reflection will be directed. If the aim is to support reflection upon past personal experiences then a more physical, and less information-based mode of output is advantageous.

7.1.1.2   *Making the Digital Feel real through Physical Interaction*

Manifesting data in, or through material objects can lend a physical presence to digital content that can make the interaction with the device seem very 'real', in turn engendering very 'visceral' emotional responses. This realness also has an important role in inspiring deep reflection on both the meaning of that data and the memories linked to that data through the design of the device.

For example, the Earthquake Shelf presented in Chapter 6 demonstrates that giving the earthquake data a physical outlet gave the participant an emotional response to the data, and

connection to the events that the data represented that could not be, and indeed never has been achieved from his looking at the data online, which instead becomes a 'scientific exercise'. Of course, the interaction of the Earthquake Shelf references a very physical, and visceral experience – that of being in an earthquake – but other research has also shown that physical manifestation of data can lend 'realness' to other, less tangible events. As part of the project 'A Conversation Between Trees'[27][41], artist group Active Ingredient created The Climate Machine (Figure 37), a device that illustrates a set of global Carbon Dioxide data from 1959 to 2012. It does this by very slowly burning rings into pieces of paper.

Figure 37: The Climate Machine, by Active Ingredient

The size of these rings corresponds to the amount of Carbon Dioxide measured in the atmosphere every month throughout that year. The way that the data was made physical, combined with the metaphors and expression of temporality used in the artwork, provided people with a more visceral and real sense of what the data portrayed that they could contextualise in relation to their own lives and experiences. This in turn allowed a more affecting engagement with, and understanding of this abstract data. To many people who are used to perceiving the world through physical and sensory perception, data and its meaning is still an abstract and obtuse concept. Making it physical brings it back to an experiential level that they engage with on a more emotional basis.

In both cases then, albeit from different conceptual approaches, the physicality of the work provided a link for personal reflection on the data in relation to ones own life, thereby providing a very personally reflective and discursive experience. Meanwhile, the inherent ambiguity, or interpretability of objects is preserved in manifestation of the data. This allows people to relate the data to their own lives and experiences, and therefore to create more personal responses and meanings. However, it is not enough to simply provide physical outputs for data.

---

[27] For more information about the project, see: http://hello-tree.com/

7.1.1.3   *The Object and its Interaction Must Fit with the Experiential Aesthetic*

In order to successfully allow genuinely engaging interaction with the past, and present, the physical design of the device must be designed to fit with the aesthetic relations of the of the digital content it mediates.

Often digital technologies that are designed to engage with digital memory or experience data do so in a general sense, that may relate to the type of objects they hold (photo frames etc.) but do not, in their physical design, reflect or relate to the meanings of the digital content within them [4], or indeed the values of the person using it.

An important way to do this is to use metaphor or to reference specific aspects of common experience. For example, if we consider the raw functionality of the earthquake shelf as a sort of earthquake alert system, we can imagine that it could have built as a simple vibrating box that sat by the participant's computer, or perhaps even a vibrating alert on a mobile device. The question then is, what does this box, or the device, have to do with the participant's ideas about, and experiences of earthquakes? The shelf, as a piece of furniture carries certain associations to the participant and others that have experienced an earthquake as a thing that shakes, and that causes objects to fall. A shaking shelf then not only recreates some small aspect of an experience while active, but also carries certain expectations and associations for the participant that relate it to earthquakes, and the earthquake data, while inactive.

Similarly, these associations might be achieved through metaphor. Returning to the previous example, The Climate Machine uses metaphors of tree rings, and burning [41], as well as simple visualization, that make it able to evoke ideas about the relationships between forests, and rising global CO2 levels. Although the machine loosely illustrates the data, the metaphorical associations that it makes in doing so, and the resulting artifacts (drawings) are arguably an equally important aspect people's engagement with the data than the actual numbers as they are what produces the emotional and reflective response [41].

Simply making a generic physical output for the digital content will not necessarily make for a meaningful engagement with either. How that physicality relates to the meanings of the experience and digital, and how you as the designer wish for the user to respond to that data are extremely important. As discussed earlier, objects and their materiality are implicated in the enactment of experience, and if systems are designed sensitively to this fact, then they have better chance of supporting reminiscence and reflection on the past in the ways discussed at the beginning of this recommendation.

7.1.2   Reflection is Embedded in Everyday Practices

Because memory and reflection on the past are not abstract activities divorced from the perception and interpretation of the world, we can also say that the act of remembering is embedded in everyday practices. There are many examples in literature [For example: 4, 45], and from within this thesis, of objects whose mnemonic and emotional value is heavily reliant on the fact that they can be, and are, actively involved in everyday life.

In spending time directly engaged with the material and functional aspects of an object, the user is often compelled to reflect upon its meaning. This is not to say that every time a person uses an object they are drawn into reminiscence, and this might only be a very occasional form of interaction, but in keeping the objects as everyday functional things their owners honour their history and meaning, thereby maintaining value [4].

Through this process objects also become embedded in the everyday to the extent that they move into the 'background' and become invisible [5, 58]. In other words they are not separate or extraordinary things that must be attended to, instead they exist quietly and frame the actions and enactment of everyday life [58]. This ability to retreat from attention is where their strength resides:

> Material things are often like that. They have a certain humility. They don't jump up and down and confront you as critical symbols of yourself and your relationships. They don't theorise themselves, or abstract themselves. Often one only really pays attention to them when they don't work or look awkward or out of place. Normally they just serve, in their relatively humble way, as forms through which relationships are expressed and developed [57 p.152]

In this way we are not over saturated or overwhelmed with their meanings and affect, and as such they allow us space and time to reflect, or even just to ignore them and do other things for a while. Drawing on examples from the previous chapters, this can be seen in the duality of relations to the objects. Although they are important meaningful objects that represent valued memories, the cereal bowl is still a cereal bowl that can be eaten from, and the Frisbee is still a Frisbee that can be thrown and caught. Their ordinariness is an important aspect of their affect. Neither is a shrine nor memorial to their meaning. Their use is an important aspect of their value, yet when not in use, they can put back in the cupboard where they are not forgotten, but retreat into the background.

When the opportunity for reflection occurs however, their familiarity and layering of meaning through use and duration provide powerful evocations of the past. When and exactly how this happens is a complex point of interaction. From the discussions had during this research we might say that it occurs when the object is bought into the foreground. When the Frisbee is being used as Frisbee, its user is engaged both with their present activity, but also with all the time they have used it (and the one it replaced) before. Similarly, in eating from the bowl, the user also engages with what the bowl represents. In these examples, the interactions with these objects taking place in the present are so much a part of everyday life of their users that they do not obstruct reflection on the past.

The Earthquake Shelf perhaps provides another example of achieving this affect. During the period of deployment where the shelf was successfully able to elicit emotional responses and

reflection on the past, it spent the vast majority of its time dormant, simply being a shelf that can be used to display objects. During this time the participant also spoke of the anticipation felt when expecting the shelf to respond to events that they suspected to be taking place. In taking the form of an ordinary piece of furniture whose primary role is to display and emphasise other objects it can retreat into the background. But, because the shelf always has the possibility of shaking at any time, and in doing so triggering memories of experience, it holds those associations even when inactive. We might then expect that even placing objects upon the shelf, an everyday mundane act, could cause reflection on the past.

Any system that seeks to promote reflection and remembrance through the combination of physical and digital data should consider the system as something to fit into everyday life, at times it will be used and engaged with deeply, while at others it will sit quietly in the background. One approach to the design of technologies for reminiscence and reflection then, is to design something that has a role to play in everyday life. This increases the opportunities for engagement and interaction with the user, thereby allowing more opportunities for interpretation, reflection and meaning making. This does not mean designing objects that need to be constantly attended to, but things that can just as easily be ignored. This raises another question over 'use'. The bowl and Frisbee can both be used, and engaged with directly in performing their function, while the earthquake shelf spent the vast majority of its time being a shelf. As such it might be so embedded in everyday life that when it eventually acts, and pulls itself into focus through unusual action, it creates its own circumstances for reflection. In other words, is it the contrast between background and foreground, or the ability to have contrasting states that allows the Earthquake shelf to evoke reminiscence and reflection?

So, in addition to thinking carefully about how the direct interaction with a system will allow reflection (discussed further below), it is very important to also think about the interactions between the user and the system when it is not in use. These are the ways that the device will fit more fully into everyday life and thereby be given the opportunity to create, and sustain meaningful interactions with the past and present.

7.1.3 Interaction and Reflection

When we do interact directly with an object, the aesthetic of that engagement is extremely important. Just as the material form should be related to the aesthetic of the experiences being referenced, so too should the nature of the functional interaction. These functional interactions are actions taking place in the present, and unless they are evocative gestures or interactions in themselves, they force the user to focus on what is happening now rather than what the thing means in relation to their past experiences.

Approaches such as Ludic design (the Drift Table for example [26]), explore ways of promoting user reflection by increasing possible interpretations of the systems meaning through designed ambiguity [26], the reflections are focussed on the present interaction with the device. In this thesis however, reflection is steered towards the past by reference to specific events. As a result

possible interpretations of the system are narrowed significantly, and the simple functionality instead gives a very direct link to a specific set of meanings. One aspect of achieving this is that functional interaction is stripped right back so as not to disrupt this reflection. We can see the effects of this again in the Earthquake Shelf. In the latter half of its deployment, the data that the Shelf used was changed in such away that it no longer related so specifically to the participants own experience. The possible interpretations of the system are therefore widened, and so the meaning of the data, and the perceived function of the device changes, and at this point the functional interactivity of the device is no longer appropriate. This all inhibits the participant's inclination to reflect on their past, and reflection through the system becomes much more about the present.

This resonates with what Ståhl et al. call the Evocative Balance:

> If emotional expressions are overly literal or unambiguous, there is little room for interpretation, meaning-making and growth. On the other hand, if the expressions come across as arbitrary and abstract, there will be no resonance in lived bodily experience and the whole topic of the interaction becomes unfamiliar and insignificant [80, p.44]

For Ståhl et al. the way in which data is manifested through the system should have enough ambiguity that it can be interpreted freely, while being related enough that it is relevant to 'lived bodily experience'.

In this case the design of the Earthquake Shelf steers away from extraneous interaction elements. There is not on or off switch, and no demo button, and the shelf offers no further information on the earthquakes it responds to. The intention here is that it behaves just like a shelf in an earthquake, and so it is not possible to have any interaction with it that does not reference this experience.

This level of interaction has further implications on the functionality of the device. Such minimal interaction necessitates a simple function, as all objects discussed in this thesis demonstrate. The Bowl, the Frisbee, the Poker Chip, and the Earthquake Shelf all have one function, and this simplicity provides a more direct link to the devices meaning. This combination of simple, or reduced interaction and direct interpretive links through singular functionality goes hand in hand with the single function of shelf and direct link to experience.

For example, the participant in the Earthquake Shelf deployment described the functionality of the shelf as being similar to an app, in that it provided a direct link to the data in question, and therefore created a more direct link to both the memory of his experience.

Keeping functional interaction with the system to the minimum possible creates this space for reflection. Every interaction that forces the participant to concentrate on the present distracts them from reminiscing and reflecting on the past. However, when interaction is at a minimum, it needs to be very concise, and this can be aided by having a single function. This combination

allows the user to reflect upon the past in an emotionally meaningful way by creating a very direct and clear link to the experiences being referenced.

7.1.4 Reflection is Personal

Memory and reflection upon ones experiences is clearly a very personal thing. While mass media encourages forms of cultural memory, in which ones own experiences may be included, we each have a very individual take on them. Objects, in their lack of explicit description or representation of information, and their material uniqueness, are extremely good at supporting this individuality [67].

Because of the deeply individual nature of reminiscence and reflection, and the abilities of objects in supporting them, the empirical and design led elements of this thesis has taken a very bespoke approach to addressing the objects and experiences of memory. This allows the design to address specific objects and experiences directly in order to engage participants on very personal levels, and in doing so allow deeper levels of aesthetic interaction.

This brings us to the distinction between personalised and personal. There is perhaps a tendency in the design of interactive systems, even those that deal with memory, to start from a generic standpoint, say the implementation of a technological system, and then apply it to a context and user, or for users to apply it to their needs as best they can (for example Instagram[28], Flickr[29], Sensecam[30], or even Photobox[31]). This approach to design does not relate fully to users' experiences other than through the data that it mediates.

This approach is undoubtedly successful in certain ways, but I argue that it in the case of manifesting data physically, this provides personalised, rather than personal devices. As such it fails to acknowledge a significant part of why objects are good at supporting memory, and therefore why physicality should be combined with data at all. Instead I argue that to truly examine possibilities for meaningful interaction with the past through the combination of physical and digital, it is not just the data that must be personal, but also the physical design of the system, and the interaction it engenders as a result of the combination of the two. Indeed, as we found with the shelf, the data needn't even be personal when the interaction is designed to evoke personal experiences. Starting instead from very specific experiences and objects, and generalising the design from there, allows you to design system according to the person's needs and values, rather than trying to fit an existing technology.

One problem with this approach however is that it is difficult to generalise a physical system from a bespoke design based on the experiences of individuals to one that might be applicable to multiple users. However, in this way you better discover genuinely meaningful interactions that will resonate with others and that can be distilled for use in further applications. For instance,

---

[28] http://instagram.com/
[29] https://www.flickr.com/
[30] http://research.microsoft.com/en-us/um/cambridge/projects/sensecam/
[31] http://markmakedo.co.uk/portfolio/photobox/

during the deployment of the earthquake shelf, the participant talked with others who, having seen it, realised its potential meaning and wished to have one too.

Here there is clearly a balance between designing specifically for one user, and maintaining enough freedom of interpretation that the system could feasibly be generalised enough to be meaningful to others. The Earthquake Shelf for example, selects an object from the participant's experience, but one that is also relevant to many people's experiences of earthquakes. Meanwhile, the specificity of the shelf's relationship to individual experience is achieved through the data, and so can easily be altered. There is then a sort of modularity to the design that, were the prototype to be deployed with multiple users, would maintain its personal applicability.

This level of personal-ness is well suited to research projects, where prototypes will be largely hand made, or made in extremely low numbers. And although applying this same ethos to the production of commercial products is trickier, recent changes in manufacturing technologies and the consequences for business wishing to produce relative small runs of products make this more possible.

Many approaches to making more personal objects follow DIY avenues influenced by the ever-increasing maker movement, and through generative design tools [52]. These approaches have been shown to increase the personal value of the resulting objects by offering a means of forming and exhibiting individuality and identity [52]. While making ones own objects can lead to an increased sense of pride and value in an object [52], we might view this as being more akin to an advanced form of personalisation, where the maker's personal expression is confined to a specific set of materials, tools and processes. This is a different idea to that described here where the 'user' is an integral part of the production of the objects meaning, thereby lending value to the object through evocative significance.

7.1.5 Reflection and Slowness

Reflection on the past is a slow process. It requires time and space to think about the meanings of interactions with things in the world, and fundamentally this means time spent away from completing tasks. First put forward by Hallnas and Redstrom in 2001, 'Slow Technology' is a design philosophy that aims to create digital interactive systems that allow space and time for reflection, rather than prioritizing efficiency:

> Slow technology can be technology where the aesthetics of functionality, i.e. the expression of functionality as such rather than its objectives, are in focus. It is design concerned with how we relate to the expression of technology itself as we use it to do certain things. [33, p.203]

So, while the aims of using a technology are not disregarded entirely, slow technology is more generally concerned with the aesthetic relation to, rather than the outcome of, technological interaction. Although the 'slow' in slow technology does not necessarily refer to the pace of

interaction, this is an important factor of interaction with a technology with significant consequences on aesthetic engagement. At the same time, judging this pace relies heavily on the modes of output of the device and the attention that these demand. For example, the change that was implemented partway through the Earthquake Shelf deployment increased the frequency with which the shelf shook, or the pace of action, which in turn had significant affects on the aesthetic experience of the system. At the same time, the Earthquake Shelf's shaking action was extremely arresting. The participant described it as un-ignorable, which may at first seem at odds with slow design due to its violent and shocking nature, however this is entirely geared towards provoking, and making space for reflection. In being difficult to ignore it asks the participant to pay attention to it, reflecting on the cause of this action. However, this only works when the pace of interaction is very slow, and action is infrequent. So while to begin with the shelf acted very infrequently it did not overwhelm the participant, and gave them opportunity, space and time to reflect on the action of the shelf, and his past experiences. Later though, when the pace of action increased, it overwhelmed the participants tolerance for attention and distraction, and became annoying and intrusive. Although the focus of his attention had shifted from his own experiences, he was no longer inclined to reflect on the actions and behaviour of the shelf.

The Earthquake shelf is an extreme example, but it is important when designing a reflective technology that the relationship between pace, mode of interaction, and the amount of attention these require is well balanced.

Rather than making arbitrary decisions about 'slowness', though, the pace of action or interaction should reflect the meanings of the data and aesthetic of the related experience. In the case of the earthquake shelf the pace of the action is determined by real events, taking place at a particular location and so reflects something of these events in an evocative way. In some cases, this may still not be appropriate, but this can be balanced by sensitive design of the mode of action in relation to the location context of the device.

In other systems that don't rely on automation, interaction may be entirely driven by the needs and intention of the participant. For example, the bowl chipper is an entirely user dictated interaction, rather than a machine that repeatedly brakes bowls based on some trigger. This is because the intention to do this action, and the aesthetic of interaction through the gesture must go hand in hand to create a reflective encounter with and production of the meaningful artefact. There are also examples where a seemingly arbitrary slow pace of action is implemented successfully. Photobox is a design project that plays with ideas of slowness and serendipity in exploring online photo archives:

> *Photobox*, an interactive technology intended to be used over many years, which occasionally prints a randomly selected photo from the owner's Flickr collection. A core aim of this prototype is to create a form that a user could 'live with', one that is

aesthetically integrated into their home over time and, in doing so, engenders slower

forms of consumption of photos in meaningful ways. [64 p.665]

The pace of action with this prototype, the frequency with which it prints photos, is more or less arbitrary in that it is just intended to act occasionally and in doing so reflect the frequency with which you might be rummaging around in draws, or boxes to find photo albums or the like. However, this occasional action puts the onus of interaction onto the user, and as such the frequency with which they interact with the device is up to them. In this way, they have and intentional interaction for which they are mentally prepared, and inclined to engage with it.

7.2 Methodological Lessons

Throughout this research there were several methodological challenges that raise interesting questions when doing design-led research with technologies to promote reflection on the past, and many of these are related to the design recommendations above. The discussions below describe when and how methodological problems were encountered in this thesis, and are provided to help researchers negotiate potential difficulties in conducting research with technologies designed to promote reflection.

7.2.1.1   Deploying Slow Technology

First is the challenge of using slow technologies in field deployments. As reported by Odom et al there is an inherent contradiction in attempting to gain meaningful insight into life with a technology designed to last a lifetime, by deploying it in a home for a few months [64]. While some deployments take place over relatively long terms, these are best counted in months, rather than years. There is a similar problem in the deployment of the earthquake shelf. While this prototype was not strictly developed to last a lifetime, the slowness of its action mean that it would best have been deployed over many months. This however, was simply not a practicable time period. The failing of the participant's engagement with the shelf towards the end of the deployment, along with the various aspects of the design covered in the analysis, may be due in part to the limited period of the deployment. Trajectories of domestication and engagement are well documented in HCI research [For example: 76], and we can assert that the shelf may not have been deployed long enough, given the slowness of its action, to be fully domesticated and accepted.

Design Fiction-like approaches that use narrative mechanisms such as film and visualisation to build compelling technological scenarios, are good mechanisms for gathering meaningful reactions to systems that cannot be built could be a good solution. However, the Earthquake Shelf relies so heavily on the visceral and real sensory experience of the interaction that, as expressed by the participant himself, a video or image just isn't a viable alternative.

New methods must be considered to overcome these deficiencies. Perhaps using a mixture of the traditional deployment and design fiction approaches mentioned above, might allow for the

proper sensory and intimate experiences of objects while allowing designer and participant to explore the possible effects of longer term life with the technology, through the development and visualisation of scenarios based on the design of the system, and the participant's everyday life.

7.2.1.2   Disrupting Deployment

Many of the points of discussion relating to the Earthquake Shelf investigation in this and the previous chapter have come about because of the way the behavior of the prototype was changed half way through the deployment. To recap, the earthquake shelf initially responded only to earthquakes that occurred in the area of Christchurch. After a period of limited engagement resulting from infrequent earthquake activity in that area, and the participant's occasional absence from the office, the decision was made to widen the area that the shelf responded to from Christchurch to the whole of New Zealand. The intention of this was that the shelf would shake more frequently, and so there would be more opportunity for reflection and engagement for the participant. However in the process of doing this, the direct link to the location of the participants own experience was broken, with the consequence that their reflections on the shelf were no longer so personal. The knock on affects of this for attention, interaction and so on discussed above saw great changes in how the participant engaged with and related to the shelf.

However, while one may see this as jeopardizing the deployment by moving away from the design concept and intended personal-ness of the experience, this decision had some positive outcomes. First, it gave the participant a point of comparison around which to reflect more deeply on their experiences, and to form deeper opinions about what it meant to them.

There is some tradition in research for learning from your mistakes, and researchers have been able to gain a great deal of insight from their prototype deployments that did not go the way they planned [27,49]. In comparison to more successful attempts these instances give researchers leverage for reflection on the workings of their technical design and implementation, design process, and research methodology. In the earthquake shelf deployment the 'failure' took the form altering of the design concept part way through. While the inactivity in the early stages of the deployment was an anticipated side affect of wanting to reflect earthquake events realistically, that latter was a decision that may have initially been against better judgment due to its potential for altering the nature of the interaction, but turned out to be a valuable turning point. The stark contrast in interaction and engagement with the prototype before and after this point provided the participant with points for comparison on which they could reflect. So, rather than a retrospective point of contrast against the expected outcomes that allow the researchers to analyze their design and methodology, causing a 'failure' during the deployment provided this perspective instead for the participant, where they could reflect on their experiences before and after the turning point. In my experience of this deployment, it seemed to allow the participant to make to insightful and critical observations and reflections than might otherwise have been the case.

Although not done deliberately to encourage more insightful reflections, this may be see as a useful approach in the study of slow technologies where time pressure might mean that the participant is unable to experience the full range of experiences possible through engagement with the device. Rather than, or perhaps in addition to, reflecting on a failure, carefully keeping an eye on the progress of a deployment may enable the researcher to deliberately disrupt or 'break' their prototypes, or method in order to expose, or provoke interesting dichotomies and comparisons in interacting with a device in various states.

7.2.1.3   *Bespoke Design and Participant Numbers: The Challenge of Assessment*

Another methodological challenge encountered in the course of this thesis is related to the bespoke approach to designing for participants. This approach was takes because of the need for addressing specific experiences in designing prototypes that provided engaging interactions, and effectively supported reflections on the past. However, it also requires designing prototypes specifically for individual users, and consequently made for a relatively time intensive design process that eventually restricted the number of participant it was possible to work with.

While there are ways of creating somewhat bespoke objects on relatively larger scales through digital manufacturing technologies such as 3d printing, this thesis was more concerned with users relationships to many different types of objects and interactive systems though all aspects of aesthetic interaction and sensory engagement through material which would have been negated somewhat using the aforementioned technologies.

In many disciplines the low number of participants and lack of data might be considered a negative. In this case though the goal of the thesis was not to make claims about a how population of people, respond to systems that support reminiscence and reflection, but rather to open up new possibilities for design in this problem space based on empirical observations and designed prototypes. As such, rather than producing hard and fast rules, or a determining prescribed design processes for designing meaningful objects, this approach was geared towards acknowledging the individuality of each person's values and needs, and how they should be addressed in a design process.

Designing for specific people also caused problems if a participant became suddenly unavailable, as was the case in the cereal bowl investigation of Section5.4. In this case it was not possible to simply find a replacement, and so a different approach to analysing these prototypes was needed. This method does not leave much space for contingency, and while I do not feel that this ended up being detrimental to the overall research, steps could have been taken early on to ensure availability of participants.

7.3 Conclusion

This chapter has offered a discussion of findings from previous chapters in the form of elements of a design position established by the practical work in this thesis. These concentrate on the interactional possibilities afforded by the material and aesthetic qualities of physical objects, and

those of the experience that the data represents. At the same time they each set out to explore the opportunities that come from in balancing the tensions inherent between these aesthetic qualities. These tensions all come down to one overall challenge in making these systems; designing for the past *and* the present.

7.3.1 Designing for Then and Now

The fundamental difficulty in designing technologies that allow users to reflect on the past is that you are simultaneously designing for two different times. The design position articulated above discusses how, although reflection and memory is fundamentally about looking to the past, the act of reflection and remembering is the result of interactions taking place now, in the present, and in being so becomes an amalgamation of past and present values.

The above presents a position on how this complex interaction might be designed for by prioritizing material, aesthetic and temporal elements of an experience. Rather than focusing on ways that data might be made sense of, the digital content instead becomes an index to an event, as another element in a system whose constituent parts work together to evoke past experiences, rather than represent or describe them.

At any one point during someone's experience of a system for reminiscence or reflection, either the past or the present is in the foreground. Balancing these perspectives to allow for reminiscence and meaningful interactions in the present in turn requires a balance of designed features and interactions that can otherwise obstruct reflection and the structuring of meaning. While the interactions in the present are necessary for deeper engagement with the system, they act as triggers for reminiscence and so need to keep out of the way after they have done their job so that the user has space and time to reflect. For instance, earthquake Shelf stores and displays objects, and when it shakes, the present action is so striking that it is at the forefront of the participant's attention. Then, once it has stopped they are left with time to consider all the meanings and associations to the past that are related to that action. Similarly, the bowl can be eaten from, but the interaction in the present is so subtle, and embedded in everyday life that the user is able to reflect on the past whilst doing it. The recommendations above each offer ways of thinking about and negotiating these.

8 Conclusion

This thesis sought to answer the research question, 'How do we make meaning from data about our experiences, and the things around us?' Here 'meaning' is seen as aesthetic and emotional value, attributed through a connection to personal memories, and the research question was posed in response to the design space defined by looking at existing research relating to technology, memory and emotional value in the Literature Review chapter. This design space concerned the opportunities evident in combining digital data that relates to our experiences and physical objects to create more emotionally valuable, 'more meaningful' interactions with the past. The research that comprises this thesis then sought to find ways designing technologies that are better able to combine objects and data related to personal experiences to evoke memory and tell stories about our past.

Building on the work of other HCI researchers and design practitioners, I found alternative approaches to combining physical objects and data about people's experiences that could enable these more compelling, and valuable interactions. By structuring the context and mode of engagement with the data the objects designed and prototyped in this research helped people construct meaningful narratives from otherwise impersonal, ambiguous and amorphous sets of data.

The approach taken in this thesis is different from many others in that it focuses on the ways that physical objects engage people aesthetically in order to evoke particular memories and meaning. In other words, rather than looking at a particular type of memory data, and working out how it might best be structured or disseminated, this work emphasizes aesthetic connections between things and experiences, and then finds ways that appropriate types of data might support the formation of these relationships through aesthetic interaction. This has several benefits. Firstly, by focusing on the way that material evokes memory, rather than how data might be disseminated, these prototypes avoid the imposition of narrative structures on the data that may be at odds with the way that the participant may otherwise want to remember. Secondly, by concentrating on the interaction with the object rather than the data, they retain some ambiguity of interpretation. This allows them to avoids being too descriptive, or representative of experiences, which might restrict users ability to remember the past constructively. Third, by focusing on specific people and their experiences, as opposed to personalizing a generic technology, the prototypes can more deeply address how objects and data can combine to connect to memory through specific case studies.

Many of the main findings of this thesis come from the design and deployment of the Earthquake Shelf described in Chapter 5: Experiential Manufacturing. Being the final prototype, it was designed to push further the findings from the previous chapters and to understand how these findings might be implemented. It followed the idea that objects and devices that mediate

data should not use that data to illustrate or recreate those experiences, but rather to evoke them so as to be able to allow for constructive remembering through ambiguity in interpretation of the meaning. Related to this, but distinct from it, was the idea that as well as combining data and object in a way that evoke, the action by which the connection is made should be evocative. For example the Earthquake Shelf seeks to combine data about earthquakes with the objects placed on the shelf, by using an action – shaking – that is remembered from the original experience. This action is in itself evocative of the participant's earthquake experience, and as such is intended to associate the object on the shelf with the data via the participants constructive remembering. Next, the intent behind the action and association was also seen to be important, as the deliberate association of data and objects through material affect plays a strong role.

8.1.1 Emotional Connection to Experience

The Earthquake shelf was designed according to the values given above, and so its evaluation by field deployment gave insight into the success of those design values in evoking memories and creating an emotional connection to a past experience. The ways in which it did this, as found through reflection on the design process and interview data from the participants, represent the results of this thesis.

Below are the findings derived from those results that concern the ways in which the interactions and characteristics designed into the earthquake shelf helped create an emotional connection between the participant and their experience.

8.1.1.1 Reflection and Utility

In the deployment of the Earthquake Shelf there seemed to be a contrast between reflection *and* utility. The way in which the Earthquake Shelf was designed meant that the participant was not able to use it to learn more about the details of current earthquake events. By not providing detailed information, it allowed the participant to focus on what they knew about such events based on their own experiences, and to reminisce and reflect on that experiences. Later in the deployment, when the need for such utility through more detailed information was demanded of the shelf, it's emphasis of personal reflection and reminiscence through ambiguity were insufficient to maintain the participants engagement, and alternative sources of more detailed information were sought. The participant's engagement with these current events then became more about knowledge of what others were going through, rather than their own experience.

In line with work discussed in the literature review concerning ambiguity and reflection, the shelf demonstrates a case where a similar principle can be applied to personal memory, where the amount of detail, or resolution of information given affects the participant's inclination to reflect in response to, or to know about.

8.1.1.2 Liveness

Another important factor in creating an emotional connection to an experience was the use of live data. Knowing that the Earthquake Shelf was indicating something that was happening *now* somewhere else created what was described as a more 'real' connection both to that place, and the past experience of the participant. This was of course amplified because both the *something* and *somewhere* held personal significance for the participant. Importantly as well, this was seen as being more effective than if the shelf had used historic data relating to the participants actual experiences. They considered that, rather than being evocative, the use of historic data may have either turned into a 'scientific' exercise geared towards knowing more about what happened, or an attempt to recreate their experience, which it couldn't possibly have achieved, even if that were desirable. Live data then not only created a 'real' connection to events, but also avoided attempts to describe the participants past experience, leaving enough ambiguity to allow for constructive reminiscence and reflection.

8.1.1.3 Physicality

Similarly, the physicality of the Earthquake Shelf contributed to the strength of the emotional connection both in terms of its realness, but also in creating a very 'visceral' response to the data. This was not just through virtue of being a physical object, but also through the physicality of its articulation. The shaking motion and sound, for example, created a very arresting, sensory, and therefore much more aesthetic, interaction with data. This was described by the participant as being much more emotionally evocative than looking at the data on the screen.
It was also important that these elements of physicality were not arbitrary, but referred to the participant's own memory and experience.

8.1.1.4 Functionality and Interaction

Also significant in the Earthquake Shelf's ability to create an emotional connection to experience was its singular function. Like any other shelf, The Earthquake Shelf has a very simple functional interaction. Although it might need to be done more frequently, you simply place objects upon it. It also only has one function – to shake when there is an earthquake in New Zealand.
This led the participant to describe the Earthquake Shelf as a 'physical app', comparing it to the way that apps on a smart phone are discrete 'objects' dedicated to a single purpose. He went on to say that this singular function meant that the shelf had a very direct and clear meaning to him, which in turn contributed to the strength of the emotional connection.

8.1.1.5 Slowness

An important factor of a person's ability to reflect and reminisce is time and space away from distractions that confine you to the present. The deployment of the Earthquake Shelf showed that when the shelf began to act too frequently, the tendency for the participant to engage with it emotionally, and to reflect on the past decreased. Because the Earthquake Shelf's mode of interaction was extremely 'violent', it needed a very low frequency of interaction, or slower pace,

to properly engage the participant on the right level. This allowed time to reflect, and to concentrate on other things. It also meant that when the shelf did act, it had more impact. When the frequency of interaction became too high, and the pace too fast, it occupied too much of the participants attention and became annoying.

So while aesthetic modes of interaction and emotional connection to memory were provoked by the shelf's action, it's ability to this was heavily contingent on the proper balance of the frequency and strength of interaction. When designing technologies to support this kind of remembering, this balance should be given special attention, as time away from the device is just as valuable as direct interaction.

8.1.2 Making a Meaningful Object

Although the final chapter, and the design work involved in it were able to combine experience data, and physical objects to create a meaningful connection top memory, it was unsuccessful in creating a meaningful object. Rather than this device being a mechanism to associate the data and object, the focus of reflection and reminiscence was largely placed on the device itself. This was considered to be the result of the choice of objects on the shelf. These were objects that the participant already owned and did not value. At the same time though, it was the device – the Earthquake Shelf – that provided direct, and importantly live engagement with the data, which the associated object could not. The attempt then to make a more lasting meaningful object was unsuccessful,

These findings, made throughout the program of design led research and from observations made after reflection on the design process, were consolidated in the Discussion chapter, and used to derived various design considerations. The contribution of this thesis then is in offering up various design considerations that will help in the design of technologies to support more aesthetic and emotional forms of remembering such as reminiscence and reflection. They are based on the experiences of, and lessons learned in attempting to design technologies to better support reminiscence and reflections. Rather than instructions for how to make a meaningful object, these considerations highlight issues to that may be encountered when designing technologies that support reminiscence and reflection. The intention of this is that these ideas can be used, critiqued and evaluated by myself and other researchers in future work.

8.2 Contributions

The findings above were used to generate the main contribution of this thesis. This takes the form of a design position, similar to a manifesto, that intends to offer a new design space for the design of technologies to support reminiscence and reflection, such that they might offer better support for the more emotional, and aesthetic aspects of looking back and reflecting on the past through digital content.

These were offered in the Discussion (chapter 7) which drew together findings from chapters 5 and 6, and represent the formation of generative intermediate-level knowledge, following on from

ideas like Strong Concepts. Rather than summarize these directly, we can now talk about them in relation to 3 broad challenges that face the designer of technologies that support reminiscence and reflection. These are: Designing for Physical and Digital, Designing for Then and Now, Designing for Personal-ness.

8.2.1   Designing for Physical and Digital

This first theme relates to the design decisions that mediate the relationship between the data, and the physical object. The details of their connection and interplay, how one gives meaning, or structures encounters with the other can be complex to design correctly for the goals of the project.

8.2.1.1   *Material Supports Meaning over Time*

Memory is embodied, and so the act of reminiscence is often provoked by some response to or perception of the physical world in the present. However, the physicality of objects allows their meanings to go beyond being simple memory cues, and to adapt to the addition and layering of meaning over time. Each time we engage with and object we reshape it meaning, and relation to that meaning according to our current needs. Objects are especially good at supporting this because of their flexibility in interpretation.

At the same time, objects maintain stability across time, in that they appear to maintain their meanings and associated values. In doing this, they lend durability to the memories we associate with them, and support the constructive layering of meaning over time.

In being stable, but malleable across time their interactions in the present relate to and build upon the past. In this way physical objects that are connected to memory exist both in the past and present. Consequently, there is a need to balance the tension between interaction in the present and reflection on the past, and the level of physicality of the interaction, and the resulting 'visceral' experience can be manipulate to achieve this.

The Earthquake shelf managed to maintain this by providing a purely physical, visceral quality of interaction in the present, rather than more literal or descriptive engagements with data.

This then allowed the participant, once the present interaction was over, to concentrate on their experience in the past, and to reflect on it freely according to their current needs and interests.

8.2.1.2   *Making the Digital Feel Real through Physical Interaction*

Creating physical manifestations of digital data can create very 'visceral' and 'real' interactions that encourage reflection on the meaning of data in relation to the user's, or viewer's, own experiences and memories. Because the prototypes had physicality that could be heard and touched, they seemed to have a more presence and connected more directly to things that the participants had sensed before. This goes beyond a description of an event and instead evokes a memory on experiential terms, thereby inspiring strong emotional responses that encourage deeper engagement with the device in the present, but also with memories of the past. This

relates somewhat to McCullough's idea of intrinsic information, mentioned in the discussion. Integrating data, or 'sent' information, into an object such that it become intrinsic perhaps makes the meaning a matter of embodied memory, rather than a reading of it, which thereby makes these interactions seem more 'real'.

8.2.1.3   *The Object and its Interaction Must Fit with the Experiential Aesthetic*

However, simply representing data physically is not necessarily enough to achieve this visceral, real, or deep connection to the past. When we browse data on a computer, we are engaging with the physical materials of the screen, the mouse and the keyboard, or the touch screen. When we see it printed we are interacting with the paper, and printer. 3d printing a physical model of a line graph makes a tangible representation of some data. Crucially though, the physical elements of these representations rarely offer any further engagement with, or understanding of, the meaning of the data, nor do they fit with the aesthetic of the experiences they represents, or their locative context.

Instead, the physical design of objects that represent data, and devices that mediate data to support reminiscence and reflection must be related to, and evocative of, the aesthetic of the experience they represent if they are to support aesthetic and emotional forms of memory.

8.2.2   Designing for Then and Now

Many of the design explorations here point to the idea that when designing technologies to support reminiscence and reflection, you are designing for interactions that will take place simultaneously in two different time periods. Interaction with these systems overlays the past with the present, and reconstitutes our memory through our current actions and feelings, but also through the functionality of the system. As such, systems need to be aware of the constructive nature of memory and to allow the user the freedom to construct memory according to their reflections on the present.

Chapter 7 describes in more detail the difficulties of Designing for this situation, and formulates a set of considerations for designers that are summarized here.

8.2.2.1   *Reflection is Embedded in Everyday Practices*

Because reminiscence and reflection are often the result of perception and interaction with things in the world, it follows they are embedded within, and part of, everyday life. In the physical use of an object the user is engaged, at various levels of depth and intent, with the memories, meanings and values that they associate with it. Sometimes they may be directly engaged with it, at other times it maybe an unnoticed part of the background that continues to perform its function and contribute to the aesthetic of the context.

This is to say that they are not always the focus of attention, and as such they allow us space and time to reflect, or simply to do other things. In this capacity these objects have a dual

identity, one that reflects their uses and values in the present and one of their meanings and evocations of the past.

This duality and integration into everyday life need to be considered in the design of the system. It is just as important to consider the aesthetic relations to the systems when not in use, and how it might support the ability to become part of the aesthetic relations that make up the home and everyday life.

8.2.2.2   Interaction and Reflection

Related to the point above, is the observation that instrumental interaction with an object or interactive system necessarily takes place in the present. As such any direct interaction with the system forces the user to concentrate on what they are doing and what is happening now. This can be very evocative, and trigger acts of reminiscence, but if it does not relate sufficiently to the aesthetic of the experience being referenced, it will distract the user from reflecting on the past.

8.2.2.3   Reflection is Slow

Reflection on the past is a slow process that requires time and space to think, free from distraction. However, as well as the ability for objects to retreat to the background, as discussed earlier, this requires the design of technologies that are not utility driven and that offer reflective space within their interaction. Here, the focus of the interaction is not upon completing a task, but on the aesthetic relation to the activity.

Slowness does not necessarily refer to a slow pace of operation, but in this case the reflective time and space within the interaction was heavily dependant on the balance between the pace and mode of interaction.

If the mode of interaction is extremely emotional or visceral, as we saw with the Earthquake Shelf, then the pace of interaction may need to be slow or infrequent. An increased frequency may lead to dissonance between user and system that negates the affect that it was meant to achieve.

Importantly though the mode and frequency of interaction should reflect the activity that is being engaged in. The Earthquake shelf reflected the activity, and participant's experience of it, by shaking. This mode of interaction was selected based on the assumption that it would act infrequently, but when the geographic area whose data the shelf responded to was enlarged, the frequency of interaction increased significantly. Had this change not taken place, the frequency and mode of interaction would have been well suited. But as it was, the Earthquake Shelf lost its emotional affect through over exposure and became an annoyance. Other examples provided in the discussion, show instances where the frequency of interaction was more controlled and predictable, and so the balance of frequency and mode are more easily aligned.

Designing this balance is a matter of familiarity with, and sensitivity to the memories being referenced, and to the affect of the devices interaction through a process of experimentation.

8.2.3 Designing for Personal-ness

8.2.3.1   Reflection is Personal

Reflection and reminiscence on ones past experiences is clearly very personal, as are our interpretations of memory data, and memory objects. Objects are especially good at supporting this individuality, and so this thesis has taken the relations between people and objects as a mechanism to mediate memory data. Also important in designing for a personal experience though, is the emphasis of evocation of the aesthetic rather than description of the event. This allows the users to perceive the data in terms of personal experience, but with an ambiguity that allows people to formulate the meanings and according their current values.

Further, I have also taken a very bespoke approach, not just in terms of using personal data, but also to the design of the research prototypes. In addressing participants' specific experiences the research explores ways of allowing deeper reflection. Indeed, the experientially focussed bespoke approach to the design of the device and interactions in the final investigation allowed the prototype to evoke deep levels of reflection through the provision of visceral interactions despite using non-personal data.

This highlights an important distinction between *personal*, and *personalised*. Many systems that support remembering start life as general technical systems that are then adapted to their users, or personalised, through the inclusion of the users personal digital archives for example. I argue that this approach does not fully engage users, as it does not relate to their experiences in any other way that through the data being used.

8.2.4 Methodological Lessons

In addition to the design recommendations described above, there were methodological lessons to be learned from the research conducted in this thesis. These apply principally to challenges around the deployment and assessment of the prototypes, but these challenges also arise from the approach the their design.

8.2.4.1   Deploying Slow Technology

One methodological problem presented during the discussion was the difficulty of deploying slow technologies over the relatively short time frames achievable in research projects.

When a device is designed to act so infrequently, it needs to be deployed for a suitably long time to allow the participants to engage with it properly. For instance, the Earthquake Shelf's aesthetic interaction relies on the participant being present while it is shaking because this is the point where it connects them to the past. However the necessarily slow pace of interaction, and its unpredictability, meant that they often missed the shelfs action. This, combined with the short deployment period lead to the fear that the participant would not have sufficient opportunity to engage with the shelf, and therefore little opportunity to reflect on its meaning and impact. Because of this, alterations were made to the device's behaviour that changes the pace of

interaction. The consequence of this was that the participant was eventually over exposed to the shelf's interaction, and what had previously been a strong emotional engagement became and annoyance.

Ideally then the Earthquake Shelf would have been deployed for many months, possibly over a year, while maintaining the slower pace of interaction. This was not possible in the time allowed and, as discussed later in 'Future Work', alternative methodologies may need to be conceived to address these problems.

8.2.4.2   Disrupting Deployment

A large part of the discussion of the Earthquake shelf revolved around the turning point halfway through the deployment where the data being used by the shelf was changed. This change disrupted the participants reading of the device and changed the meaning he attributed to it. Changing design features that are supposed to achieve certain things, such as using a specific location to encourage reflection on personal experiences, midway through a deployment could help the researcher to see the extent to which they are working. In certain cases such as this where interaction with a device is heavily dependent on carefully balanced design features, deliberately changing those behaviours to disrupt participants relationship to, and experience of, the device could reveal interesting elements of interaction that might not have been so easy to identify otherwise. Perhaps this could give researchers a new approach to more directly analyse the affects of specific design features in more ambiguous or aesthetic interactions, by eliciting contrasting responses based on specific design features.

8.2.4.3   Bespoke Design and Participant Numbers: The Challenge of Assessment

One of they key elements of this thesis was the reference to particular personal experiences, as opposed to concentrating on certain types of data or objects. Designing prototypes for engagement with specific people, about specific experiences necessitated a very bespoke approach. Although this approach was taken because of its perceived benefits in exploring new avenues and opportunities in the design of technologies to support reminiscence and reflection, it also caused difficulties from a research methodology point of view.

Despite an entirely qualitative program of research, the bespoke nature to the design meant that participant numbers were very low. The various research activities were very discursive and interview data was used to gather insight form the participants who, of course, were experts in the own experience, and well able to articulate their responses to prototypes. In addition this thesis emphasized design, both in terms of contribution and process, and the research was focused towards gaining insight from the participants to inform the next stage of design work. As such the qualitative data is combined with extensive reflection on the design, and experience of designing the prototypes. As a result the findings and contributions of this thesis are not intended to describe how 'people' as generalized from a group of users, engage with or use technologies that support reminiscence or reflection. Instead these contributions and findings

are intended as a set of issues that designers of technologies that support reminiscence and reflection should consider in their design work, that are based on reflections and insight from the experience of designing such technologies.

8.3 Summary

In order to lend some context to the design position detailed above, the following section will now summarize the formative chapters of this thesis. This will include the literature review that defined the design space and research question, the methodology, and details of the design work, research activities and findings that lead to these contributions.

8.3.1 Literature Review

The research question and object-centered approach to addressing it described at the beginning of this chapter were derived from a conceptual problem space constructed form 4 main sections of the Literature Review (Chapter 2). These were; "Personal Digital Records of the Past", "What Kind of Remembering?", "Making Sense of the Records", and "Incorporating Artifacts".

To begin, *'Personal Digital Records of the Past'* defines the problem *space by* reminding us that the development of digital recording technologies, and the availability of domestic and online storage space have allowed people to create larger and larger digital records of their experiences. While these archives have great potential to provide a rich source of emotional value by evoking reminiscence and reflection on the past, they are often large, disorganized, and unwieldy. This makes it difficult for people to engage with the content, and the memories it represents, in meaningful ways.

Before moving on to look at existing work, '*What Kind of Remembering?'* looks at the kind of remembering and memory that we are concerned with, and some important characteristics of these that further inform the problem space. Memory of personal experience, in being autobiographic, is a very emotional form of memory, that has requirements beyond the recall of information, and seeks a more sensory and aesthetic experience. Being primarily interested in more emotional and aesthetic forms of memory such as reminiscence and reflection helps select a more focused set of related work for review, and helps establish a set of values against which it can be critiqued.

The problem space above has led HCI researchers to explore different systems that can take advantage of this rich mnemonic resource, and create technologies that enable easier and more evocative interaction with memory data. *Making sense of the Records* then looks at the affects that some technologies might have on the way we remember, from how they have changed the ways we construct narratives about our past, to how they constrain and influence the ways that we remember. It also argued, however, that many of the systems through which people re-engage with this data impose ordering systems upon the data that may constrain the ways that

they are read and responded to, and lack the proper kinds of aesthetic engagement that is required for the given types of remembering.

Next, *Incorporating Artifacts* sought a new way to negotiate this problem. In this section we saw how objects are good at supporting meaning with high levels of interpretability, making them potentially powerful interfaces for constructive memory. The aesthetics of memory objects, understood here as the relations between objects, people, data and the past make a difficult setting for design, but one that can be extremely valuable in enabling the conditions for emotional and aesthetic engagement with constructive remembering.

Finally, I identified opportunities for further research in this area by moving away from systems that prioritize the navigation of digital archives, and the direct presentation of personal data, concentrating instead on the way that data can be integrated into a relationship between people and an object. By focusing on objects and their aesthetic relations to memory I hoped to be able to create new digital and physical interactions that integrated into those relations more sensitively, evocatively, and meaningfully.

8.3.1.1   Methodology

To go about this I took a design led approach informed to varying degrees by speculative, critical and ludic design. These ideological approaches to design research are particularly useful when investigating aesthetic responses and emotional engagements with technologies, but also for encouraging discussion around ideas and experiences through interaction with prototypes. For example, creating a speculative design prototype leverages the familiar language of objects to turn abstract ideas into tangible interactions. This allows participants to directly interact with something they can interpret, and in doing so grounds their thoughts and responses in terms of their everyday life and previous experiences to more meaningfully imagine what the object, and the proposed context around the object, might mean to them.

Ludic approaches to design use an arguably similar technique, but that designs prototypes to engage participants in technological interactions that prioritize reflection and curiosity; values that are difficult to imagine in interaction with technological objects. This tends to involve designing in a high level of ambiguity so that users can more flexibly interpret the system's meaning and value. Leveraging these alternative values and allowing freedom of interpretation enables deeper engagement with a device as users are able to make their own meanings that relate more fully to their own lives and experiences. This approach was deemed particularly applicable for this thesis due to its emphasis on personal reflection and deeper engagement with users during the evaluation process.

The research activities that made up this thesis included a mixture of interviews, design provocations, reflective design practice and field deployments. These approaches do not directly follow scientific traditions of design ethnography, or qualitative studies, but instead take precedent from research through design, conducted to create knowledge that supports design practice. They were selected both because of their suitability to the design led emphasis of the

thesis, but also in response to the circumstances and needs of each research activity. In other words, each approach was selected on a case-by-case basis by its suitability to the design work and research questions of each stage.

8.3.1.2 CH4 Design Rationale

Before getting into the main body of research, and describing the prototypes that were designed and made to inform it, this chapter presents some of my previous design work. Prototypes discussed in this chapter were designed as part of the Technology Heirlooms research project at Microsoft Research Cambridge. This project looked at our ever growing digital personal autobiographical records, and sought to understand what it might be like to own and engage with such an archive over an entire lifetime. How might we search and excavate such a huge and diverse archive in meaningful ways? How might we pass them on to others, or inherit them ourselves?

The purpose of discussing these projects (that are not formally part of this PhD research) was to build upon the Literature Review and Methodology chapters to further explain the design rationale, or the conceptual approach taken to the design work in this thesis, by providing examples of previous work. As well as further contextualizing the design space of the thesis, this chapter also explained how for the research developed from these previous projects, which were major source of inspiration in the desire to undertake this PhD research.

The prototypes shown were the Digital Slide Viewer, and Photobox. The Digital Slide Viewer is a physical memorial of a Flickr account that provides a physical manifestation of, and interaction with an inherited digital photographic archive. This was based on research that demonstrated how the sense of obligation that comes with inheriting some things, like extensive collections of physical photos, can be a burden. Similarly we imagined that maintaining an inherited online archive might also be burdensome, in terms of paying subscription fees to online services for example, while not having the benefit of a meaningful visible presence in everyday life. The Digital Slide Viewer then creates a static physical collection from digital content in order to give a potentially emotionally valuable collection a physical presence in the home. It also reintroduces rituals and practices that exist around precious material objects to interactions with personal digital content, in an attempt to provide a more aesthetic, and therefore emotionally engaging experience that clicking through files on a PC.

Next, Photobox, also dealt with digital photo collections, but in a very different way. It was inspired by the serendipitous encounters with the past we can have when searching among things that have been put away, and forgotten about. These are things that we may not want to throw away, but also do not need, or want to engage with everyday. Perhaps while searching through the attic we may come across a box of old photos, or a childhood toy that we were not expecting to find, and have a moment of reflection as we reminisce on the memories associated with that object. Photobox explores how this mode of discovery, and the aesthetic and value

that can result from this interaction, might be applied to the archives of personal photos that we keep online.

Photobox was the subject of a relatively long user study by Will Odom, a PhD candidate at Carnegie Mellon, where it was deployed in 3 households for a period of 14 months. Findings detailed in the subsequent paper that analyzed this study were re-examined in this chapter from a design perspective. In this way people's experiences of and reflections upon Photobox were linked, and discussed more in relation to elements of its design.

This, along with the reflections from the Digital Slide Viewer prototype were combined to derive a set of principles that would be carried forward to

The intention going into Chapter 4 was that the thesis would explore more material and experiential ways of engaging with autobiographical data. I wanted to explore interactions with personal autobiographical data that went beyond the presentation of the data to evoke memory, and into ways of manifesting that data to evoke the aesthetics experience of the event being remembered. Chapter 4 was valuable in that it helped formulate a few principles that could be used to work towards this goal, by informing the forthcoming design work.

Firstly, the physical manifestation of digital data was seen to play an important role in the value of interactions. The possibility for digital content to have a physical presence, allowed otherwise invisible or intangible content to be embedded within the aesthetic of the home, and lead to a wider engagement through its physical presence on sensory and spatial level, rather than purely a visual one.

However, it is not just a case of making something physical. There are aspect of our relations and interactions with objects that need to be paid careful attention in order for the physical manifestation to be meaningful.

This physical manifestation of the photos allowed the content to be implicated in material practices, such as placing photos in particular places around the home so that they could be kept private, found by specific people, or shared with everyone. These created valuable interpersonal interactions that revolve around the relation between material, people and space in the home that would not be possible (at least in an elegant way) with purely digital formats.

Another important element is consideration for the aesthetic relations at play within the given context, such as the home. The interactions that result from the materiality of the photographs, the materiality of the devices and their behaviours in these cases are derived from research into the ways that people organize meaningful things in the home. As a result they fit with the aesthetic of the home, and allowed the device to integrate with people's behaviours and social relations, while still providing enough disruption to create valuable research insights.

This chapter also highlighted that when designing technologies to support memory, there are other aesthetic relations to consider other than those into which the objects is placed. As well as paying attention to the domestic aesthetic, designers of technologies that support memory should pay attention to the experiential aesthetics of looking back at the past. Whether that is

intimate sharing of shared memories with those close to us, or serendipitous discovery of a forgotten memento there are many different ways that people experience or engage in the act of looking back. The relations between people, objects and place in these acts all add to the value of the memory, and its relevance to present values.

Finally, there is also the aesthetic of the past experience to be considered. The way that we remember a positive memory, or a negative one may be very different. Indeed, the distinction between positive and negative are simplistic, and many memories may be quite emotionally complex.

Another significant aspect of the value found in Photobox that may also be seen in the design of Digital Slide Viewer, was slowness. Photobox in particular made use of a slow pace of interaction. That is, there were long periods of time where it was inactive, which is in contrast to the interactions of many digital technologies.

Living with things for long periods of time creates very different relationships than with things that are quickly discarded. This engagement over long time periods is part of what allows stories and memories to be associated with the objects, and can (but does not necessarily) help increase their value. However, designing for this kind of temporal engagement requires a very different approach to designing their interaction.

Part of physical objects' ability to engage us over long time periods is that they are able to be interacted with directly and ignored at various times. Any digital systems that supports reminiscence and reflection should therefore pay attention to the ways that people interact with physical objects not just in the moment of interaction, but over time, including when they are not being directly used or paid attention.

8.3.1.3   CH5 Material and Memory

The first research activity was a series of exploratory interviews that sought to gather real examples of people's relationships to their meaningful objects, both in everyday life, and while actively remembering the events to which they are associated. The purpose of this was to find points of interest and inspiration for further investigation and design work. Recruited participants were asked to bring along a set of emotionally valuable objects that they were then interviewed about. Across these interviews a diverse range of objects were shown, from plants to musical instruments, while the memories and values attributed to them were just as varied.

A couple of interview participants brought along what would later be termed as 'replacement objects'. Where the original object collected from an experience was missing, they had by various means acquired replacements that now adopted the associations and values of the original while adding their own new layers of meaning. The participants' engagement with these replacements was interesting for a number of reasons, among which the physical tactile properties of the objects played an important role. In being an unexpected relationship between person, object and memory, this was chosen as a subject for further investigation along with other objects whose tactile properties and physicality was a significant part of their value.

The next step was a series of design responses to these objects and interviews that would help ask further questions about the relations between the people, the objects and the memories. The first object chosen, a poker chip, was a replacement of an original that it was physically identical, but visually different to. My interest was primarily in investigating the role of tactile perception in linking objects to a memory and asking of it was possible to create an object that, through its materiality could be associated to an existing memory? I made a series of 6 replicas of this replacement poker chip. Starting with an exact material copy, each replica thereafter lost a physical feature until the final one was a blank square of material. I then gave these to the participant one by one, and asked him to respond based only on touch. I found that it was possible to create an object whose material similarity to the original effectively linked the replica object to the memory. However, because these objects were newly fabricated, rather than gathered from some new experience, the materially *identical* replica was not valued. Instead, an approximation, roughly half way between this and the blank replica was favored. The full replica was seen as an imitation of something that it could never become, or replace, while the approximation was something new that fit better with the aesthetic relations between person, objects, and memory, while still providing some new meaning – the experience of taking part in the research and of sharing the story. This also led to ideas around how objects can be made to evoke rather than describe events, referring back to the literature review where we discussed ideas of imprecise representations of data. Here though, in the case of a non-digital object, we had a lesson in how this can be achieved through material form only.

The next research activity was an exercise in reflective design practice that explored ideas and interactions through engagement with making them in tangible form. This activity was based around a cereal bowl, also bought to interview, that had a small chip on the rim. Although this was not wholly responsible for the bowl's emotional significance to the participant, they were able to recall the exact circumstance in which the damage occurred, including the location, people present, activity, and familial relations. This material feature then is significant in that it takes the participants reading of the object beyond a 'sense of history', and instead represents a very specific memory, and set of values. The participant was also aware that this damage had weakened the bowl, and that one day it would break and have to be discarded. Does this meaning, and the perceived ephemerality, make it the damage a desirable feature to be able to reproduce? In order to think more about this question I began to explore the materiality of this object and the interactions that surround it I began experimenting with ways to make a device that would allow a person to make similar chips to the bowl with some consistency. The idea behind this is that if that bowl is lost or broken, they would be able to recreate the meaningful feature other objects thereby allow the meaning to persist beyond the life of the original object. However, upon completing the first device, it was obvious that the limited and mechanical interactions involved in operating it largely diluted the intent in the act of recreating the damage, and so did not do justice to the emotion of the original event. This highlighted the value of

gesture and action in recreating an emotionally significant event, and so new ways of achieving the result that allowed for a more emotionally involving gesture were needed. To this end, hammer like objects were designed that would make the act of damaging the bowls intentionally destructive and in doing so reflect the intention of transferring a feature of memory, and the emotion of the original. These were made to look and feel more like household kitchen appliances than workshop tools. This was to avoid the association of tools that would come from using an ordinary hammer, and instead to be more aligned with values of the home and domesticity entailed in the original event.

This focus on evocative gestures and interactions lead to the idea that recreating an event to affect an object could be an emotional and aesthetic act. Following this, data related to people's experiences, be it personal or otherwise, could be used to drive devices that could evoke emotions and values tied up in original experiences and memories, by recreating small aspects of interactions within the, rather than simply describing or illustrating them.

8.3.1.4   CH6 Experiential Manufacturing

The next chapter developed this idea and described the concept of *Experiential Manufacturing*. The idea was to design devices that use data related to people's personal experiences to recreate small aspects of those experiences in order to evoke associated memories. In doing so these devices were also to affect the material properties of objects such that they then also represented that memory.

This was a new approach to combining data and objects as a way of structuring interactions with data about specific memories, in that the process by which data and objects are combined references and evokes the aesthetic experiences of the remembered event. In order to investigate this, the research activity in this investigation was based around the field deployment of a prototype. The prototype itself would be based closely on the specific experience of an individual participant. First a suitable type of experience was needed – something likely to be emotionally affecting that there would also be readily available data about. After the discovery of several live earthquake data feeds online, earthquakes were chosen as the subject due to their emotional impact, affects on material and available data. Because of the potentially traumatic nature of the experience, a sensitive approach was needed, and in addition to ethical review, an expert in disaster management was consulted. Next a participant was recruited who had had experience of the Christchurch, New Zealand earthquakes of 2010. After being fully informed of the nature of the research, and their involvement, they were asked to supply any relevant data they might have such as photos, video or text. We then discussed their experience in detail, and the interview was transcribed and analyzed for subjects that could be used for the design of a device that evoked their experience.

After an ideation process, the idea of an Earthquake Shelf was chosen for continuation. This was a wooden box shelf, connected to the web that contained physical actuators. It read live earthquake data feeds and shook whenever there was an earthquake in Christchurch, New

Zealand. This prototype was chosen as it was seen to best adhere to the four design principles derived from the findings of the previous chapter, as follows.

Objects should evoke: By not illustrating the data, but manifesting it physically through the language of a familiar object, the Earthquake Shelf avoids to detailed description, and instead provokes emotional response. As such it evokes memory rather than informing. Further, in using data related to, but not derived from the participant's original experience, it was able to use similar events to provoke remembering of the past, rather than describe a current event.

Evocative Actions: In referencing the way that shelves shake and drop objects in earthquake, the shelf evoked a small part of the original experience. Careful attention was paid not to attempt to directly recreate the details of the participants experience as this could have potentially been traumatic, and in any case would not have been possible to do well, and therefore would have been insensitive to the emotional impact of their experience.

Intent: The shelf was an automatic system, meaning that the participant had little involvement in its function. However, they were to select the objects placed on the shelf, and also to replace the objects when they fell. This was a system to provide an aesthetic experience and evoke the past. This avoided the imposition of usability and functional values that might come with a system that was to be 'used'.

Objects as Personal Connection: In connecting to the web, and using data gathered from current events in Christchurch, the shelf connected the participant to that place. As such it also connected them to the people they know who still live there, and to those who lived there at the time but later left.

Following its selection, a series of iterative prototypes were built, and the final version of the shelf was deployed in the participant's office at work for a period of 6 weeks. It was accompanied by a diary study where they were given a private blog to record their thoughts as and when they occurred. During the first 3 weeks of the deployment, there was only very occasional earthquake activity in Christchurch and so the shelf was largely dormant. This combined with the participant's intermittent office hours meant that they had little opportunity for interaction with the Earthquake Shelf. Over a long-term deployment of many months, this would not have been cause for concern. However various practicalities that restrained the participant's availability also constrained the possible length of the deployment. As such it was feared that through the whole deployment there would not be sufficient opportunity for reflection upon their experiences of the shelf and its ability to connect them to their past. Because of this, approximately half way through the deployment, the geographic area that the earthquake shelf responded to was changed from Christchurch to the whole of New Zealand. This roughly coincided with a significant earthquake event in Wellington, which of course led to a dramatic increase in the shelf's activity.

This change divided the deployment into two stages that provided useful comparison in analysis. In essence each stage lead to a different interpretation of the shelf and point of reflection on its

interactions. Thanks to the direct connection to Christchurch the first stage was very much one of reminiscence and reflection upon their personal experience. The lack of activity allowed space and time for this reflection, while also being infrequent enough that when an event did occur, the participant felt a string emotional reaction.

One this connection to place was less explicit, the participant's interpretation of the system was much more focused on empathy for others, based on their memory of what the experience of an earthquake is like. Shortly thereafter the increased activity in this stage of the deployment caused what the participant described as a 'wearing off' of the emotional impact and tendency for reflection.

This investigation showed no evidence that the objects on the shelf had taken on new, or indeed any, significant meaning. Despite various scrapes and scuffs made by falling, the participant's perception of the books he placed on the shelf did not change throughout the course of the deployment.

There are three possible reasons for this. Firstly they were objects that the participant already owned, and that they therefore had preconceived ideas about. It is possible that their perceived valueless-ness as 'worn out old books' obstructed the attribution of new meanings. Secondly, the marks of wear that the books already bore were not affordances of memory but simply the signs of an old book. Any further damage or change of state was not seen as remarkable or significant. Thirdly, physical and visual marks from being shaken off of the shelf were lost amongst existing marks. As such the material affects of being on the shelf were not significant enough to be noticed, or considered as being related to a specific event. In order to solve these problems, new objects could have been made to place on the shelf. These would be free from these restrictive preconceptions, but also 'primed' with the possibility for the associations of meaning and value.

Where the Earthquake Shelf was successful though was in creating an emotional connection to the past by evoking memory. By being largely evocative of their experience, as well as the emotions and values formed during and since the physicality of the shelf created a very 'visceral' connection between the participant and their past. However, between the two stages of the deployment, several of the factors that contributed to the prototype's evocative power also later lead to a 'wearing off' period where its affect was lost, ultimately leading to its loss of acceptance. This change in the participant's interpretation of, and the comparison between the participants differing interpretations of, and engagement with the shelf highlighted many aspects of the design that affected their relationship with the prototype.

Reflection and utility: During the deployment, the participant's strong emotional response to the shelf prompted them to reflect on their own thoughts and experiences. Often though, after this reflective emotional response, they would look for more detailed information online. Looking at more detailed data tells the participant more about the event, but in becoming a 'scientific exercise', is not an aesthetic engagement with the subject matter and so does not evoke much

in the way of reminiscence or reflection. On the other hand, while the physicality of the shelf does provide this aesthetic, visceral, and personal reflection and reminiscence, it does not tell them much about what actually happened. For example, as soon as the characteristics of the shelf were changed (changing from earthquakes in Christchurch the whole of New Zealand) a sense of utility was needed from the data, the simple interactions of the shelf became deficient. The shelf did not tell the participant about what had happened, just that something had happened, so at this point on the deployment they were compelled to seek out further information for themselves to satisfy their needs. Conversely, had the shelf displayed too much detail while being focused on the participant's personal reflection, the emotional affect and reminiscence would have given way to 'scientific' interest. There is then a distinct balance between legibility and affect depending on the intended interactions.

Live-ness: The knowledge that the Earthquake Shelf was responding to live data was very important to the participant's engagement with it. Live data, and the knowledge that an event is occurring *now*, connects the user to that event and place very directly. Connecting them in such a way to a remote event effectively enables them share in that experience, and compels them to reflect upon it in relation to their own experiences, memories and values. However, live data of the kind used in this investigation can also cause difficulty. Earthquakes, and the subsequent production of data recorded about them, are largely erratic and unpredictable, and after a few days of inactivity the participant was often left wondering if the device was working. This has consequences for the participant's acceptance of the device, and can cause problems over a shorter-term deployment. For instance, in the absence of current events, the participant was unable properly interact or engage with the shelf and therefore unable to reflect properly upon its meaning. Similarly, they were unable to test or demonstrate the shelf, and were therefore unable to properly explain the affect of its physicality to others. Although this is not so important for the scope of this investigation, it shows that denying users any form of direct control of a device can make them uncomfortable.

Functionality and Interaction: Because the shelf only had a single function it connected the participant to the referenced experience very directly. In other words, for the participant, interaction with the shelf had a very direct link to its meaning, that was un clouded by alternative functions or possibilities. This too was demonstrated by the disruption that occurred halfway through the deployment. Changing the Shelf's function to reflect earthquakes from the whole of New Zealand effectively changed what the shelf was 'for', and changed the value they got from it by allowing a different interpretation of its meaning. This singular function was greatly valued by the participant, who talked about it in terms of 'physical apps'. That is, although it is physical, like a smart phone app it is dedicated to a single purpose, and any functionality that might distract from that purpose is removed. In allowing for more direct and un-distracted engagement with a subject, it allows for a deeper and more dedicated engagement with its 'function'.

Balancing Slowness: Finally, the Earthquake shelf may be considered as being a 'slow technology'. It acts infrequently, often occupying the background of attention, and its function is geared towards aesthetic engagement with memory and reflection. This infrequency of action, and the lack of direct interaction allowed space for reflection on the past, and current events. Again this is illustrated by the contrast in activity to the second half of the deployment where the increased frequency of interaction became overwhelming and irritating. However, this 'slowness' depends on more than the pace of interaction, which must be balance according to the mode, or form of interaction.

8.4 Future Work

In the pursuit of the research question, several areas for further work have been revealed. From the continuation of the design work begun in these research activities, to new questions that have arisen throughout the process.

8.4.1 Experiential Manufacturing

Chapter 6 of this thesis was based around the idea of Experiential Manufacturing. This was the idea that data related to a person's personal experience could be associated, in an intrinsic way, with a material object via a mechanism that uses that data to affect the materiality of that object in an evocative way. Although the Earthquake was able to use data to make a personal emotional connection, it was not successful in creating a meaningful object through association to that data. The reasons for this are discussed in Section 6.6.1.1, and while this was interesting in terms of the research discussion and contribution of this thesis, from a design point of view, we might view this as the first attempt in the exploration of this idea. Using the lessons learned from this thesis, a further attempt at an experiential manufacturing system would be a valuable course of further work. However, due to the personal nature of the work, this is not so simple as creating another iteration of the earthquake shelf for the same participant, and new versions would have to be made for new participants.

Another interesting avenue might be to try the earthquake shelf in a gallery or public exhibition setting. In moving away from addressing an individual's personal experience, placing the shelf in such a setting would open questions of cultural memory and value. For example, would the Earthquake shelf create a sort of souvenir by proxy? What value would people place on an object affected by a remote event? Would people with no experience of earthquakes also experience a 'real' and 'visceral' connection to another place and its inhabitants?

8.4.2 Designing for Past and Present

This thesis revealed the idea that designing for memory, and in particular more aesthetic modes of remembering like reminiscence and reflection, require careful design of interactions with data that negotiating movement, and interplay between the past and present. A rich area for further work would be to address this more directly, and to find further evidence for how this works in

the course of interacting with objects and data. If prototypes were designed to more consciously orchestrate this interplay we might get a better idea how, and when, to engage support reflection on the past.

8.4.3 Slow Methods

Another strand of future work could involve some deeper and more deliberate investigation into design-led research methods that could overcome the limitations of deployment periods in research conducted into slow technology.

This might involve the combination of traditional field deployment and design fiction, or scenario building to allow for the desired sensory and emotional experiences of objects while still allowing researcher and participant to explore the possible effects of longer term life with the technology. These scenarios and fictions could be developed through a process of co-design with the research participants, so that the scenarios and fictions are tailor more closely to their lives, and expectations of the future. So, rather than their reflections of scenarios developed by the designers and researchers, the process of creating these scenarios, and the discussions therein would reveal the participants values and thoughts on living with the such a personal technology over long periods of time.

9 References

1. Arduino. Online. Available at: http://www.arduino.cc/. Accessed: 21.08.2013

2. Baddeley, A., Eysenck, M., Anderson, M. (2009). Memory. Psychology Press.

3. Baddeley, DA. (1999) The Essentials of Human Memory. Psychology Press, Hove.

4. Banks, R (2011) The Future of Looking Back. Microsoft Press. Redmond, Washington USA.

5. Banks, R. 2010. Techfest 2010: Some Technology Heirlooms. Rb.log. Online. [Accessed 28.07.2014]. Available at: http://www.richardbanks.com/2010/03/16/techfest-2010-some-technology-heirlooms/. Rb.log.

6. Banks, R. Sellen, A. 2009. Shoebox: Mixing Storage and Display of Digital Images in the Home. In Proceedings of 3rd International Conference on Tangible and Embedded Interaction, Cambridge, UK. Pp. 35-40. ACM Press.

7. Banks, R., Duffield, N., Sellen, A., Taylor, A. Things We've Learned About Memory. Online. Available at: http://research.microsoft.com/en-us/projects/thingswevelearnt/things_issue2_memory.pdf. Accessed: 14.10.2013

8. Banks, R., Kirk, D. and Sellen, A. (2012) A Design perspective on three Technology Heirlooms. *Human-Computer Interaction.* 27, 1-2, p.63-91

9. Barthel, R., Mackley, K. L., Hudson-Smith, A., Karpovich, A., de Jode, M., Speed, C. (2011) An internet of old things as an augmented memory system

10. Beaver, J., Kerridge, T, Pennington, S. (2009). Material Beliefs. London, Goldsmiths, University of London.

11. Bleeker, J. 2009. Design Fiction: A short Essay on design, science, fact and fiction. [Online] Available at: http://nearfuturelaboratory.com/2009/03/17/design-fiction-a-short-essay-on-design-science-fact-and-fiction/. Accessed 06.08.2013.

12. Boehner, K., DePaula, R., Dourish, P., and Sengers. P. 2005. Affect: From Information to Interaction. In Proc. 4th Decennial Conference on Critical Computing, 2005, pp. 59-68.

13. Brown, B.,Sellen, A., O'Hara, K. 2000. A Diary Study of Information Capture in Everyday Life. CHI '00. In the proceedings of the SIGCHI conference on Human Factors in Computing systems. Pages 438-445.

14. Bush, V. (1945) As We May Think. Online. Available at: http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/. Accessed: 05/09/2012.

15. Card, S. Moran, T. Newell, A. (1986). The Psychology of Human-Computer Interaction. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

16. Carter, S,. Mankhoff, J. 2005. When participants do the capturing: the role of media in diary studies. CHI '05. In procedings of the SIGCHI Conference on Human Factors in Computing Systems. Pages 899-908

17. Csikszentmihalyi M., and Rochberg-Halton E., The meaning of things: Domestic symbols and the self. Cambridge University Press, 1981.

18. Designing With People. Online. Available at: http://designingwithpeople.rca.ac.uk/methods/design-probe. [Accessed on: 2.08.2013]

19. Dunne and Raby FAQ http://www.dunneandraby.co.uk/content/bydandr/13/0

20. Dunne, A. 1999. Hertzian Tales: Electronic Products, Aesthetic Experience, and Critical Design. MIT Press. Cambridge Massachusetts.

21. Dunne, A., Raby, F. Placebo Project. Online. Avalaible at: http://www.dunneandraby.co.uk/content/projects/70/0. [Accessed: 25.08.2013]

22. Frohlich DM, Murphy R (2000) The memory box. Pers Technol 4:238–240

23. GAVER, W. 2012. What should we expect from research through design? Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI'12). Pp 937-946

24. Gaver, W., Beaver, J., and Benford, S. (2003). Ambiguity as a resource for design. Proc. CHI'03, Ft. Lauderdale. New York: ACM Press.

25. Gaver, W., Blythe, M., Boucher, A., Jarvis, N., Bowers, J. and Wright, P. (2010). The Prayer Companion: Openness and Specificity, Materiality and Spirituality. In Proc. CHI'10, pp. 2055-2064

26. Gaver, W., Bowers, J., Boucher, A., Gellerson, H., Pennington, S., Schmidt, A., Steed, A., Villars, N., and Walker, B. (2004). The Drift Table: Designing for ludic engagement. Proc. CHI'04 Design Expo. New York: ACM Press.

27. Gaver, W., Bowers, J., Kerridge, T. Boucher, A., and Jarvis, N. (2009). Anatomy of a Failure: How We Knew When Our Design Went Wrong, and What We Learned From It. In Proceedings of CHI'09. Boston, Massachusetts, USA.

28. Gaver, W., Dunne, A., Pacenti, E., Cultural Probes. Interactions Volume 6 Issue 1, Jan./Feb. 1999, 21-29. ACM: New York.

29. Gaver. W., Bowers, J. Boucher, A., Law, A., Pennington, S., Villar, N. 2006. The History Tablecloth: Illuminating Domestic Activity. Proc. of DIS '06, 199-208.

30. Gemmell, J., Bell, G., Lueder, R. 2006. MyLifeBits: a personal database for everything. In Communications of the ACM (CACM), vol. 49, no. 1, pp. 88-95, Association for Computing Machinery, Inc., January 2006

31. GeoNet. Online. Avalilable at: http://www.geonet.org.nz/quakes/felt. Accessed: 19.08.2013

32. Glenn, J., Hayes, C. (2007) Taking Things Seriously: 75 Objects with Unexpected Significance. Princeton Architectural Press, NY NY, USA

33. Hallnas, L., Redstrom, J. 2001. Slow Technology: Designing for Reflection. P. Ubi. Comput. *5*, 3, 201-212.

34. Harada, T. 2000.Space, Materials, and the 'social': in the aftermath of a disaster. In Environment and Planning D: Society and Space 2000, volume 18, pages 205-212

35. Hodges, S., Berry, E,. Wood, K. 2011. SenseCam: A Wearable Camera Which Stimulates and Rehabilitates Autobiographical Memory. Memory, 2011.

36. Höök, K. and Löwgren, J. 2012. Strong concepts: Intermediate-level knowledge in interaction design research. ¨ACM Trans. Comput.-Hum. Interact. 19, 3, Article 23 (October 2012), 18 pages.

37. Hoven, E. van den and Eggen, B. (2005). Personal souvenirs as Ambient Intelligent objects. In proceedings of sOc-EUSAI 2005, Oct 12-14, Grenoble, France, pp. 123-128.

38. Hoven, E. van den, and Eggen, B. (2003). The Design of a Recollection Supporting Device: A Study into Triggering Personal Recollections. In proceedings of the HCI-Int. 2003, June 22-27 2003, Crete, Greece, part II, pp. 1034-1038.

39. Hoven, E. van den, Frens, J., Aliakseyeu, D., Martens, J-B., Overbeeke, K. and Peters, P. (2007). Design Research & Tangible Interaction. In proceedings of Tangible and Embedded Interaction 07, Baton Rouge, Louisiana, USA, pp. 109-116.

40. Interaction Research Studio, Goldsmiths, University of London. Online. Available at: http://www.gold.ac.uk/interaction/. Accessed: 6.08.2013

41. Jacobs, R., Benford, S., Selby, M., Golembewski, M., Price, D., Giannachi, G. (2013) A Conversation Between Trees: What Data Feels Like In The Forest. In Proceedings of the 2013 SIGCHI conference on Human Factors in computing systems (CHI 2013), ACM, April 2013.

42. Kalnikaitė, V., Sellen, A., Whittaker, S., Kirk, D. 2010. Now let me see where I was: understanding how lifelogs mediate memory. In Proceeding of CHI 2010: 2045-2054.

43. Kalnikaitė, V., Whittaker, S. 2011. A saunter down memory lane: digital reflection on personal mementos. International Journal Human-Computer Studies 69(5): 298-310.

44. Kirk, D., Banks R. (2008) On the Design of Technology Heirlooms. In Proceedinings of The International Workshop on Social Interaction and Mundane Technologies (SIMTech Ã-08).

45. Kirk, D.,Sellen, A. (2010) On Human Remains: Values and Practice in the Home Archiving of Cherished Objects. Transactions on Human-Computer Interaction (TOCHI), 17, 3, 1-43

46. Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., Wensveen, S. 2011. Design Research Through Practice: From the Lab, Field, and Showroom. Morgan Kaufmann.

47. Lindley, S. E., Durrant, A., Kirk, D., & Taylor, A. S. (2009). Collocated social practices surrounding photos. International Journal of Human-Computer Studies, 67(12), 995–1004.

48. Lindley, S., Marshall, C.C.., Banks, R., Sellen, A. and Regan, T. (2013). Rethinking the web as a personal archive. In Proceedings of the 2013 international conference on World Wide Web (WWW 2013), 749-760.

49. Lindley, S.E., Banks, R., Harper, R., Jain, A., Regan, T., Sellen, A., and Taylor, A.S. (2009). Resilience in the face of innovation: Household trials with BubbleBoard. International Journal of Human-Computer Studies, 67, 2, 154-164. doi:10.1016/j.ijhcs.2008.07.008.

50. Lindley, S.E., Randall, D., Sharrock, W., Glancy, M., Smyth, N. and Harper, R. (2009). Narrative, memory and practice: Tensions and choices in the use of a digital artefact. In Proceedings of the 23rd BCS conference on Human Computer Interaction (HCI 2009), 1-9.

51. Löwgren, J. 2013. Annotated portfolios and other forms of intermediate-level knowledge. Interactions. 20, 1 (Jan. 2013), 30–34.

52. Marshall, J. Unver, E. Atkinson, P. 2007. AutoMAKE: Generative Systems, Digital Manufacture and Craft Production. Generative Art Conference, Milan, 11th -14th December 2007

53. Material Beliefs. [Online] Available at: http://www.materialbeliefs.com/

54. Mayer-Shönberger, V.2011. Delete: The Virtue of Forgetting in the Digital Age. Princeton University Press, USA.

55. McCullough, M. 2013. Ambient Commons: Attention in the Age of Embodied Information. MIT Press, Cambridge Massachussetts.

56. Middleton, D. & Brown, S, D. 2005. The Social Psychology of Experience: Studies in Remembering and Forgetting. Sage Publications, London

57. Miller, D; (2008) The Comfort of Things. Polity: Cambridge.

58. Miller, D; (2009) Stuff. Polity: Cambridge.

59. New Zealand Shakeout. Online. Avaliable at: http://shakeout.govt.nz/. Accessed: 16.08.2013

60. Niedderer, K. Roworth-Stokes, S. The Role and Use of Creative Practice in Research and its Contribution to Knowledge

61. Nunes, M., Greenberg, S. and Neustaedter, C. (2008). Sharing Digital Photographs in the Home through Physical Mementos, Souvenirs, and Keepsakes. In Proceedings of the Conference on Designing Interactive Systems (DIS 2008), ACM Press.

62. Obrenovic, Z. 2011.Design-Based Research: What We Learn When We Engage In Design of Interactive Systems. *ACM interactions*, September + October 2011. Vol. 8. Issue 5. Pages 56-59.

63. Odom, W., Banks, R., Kirk, D., Harper, R., Lindley, S., and Sellen, A. Technology heirlooms? Considerations for Passing Down and Inheriting Digital Materials. *In Proc. CHI'12,* (2012), 337.

64. Odom, W., Selby, M., Sellen, A., Kirk, D., Banks, R., Regan, T. (2012). Photobox: On the Design of a Slow Technology. In *Proceedings of Designing Interactive Systems.* (DIS '12). ACM Press.

65. Odom, W., Sellen, A., Kirk, D., Banks, R., Regan, T., Selby, M., Forlizzi, J., Zimmerman, J. (2014). Designing for Slowness, Anticipation and Re-Visitation: A Long Term Field Study of the Photobox. In In proceedings of SIGCHI Conference on Human Factors in Computing Systems. Toronto, Canada. CHI '14. ACM Press.

66. Odom, W., Zimmerman, J., Forlizzi, J. (2011) Teenagers and Their Virtual Possessions: Design Opportunities and Issues. In Proc. of CHI '11, 1491-1500.

67. Petrelli, D. and Whittaker, S. (2010). Family Memories in the Home: Contrasting Physical and Digital Mementos. Personal and Ubiquitous Computing, 14, 2, (Feb. 2010), 153–169.

68. Petrelli, D., Villar, N., Kalnikaite, V, Dib, L. and Whittaker, S (2010). FM radio: family interplay with sonic mementos. In: CHI '10 Proceedings of the 28th international ACM conference on Human factors in computing systems, Atlanta, Georgia, USA, April, 2010. 2371-2380.

69. Petrelli, D., Whittaker, S., Brockmeier, J. (2008). AutoTopography: what can physical mementos tell us about digital memories? In: CHI '08 ACM conference on Human factors in computing systems, Florence, Italy, 5-10 April 2008. 53-62.

70. Prayer Companion image: http://www.moma.org/interactives/exhibitions/2011/talktome/objects/145526/

71. Processing. Online. Available at: http://processing.org/. Accessed: 21.08.2013

72. Raford, N. From Design Fiction to Experiential Futures. Online. Available at: http://noahraford.com/files/Design-Fiction-to-Experiential-Futures.pdf. Accessed: 06.08.2013.

73. Schön, D. A. (1983). *The reflective practitioner*. New York: Basic Books.

74. Sellen, A. & Whittaker, S. (2010). Beyond total capture: A constructive critique of lifelogging. *Communications of the ACM, May, 2010.*

75. Sellen, A., Fogg, A., Aitken, M., Hodges, S., Rother, C. and Wood, K. (2007). Do life-logging technologies support memory for the past? An experimental study using SenseCam. Conference on Human Factors in Computing Systems, CHI '07, Irvine, CA, 81-90.

76. Sengers, P., Gaver, W. (2006) Staying Open to Interpretation: Engaging Multiple Meanings in Design and Evaluation. DIS 2006.

77. Solnit, R. 2009. A Paradise Built in Hell: The Extraordinary Communities that Arise in Disaster. Penguin Books, London, England.

78. Speed, C. (2011) A rolling stone gathers no moss and other consumer conspiracies. Online. Available at: http://www.chrisspeed.net/?p=787. Accessed: 29.10.2013

79. Ståhl, A., Höök, K., Svensson, M., Taylor, A., Combetto, M. (2009) Experiencing the Affective Diary. Journal of Personal and Ubiquitous Computing, 5 (13). Pp.365-378.

80. Ståhl, A., Löwgren, J., & Höök, K. (2014). Evocative balance: Designing for interactional empowerment. International Journal of Design, 8(1), 43-57.

81. Stevens, M.M., Abowd, G.D., Truong, K.N., Vollmer, F. Getting into the Living Memory Box: Family Archives & Holistic Design. In Personal and Ubiquitous Computing, Volume 7(3-4), pp. 210-216, July 2003. doi:10.1007/s00779-003-0220-4

82. Stolterman, E. (2008). The nature of design practice and implications for interaction design research. International Journal of Design, 2(1), 55-65.

83. Student Volunteer Army. Online. Available at: https://en-gb.facebook.com/StudentVolunteerArmy. Accessed: 17.08.2013

84. Sudjic, D. 2008. The Language of Things. Allen Lane: London, UK

85. Superflux. Domestic Gubbins. Online. Avalable at: http://superflux.in/work/domestic-gubbins. [Accessed: 04.08.2013]

86. Superflux. Online. Available at: http://superflux.in/. Accessed: 6.08.2013.

87. Superflux. Song of the Machine. Online. Avaliable at: http://superflux.in/work/song-machine. Acessed: 06.08.2013.

88. Swan, L. & Taylor, A. S. (2008). Photo displays in the home. Designing Interactive Systems Conference, DIS '08, pp. 261-270.

89. Talk To Me. Online. Available at: http://www.moma.org/interactives/exhibitions/2011/talktome/objects/145526/. Accessed: 6.08.2013

90. Taylor, A. S., Swan, L. & Durrant, A. Designing family photo displays. In Proc. ECSCW 2007: 79-98. Springer (2007).

91. Taylor, A., Jain, A. 2008. Objects Incognito: An everyday Enquiry Into Everyday Ideas of Intelligence. [Online] Available at: http://superflux.in/work/objects-incognito. [Accessed: 27.07.2013]

92. Tolmie, P., Crabtree, A., 2008. Deploying Research Technology in the Home. In: CSCW '08: Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work. 639-648

93. Turkle, S. 2011. Evocative Objects: Things We Think With. MIT Press, Massacheusetts, USA.

94. US Geological Survey. Online. Avalaible at: http://earthquake.usgs.gov/. Accesed: 19.08.2013

95. USGS. The Great 1906 San Francisco earthquake. Online. Available at: http://earthquake.usgs.gov/regional/nca/1906/18april/index.php . Accessed: 10.09.2013

96. World Economic Forum. 2011. Personal Data: The Emergence of a New Asset Class. Online. Available at: http://www.weforum.org/reports/personal-data-emergence-new-asset-class. [Accessed: 11.12.2013]

97. Wright, P., Wallace, J., and McCarthy, J. 2008. Aesthetics and experience-centered design. ACM Trans. Comput.-Hum. Interact. 15, 4, Article 18 (November 2008).

98. Xively. Online. Available at: https://xively.com/. Accessed: 21.08.2013

99. Ylirisku, S., Lindley, S., Jacucci, G., Banks, R., Stewart, C., Sellen, A., Harper, R. and Regan, T. (2013). Designing web-connected physical artefacts for the 'aesthetic' of the home. In Proceedings of the 2013 SIGCHI conference on Human Factors in computing systems (CHI 2013) 909-918. New York: ACM Press.