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Designing Museums for Participation, Collaboration and Social Interaction

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Declaration

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This thesis is entirely my own work except where otherwise accredited, and has not been submitted for an award at any other institution.

Signature

Martin McCarthy

Abstract

This thesis documents the design and development of novel interactive experiences that explored concepts aimed to enhance the visitor experience to Cork Butter Museum, Cork, Ireland.

The context to the work is that in recent years, museums and cultural institutions are increasingly motivated to apply creative strategies to engage visitors who come for recreational, social and sometimes educative purposes. Novel museum exhibits designed to cater for such needs often involves the integration of new media technologies in response to rising expectations visitors have with regards to being actively engaged during their visit. This often requires a higher level of participation than reading text or looking at artefacts from a controlled distance.

Researchers have explored transforming the visitor experience through a wide range of projects in the fields of embodied interaction and experience design, which might be regarded as emerging subfields of research practice in HCI. Recent approaches to the design of public exhibition spaces have often made use of widely available input/output sensing technologies which support alternative strategies for the creation of novel interfaces and delivery of dynamic content.

In light of such developments, the aim of this work was to explore the design of engaging experiences that would facilitate participation, collaboration and social interaction in a museum through the creation of technologically augmented artefacts. From the outset, a principle of the research was to ensure that any interventions were sensitive to and respected the natural aesthetic of the museum environment.

Aims and objectives that were suitable for the research were first identified through design research, out of which a set of design principles that were specific to the museum emerged.Authentic artefacts which were suitable for the creation of novel experiences were identified and transformed over the course of an iterative design and development cycle. They were then brought into the museum for a case study, and their effects were analysed and discussed. The process, methods, and findings that were uncovered over the course of the research will be described in the thesis.

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Introduction

1.1 Overview

The aim of this research was to design interactive experiences for museum visitors that were respectful to the museum's natural environment. The intention was to achieve this aim by creating augmented artefacts that supported authentic tangible interactions which would allow for a more rewarding, proactive and engaging visitor experience.

The point of departure was exploring the circumstances required to make possible interactive experiences that allow people to engage with the museum in a way that placed an emphasis on the artefacts and the heritage they embodied, not the technology that was embedded in them. Though the aim involved the introduction of technology into the museum space, a guiding principle from the outset was to ensure that any interventions were sensitive to and resonated with the heritage and arrangement of the museum. The focus was on the human experience of such interventions, not on the technological elements that such interventions were built with. Further still, the intention was not to explore the use of technology to deliver information through novel mediums.

The research is situated between the fields of Interaction Design and Experience Design. Broadly, Interaction Design focuses on designing interactive systems for people's use. It implies five major characteristics: changing situations by shaping and deploying artefacts; exploring possible futures; framing the 'problem' in parallel with creating possible 'solutions'; thinking through sketching and other tangible representations, and; addressing instrumental, technical, aesthetical and ethical aspects throughout (Lowgren, 2013). Experience Design, a somewhat similar discipline which is still in its infancy, posits that developers understand what makes a good experience, and then translate these principles 'into desired media without technology dictating the form of the experience' (Shedroff, 2014). In order to create effective, meaningful and successful experiences, it lists a number of dimensions in the description of possible experiences; time/duration, interactivity,

breadth/consistency, sensorial and cognitive triggers and significance/meaning (Ibid).

In the past when computers and technology were largely confined to the desktop, researching the possibilities of people engaging with interactive systems was most often reserved for practitioners and researchers from the fields of Human Computer Interaction (HCI) and Computer Supported Co-operative Work (CSCW). However, recent open-source movements and ubiquitous technologies have made interactive experiments more accessible to designers, encouraging more speculative and practical investigations in the field.

The research documented in this thesis situates itself in this area of recent contributions, aligning itself with a speculative approach to designing and developing unique interactive experiences for people to engage with. As the thesis will show, the research took a 'human centred' approach to design. Stakeholders were interviewed to frame the design problem that needed to be solved, which then led to a series of observational studies in the museum. This design research was done in parallel with a literature review out of which a number of design principles emerged. After a number of artefacts and an area of history suitable for creation of novel experiences were identified, prototypes went through an iterative design cycle that made use of focus groups and analysis of qualitative interviews with participants. Prototypes were then introduced into the museum, where observational studies and qualitative interviews were conducted, which led to further iterations.

1.2 Framing the Research

The research was carried out in the context of contemporary views of technology where it is seen to have moved beyond functioning simply as a tool that is used to fulfil a utilitarian purpose and into the domain of being something that is lived with and experienced, integrated into peoples' lives (Bagnara and Smith, 2006; Hassenzahl et al., 2013). Technology in this sense is not taken as something that is created for depersonalised or inert 'users' – instead it is conceptualised as something that is created for people who have a rich array of motives and agendas for engaging with designed artefacts (Norman, 2006). It is something that people build up a

relationship with in the context of specific environments and activities, with rules and constraints that dictate how they act and behave around it.

As part of this reconceptualization of technology, an active area for research since technology has 'come off the desktop' (Greenfield, 2006) has been to investigate the introduction of technology into spaces of all kinds – public, private, work and play (Fitzpatrick, 1998; Streitz et al., 2007). Such research has focused on both the immediate and more latent effects of how technologies have changed peoples' behaviour and perceptions over time. The more immediate effects it can have brings into focus various ideas of tangible and physical interaction with systems and how 'performing' these interactions might have an effect on interpersonal interactions (Dalsgaard and Hansen, 2008). Such explorations have used theories that emphasised the distinctions between space and place, recommending that 'places' are specific constructs with features and functions that need to be sensitively approached and taken into account when designing (Harrison and Dourish, 1996; Ciolfi, 2004).

The research documented in this thesis was inspired by an experimental and explorative approach to the design of interactive experiences and artefacts (Flint and Turner, 2011). It did not cast the people who would engage with the artefacts as having pre-defined goals that needed to be met following their interactions with the artefacts, so in this sense it was not designing to create interactive learning experiences for museum visitors, as has been done in the past (Hall and Bannon, 2005). The aim was not to communicate some type of intellectual content to the visitors in order to teach them something. In this way, it was not focused on traditional interaction design heuristics such as design for usability or ease of use. Rather, this research aligns itself with the view that such a one dimensional approach to interaction design 'largely undervalues users' dynamics in learning and experiencing' (Bagnara and Smith, 2006).

1.3 Brief History of Technology in Museums

Museums have for a long time been using digital and interactive technology as part of their offering to visitors. This has taken many shapes and forms, ranging from novel audio guides that allow for social interaction (Aoki et al., 2002) to fully fledged immersive and interactive 3D environments (Kenderdine et al., 2009).

The reasons for introducing interactive technologies into museums have been varied, often dependant on what type of museum it is and how they characterise their visitors (i.e. 'target audience'). Typically however, museums make use of technology in order to deliver media content and provide contextualising information for their collections. Whether it comes in the form of fixed interactive kiosks, mobile audio guides that visitors can carry around the exhibit with them, or interactive websites that visitors can access before, during or after their visit, the mode of engaging visitors has often been focused on delivering media content. The emphasis is on giving information to visitors, which characterises the relationship that underlies the intent of those who created the exhibit: a didactic form of communication, where curators maintain control of the conversation in a teacher/student type of exchange. The curator holds the knowledge which they dispense to the visitors, placing the museum in the role of an authoritative conserver of history providing limited accessibility to generic learners. This focus on providing information can sometimes prevent visitors from observing or appreciating the actual artefacts, as has been noted in the past (Bannon et al., 2001). While these examples show how technology has been used to provide contextualising information for collections on the museum floor which are in the presence of visitors, in some cases technology has also been used to 'exhibit' collections that may not be in the immediate presence of the visitor (Gorgles, 2013; Alexander et al., 2013). In these cases, technology is being used to exhibit artefacts that the museum does not have the physical space to put out on the museum floor, resulting in the museum making use of digital technologies to show a more comprehensive view of their collection.

However, in recent times some museums have taken on the role of a facilitator rather than an authoritative provider of knowledge (Simon, 2010). In such cases museums provide a stage for conversation based around participation and active engagement, rather than being a space for the passive consumption of museum materials (Smith et al., 2011). A dialogue between the curator and the visitor is opened up, where the museum is a facilitator who aims to help visitors reconstruct and reflect on memories of the past, listening to the voices of many in the process. Here, technology can be used to encourage people in exploratory, inquisitive and playful modes of engagements where the aim is to provide an experientially rewarding visit that may

have an impact on the visitor beyond the relatively short duration of time that they spend inside the walls of the museum.

Mobile technologies have also impacted the field, with many museums now offering mobile applications and mobile ready websites. Some museums even encourage visitors to use their phones during their visit by placing QR Codes next to exhibits and providing free wireless internet access in order to access the content that the QR Code links too (Youn and Stewart Titus, 2011). This can be taken as a sign that museums are opening up to facilitating visitor engagement through mobile technologies, both inside the museum in the case of the QR Codes, and beyond the museum in the case of mobile sites and apps. However, given that the primary purpose is to make information accessible, the ways in which museums have been connecting with people through mobile and web technologies could still be characterised as being a teacher/learner relationship that do not go beyond the museum delivering information to the visitor. As with fixed interpretative tools such as audio guides and kiosks, the type of engagement supported by mobile technologies are often focused on delivering content (Othman et al., 2013), which may end up taking away from engaging directly with the artefacts and heritage in the museum.

Further to this, much of the technologies that have been introduced into museums in the past have been unsuitable to the social dynamics that museums are naturally home to, something which (Aoki et al., 2002) aimed to resolve when they developed electronic guidebooks to 'support social interaction between companions as they tour a historic house'. Visitors often come in pairs or groups and communicate (verbally and non-verbally) with one-another throughout their visit. This dialogue is essential in their process of making sense of and enjoying their visit – they interpret the content collectively and share opinions, turning the visit into a social experience that is determined as much by the company they are with as the content inside the museums (Falk and Dierking, 1992). Studies have also shown that visitors are intensely aware of and take cues from the actions of others who are within a close proximity to themselves (vom Lehn et al., 2007). However, the design of technology for museums has often cut visitors off from the necessary cues that enable them to be within the loop that connects them to the complex web of social interactions they

need to be connected to in order to have a fulfilling visit. Audio guides that inhibit visitors from talking and listening to one-another, kiosks that take visitors attention away from the artefacts, and interactive interfaces that only allow for single user input are all examples of poorly designed technologies and interfaces that inhibit the visit experience.

This research did not associate itself with such technologically led approach to the design of museum interventions. By attempting to design for experience, the question that the research aimed to answer was how to create more meaningful experience for visitors that resonated with the artefacts and history of the museum. While novel technology would be used, it would be used in a manner that was sensitive towards and respected the uniqueness of the museum and its' environment. The objectives were identified as:

- Determine how best to introduce digital media technologies into the museum;
- Support the visitor experience through the creative use of digital technologies in a way that compliments the existing goals and objectives of the museum;
- Establish design principles that guide the development of physical prototypes;
- Implement a range of physical prototypes supported by a design philosophy that respected the museum's natural environment and integrity;
- Extend the reach of the museum and allow visitors to engage with it beyond the physical walls of the museum.

In order to ground the research and give it purpose, a local museum where practical investigations could be explored and tested was identified. What follows is an account and description of the museum. This was written by the researcher aftery the visited it a number of times and engaged with the curator over the course of the study. This description will help to contextualise the research and give insight into the challenges it faced in attempting to fulfil the aims and objectives that have been described above.

1.4 Cork Butter Museum

Cork Butter Museum is a unique museum located in the north side of Cork City, Ireland. It was founded in the 1990s to celebrate the butter and dairying history of the region and surrounding areas. Though butter and dairying is its primary focus, the history of the museum emerges through the interesting stories that the artefacts and material tell about the people who made butter. The museum is located next to the site of the original Butter Exchange, a place whose history is given particular attention in the museum itself. The Butter Exchange operated between the years of 1769 and 1924, and was one of the first places in the world that tested and graded food. Between these years, butter that was produced in the area was brought to the Butter Exchange where it was graded before being exported around the world. Figure 1.1 shows an image of the locality plotting both places, and Figure 1.2 shows the façade of the museum.

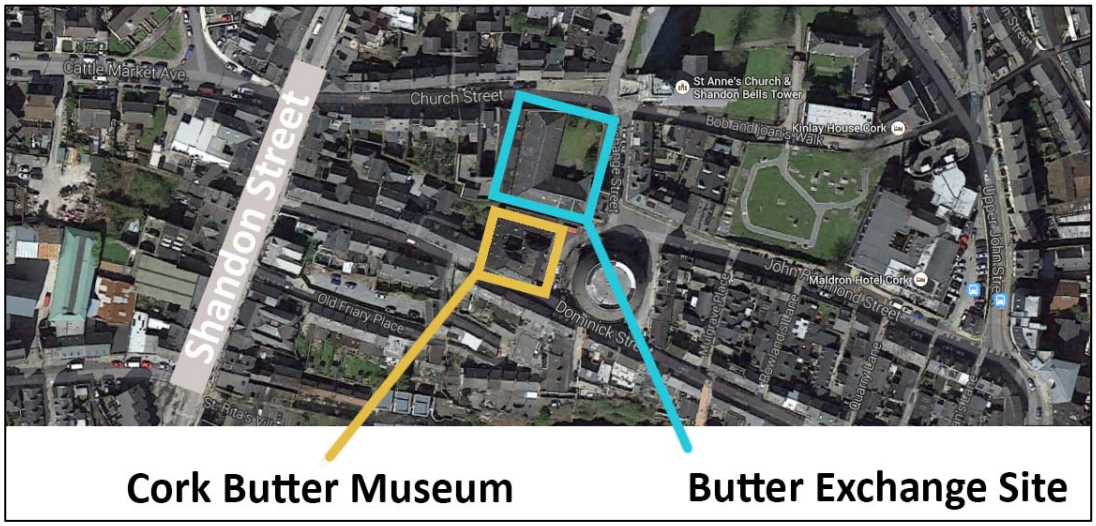

Figure 1.1 The location of the museum and the original site of the Butter Exchange.

The Butter Exchange was hugely successful and extremely innovative for its time – the concept of grading food and quality control in general was novel, so those who bought butter that passed through the Butter Exchange were guaranteed that it was of a certain standard. The reasons for its success can be attributed to a critical mass of a number of different factors that made Cork an ideal place for such a venture; farming conditions in Ireland were suited to making butter; the port of Cork was one of most important shipping ports in Europe; a highly successful and motivated business class

already existed in Cork; and the skills to package butter for long journeys also existed in Cork.

Figure 1.2 Façade of Cork Butter Museum.

Every day, butter was sent to the Exchange by farmers where it was graded for quality and sold. There were a number of different grades, and the price a farmer could get for their butter depended on the grade. Butter was exported to places such as New York, Australia, and New Zealand. In the end however, changing consumer tastes, declining markets, and new technologies led to the decline of the Exchange, leading to its closure in 1924.

Besides the significance of the Butter Exchange, butter and the conditions in which it was produced is an interesting concept to build a museum around. While making butter didn't require a lot of tools, it was an unpredictable and arduous task that took time and intuition. Throughout Ireland's history, going from medieval times right up to the 1950s when it was still being made in the home, butter was an important commodity. Because farming was done on such a small scale, making and selling

butter was one of the few ways through which farmers could make extra profit. As a result, the act of making butter was elevated to a serious but mysterious task that commanded a huge amount of reverence amongst the people. When the task went awry and butter failed to make (which often happened), people searched for reasons to explain their misfortunes. This led to a whole host of superstitions that influenced butter making, something that was amplified by the intense social interaction amongst people at the time.

The museum itself is a relatively small, quiet and dimly lit space, mostly populated with assemblies of physical artefacts from different eras of the butter trade in Ireland. It is loosely split up into four sections which are laid out over two floors; Early Ireland, The Butter Exchange, Traditional Butter Making, and Mechanisation. Certain parts of the museum, such as the Butter Exchange and Early Ireland, have many panels with text and illustrations that contextualise the artefacts on display. Thousand year old 'bog butter' – butter that had been packed into a timber cask and buried in a bog (Figure 1.3) – is exhibited in the Early Ireland section and contextualised with questions surrounding whether or not burying butter in a bog was done as a means of preserving butter or a pagan ritual. The Butter Exchange section highlights how the exchange operated and the reasons for its success and eventual closure. The story of the Butter Exchange and its rapid expansion is contextualised by showing the architectural transformations that the city went through during this period, as illustrated through the maps in Figure 1.4. The museum devotes a lot of space to Traditional Butter Making, and a variety of the tools that were used in the process are exhibited as artefacts. Though some of the more delicate artefacts are protected behind glass, many artefacts are exhibited out the museum floor, as illustrated Figure 1.5. The mechanisation of the butter trade, which is most recent period of butter history that the museum deals with, is exhibited through a mix of film and artefacts from that era.

Figure 1.3 Firkin of thousand year old bog butter.

Figure 1.4 Maps documenting the change in the topography of Cork City during the time of the Butter Exchange.

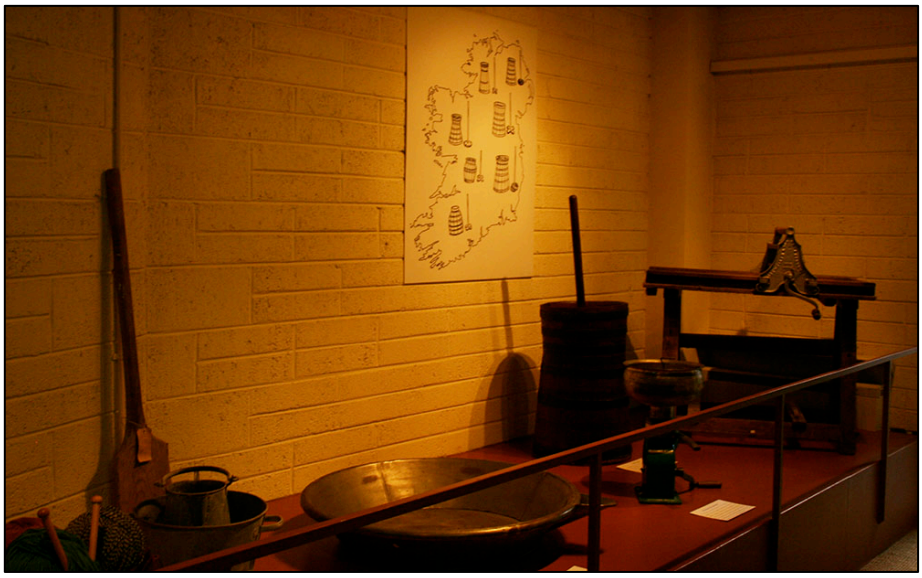

Figure 1.5 An arrangement of butter making artefacts exhibited along the back wall of the museum.

Figure 1.6 An exhibit showing the amount of creameries that existed in the country at the time through the large variety of individual wrappers that were used to package their butter.

According to the curator, CBM is essentially a folk museum, and some of the history it deals with is within a memorable reach of some of its visitors. It offers a fascinating and some-what 'hidden history' of Ireland that reveals surprising stories that might otherwise be difficult (or impossible) for visitors to come into contact with. Although there are a great deal of artefacts and additional materials such as

panels of text and images inside the museum, most of the history emerges through the human stories that the artefacts embody and the ways in which they are arranged.

Though some museum content is mediated through technological tools such as audio/visual media, the museum does have quite a simplistic aesthetic that allows visitors to connect directly with artefacts and history of butter making. Besides three audio/visual media presentations in museum, no other audio emitting screen technologies exist in the environment. Exhibits of artefacts are sometimes contextualised with images of people using identical artefacts as part of their everyday working lives, as can be seen in Figure 1.7. Most of the artefacts are arranged in an open style without much accompanying text. This allows visitors to appreciate the artefacts for what they are and the history that they embody, rather than encouraging them to read copious amounts of text in order to learn the historical significance of the artefacts.

Figure 1.7: Milk churns of different shapes and sizes, contextualised with images of people working with similar churns in their everyday lives.

1.5 The Research and Thesis

Within the context of Cork Butter Museum, the aim of creating novel interactive experiences for visitors that were respectful to the natural environment took a

sensitive approach to design. The unique nature of CBM, both in terms of subject and presentation, meant that the objectives of complementing the existing goals and objectives of the museum and respecting its natural environment guided the research towards explorations that were non-invasive to the space and the history it remembered. The research attempted to use technology in a manner that would not negatively disrupt the environment but still offer the museum the advantages that novel digital technologies can bring. A range of explorations were carried out over the course of the research before focusing on embedding technology into authentic artefacts to create interactions that resonated with the heritage associated with those artefacts. This thesis will document the design process that was initiated before going on to describe the work that was carried out over the course of the research.

1.5.1 Structure of Thesis

Chapter two will present a literature review that identifies two theoretical concepts (embodied interaction and living heritage) that have influenced work in the area that this research is investigating and how they have affected it. It will also include examples of relevant projects.

Chapter three will describe the approach to design that was taken and how a set of design principles emerged which were used to guide design and development.

Chapter four describes the prototype design and development methods that were used to create two augmented artefacts and chapter five describes a case study that was carried out in the museum with these artefacts.

Chapter six discusses will how the artefacts performed and changes they went through over the course of the case study.

The thesis will then conclude with chapter seven, which will discuss how the questions raised by the aims and objectives of the research have been answered before finishing with recommendations for future work.

Chapter 2
Literature Review

The goal of this chapter is to build an understanding of how designing for experience in museums took shape in the past and how it has been changing in light of recent developments. It will present two theoretical concepts that have influenced work in this area (embodied interaction and living heritage) and include examples of work that is relevant to this research. The chapter will help position the research, highlighting the key concepts and themes that shaped it.

2.1 Embodied interaction

While digital and interactive technologies have been used by museums to engage visitors for quite some time, the objectives of mainstream approaches have sometimes solely been to deliver information to visitors at the museum. Much has been written about this approach in conferences such as Museums and the Web, where some practitioners 'research and develop the transformative potential of the technology [augmented reality technology] in service to informal science learning' (Elinich 2014, para. 4). There are many possible reasons for the introduction of technology to museums; the belief that traditional displays do not engage visitors (Koleva et al., 2009), the increasing ubiquity of technology, or the improved accessibility to digital and tangible prototyping tools to designers. However, recently practitioners have also been adopting approaches that aim to create more experientially based interactions for visitors, where they have explored 'engagement at the museum by leveraging the evocative aspects of physical artefacts and promoting a museum experience that is deeply personal and social at the same time' (Warpas, 2014). In such cases, technology has been used to imagine, design, and realise 'an alternative model of engagement' (Ibid) for people to experience over the course of their visit.

This emphasis on designing novel experiences with interactive systems has its roots in the growing body of literature called embodied interaction, which is 'interaction with computer systems that occupy our world, a world of physical and social reality, and that exploit this fact in how they interact with us' (Dourish 2001a, p. 3). Designing for embodied experience can be traced back to ubiquitous computing. Features of ubiquitous computing aim to exploit our natural abilities and take advantage of our spatial and physical skills in order to control computers, use affordances of the real world to make computers better fit the actions in which users are engaged, and attempts to tie computational and physical activities together in such a way that the computer 'withdraws' into the activity where the 'distinction between "interface" and "action" is reduced' (Dourish, 2001b). In the past, the constraints of technology sometimes resulted in interactions (and therefore experiences) being largely determined by the affordances of the technology itself. Further, interactions were conceived as abstract plans, procedures, tasks, and goals, and technologies deigned to be used as part of such activities were designed as

equally abstract tools. In contrast, this recent model 'considers interaction not only as what is being done, but also how it is being done' (Dourish 2001a, p. 4) – so interactions are carried out in the context of a specific environment, and rather than being based on prescriptive abstract plans, action is enacted (and improvised) in response to environmental cues and opportunities, described as 'situated action' by Suchman (2006). This model takes a phenomenological approach, which broadly speaking, grounds itself in a philosophy which investigates the phenomena of experience. Phenomenology has been especially influential in interaction design research since the 2000s, and 'it explores the ways that our physical and social environments, including the things and instruments in such environments matter for experience, cognition, problem solving, and for shaping our intersubjective and social interactions' (Gallagher 2014, para. 1). It places an emphasis on designing for embodied experience – 'attention to the human body in space, and to the environment in which activities are performed, becomes more pronounced' (Bannon, 2011).

Bearing in mind this recent emphasis on designing for embodied experience, this chapter will document a number of relevant examples of novel interactive experiences designed for museum settings. It aims to demonstrate the changing face of modern museums and how they are transforming into institutes that attempt focus on the visitors' experience of the museum environment, rather than the content or technology inside the museum.

2.2 Relevant Design Explorations and Philosophies

Museums have been active areas for this type of research, with many practical investigations carried out into how technological tools and environments can be used to augment the museum's offering (Ferris et al., 2004). Whereas a 'human-centred' approach (ie. an approach that helps organisations to connect better with the people they serve (IDEO, 2009)) has been employed in some cases, others have been more technologically driven, perhaps aiming to see how innovations such as virtual reality technologies could be appropriated to suit the museum environment (Toyama et al., 2011). However, this research was more aligned with investigations that placed an emphasis on creating novel experiences for visitors. The following projects will

focus on explorations that aimed to provide visitors with experientially rewarding visits through interactions that were sensitive to the museum setting.

According to (Pallud, 2009a), ‘we go to museums to remind ourselves [about] who we are’. They note that visitors gain a lot from visiting heritage sites, such as connecting with the past and building a sense of identity. It is a personal experience for the visitors where they can interpret and reflect on the past. Traditionally however, museums have adopted a stance where they play the role of a ‘protector’ or a ‘conserver’ of material from the past, or even an educator. This has led to the casting of visitors in roles such as a viewer or a learner, which may not accurately reflect their true intentions for visiting the museum. The museum often views visitors as people who need to be taught and provided with information in an authoritative and didactic exchange which impacts on the arrangement and presentation of the resources inside the museum. The result is that an emphasis is frequently placed on the provision of information rather than attempting to create meaningful interactions that resonate with deeper, more visceral needs that museum visitors might have.

Designing for experiences that meet the needs of people who come to connect with the past or build a sense of identity is far removed from creating interactive technologies that are designed to act as a medium to transmit information from the curator to the visitor. Whereas the latter is might be evaluated against standard interface design heuristics such as visibility of system status, error prevention, and aesthetic and minimalist design (Nielsen, 1995), the requirements for the former would dictate more experientially based measurements. As such, it has been noted that the evaluation of technology in the context of the museum space and cultural institutions ‘should be done in accordance with … cultural objectives’ (Pallud, 2009b). In this respect, the challenge for the research was to discover how to create interactions with augmented artefacts that help connect visitors to the past through interaction. One of the main ideas driving the research was to explore how the conditions for an authentic experience that resonates with heritage and history could be supported by using novel interactive technologies. It aimed to design interactions that elicit visceral responses from the visitors that allowed them to connect to the museum through ‘appearance, touch and feel’ (Norman 2004, p. 37). In doing this, it

was moving away from creating interfaces that are designed to act purely as a medium to exchange information between two people that could be characterised as a cognitive or learning encounter.

Designing to support such experiences requires a sensitive approach that takes the whole visitor experience into account; situated, material, social, etc. Recent analyses of exhibition design have focused on how the experience of exhibits is produced in social interaction between visitors, 'noting the relationship between visitors' verbal and bodily actions and the material and informational environment' (Vom Lehn, 2010). Because this research was aiming to create experiences that would allow visitors to connect with the past, it was natural to start looking towards how authentic artefacts could be used to achieve this aim. Using tangible artefacts would allow for a sensorial exploration of the heritage, creating objects that have the potential to enhance visitor curiosity through creative, participatory and tactile experiences. This would help ensure that interventions would be a closer fit to the museum environment as they would either be made from or contained within authentic materials that are already found inside the museum. It would also help ensure that the tone and emotion of the interaction would be suitable for the setting: it would help 'provide a context for emotions' (Desmet, 2013). Taking this approach would also positively limit the scope for interactive experiences that the novel interventions could support – clearly, they would be constrained by the features of the artefacts themselves in some way. This would shape a number of elements with regards to the interactions and the functions they could support: they would have to be commensurate with the visitors preconceptions of how the artefacts would have performed in the past, the interaction and its purpose would have to be closely aligned, and they would naturally be sensitive to the museum environment. Ensuring that visitors' interactive experiences resonated with the heritage of the museum was important for the research. As obvious as this might sound in the context of a museum setting, this is not typically the case for interaction design in general. As Bardzell notes:

> 'There is a strong tendency to think about information as something to be structured and architected in its pure form, then provided to the user

> through an interface that makes access as efficient and comprehensive as possible' (Bardzell et al., 2010).

While exploring novel interactions, they detail a project where the experience of an interaction would not be separated from the purpose of an interaction as in typical model-view-controller systems, an interaction where, 'from the user's point of view, the interaction is the contents' (Ibid). In such a case, the act of interacting is very closely tied to the content that is received through the interaction. They give an example of a project called Mæve, which was designed to present student submissions to an architectural competition. It comprised of an interactive tabletop display and sets of paper cards which were detected when they were placed on it. When a card was placed on the tabletop display, an information structure appeared around the card showing media files, and if more than one card was placed on the tabletop, the similarities between the cards were highlighted. The tangible cards were closely coupled to the digital content on the display, and 'user's hands are a part of the interaction' (Ibid). A much earlier project, metaDESK, also took a somewhat similar approach to how interactions were designed. metaDESK was a platform for tangible interaction which allowed users to explore a geographical space using a variety of tangible tools that could augment the digital content. For example, a two-dimensional map of a space could be manipulated with physical tokens and a small flat-panel display mounted on an arm could be used to see a three-dimensional view of the space. Dourish notes that these features of the interaction should not be characterised in terms of 'input and output, but in terms of the coordination between phenomena' (2001a, p. 47).

Such conceptualisations of interactions with and through technology formed the foundations to this research. The intention was to create scenarios where visitors could engage in a way that resonated with the history that the museum commemorated. Interaction was not conceived as being simply about input and output: instead the goal was to bring visitors closer to the history that the artefacts embodied through meaningful and authentic interaction.

2.3 Living Heritage

The concept of living heritage has also influenced the discourse of contemporary museum design. It has close connections with intangible cultural heritage, which is heritage that goes beyond physical objects and artefacts that have survived from the past; it aims to preserve traditions and expressions so that they can continue to be practiced in contemporary cultures (UNESCO, 2003). In the context of museums, the living heritage design perspective often aims to explore how digital technologies can be used and adapted to encourage participation and collaboration around heritage, often local heritage (Giaccardi et al., 2006). The possibilities of using technological tools to record and mediate living heritage practice has been explored by Giaccardi in (2011). Here, the author looks at how we value artefacts and heritage sites in our everyday lives over an extended timeframe, rather than just a single episode of interaction and experience. Such work is of particular interest for this research given that they explored how people engage with the museum over time, and not just that single episode inside the museum, which resonated with the research objective or extending the reach of the museum. For example, Giaccardi and Palen explore the possibilities of 'cross-media interaction to create [socio-technical] 'infrastructures' that act as places of cultural production and lasting value' in (Giaccardi and Palen, 2008). Mixing media and modes of interaction over durations of time, both inside designated fixed spaces and outside in public spaces, helped participants to contribute and build up a connection with heritage over time. They note that 'things in themselves rarely if ever have any one, fixed unchanging meaning' and that it is important for participants have time to interpret and make sense of their heritage (Ibid). Participants were encouraged to reflect on their heritage, not just inside a brief visit to a designated space of appreciation such as museum or heritage centres, but also in public and private spaces where they spend most of their time, such as their homes or towns and cities. Participants were also given time and space to reflect on their locality in an authentic manner, and then record their experiences and contribute them to a collaboratively built archive to build a soundscape. The design encouraged 'participants to connect to the experiences of other community members and imaginatively build a shared representation through collaborative play' (Ibid).

Two relevant concepts that have been identified thus far (authentic and meaningful interactions that would enable visitors to connect to the heritage of the museum, and

an approach to heritage that allows the museum to 'reach out' beyond its walls) were areas that were important to the research objectives. The challenge was to define a point where they could converge to create an experience where augmented artefacts could be used to extend the reach of the museum for visitors who engaged with them. Usually, visitors take time out of their everyday lives in order to visit a museum. The museum visit is characterised as a 'pause' – the visitor puts their life on hold in order to connect, but after this connection they often lose contact with the museum and its heritage. This was looked at by Giaccardi to see how the relatively brief episode of interaction could be extended over both time and space to be turned into a 'duration', so that the visiting experience could extended to last beyond the short period of time inside the museum and reach outside the physical space that the museum is confined within in (2011). Taking concepts such as pause and duration into account, this research aimed to explore how artefacts augmented with novel technology could be used to extend the reach of the museum. Questions that this challenge raised related to the design of augmented artefacts that are conducive to building lasting relationships and the appropriate interactions that visitors could engage with through such artefacts.

The first concept (that of creating authentic experiences using artefacts embedded with novel interactive technology) and the second (extending the reach of the museum) are both relatively novel perspectives in terms of museum design and have the potential to create novel and unique experiences for visitors. However, though they may be novel in respect to designing for museum experiences, some of their features have been written about and explored elsewhere: the notion of the importance of consuming and reliving an experience *after* the event has been noted by Hassenzahl *et al.* in (2013). Here, they note that in the context of a shared experience of going to a music concert, 'due to the restricted communication and interaction during consumption, people shift communication and interaction to an anticipation phase (before) and a cooling-off phase (after)' (Ibid). Though the context is different, there are some similarities that can be exploited to support a more rewarding museum visit. Sometimes, due to the sensory and cognitive load, visitors may not have ample time to absorb and make sense of what they are experiencing. It also may not be socially acceptable to have in-depth conversations in a museum space. Giving visitors an opportunity to re-engage with the museum

after a visit could help to create a more meaningful overall experience that extends beyond the walls of the museum.

Given that the scenarios described above implied a level of participation amongst visitors to the museum, relevant research was also consulted. Dindler and Iversen say that creating links between the visitor's interest and the knowledge presented in the museum is the central challenge (2009). They draw distinctions between *situational interests* and *personal interests*; situational interests are fleeting and transient, whereas personal interests are sometimes a result of cultural immersion. They also identify the difference between *situational motivations* and more enduring *motives*; situational motivations are influenced by the features and characteristics of a particular situation, but motives are influenced by personal interests. The separation of these terms and the effects that they have on the engagement of visitors offers an interesting perspective in their approach to designing museum installations. In a case study at the Moesgaard museum in Denmark, they attempted to engage young visitors by allowing them to create their own digital versions of rune stones by enabling them to go through a similar process that was followed to create the original artefacts that were on exhibit. Young visitors were invited to draw on features of their own life whilst creating these digital rune stones. The experiences offered by the interactive exhibit resonated with how the authentic artefacts were created; 'in this sense, the installation aims at a very direct mediation between the museum knowledge embedded in the input station and everyday engagement of the visitor' (Ibid). By creating such an interface they allow visitors to bring their own personal interests to bear on the installation. They created a bridge between the museum and its visitors, exploiting visitors existing personal motives and life experiences so they could be drawn upon in situational motivations and interactions inside the museum. Given that this research hopes to allow people to reconnect with the museum after they've left, it will explore if situational experiences and motivations that happen inside the museum could be transformed into more enduring motives that are acted upon outside the museum, resulting in visitors re-engaging with the museum.

Besides the aforementioned concepts that are specifically related to the aims and objectives of this research, fundamental interaction design questions that are universal to designing novel interactions that don't rely on conventional heuristics or

guidelines will also be explored. How users make sense of interfaces that move beyond the familiar windows, icons, menus, pointers (WIMP) interface will be a factor if visitors are going to manipulate the novel artefacts that have been proposed. The ways in which visitors bring their knowledge to bear on the interfaces and how they use and make sense of them will be a topic of interest, especially seeing as the proposed interfaces will be made out of authentic museum artefacts that already come bearing pre-conceived meanings and uses.

Further, it has been noted that creating interactive interventions requires an approach that takes a number of theoretical constructs into account that can be used as lenses (or perspectives) to analyse and design for particular situations (Eirckson, 2006). One lens that this research will pay particular attention to is what Erickson calls 'the social lens'. He notes that it can be useful to examine 'relationships, both among people and between people and objects' (Ibid). A picture of people playing chess and the crowd gathered around them is used to demonstrate the how this perspective can shed light on the 'unwritten rules of engagement' that are being supported by everyone in the picture. For instance, one can observe that onlookers watch quietly and refrain from offering advice, unlike other games such as soccer or rugby. This perspective is important to analyse how interventions may disrupt situations and will be applied to the museum in order to evaluate how the interventions affect visitors' interpersonal relationships in the space. Will the interventions encourage collaborative exploration amongst visitors who are visiting together, or will they even encourage interaction between onlookers who are not directly part of the action but still indirectly involved by being in the same space? The social nature of a museum space means that interventions are used and made sense of in a social setting, where 'using' turns into an act or performance (Bardzell et al., 2010; Kenderdine et al., 2009). While using personal computing devices such as phones and computers comprises of a loop that concerns just the user and the system, interactive systems in public spaces incorporates a user, the system, and the surrounding audience. Bearing this in mind, the research will analyse how interventions augment behaviour, attempting to ensure that they do not create uncomfortable experiences for visitors.

2.4 Towards Practical Investigations

This chapter has identified the foundations that the research aimed to build upon. Embodied interaction (interaction that considers not just what is being achieved through interaction with computer systems, but also how the interaction is carried out) and living heritage (a more open and participatory approach to remembering the past that is not limited to tangible heritage) established themselves as being relevant areas that would be explored and experimented with in order to create novel experiences for visitors to CBM. The chapter also investigated the museum space and their features as a stage for design and how the needs of visitors have been considered in the past. It explored relevant work that introduced technology into museums to create embodied experiences for visitors, projects that aimed to encourage participation, and research that aimed to extend the reach of the museum. This informed the next stage of the design process, which will be detailed in the following chapter and will outline the approach that was taken to the first practical steps of design.

Chapter 3
Design Research

Determining how to design interactive experiences for museum visitors that were respectful to the museum's natural environment was the aim for the research. Critical to this was a requirement to ensure that the use of digital technologies complimented the existing goals and objectives of the museum. The challenge was to design and develop physical prototypes supported by a design philosophy which respected the museum's natural aesthetic and integrity. This chapter will describe the approach taken to the design challenge.

3.1 Approach

Given the type of work that the research was engaging in (i.e. creating interventions), a set of principles needed to be established in order to ensure the environment was respected and not disrupted. These principles could be regarded as a kind of framework inspired by the unique features of CBM to support the design process and took some direction from frameworks such as (Lucero et al., 2013; Hornecker and Buur, 2006; Saffer, 2009). To understand the complexity of the task of establishing a number of principles, it might be useful to briefly revisit and expand on the description of the museum that was included in chapter one. Upon entering the museum, visitors are shown a 18 minute audio/visual feature on the mechanisation of the butter trade which is started by the museum attendant, after which their visit takes a much more self-directed style where they generally walk around the museum, investigating the objects and assemblies they wish to examine in detail or read more about. As stated in chapter one, only three audio/visual features exited in the museum. Considering the amount of artefacts and their arrangement (see Figure 3.1), this appeared to be a conscious decision taken by the curator.

Figure 3.1 Clockwise, from top left. The first image is of a glass cabinet showing some delicate artefacts that were used to make butter in the home. Next is an exhibit showing the individual different butter wrappers that were used by the large number of creameries in Ireland up to the 1960s. After this is an assembly of milk churns that are contextualised by images of people using them in their everyday lives. Finally, an assortment of scientific tool that were used to test butter.

An increase of technology in such an environment could carry a high risk of being invasive and distracting to the experience of visitors. Given the sensitive nature of the museum space, a solid understanding and appreciation of how the museum was experienced by visitors was critical to successfully introducing media technologies into the space. This work was carried out in parallel with the literature review which allowed the primary research to dynamically respond to research that was being identified through the literature.

Due to the complex nature of the museum, a 'grounded approach' was adopted which ensured that the research could discover hidden layers of meaning and formulate the right questions to ask. This approach allowed themes to emerge through an analysis of the data rather than imposing preconceived themes or ideas on it. Rather than gathering data and then analysing it, grounded theory makes no attempt to separate collecting data from analysing it. Because of this, it was chosen as a suitable qualitative research method as it allowed the researcher to immediately begin the process of analysis, emphasising the development of theory from empirical findings (Langdridge and Hagger-Johnson 2009, p. 406). At the outset of the inquiry it was essential to understand how it characterised its relationship with visitors, as ultimately these were the people who the novel experiences were being designed for. What in practice is the function of the CBM? Does it aim to preserve artefacts related to the traditions of the past, or is it mainly focussed on providing people with an experience of the past? Does the museum explicitly and intentionally offer an educational experience where people come to acquire historical knowledge of the butter trade? What kind of a relationship with visitors does the museum foster? The research was interested in how such questions impact on the arrangement of the physical museum space, it's mode of presentation, and the kind of dialogue it wished to establish with its visitors.

Investigations began with a number of study visits to the museum. Notes on the layout and organisation of the museum building and the content contained within were made, along with any noteworthy actions or behaviours of visitors who were present at the time. The space was mapped and the assemblies and their relations to one-another were noted. This map was then used during observations and annotated with visitors' behaviour. The map allowed the research to identify not just where in the space visitors

were, but also the different museum content they were interacting with along their journey. Figure 3.2 shows one such map.

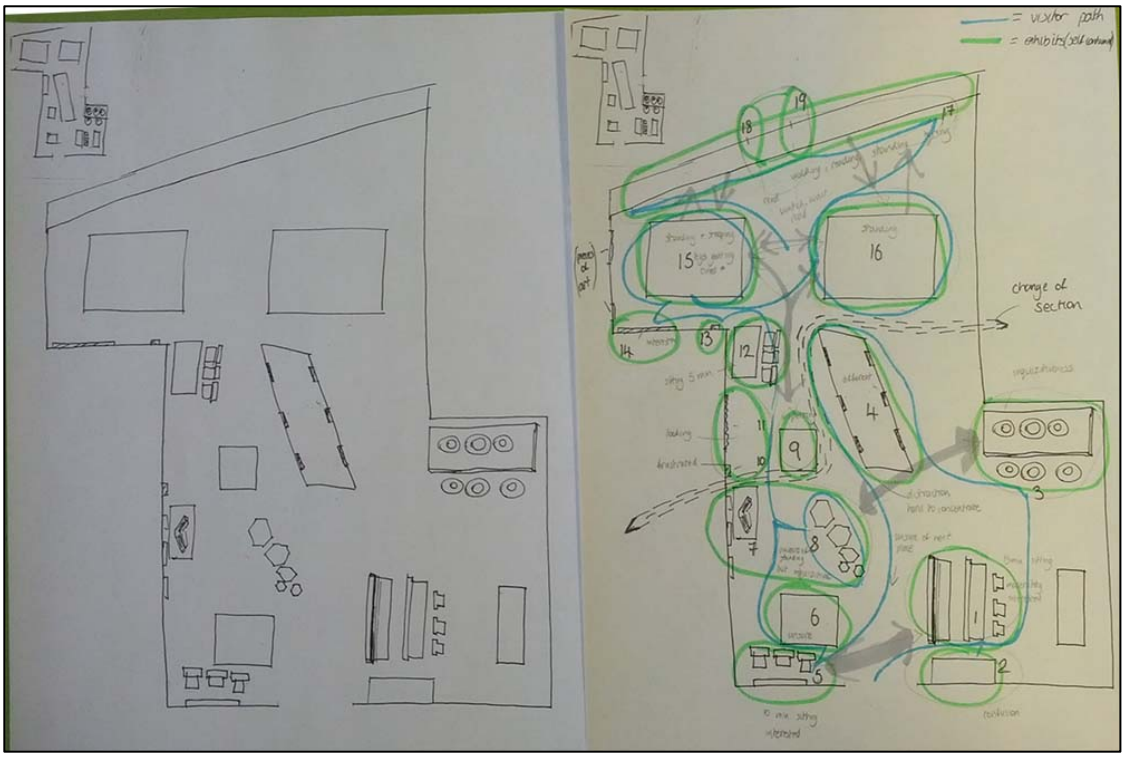

Figure 3.2 On the left is a blank map of the space. On the right is an example of a map that was used to track a visitor's journey on the first floor. Each exhibit is numbered. The blue marker shows the path visitors took, and the green shows the different assemblies.

The history that CBM remembers was also investigated. This was essential as it ensured that any interventions would be sensitive and respectful to the historical context of the space. An understanding and appreciation for butter making and the conditions under which butter was made in peoples home and creameries was built up through numerous visits to the museum and informal conversations with the curator. People who had a first-hand experience of butter making and creamery activities were also interview in order to build an authentic picture of butter making and the role it played in peoples' lives. This research discovered some very critical elements to butter making which resonated with what was being identified in the literature review. Making butter was as much a social practice as it was a technical practice; it was unpredictable and often went wrong, resulting in a huge amount of superstitions being built up around the practice. So, whilst the artefacts on display in the museum did manage to portray an accurate picture of the tangible elements (or material culture) to making butter, they did not quite portray the huge body of intangible cultural heritage that was essential to making butter.

At this early stage of the research it was clear that this imbalance in the telling of the heritage of butter making could provide opportunity for both subject matter and creating novel and authentic interactions.

Following this, a formal dialogue with the museum's curator was considered necessary so an interview was arranged. The interview took the form of a semi-structured interview which guided the conversation and allowed the curator to talk openly about the philosophy that influenced the inclusion and arrangement of artefacts and materials in the museum. Broad, open-ended questions such as 'what would you like visitors to experience when they're here?' and 'what was your intention with the layout of the artefacts?' shaped the dialogue whilst still providing opportunity for the curator to include evaluative, as well as descriptive, commentary (Appendix A). This allowed for the possibility of seeing the attitude of the museum relative to its content and stakeholders. The interview was transcribed, coded, and analysed, which, along with the primary research (grounded observations and researching the context to the history) and secondary research (literature review on interaction design and living heritage) led to the identification of a number of concepts that were at play inside the museum. To code the transcribed interview, themes and concepts that influenced the curator in their approach to arranging the museum emerged by identifying recurring words used by the curator to describe their intentions and what they were doing in practice. These concepts emerged through synthesising the gathered data into a cohesive structure (Kolko, 2007), which could be used to define a number of principles that would support design. In total, four principles were defined. These principles would then be used to guide the design of the augmented artefacts to achieve the objectives of the research whilst respecting the museum environment. Principle one related to footing, principle related to narrative, principle three related to collaboration, and principle four related to authenticity. These principles were interrelated and there were some crossovers. For instance, the third principle (collaboration) required that the second principle (narrative) was attuned so that collaboration could in fact occur. Some of these principles strongly resonated with what was discovered through the literature review (such as collaboration and narrative). While the others (footing and authenticity) may not have explicitly featured in the literature review, they still resonated with what was identified. For instance, while Dindler and Iversen didn't explicitly use the word 'authentic' in the description of the installation they created, the interactions that it supported could have

been seen to be authentic in the sense that the process that visitors could participate in aimed to create a 'very direct mediation between museum knowledge embedded in the input station and everyday engagement of the visitor' (2009).

3.2 Design Principles

What follows is a description of the design principles, how they related to the museum, and the opportunities for design that they illuminated.

3.2.1 Principle 1 - Footing

Footing is a term used to reflect the attitudinal stance or discursive position taken in social interaction involving different parties. A traditional analysis would assume that during any moment of the interaction, one will be speaking and expressing themselves while the other is listening. Over the course of the interaction the roles of the speaker and hearer are continuously swapped in support of a statement-reply format, where the 'floor' (or current speaking rights) is passed back and forth. However, as Goffman points out, terms like "speaker" and "hearer" imply that sound is the only important factor in an interaction when in fact 'footing is not just about speaking and listening – conveying words is not the only thing that is crucial' because 'coordinated task activity – not conversation – is a what lots of words are part of' (Goffman 1981, p. 143). Here we can see that footing can cast the behaviours and activities of people who may be engaged with one another. Further, Goffman also notes that notions of 'hearer or recipient' are rather crude as they imply and restrict analysis to ordinary conversation, but that conversation is not the only context of talk and interaction. For instance, in the case of a single speaker on a podium speaking to an audience, the audience would not typically engage in a conversational exchange with the speaker – 'the role of the audience is to appreciate remarks made, not to reply in any direct way' (Ibid, p. 138). This shows that footing can influence not just words and conversation, but also actions and behaviours. So if in a social situation one adopts the role of an expert, this could cast the other in the role of a novice, which would influence not just the conversations but also the activities that the novice is likely to engage in. An example of this could be a master craftsman with a novice apprentice, where the apprentice is unlikely to engage in any activities until the master gives them guidance, permission and encouragement.

In the context of the museum, footing is used to characterise the kind of interaction between the museum and the visitor. A museum could adopt many different types of roles, which would cast the visitor in a corresponding role, some of which are listed in Table 3.1.

Museum's Role	**Visitor's Role**
Subject Expert	Novice
Teacher	Learner
Facilitator	Participant
Protector	Viewer

Table 3.1 The role taken up by the museum and examples of corresponding roles that might be assumed by the visitor.

In the museum environment, the role adopted by a museum in relation to its visitors is often made manifest through the arrangement of the space and opportunity for interaction it affords, which can be seen in the Figure 3.3 and Figure 3.4. These images, taken at Cork Public Museum, demonstrate that the museum has adopted the role of a teacher and protector, casting the visitors in the role of a learner and viewer. This is evident in the arrangement and access (or lack thereof) to the artefacts; they are placed behind glass (protection) and panels of text are placed adjacent to the artefacts. One set of text provides context and the other set provides information on the individual artefacts on display, designed to provide information in a teacher/learner relationship. This arrangement does not allow for active or participatory engagement with the museum – similar to how Goffman characterised a single speaker talking at a podium, the role of the visitors is to observe and appreciate but 'not to reply in any direct way' (Ibid).

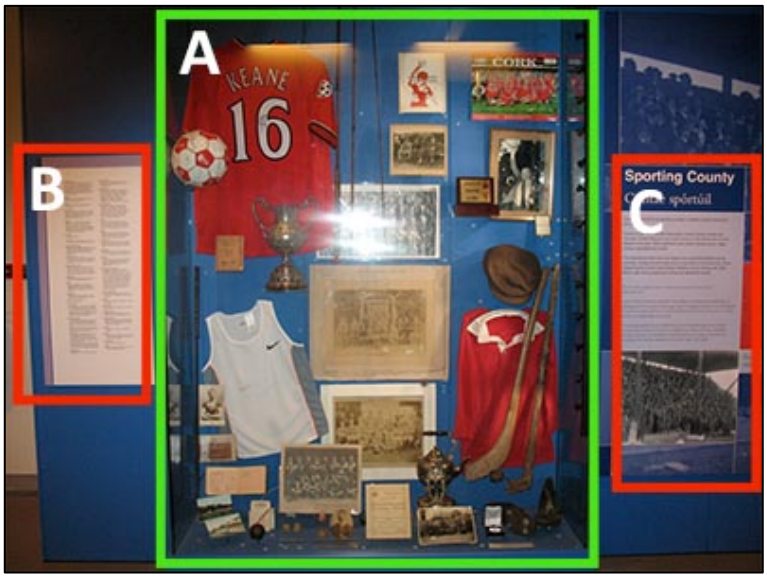

Figure 3.3 Area 'A' shows the artefacts, area 'C' gives context to the exhibit, and area 'B' gives information each of the individual artefacts on display in the exhibit.

Figure 3.4 A similar approach to curation in Cork Public Museum.

In the case of Cork Public Museum, the exchange between the museum and the visitor could be seen as being didactic in that the discourse supported by the museum is that of a specialist communicating to a non-specialist audience, where the non-specialist is acquiring knowledge from the specialist. In the case of CBM however, the interview with the curator suggested that the museum does not aspire towards a purely cognitive goal of translating information about the history of butter. The museum might therefore be considered as being goalless in the sense that a conversation can be. It does not set out with a strict agenda to inform the visitor; instead it leaves room for the visitor to explore, discover and (co-)construct meaning – that is, activities that support a participative and potentially more engaging experience. The role that the museum

aspires to adopt aims to create a balanced exchange between the museum and it's visitors and might be considered as social, responsive, non-didactic, conversational, community oriented and durative (in Giaccardi sense). However, as we will see later on, these intentions were not entirely embodied in the arrangement of CBM which presented opportunity for sensitively introduced interventions.

3.2.2 Principle 2 – Narrative

The kind of museum experience supported by an easily accessible story-line – such as in the form of a biography or historical events casually connected, one which is common-place in museums – is not considered by the curator as being desirable. An interview with the curator (Appendix A) indicated the museums attitude in this regard by revealing:

> "it's not about stories, it's about experiences [...] museums are affective experiences and not cognitive experiences [...] you're not offering a narrative, you're offering fragments, and they've to put the pieces together as they wish, or as they can [...]". (Appendix A, p. xi)

In this sense CBM's curatorial intention to exclude conventional narrative devices could be interpreted as an 'anti-narrative' stance. Such a stance underlines the desire to support a museum experience where the visitor is free to be inquisitive and interpret the function and meaning of the presented artefacts in a more open-ended and active way; to allow the visitors to make the connections themselves. It indicates the wish for a more engaged experience for visitors where they must play an active role in making sense of the 'fragments' that the curator has arranged throughout the museum. In this way, the curator recognises that the narrative inside the museum is not fixed and prescribed but instead dependent on the engaged visitor. This is in contrast to museums that take a chronological approach to narrative where the artefacts are arranged in the order of the eras from which they originate. An example of this could be a natural history museum exhibiting the skeletal remains of dinosaurs, where the most recent might be exhibited first and the earliest are exhibited last. In such a scenario, the space inside the museum and the arrangements of the artefacts therein is used rather rigidly to create a chronological narrative that visitors have little choice in confronting as they navigate through the space.

The curator's view shows a certain artistic sensibility, which recognises that stories following traditional and well-worn narrative structures, while accessible, can in fact produce a disinterested museum experience. This however does not necessarily constitute an anti-narrative position but makes use of narrative in the museum in a way that is distinct from the experience of narrative found in other media such as the novel or film. The curator also went on to say 'this is a space, it's not a book, right, so that's not about stories, it's about experiences' (Ibid, p. x). This further reiterated their intention not to rely on typical approaches to narrative that are usually found in books, highlighting the contrast between 'a space' and 'a book'. Here the curator gives an insight into their rational for rejecting a typical type of linear narrative for the museum – because it's a space and not a book – so the approach to delivering a narrative should be different to the typical approaches taken to narrative found in books. The importance of understanding how spaces augmented by technology can affect how people experience and make sense of the environment has been identified by Ciolfi where walkthroughs were used to highlight how the features of a physical space are embodied in personal narratives (2007). Docents' movement through space was used to construct a story, where physical progression influenced how stories unfolded and were articulated. Though there are no docents in CBM, it does appear that it takes a similar approach to how narratives (and therefore visitor experiences) emerge as they move through the space. If the museum intends to set out assemblies of artefacts in a way that demand the visitor participate in the construction of meaning then it is possible to see narrative being involved, but in a way that is not necessarily informed by literary of cinematic models. In this sense, the approach to narrative that the curator wishes to adopt could be characterised by keywords such as: participatory, engaged, multi-linear, and explanatory.

3.2.3 Principle 3 – Collaboration

In recent times, there has been a rise in attempting to provide more active and participatory experiences for visitors to museums. In her book 'The Participatory Museum', Simon outlines the differences between this contemporary approach to museums and the more traditional approach:

> 'The chief difference between traditional and participatory design techniques is the way that information flows between institutions and users.

> In traditional exhibits and programs, the institution provides content for visitors to consume. […] In contrast, in participatory projects, the institution supports multi-directional content experiences. The institution serves as a "platform" that connects different users who act as content creators, distributors, consumers, critics, and collaborators.' (Simon, 2010)

In these cases, the museum does not attempt to prescribe one single version of history for the visitor to consume or even to 'protect' a particular view of the past. Instead, the museum aims to be a platform on which experiences can emerge through facilitating visitor participation.

An example of one such project was the Akerselva Digitalt Project which aimed to create an active museum communication project outside the museum where visitors' contributions could be integrated with museum-produced content. Akerselva is a river that runs through Oslo which traces the cultural, economic and societal transformation of Norwiegan society over the past 150 years. The project made use of the photo sharing app Instagram, and invited users to participate in the experiment by means of 'self-documentation, suggesting reflection upon personal context and perceptions to support the explorative character … through social mobile interactions along the river' (Stuedahl and Lowe, 2013). Another project was 'Light is History', which is an example of an inclusive approach to designing museum prototypes. The prototype was built from recycled materials and featured light fixtures and energy artefacts mounted onto a wooden panel which was exhibited in the Hakaniemi Market Square in Helsinki, Finland. The light fixtures and artefacts were donated by 16 families, who saved electricity for one week which was then used to power the prototype while it was being exhibited in the Market Square. The process 'showed that new practices of community engagement could be explored with the use of emerging media technologies in the co-curation of artifacts [sic] in the public and museum context' (Bhowmik and Karthikeya, 2013).

It was clear from the interview that CBM is already attempting to foster this type of dynamic. The curator described the museum as being 'reactive' in the sense that it facilitates donations of artefacts from the community to the museum that could otherwise be lost. This indicates a traditional responsibility for protecting heritage but also demonstrates a kind of dynamic that is less common. It shows that the museum

takes a democratic approach to how heritage should be remembered and that the museum is not a static and fixed place, but a dynamic and responsive environment that tries to incorporate the voices of many.

There was a sense that this kind collaborative exchange, which allowed the local butter and dairying heritage to be created between the museum and its visitors, was something that could be augmented or amplified by the use of new media technologies. However, though the museum sometimes makes room for donations from the public, it would be unreasonable to assume that even a small percentage of visitors would be in the position to participate in a collaborative exchange that relied on the contribution of physical artefacts. Instead, this opportunity called for a design solution that supported a type of exchange where visitors could actively participate in the creation of the unfolding history that was facilitated by the museum *without* relying on tangible artefacts. Such an approach would be inspired by the examples provide above, where CBM could serve as a 'platform', as described by Simon. The aim would be to create scenarios that encourage visitors to reflect on their own interpretations of heritage rather than creating content for visitors to simply consume without question. The type of keywords that would characterise this type of exchange would be pro-active, shared, facilitated, and collaborative.

3.2.4 Principle 4 – Authenticity

The curator intended for the space to keep the appearance and character of a museum environment that gave primacy to the artefacts and keep mediating devices such as screens, posters and texts to a minimum. It was not their intention to fill the space with 'digital media' technologies such as screens, kiosks, or information panels, which they believed would result in disengaged visitor experiences. Instead, their objective was to create an environment where the artefact could be appreciated without technological clutter that may come between the visitors and the artefact.

This intention manifested itself in many ways throughout the museum, especially in the presentation of contextualising information that one would typically expect to find in most museums. This passage from the interview reveals the complexities that underlie the curation style:

> ‘the place works visually in a set of zones right, amm, and those zones should be reasonably self-contained, that’s my view. […] In other words, those churns there right, and the woman Magie, turning those churns [the curator gestures towards the wall panel with a photo of a woman moving a churn], amm, unless you really knew a bit about the dairy industry, you would not necessarily make a connection with those churns [the curator points to the milk churns in one part of the museum] and those wrappers [curator points to butter wrappers in another part of the museum], unless you knew something about the dairy industry. Now we don’t make that diary connection, partly because if you do that, well, I don’t want a language driven museum in the first place, and I don’t want a narrative museum in the second place’ (Appendix A, p. xi)

This extract shows that after the exposition of artefacts, not wanting a ‘language driven museum’ is identified as being one of the main factors influencing the arrangement of the museum, even if perhaps not having a ‘language driven museum’ comes at the expense of visitors not being able to make connections between the material throughout the museum.

Further to this, the curator also goes on to say:

> ‘I think that’s what makes a museum a museum, it is the authenticity of the artefact – that’s what makes a museum a museum. Otherwise it can be a video show.’(Appendix A, p. vi)

The most appropriate term for this approach to curation to emerge was authenticity. It shows an artistic sensibility where the artefacts and the visitors experience of those artefacts is given primacy and put ahead of more traditional concepts that might be at play in other museums such as learning or understanding. Again, this is demonstrated when the curator says:

> ‘you’ve got to dethatch the content from…sort of the intellectual content from the place, d’you [sic] know or the experience you’re offering… you know, the question ‘affective versus cognitive’ I think museums are affective experience and not cognitive experiences…’ (Appendix A, p. x)

It appeared that creating the conditions for experiencing the artefacts themselves without being burdened with 'intellectual' content is what the curator was aiming for. The curator wanted to allow for people to connect directly with the artefacts, without any intermediary device. In a sense, this could be seen as an intention to allow people to connect with the 'aura' of an authentic artefact. In (1968), Benjamin notes that authenticity is taken as "*the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history which it has experienced*". With the artefacts in CBM, this testimony of history can be seen in many ways, whether it's made manifest through scratches and marks due to carelessness during use or rust and wood rot due to natural decay over time. All these things express meaning, adding an extra layer to the artefact. When the curator expresses that a video show is the antithesis of a genuine museum, one can also see how this resonates with a particular opinion expressed by Benjamin:

> "Let us compare the screen on which a film unfolds with the canvas of a painting. The painting invites the spectator to contemplation; before it the spectator can abandon himself to his associations. Before the movie frame he cannot do so. No sooner has his eye grasped a scene than it is already changed. […] The spectator's process of association in the view of these images is indeed interrupted by their constant, sudden change." (Ibid, p. 238)

Although the context and the medium is different, this echo's with the approach to the presentation and arrangement of the museum, and certainly would act as a guide in the challenge to introduce interactive experiences that remained respectful to the sensitivities that were shaping CBM.

3.2.5 Design Principles Summary

Table 3.2 gives an overview of the design principles. It includes the four principles, the terms that were used to describe each of them, and a concise summary of what they aimed to address. These principles were used to identify opportunities for design and then to create a number of augmented artefacts that aimed to satisfy the aims and objectives of the research, which was to explore the creation of interactive experiences for visitors to museums that respected and was sensitive to the museum environment.

Principle	Summary
Footing	The museum does not intend to adopt the role of a teacher; instead it aims to facilitate an exploration of heritage. The content is not set out with a strict didactic agenda but offered up for consideration for the visitor to explore, discover and construct meaning.
Narrative	The narrative in the museum is heavily dependent on visitors understanding and engagement with the space. It does not attempt to be a linear, fixed narrative; instead it is fragmented and dynamic, relying on visitor's active participation in order to make sense of it.
Collaboration	The museum doesn't intent to present its own view on history; instead it wishes for visitors to interpret the museum content and put it together in whatever way they can or wish to do so. In this sense the history is constructed through a dialogue between the museum and its visitors.
Authenticity	Visitors are encouraged to experience the artefacts and appreciate them without needing to have a comprehensive knowledge on their history. The aura and authenticity of the artefacts is given primacy.

Table 3.2 A summary of the design principles followed by a concise description used to support the design process.

3.3 Identifying Subject Matter

After the design principles were identified, concrete explorations into heritage that could be used to shape novel and authentic interactive experiences for visitors to CBM begun. As mentioned above, the intangible cultural heritage that was associated with butter making was identified as an area that was under-represented in the museum. Superstitious beliefs that people held manifested themselves in the practice of butter making through a range of different and interesting ways that illuminated a side to butter making that focused more on the people who made butter than on the technical aspects of the task. As a result, these superstitions emerged as a suitable topic on which to base interactive experiences, the reasons for which will be detailed in the following chapter.

Before this however, another area of the heritage that was explored was the so called 'Butter Roads' and the history associated with them. These were tolled roads that were built specifically to transport butter from remote locations to the Butter Exchange.

Investigations into these roads revealed the wider social and economic conditions that were at play during the time of the Butter Exchange, especially in the 1800s. Journals that included extracts from affluent tourists who travelled along the Cork-Kerry Butter Road highlighted the poverty in which the peasantry lived were studied. In an attempt to capture this history, a prototype website was created. The website had an interactive map that used Google Maps to show both a contemporary map and a historical map of the Butter Road, allowing users to toggle the historical map and see it relative to the modern topography of the land. Markers were located along the road, and clicking on a marker played a story related to the history. This prototype was then developed further and connected to a museum artefact that remote users could interact with through the website. Appendix B gives more detail about this prototype. Other early explorations that focused on augmenting artefacts were also carried out. Milk churns, an assembly of which feature prominently in the museum, were the focus of such an exploration. An initial concept of using a milk churn to deliver stories evolved into augmenting the cap of the churn so that it rotated in the direction of people who walked passed it, thereby making the milk churn responsive to peoples' presence. These explorations are detailed in Appendix C.

While these early prototypes and explorations delivered promising and insightful results, superstitions emerged as being an area of butter making heritage with the most potential for creating novel experiences that visitors could engage with. This in turn led to the identification of two artefacts that would form the basis for in-depth explorations and a design process that would eventually lead to the creation of augmented artefacts and their introduction into the museum space. The two artefacts were a table-top butter churn and a firkin crane, which will be discussed in the next chapter, along with a more in-depth discussion on superstitions and their effects on butter making.

3.4 Design Research Summary

This chapter has documented how a set of principles that would guide the design of novel and authentic experiences emerged through design research. The principles related to footing, narrative, collaboration, and authenticity. It also documented how superstitions emerged as an area of butter making heritage suitable to create content for these experiences and how this led to the identification of two artefacts that were fitting for augmentation. The following chapter will introduce the two artefacts and their

historical significance. It will then give a detailed description of the design process that transformed the artefacts so they could support novel experiences for visitors to engage with.

Chapter 4
Prototype Design and Development Methods

This chapter will describe the design and development methods that were used in the process of creating novel experiences for visitors to the museum. It will first introduce the subject matter and artefacts that emerged as being suitable to create experiences around before detailing the design process itself. The artefacts will be introduced as they were found before any modifications were made and descriptions will focus on their historical significance. The aim is to give the reader an appreciation for the artefacts and the subject matter, and to build an understanding of why they were suitable for the creation of novel experiences for visitors to Cork Butter Museum to engage with. After this, the design and development methods will be introduced. The chapter will discuss the artefacts separately, describing how they were created and the usability studies that were used to refine them.

4.1 The Importance of Butter

Over the course of researching suitable subject matter on which to base interactive experiences, it was important to find and area of history that would ensure that tangible interactions and the content that was being delivered through these interactions were complimentary to one another. This research was influenced by conversations with the curator on lesser known aspects to butter, which led to superstitions emerging as an area of butter making history with plenty of potential to create novel experiences that would allow visitors to engage with interesting artefacts and appropriate content. The two artefacts that were identified were the table top butter churn and the firkin crane. Each of these artefacts are emblematic of two different periods of butter making that the museum remembers; traditional butter making in the case of the table top butter churn, and the Butter Exchange in the case of the firkin crane. However, before describing the artefacts, it is worth pointing out the importance that butter and butter making had during the times the artefacts were used as tools associated with butter.

During the periods when these artefacts were in use, the vast majority of farming that was practiced in Ireland was done on a small scale. Social and economic conditions were poor, and farmers kept few cows (anything more than 10 was considered to be a lot). Most farming was subsistence farming, run as a means to an end rather than as a business. Butter was of critical importance as it was one of the few ways through which farmers could make additional money. As a result, butter was often referred to as ‘profit’, and having good butter to sell often meant the difference between barely surviving and living is destitution. This culminated in butter and butter making being of critical important to the people of the time. The dependency on dairying together with its unpredictable nature led to superstitions emerging around the production of butter. As is detailed below, different types of superstitions were practiced around the times when each of the artefacts were in use, and the design of the interactive experiences attempted to use the artefacts to express these practices in a way that was befitting to both the heritage and the artefacts. In accordance to what was identified in chapter two, the intention was to ensure that the interactions that the experiences supported were designed to be more than simply input and output. Instead, the interactions were designed to be a coordination of phenomena that delivered novel experiences whilst also resonated with the heritage associated with the artefacts.

4.2 Artefact Descriptions

4.2.1 Table Top Butter Churn

Figure 4.1 The table top butter churn that was sourced for this work.

Though the practice of making butter in the past was relatively straightforward and required few tools, the science and chemical process behind it was quite complex. A quick and broad description of the process will be sufficient for the purpose of this thesis; cream, taken from the milk of cows, was put into a churn and agitated until it became butter. Butter churns of various shapes and sizes fulfilled the same basic purpose with similar mechanical features that varied depending on size. For larger butter churns, the whole churn itself turned continuously around 360 degrees, but for smaller churns, such as the one in Figure 4.1, the churn stayed in the same position and beaters inside it were turned using the handle to agitate the cream. Regardless of what type of churn was used to make butter, the making of butter often went wrong and failed for various reasons including the conditions under which it was being made.

Factors that were unknown, poorly understood or difficult to control had an effect on the outcome of the success and quality of butter. For instance, if a cow became sick then its quality of milk would be affected, which would have an effect on the cream, and therefore the butter. The weather also had a bearing on butter-making because humidity would affect the chemical process. All of this meant that technically, butter making was

an unpredictable practice where people had little knowledge of what was happening or why things went wrong.

Further to this, the social fabric in rural communities in Ireland up to the 1940s, the period of time up to which butter was made in the home, was unique in that there was an intense level of interaction amongst people. Large extended families lived in close quarters, and rural communities also lived in close proximity to one another. Neighbours were very well acquainted with one another and often socialised in each other's houses. As a result, folk theories developed through superstition and passed on through conversation produced a culture of mistrust and superstition. It has been said (Jenkins, 1997) that these two factors (the unpredictable nature of making butter and the social conditions under which butter was made) contributed to people arriving at folk superstitions in order to explain all manners of undesirable and unfortunate outcomes that couldn't be explained through rational logic. Because butter making was of critical importance to a families economic wealth, many of these superstitions revolved around the act of butter making, so butter making and dairying in general featured heavily in folklore and superstitions. These superstitions often had a tangible effect on how people made butter. For instance, if a visitor called into a house while butter was being made, then they were expected to turn the churn three times in order to prove that they were not there to take the butter luck. This was because it was believed that luck was needed to make butter, and that this luck could be 'taken' by evil neighbours. The only way for visitors to prove that they were not attempting to 'take' butter luck from a house was to help make the butter (Westropp, 2000). Visitors were also not allowed to light their pipe from the fire in a house, as this was seen as another way to take someone's butter luck. Butter churns were not loaned out to people, and sometimes horse shoes would be placed under the churn. Many superstitions were recorded and they varied hugely throughout the country, but they mostly centred around protecting butter luck from supernatural forces and suspicious neighbours. Butter churns like the one used in this research were a common sight around Ireland up to the 1940s. (An overview on superstitions can be found in Appendix D.)

As a result of these activities, butter churns were an important part of rural life in Ireland, both as a practical tool that was used in the lives of everyday people, and as a symbol that commanded respect and reverence. Further research on the topic of

superstitions and butter churns was carried and an interview with a folklore expert was conducted (see Appendix D). This led the research to identify concepts that would be suitable to build experiences around. Following this a number of semi-structured interviews were conducted with people who had a memories from their childhood of seeing butter churns being used pre-1940s Ireland. These interviews were influenced by the concepts that had been uncovered from the research thus far, and interviewees were encouraged to share their personal memories of butter making. This research clearly defined the status of the butter churn as an important tool in the butter making process, both in terms of its social significance and its technical function. Because of its status and its tacit affordances (i.e. a handle for churning), it emerged as a suitable object for exploration and augmentation with digital and physical media technologies. The affordance of the butter churn was something that objectives of the research could take advantage of. Similar to how Norman describes glass on a bus shelter having the affordance tor being broken or a knob for turning (Norman 2002, p. 9), the handle on the butter churn invited interaction. Also, its natural affordance would be of critical importance in the context of Cork Butter Museum, as an interaction like this would be appropriate and not out of context in such an environment.

4.2.2 Firkin Crane

To understand what a firkin crane was and its significance, one would need to be aware of the context in which it was used. Chapter one introduced the Butter Exchange, its legacy, and its relevance to Cork Butter Museum. In summary, the Butter Exchange, which was located next to Cork Butter Museum and ran between the years 1769 and 1924, was a place where locally produced butter was graded and exported around the world. Newspaper clipping in the museum show that Cork butter was exported to places as far away as New Zealand in 24th August 1840 and even New York in June 1771, which can be seen in Figure 4.2.

Butter was sent to the Butter Exchange where it was tested and graded before exportation. In many respects, this testing and grading process is what the Butter Exchange owed much of its success to. Butter was sent to the Exchange in a timber cask called a firkin, so they were often referred to as a ‘butter firkin’. These casks were made by coopers, as a coopering trade already existed in Cork to serve the whiskey and beer making industry.

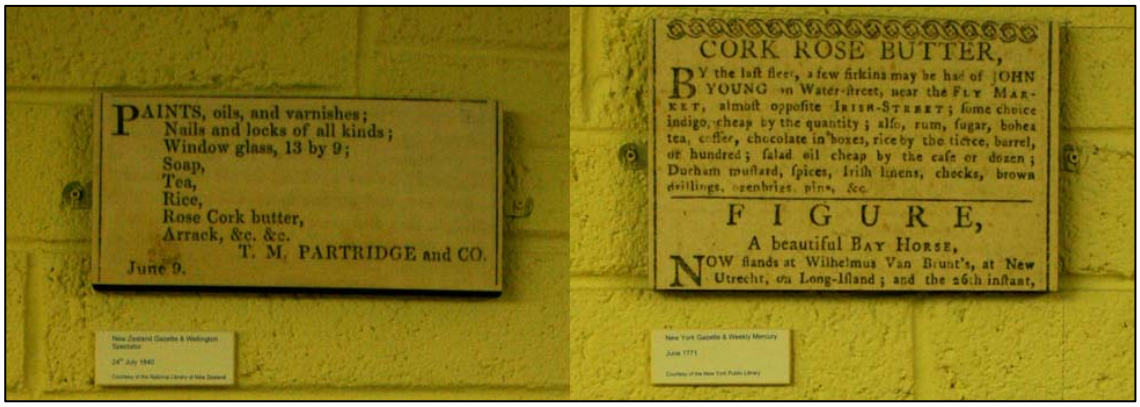

Figure 4.2 Panel on the left shows a paper clipping from 24th July 1840 in a New Zealand paper recording the shipping of 'Rose Cork butter' to New Zealand. Panel on the right shows a record of Cork Rose Butter arriving in a New York newspaper in June 1771.

Each firkin had to be of a certain size and weight with a certain amount of butter packed into it. The quality control process was quite rigorous and transparent, and was carried out by appointed officials called Weighmasters. Interference with the quality control process by the farmer was not tolerated, and those who were caught trying to break the rules were punished with heavy fines.

The first test was to weigh the butter firkin to ensure that the correct amount of butter had been packed into it. To do this, a crane (or balance), similar but larger in scale to the one seen in Figure 4.3, was used. The regulation weight that the firkin ought to be was placed on one side of the crane, and the firkin was placed on the other side; if they balanced each other out then the firkin passed the test. If not, it failed and was rejected. The crane (or balance) that was used for this process became known as a firkin crane. Firkin cranes became synonymous with the Butter Exchange to the point that a 19th century building close to the original site of the Exchange was named the Firkin Crane, which still stands to this day.

Similar to the conditions during the times when butter was made with butter churns, the era when the firkin crane was in use was a time when superstitions were common and had an impact on how butter making was practiced.

Figure 4.3 The image on the left was sourced from Cork Butter Museum. It shows a roadside butter market and farmers selling their butter. To weigh the quantity of butter they use a balance which can be seen hanging off the horse cart in the background. Exact date unknown, pre 1900s. The image on the right shows a similar type of balance. This type of balance worked in the same way as a firkin crane.

Butter makers went to great lengths to ensure that their practices resulted in success. Preventative measures such as blessing cows with holy water and tying red ribbons to their tails were taken to keep them healthy, and sometimes charms were recited during the act of churning itself. (See Appendix D for more research on superstitions.)

In the same way that the butter churn emerged as an object that novel experiences could be based around, the firkin crane also emerged as an equally interesting object. Its significance and role in the history of the Butter Exchange also meant that it was ideally placed as an artefact that had both a symbolic and technical importance in the history of butter exportation. Research was carried out on firkin cranes, the butter testing process, and superstitions during the period of time they were used. This research was then used to identify ways in which an augmented firkin crane could be used to express the history of butter making, which will be seen later in this chapter.

This concludes the introduction to the artefacts. The design methods used in the prototype development stage will be discussed next.

4.3 Design Methods

After the design principles, artefacts, and subject matter had been identified, explorations for creating interactive experiences began. Explorations started with sketches on paper and concepts for interactions and experiences were ‘ideated’ in order to generate a wide variety of ideas that could potentially be built into prototypes to test with users (Hasso Plattner Institute of Design, 2009). The sketches were then developed into scenarios (Nielsen, 2013) which made use of personas (a concept to describe

fictitious and potential users of a system) that imagined how visitors might engage with the situations proposed in the sketches. These design methods, sometimes called paper prototypes, allowed for the principles to be imagined more clearly in the context of an experience that a hypothetical visitor might encounter, as opposed to being disembodied principles that may otherwise to be difficult to realise or integrate into a possible design. It also ensured that problems could be quickly identified and attended to. The alternative, which would have been to actually build the scenarios into a tangible manifestation, would have meant that problems would have taken much longer to identify, given that tangible prototypes take longer to create than paper prototypes. Sketching, persona development, and scenarios all allowed for a discursive and speculative approach to the design challenge. Focus groups were used as a method to iterate upon the concepts presented in these early explorations; a group of peers were recruited to critique the concepts in an open and informal setting where negative aspects of the concepts were discarded and positives were extracted and incorporated into new concepts. Many concepts were presented, iterated, and refined using this rapid prototyping process, and by the end of it concepts that provided the basis to start building tangible interactive experiences using the artefacts had been identified.

A user centred approach was taken in the design and development of the interactive prototypes. Focus groups were used to test low-fidelity prototypes, which were followed with surveys and interviews. This allowed for an iterative development cycle that was shaped by the findings, as will be documented in the following text.

The basic concept for the churn was to allow visitors to use the churn to listen to stories about superstitions that influenced butter making; when someone churned the churn, they could listen to these stories. The concept for the firkin crane was to allow visitors to explore the effects that particular superstitions had on the butter making process. (These concepts will be expanded upon below.) Concepts were developed into low-fidelity working prototypes and tested with focus groups in usability studies. The usability studies took place in a lab setting and each participant was given a brief introduction to Cork Butter Museum and the overall aims of the research. Though the final versions of the prototypes would eventually be deployed in the museum, an environment vastly different to the lab where the usability studies took place, the purpose of the usability studies was to discover if the prototypes were usable and if the

participants were able to make sense of them. In this sense, the studies were designed to investigate the technical aspects of the design – an emphasis was placed on discovering the usability of the artefacts in the more technical sense of the word. The aim was to measure the performance and satisfaction of the user experience that the artefacts supported. Although the long term objective was to design artefacts that would support concepts from the design principles such as collaboration that was initiated by the visitors, early usability studies made use of standard usability metrics such as completing a task (i.e. playing a track) and problem discovery (Tullis and Albert 2008, p.52).

It was arranged that the focus groups contain a mix of individuals and pairs of users in order to get a broader view of how the artefacts performed. Each session was video recorded so behaviours and activities could be analysed and transcribed at a later stage. Participants were asked to use 'think-aloud protocol' (Nielsen, 2012), where they verbalised their thought process and actions and were asked to complete a short survey afterwards. An informal interview followed the focus groups and participants were probed and encouraged to reflect on their experience. This ensured the elicitation of qualitative information relating to why participants acted in the ways that they did, as this was more valuable than simply observing activities which would not give as much insight into why participants were acting in particular ways. This allowed the research to uncover not just what the participants were doing when engaging with the artefacts, but also how they were making sense of their interactions with the artefacts. Participants were asked explorative questions about the artefacts and their experience of using them, but care was taken so as not to explicitly question or interrogate participants' activities and actions as this may have made them feel as if they had to justify or explain themselves in some way. The aim was to initiate a free flowing conversational discussion of their experiences. The interview took place in the same location as the focus group, and participants were able to use the artefacts themselves as aids to explain what they were expressing during the interview. This was helpful, as participants often found it difficult to verbally articulate what they felt, and so made use of pointing, touching, and handling the artefacts during the conversation as a way to explain these emotions. These informal interviews generated useful qualitative data to ground the design problems that were evident in the early stage prototypes.

As mentioned above, despite the lab not having the environmental cues that would be present in the museum, the studies generated valuable and formative results that positively affected the development of the artefacts. The purpose of these observations and evaluations were to generate insight that would feedback into the design of the artefacts while they were still in a development stage. Also, due to the nature of these (somewhat primitive) prototypes, it would have been unfeasible to test them in the museum. It was clear to see from the analysis of the data gathered during and after the tests that the early prototypes were poorly designed and technically their performance didn't match up to what was expected of them. Users found it difficult to make sense of the prototypes, often expressing confusion, frustration, and even annoyance during their attempts to engage with the artefacts. As a result, the artefacts went through a number of iterations based on this data.

What follows is a detailed description of the design and development work that was carried out in order to create the augmented artefacts that were brought into the museum. Each artefact will be described separately, starting with the butter churn.

4.4 Design and Development

4.4.1 Table Top Butter Churn

The design and development of the butter churn started with the basic idea that emerged from the paper prototyping process. The main concept at play was a design that would enable and encourage visitors to use a butter churn in order to listen to a story – unless they churned, they would not be able to listen to the story. However, because the visitors would have no way of knowing that they *could* listen to a story if they did churn, a creative solution that could express the potential of the churn was required. For this, it was envisaged that an audio track would be set to play at a slowed down speed (x 0.8). When the churn was churned, the audio would go back to playing at the normal speed (x 1.0). For this prototype, the Arduino hardware and software platform, and the Processing and Pure Data software platforms were used. A rotary encoder was embedded in the churn and connected to the handle so its rotations could be calculated using Arduino. Processing acted as a 'bridge', and sent these values to Pure Data. Figure 4.4 illustrates the physical setup, the Processing sketch, and the Pure Data patch. Figure 4.5 shows the flow of interactions it was designed to support, and Figure 4.6 shows the churn itself and focus group participants interacting with it.

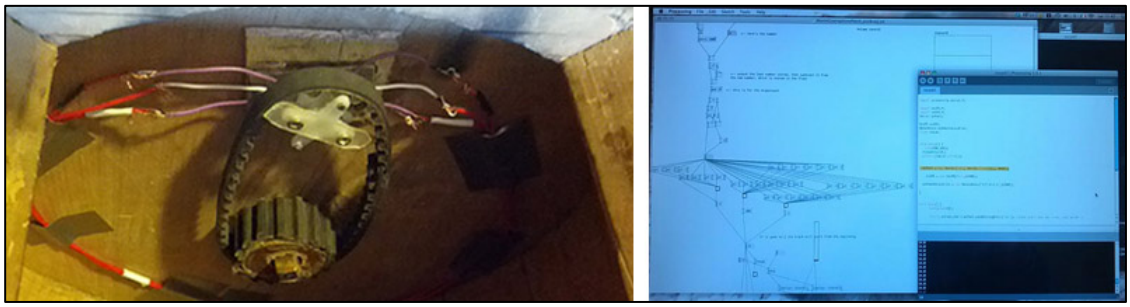

Figure 4.4 The image on the left shows how the handle was connected to the rotary encoder using a fan-belt salvaged from a car engine. The image to the right shows the Processing sketch running on the right of the screen, and the Pure Data patch running on the left of the screen.

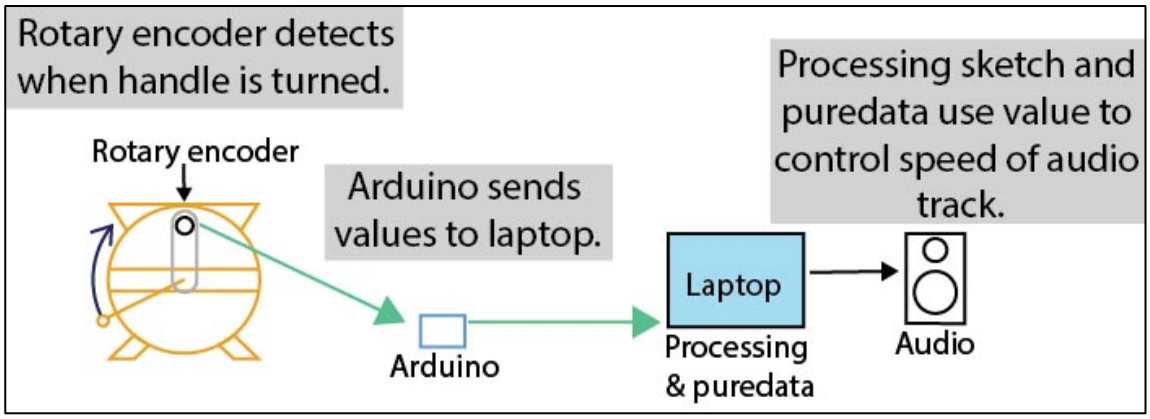

Figure 4.5 If there was no churning an audio track would playback at x0.8 speed; if churning was detected, the audio track would playback at x1.0 speed.

Figure 4.6 The first iteration of the churn and a group of participants engaging with it during a usability study.

Usability testing sessions (the methods of which were described above) uncovered that interacting with the churn resulted in a poor user experience. Not only did the artefact itself perform poorly, users also exhibited confusion and frustration when interacting with it. Analysing the video of participants interacting with the churn and the interview following the study discovered that participants found it difficult to make sense of the artefact and the feedback it was providing.

Notwithstanding the poor user experience, even if the churn had performed as it was designed to, it still would not have allowed for users to have much control over their actual experience seeing as they could only ever listen to one pre-determined story. The next iteration of the churn aimed to resolve this issue by enabling users to select stories, load them, and then play them by putting tokens on the churn cap. (The functionality of churning to speed up the track was disregarded.) This iteration made use of Arduino, Processing, and TUIO, the computer vision software. Stories were loaded by placing tokens over a cut-out on the cap of the churn. After a particular token was placed on the cut-out, a corresponding story would begin to play once the user started to churn. When they stopped churning the story would stop and return to the beginning of the track. Figure 4.7 shows a diagram of interactions that this iteration supported and Figure 4.8 shows a participant using it. The possibility of having two cut-outs on the cap, which would allow users to combine two tokens in order to listen to a new story was also explored. Again, this iteration went through a number of usability testing sessions.

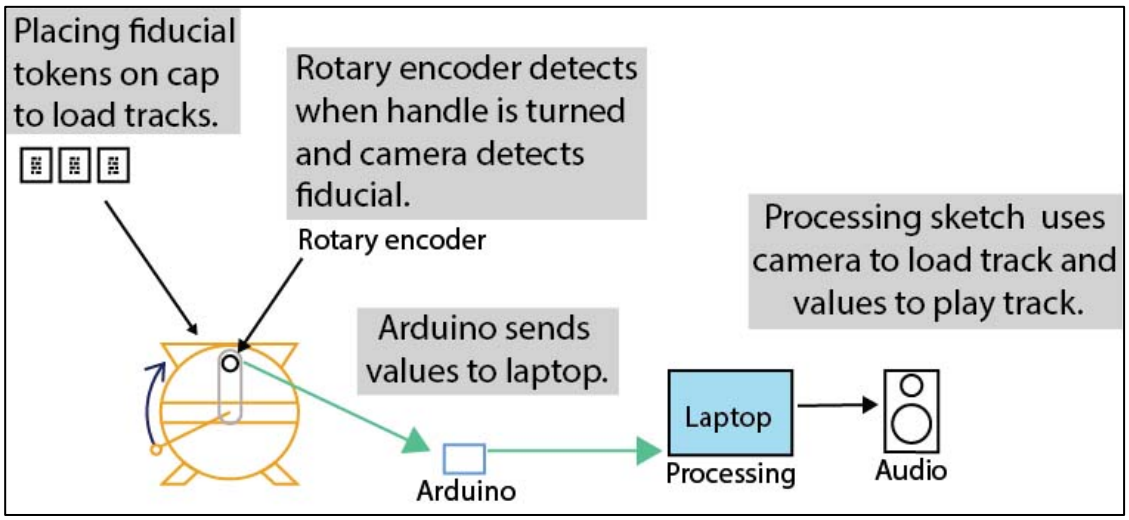

Figure 4.7 Placing a token on the churn and churning played a track. When churning stopped, the track stopped playing. Each token loaded a unique track.

Figure 4.8 Participant from a usability study engaging with the churn.

Despite some issues, this iteration showed some obvious signs of improvement. Participants appreciated being able to select from a number of different stories to listen to and then churning to actually play those stories. However, interview with participants revealed that some found it difficult to understand *why* they had to load tracks in the way the artefact was designed to support, as can be seen from this extract of an interview:

> Like if they used to take out the milk or the butter even then that's, I get it, [motioning with their hands of something going out of the churn], but I just need something that I can [participant motions with both of their hands as if there is a panel in front of them] like 'oh, the reason why you taken on and off this [the fiducial] is because of this' (Appendix D, p. xiii)

Here, the issue identified was that the interactions that the augmented butter churn supported were incommensurate with the interactions that the user would expect to engage in if they were to use a butter churn for its intended use, which was to make butter. It appeared that the participant's issue revolved around the fact that loading a track (which was done by putting a token on the cap) was not the same as either putting something into or taking something out of the butter churn. Clearly, this was an issue that needed to be resolved. Beyond this, the notion of being able to combine two tracks to play a new one was not clear to participants, and none attempted to do this.

These brief examples from the usability studies highlighted the fact that in the early stages of development, the interactions that the butter churn supported were too complex and difficult to make sense of.

After analysing the data from the usability studies, the final iteration of the churn aimed to create a simplified experience that resonated much more closely with how butter churns were originally used. In order to load a story, a token embedded with an RFID tag was inserted into the churn. Putting a token into the churn was designed to resonate with how cream, which was used to make butter, was put into the churn. In this way, the act of loading a story was reminiscent of how the butter making process began. The title of the narrative fragment was engraved on one side of the token, and the length of time it lasted was engraved on the other side. Churning caused the track to play, and when the story came to the end the token dropped out the bottom of the churn. Again, this was designed to echo with the whole process of making butter, where the final product was taken out of the churn after the procedure was complete. By creating an interaction that was commensurate with the original use of the artefact, the design was attempting to achieve what had been identified by (Bardzell et al., 2010) in chapter two, where the experience of the interaction is closely tied to the purpose of the interaction.

A thermal printer that printed snippets of content was also introduced to the design. There were a number of reasons for this addition to the design; as well as being a means to deliver content, it would also resonate with the notion of how something ‘new’ was created when cream was churned. (So, originally cream was put into a butter churn and churned until it transformed into butter; here tokens are being put into a butter churn and churning causes a story to play and a ‘new’ receipt to be printed out.) Further, it would also give visitors something tangible to take away after engaging with the churn, which aimed to satisfy the objective of expanding the footprint of the museum. After someone played a story, a receipt was programmed to print. This was designed to encourage visitors to continue to appreciate the museum after they had left the physical walls through a personal and physical memento that they got from engaging with an artefact. Textual content and a QR Code that linked to a webpage would be printed onto the receipt. The rational for including the QR Code was to give a relatively simple way to connect to a web page. However, because the aim of the research was to allow visitors to engage in participatory activities, the QR Code was printed quite small. This

decision was based primarily on aesthetics but also mechanical considerations. If the QR Code was printed too large, not only would it be unsightly and go against the aesthetics of the museum, it might also encourage visitors to immediately go to the link inside the museum, which would bring them away from engaging with the churn. Mechanically, QR Codes took a considerably longer amount of time to print than text, an issue which was exasperated by large QR Codes. This posed a problem, because the Arduino board was not able to communicate with Processing while it was printing a QR Code, and this would have had a serious negative impact on the system. (If the Arduino board was not able to communicate with Processing, Processing would assume that the churning stopped and would therefore eject the token when in actual fact the user might still be churning.) After a number of tests, a balance between a size of QR Code discrete enough not to be distracting for the visitors and short printing time was achieved, and discreetly sized QR Codes were printed onto the receipts.

The receipts were designed to allow visitors to relive the experience after the event at the museum happened, similar to what was noted in chapter two by (Hassenzahl et al., 2013). It was also designed to explore and possibly expand on what Dindler and Iversen spoke about in relation to situational and personal interests in the same chapter (2009), where the engagement with the artefact in the museum created a situational interest that could be transformed into a more enduring interest through the use of physical memento that visitors could use to reconnect with the museum after their visit. Figure 4.7 shows a diagram of the system and Figure 4.8 shows an image of the churn. Figure 4.9 shows the front and back of the tokens, followed by a description of the final iteration.

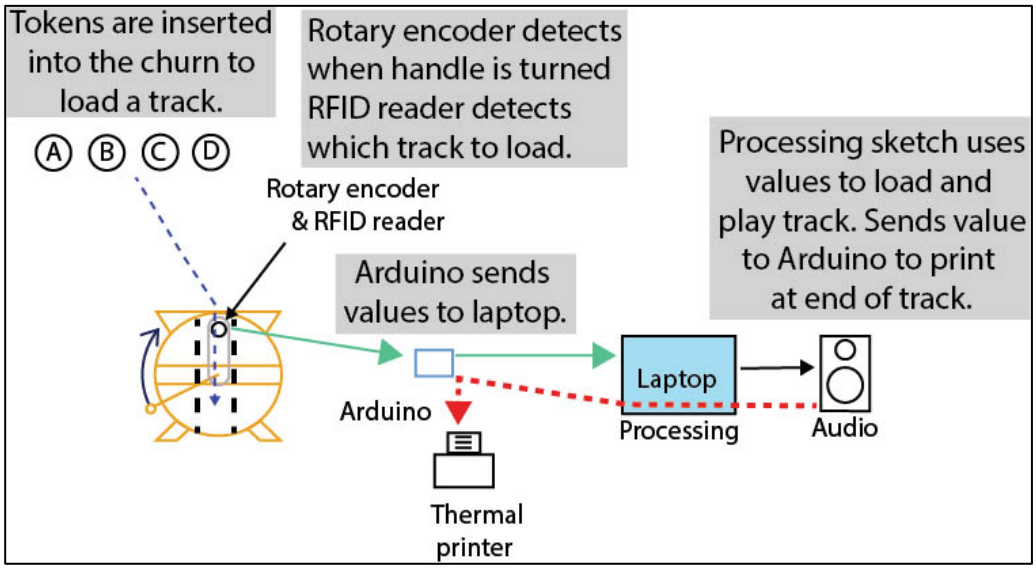

Figure 4.7 If a token was inserted and churning started, a story started to play. When the story finished the token dropped out the bottom of the churn and a receipt was printed. If churning stopped in the middle of a track the volume reduced and the token dropped out the bottom of the churn.

Figure 4.8 An image of the final iteration of the augmented churn with thermal printer.

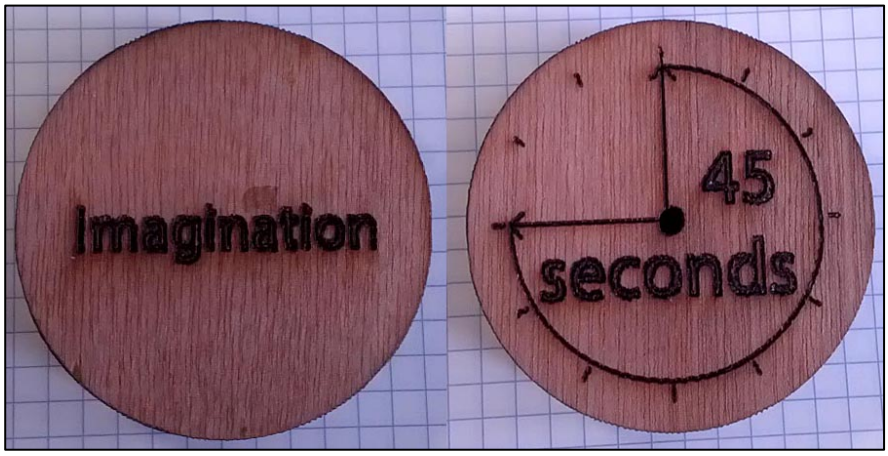

Figure 4.9 The front and back of the tokens. The front labelled the subject of the story, and the back showed the length of time it lasted.

The butter churn was designed to allow users to play stories by inserting tokens through a slot on the cap. Only one token could be inserted at a time. Each token had engravings on both sides – one showed the length of time the story would last (45 seconds), and the other had the title of the story. When a token was put through the slot, the slot would close and the story would load. Churning the butter churn would start the story to play. At the end of the story a receipt was printed from a thermal printer next to the churn. It printed an inquisitive question based on the story and a QR Code that linked to a .pdf about it. The token dropped out the bottom of the churn when the story came to the end. If churning stopped for 5 seconds in the middle of the story, then the audio levels reduced. If churning stopped for 15 seconds in the middle of the story, the audio would go off completely and the token would drop out of the bottom of the churn.

This concludes the section on the design and development of the augmented butter churn. Next the section will detail the development of the firkin crane.

4.4.2 Firkin Crane

Similar to the development cycle that the butter churn went through, the firkin crane was first developed as a low-fidelity working prototype. As was mentioned above briefly, the initial concept aimed to use the firkin crane as a tool that would allow visitors to explore the effects that superstitions had on the butter making process. While original firkin cranes were used to weigh butter firkins, the concept proposed that a firkin crane could be augmented so it could weigh superstitions. It was envisaged that superstitions would be represented in tangible tokens that could be placed onto the artefact. However, because a genuine firkin crane was difficult to source, a simple replica fashioned out of timber was used instead. Figure 4.10 shows how the first iteration worked: a servo motor connected to an Arduino controlled the angle of the arm which meant that it could be easily manipulated.

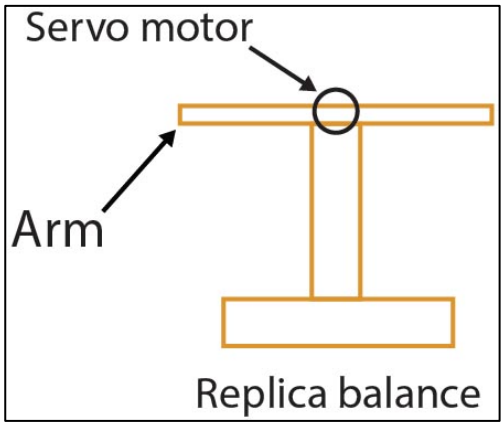

Figure 4.10 A replica firkin crane was made out of timber, which could easily be controlled using a servo motor connected to an Arduino.

Interaction with the firkin crane essentially took a game based approach that was inspired by the superstitions that influenced butter making. The firkin crane invited users to take up the role of a farmer who had to defeat supernatural threats that put their butter making capabilities in danger. The replica was designed to express whether or not their butter was in danger through being either balanced or imbalanced (if the replica was balanced the butter was safe, but if it was imbalanced it was in danger). A screen was placed behind the replica gave information on why the butter was in danger, the reasons for which were in accordance to the superstitions that had been researched. (So it may have been that fairies were threatening the cows or the milk for example.) To avert danger and ensure butter could be made, users had to use the superstitious remedies that were embedded in tokens to rebalance the replica. To do so, they would have to place the correct remedy onto the side of the replica with less weight which would cause it to rebalance by actuating the servo motor. Each remedy was labelled, and the screen gave additional information on the remedies and why a particular remedy did or didn't work. A range of technologies were used to create the interactive prototype: Flash and ActionScript3 to display information on the screen, TUIO and fiducial markers to detect the tokens, and Arduino to control the angle of the arm. Figure 4.11 shows a diagram describing how the system worked and Figure 4.12 shows an image of the prototype setup prior to a usability study.

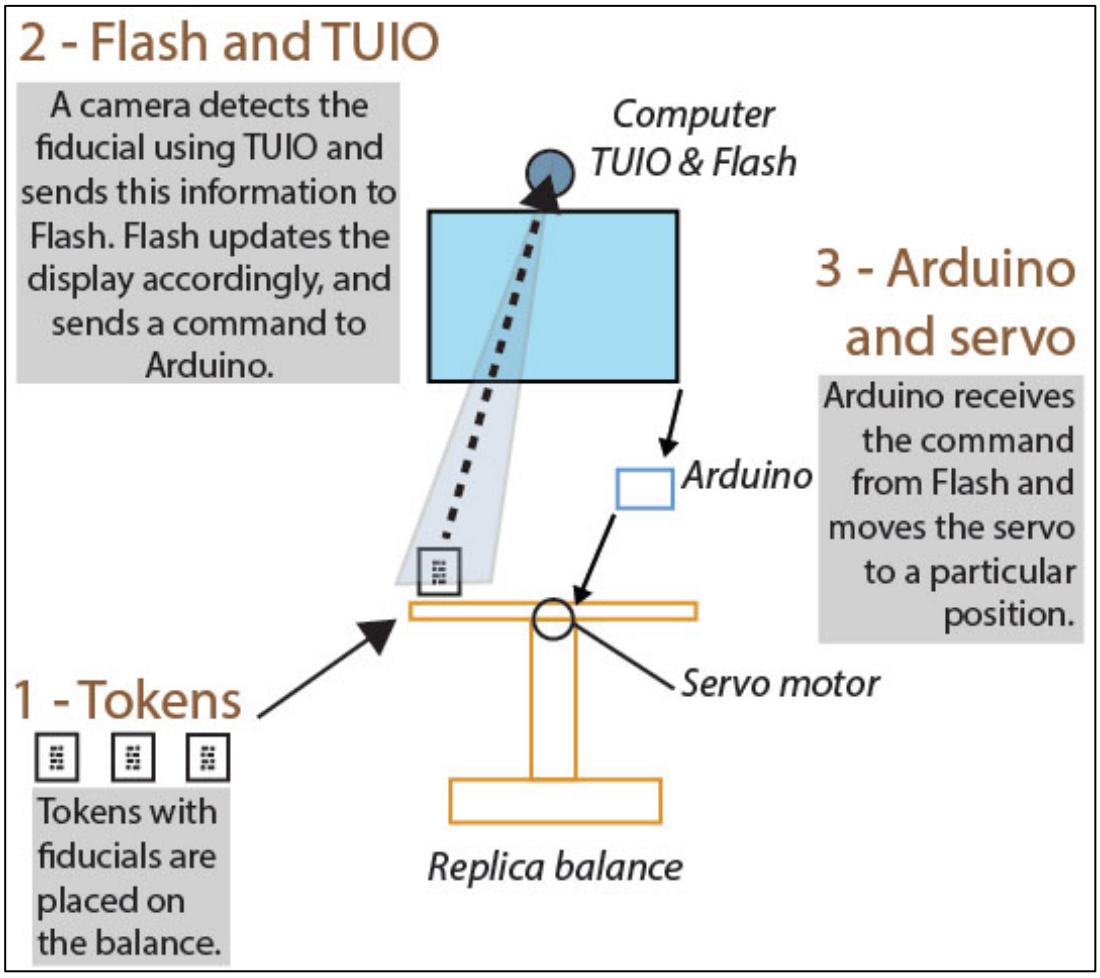

Figure 4.11 A diagram showing how the first iteration of the firkin crane operated.

Figure 4.12 The firkin crane prototype that was used for the usability testing. In this image a token has been placed on the lighter side of the firkin crane.

An analysis of the data gathered from testing this iteration of the replica firkin crane came to similar conclusions to that of the first iteration of the butter churn. Participants

found it difficult to make sense of the artefact and the interactions that it supported; their conceptual model of how it worked was unclear (p. 12, Norman, 2002). In some cases, participants were even unclear as to whether or not the replica and the screen were even related to one another. Further, using tokens and fiducial markers caused problems as participants often placed them with the fiducial marker facing down, which meant that the system would not work (because a camera needed to be able to see the fiducial). (More information on the usability studies can be found in Appendix E.)

However, despite these obvious usability issues, a much more pertinent issue needed to be addressed. Upon reflection, the replica firkin crane was incommensurate with the aims and objectives of the research, as it meant that the visitors weren't actually engaging with an authentic artefact. Further, the game mechanics that were the basis of the interaction were unsuitable to many of the design principles as they prescribed tasks and goals for the visitors to engage in. These two issues resulted in a redesign that aimed to simplify both the concept and the interaction.

The game approach to interaction was disregarded and an exploratory approach to the interaction and content was adopted and an early 20th century balance, very similar to the firkin cranes that were used in the Butter Exchange except smaller in scale, was sourced from CBM. (This balance can be seen in Figure 4.3.) The new approach aimed to transform the balance (or firkin crane) into a tool that gave insight into butter making folk explanations that helped butter makers from the Butter Exchange era explain the things they couldn't understand through rational logic. Visitors could use the firkin crane to measure the effects that folk superstitions had on butter making. The firkin crane was augmented so that it could be balanced and imbalanced using a stepper motor, which was controlled by RFID cards. Tokens, which had RFID card embedded in them, were designed to represent the folk superstitions. However, because the balance was quite heavy and allowing users direct access to it could be dangerous, an interface through which users could interact with the balance was designed. The interface took the form of a holder with a cut-out the same size as the tokens, so the cut-out afforded the tokens to be put into it. An RFID card reader was placed behind the cut-out, so when tokens were placed on the cut-out, the stepper motor was actuated. The stepper motor was connected to a chain which had weights on it; moving the chain pushed the weight along the axes of the balance, causing it to balance and imbalance.

The stepper motor and chain was placed on the rear so it was not visible from the front, which can be seen in Figure 4.13.

Figure 4.13 A stepper motor was placed on the rear of the balance. The stepper motor moved a chain that had weights attached to it, causing it to move between balanced and imbalanced positions.

The type of superstition each token represented was engraved on the front. A screen was used to provide information on how and why a particular superstition affected the butter making process after it was placed on the holder. This screen was considered necessary as otherwise users could have no way of knowing how or why a particular superstition affected the butter making process. A Processing sketch that could listen to the Arduino board was written, and each time an RFID card was detected the Processing sketch updated the display. Figure 4.14 shows a diagram of how the final artefact worked at the end of the usability studies. Figure 4.15 shows an image of the artefact with the holder and screen.

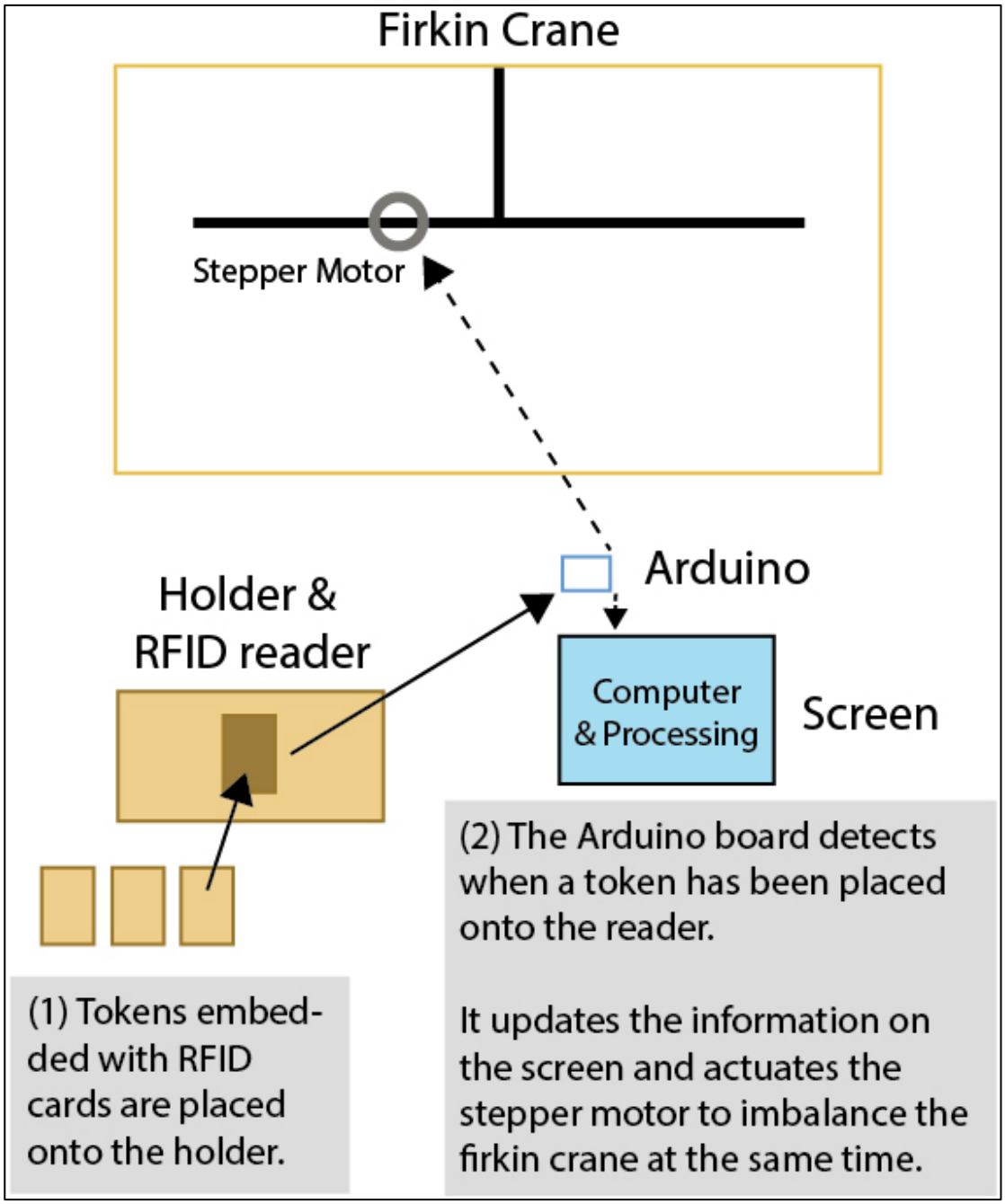

Figure 4.14 A diagram showing the flow of how the firkin crane worked by the end of the usability study.

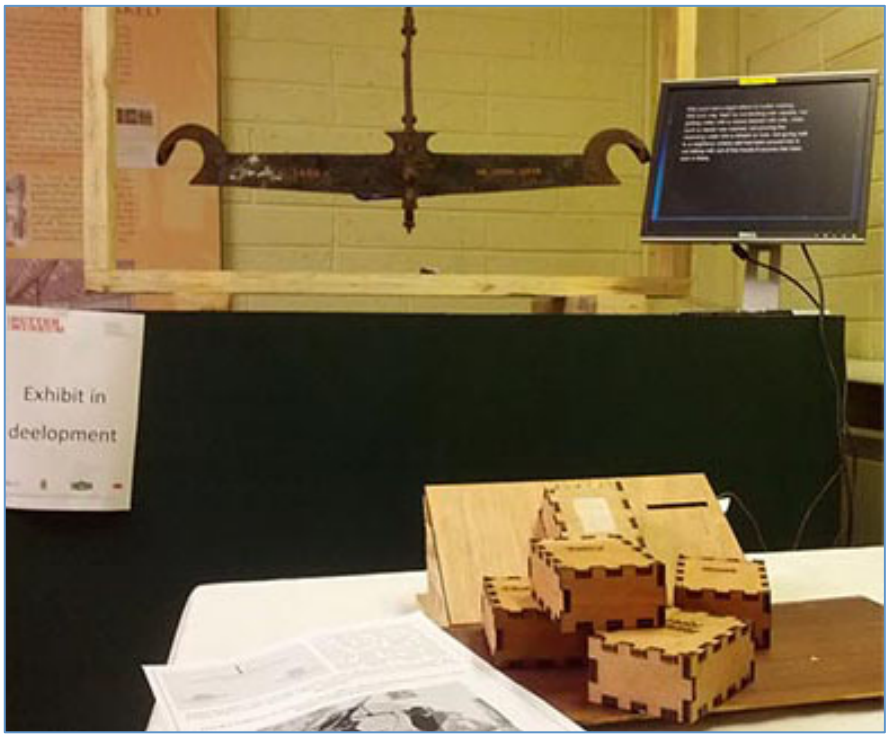

Figure 4.15 The tokens and holder in the foreground, and the firkin crane and screen in the background.

What follows is a description of the system as it was designed to work.

In the past, butter makers held many superstitions that affected butter making, and some superstitions had more of an effect than others. The firkin crane was designed to allow visitors to weigh the effects that superstitions had on the butter making process. Tokens were designed to represent the superstitions. Each token had RFID cards embedded on the inside, and putting a token into a holder (which had an embedded RFID sensor) affected the firkin crane. Each token was engraved with the title of the superstition it represented. A screen was placed next to the firkin crane which gave contextual information on the particular superstition that had been put onto the holder and how it affected butter making. The superstitions were of three different strengths (light, medium, strong), each of which imbalanced the firkin crane to a different degree.

This concludes the description on the development of the firkin crane and the design cycle that each of the artefacts went through.

4.5 Design and Development Methods Summary

This chapter has described design and development methods that were used in a process that resulted in two augmented artefacts being created to support novel and authentic

experiences for visitors to CBM. The artefacts and the heritage they were designed to express emerged through a research process that took a grounded approach to identifying areas that would be suitable for interventions. The chapter profiled the historical significance of the artefacts and early initial concepts that the design process aimed to make possible through the creative use of digital media technologies. A critical feature of the interactions that the artefacts supported was that interactions were designed to be a coordination of phenomena that delivered novel experiences whilst also resonating with the heritage associated with the artefacts. In this sense, interaction was not simply the co-relation of input and output. Usability studies that the artefacts went through and iterations that were carried out following the analysis of these studies were also included in the chapter. The next chapter will document a case study that was initiated after the artefacts were introduced into the museum and the methods that were applied over the course of the case study.

Chapter 5
Public Case Study and Methods

After the design and development cycle the augmented artefacts were brought to the museum for a public case study. This chapter will profile the case study and the methods used throughout in detail, giving examples of visitors engaging with the artefacts and the activities that took place around them. It will introduce the methods that were used over the course of the case study and illustrate what was observed when the interventions were in place using vignettes. The vignettes will draw attention to the performance of the artefacts, observations of visitors engaging with the artefacts, and interaction amongst visitors who engaged with them.

5.1 Observation methods

Before the case studies were initiated it had been decided that they would be conducted over a prolonged period of time. This way, observations could have a formative effect on the artefacts and redesigns could be implemented if necessary. The time of year when the artefacts were ready for deployment in the museum coincided with a time when the museum was quiet but starting to get busy (the middle of May). The curator advised that one could only expect few visitors during weekdays around this time but that the weekends would be busier. Therefore, it was decided that the artefacts would be introduced into the museum on the weekends for observations. This provided time to analyse data that had been gathered and use it to iterate upon the artefacts during the week which meant that changes could be made in response to how visitors were engaging with them. This iterative method of conducting the case study proved to yield very positive results and tangible improvements were observed as time progressed.

Notes were taken on the activities and behaviours of visitors who engaged with the artefacts. The design principles that guided the development cycle informed the heuristics that were brought to bear on the observations. Observations focused on how visitors responded to the artefacts, how they engaged with them, and interaction that emerged around them. Features of each of the artefacts informed the particular things that notes were taken on; for instance, could people hear the audio, were the physical factors ergonomically sound, did their placement cause any unintended obstructions, etc. Behaviours that were not anticipated and brought on as a direct consequence of the design features were also noted.

Initial observational methods took a naturalistic approach (Langdridge and Hagger-Johnson 2009, p. 77). Visitors' activities were recorded in a manner that attempted to be non-intrusive, however some visitors did take note of being observed and there was a concern that this would affect their interaction with the artefacts. As a result, participant observational methods were adopted and the researcher took on the role of a 'full participant'. This observation technique allowed the research to capture data with a higher degree of ecological validity than the previous method (p. 84, Ibid). Brief notes were taken during the observations when opportunities for discrete note taking presented themselves which were later expanded upon, followed by a reflection and analysis. This method had many valuable advantages that suited the research (high

ecological validity, detailed insightful data, and highly contextualised data) but also some disadvantages (researcher needing to rely on memory, highly subjective, may be unreplicable, and could be difficult to generalise results) (Ibid). Video recording was used in cases where it could be done so inconspicuously. Appendix F shows an example of the type of data that was gathered in situ and how it was later reflected upon and expanded.

After the data from observations was analysed for patterns, a simple observation sheet was created. This aimed to capture the most pertinent details of peoples' interactions with and around the artefacts. Informal interviews with visitors were also conducted with people after they left the museum. Interviewees were asked a number of short, open ended qualitative questions that aimed to explore their experience in the museum and the augmented artefacts. Interviewees were not specifically asked about the augmented artefacts at the start of the interview so as not to bias their responses. (See appendix F.)

After results from the first observation sheet were analysed together with the data gathered from the informal interviews, a second more detailed observation sheet was created. Given the complexity of the data that was uncovered from the informal interviews it was decided that the research would continue to use this as a method to elicit peoples' experiences with the artefacts. However, in order to gather more standardised data, a short survey was designed in order to structure the interviews. Visitors were asked questions from the survey which was filled out in their presence and notes were taken on informal conversations that followed.

For the purpose of organising and analysing the most interesting findings that were uncovered, data gathered from observations will be presented in the form of vignettes and then analysed. Like the previous chapter, the analysis will detail each of the artefacts individually.

5.2 Engaging with the Artefacts

5.2.1 Table Top Butter Churn

A description of the augmented butter churn and the interactions it supported when it was first introduced into the museum is below. Figure 5.1 shows a diagram of how the interactions flowed and Figure 5.2 shows a picture of the butter churn in the museum.

The butter churn was placed on a table with a thermal printer and some circular tokens next to it. Each token had word engraved on one side and a clock face with '45 seconds' engraved on the other side. The churn had a slot on the cap that was big enough for the tokens to fit through. The cap also had two diagrams engraved in it: one showing a token being put into the churn, and the other illustrating the handle being turned. Putting a token into the churn through the slot loaded a story and caused the slot to close, which ensured that only one token could be inserted at a time. If a token was loaded and churning begun, the story started to play. Churning needed to be maintained in order to listen to the full story. When the story came to the end a receipt was printed out of the thermal printer and the token was ejected through the bottom of the churn. However, if churning stopped midways through a story the audio level on the track reduced. If churning stopped for 15 seconds the story would stop and the token would be ejected.

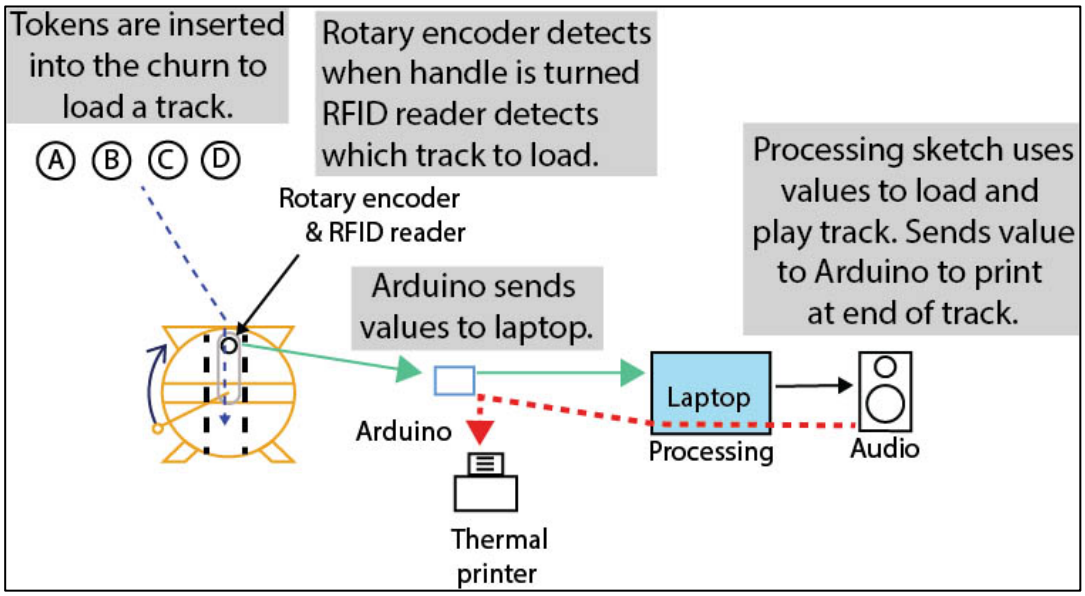

Figure 5.1 If a token was inserted and churning started, a story started to play. When the story finished the token dropped out the bottom of the churn and a receipt was printed. If churning stopped in the middle of a track the volume reduced and the token dropped out the bottom of the churn.

Figure 5.2 An image of the churn at the museum.

Soon after the butter churn was introduced into the museum issues began to present themselves as people engaged with it. Many visitors churned and walked off without inserting a token; very few visitors churned until a receipt was printed, and when a receipt was printed some visitors were not able to make sense of it. Table 5.1 shows the data that was gathered from an observational study that aimed to uncover visitors basic interactions with the churn (whether or not they churned, inserted a token, took a receipt, etc.).

Amount of People	**Visitor Description**	**Did they Stop Slow down?**	**Did they churn?**	**Insert token?**	**Take receipt?**
2	Two Women	Yes	Yes	Yes	No
2	Mother & Daughter	Yes	No	No	No
2	German ladies	Yes	No	No	No
1	Young girl	Yes	Yes	No	No
4	Family	Yes	Yes	Yes	Yes
Total					
Group: 4		**4**	**2**	**2**	**2**
(People: 11)					

Table 5.1 Data uncovered from the observations of the first iteration of the butter churn.

In Table 5.1, the young girl and family (identified by the shaded cells) were part of the same group. In order to illustrate this data, Vignette 5.1 describes the engagement that the young girl and family had with the butter churn.

Vignette 5.1

A family of five enter the museum. As they are watching the 18 minute audio/visual feature a young girl (roughly seven or eight) gets up and begins to walk around. She approaches the churn and immediately begins to churn, but because she didn't put any tokens in no story starts to play. She continues to churn, but eventually walks off. When family begin to explore the museum, the mother (who is holding a toddler in her arm) and brother approach the churn, and the young girl joins them. The mother stands directly in front of the churn, and the young girl stands to the left of her in front of the printer. The mother churns using her right hand without inserting any tokens. She then takes a closer look at the cap. She looks towards the tokens and realises that she must put one in. She puts one in and starts to churn again. She then gives the toddler an opportunity to churn. When they reach the end of the track a receipt is printed and a token drops out. The mother inserts another token and begins to churn again. As the second story is playing the daughter tears the receipt from the first story off. When the mother hears the tear she sternly asks her daughter "what are you doing?" It appears that the mother doesn't know that the receipt was as a direct consequence of the churning out the first story.

Vignette 5.1 Illustrates a young girl interacting with the butter churn for a short time until she leaves and then returns to it as her mother starts to interact with it.

One problem seen here is the issue with a design that requires users to execute a particular task in order to get feedback or a reward. Whereas the churn drew enough interest from the girl in order for her to approach it and begin to churn, churning it without inserting a token meant that it was static and unresponsive, which may have been the reason why she abandoned her interaction with it. The distance between the user's intentions and actions and the state of the system was too great for the user to make sense of, resulting in difficulties. Norman uses the concepts of 'Gulf of Execution' and 'Gulf of Evaluation' to characterise this problem with regard to designed artefacts, and in particular to computer based interfaces (p. 51, Norman, 2002). However, whereas the Gulf of Execution ("*the difference between the intentions and the allowable actions*" (Ibid)) may not be critical in the context of attempting to create an exploratory and novel experience with an augmented artefact, the Gulf of Evaluation ("*the amount of effort that the person must exert to interpret the physical state of the*

system and to determine how well the expectations and intentions have been met" (Ibid)) appeared to be causing a problem. If no token was inserted prior to churning, the churn was not designed to respond to the user's interactions in anyway, so the user did not know what physical states of the system to look for to see if their intentions had been met. This issue was identified as something that further iterations could improve upon.

Following on with the analysis of the vignette, later the girl returns with her mother, who encountered the same problem but eventually realised that there were tokens that could be inserted into the churn. After she inserted one token she started to churn, encouraged her toddler to churn, listened to one full story, and then she inserted another token to listen to a second story. However when the daughter tore the receipt off the mother gave out to her, again illustrating the problems that were created as a result of the Gulf of Evaluation being too challenging for the user to make sense of. When the mother heard the daughter tearing the receipt off she reacted angrily, presumably because she thought that her daughter was misbehaving. Given the context of the situation that they were in (i.e. a museum where tearing paper isn't a typical activity to engage in), thinking that her daughter was misbehaving was a reasonable assumption for her to make given the knowledge of the situation that she had. Clearly, the mother didn't know that the printing of the receipt was as a direct result of churning, most likely because she was holding her toddler in her left arm, which was obscuring her view of the printer. It is also reasonable to assume that the artefact placed a considerable cognitive load on the user: making sense of the artefact and the interaction, the act of churning, attending to the toddler, encouraging the toddler to churn, supervising the activities of her daughter, and listening to the audio were all things she had to cope with. These activities may have been too demanding for the user, resulting in her not making the connection between the churning and the printer.

While this first deployment did raise some negative issues (not being immediately responsive and not making the link between churning and the receipt clear), it also showed some encouraging signs that could be mapped back to the design principles. The fact that the churn facilitated the coordinated interaction of the family group was a positive, especially when the mother helped the toddler to churn, was a positive sign at

this early stage of the deployment. This shows that it allowed a collaborative exploration of the content, where participants helped one another to engage.

Clearly however, the analysis of the vignette highlighted issues that required attention, leading to a reconfiguration of the design. The churn was programmed to play a story without the need to insert a token, but the functionality of inserting tokens to load alternative stories was maintained. This was done to make the artefact immediately responsive to visitors who tentatively started to churn, but didn't realise that they had to insert tokens. Next, the printer was programmed to print intermittently throughout the duration of the story to encourage visitor to maintain churning and provide information relating to the content of the story; after 5 seconds it printed '*keep churning*', after 15 seconds it printed a line from the story, after 25 seconds it printed a QR Code and instruction that it was a web link, and finally, after 35 seconds it printed '*Lucky you, the butter is made*'. This was designed to inform visitors that they come to the end and could stop churning. Finally a physical redesign was implemented and the printer was embedded into the top of the churn, as can be seen in Figure 5.3. This was done to create a much stronger tangible and semantic link between churning the butter churn and the receipt printing out. Pictorial instructions were also engraved onto the cap. Appendix G show Arduino and Processing code for this iteration of the butter churn.

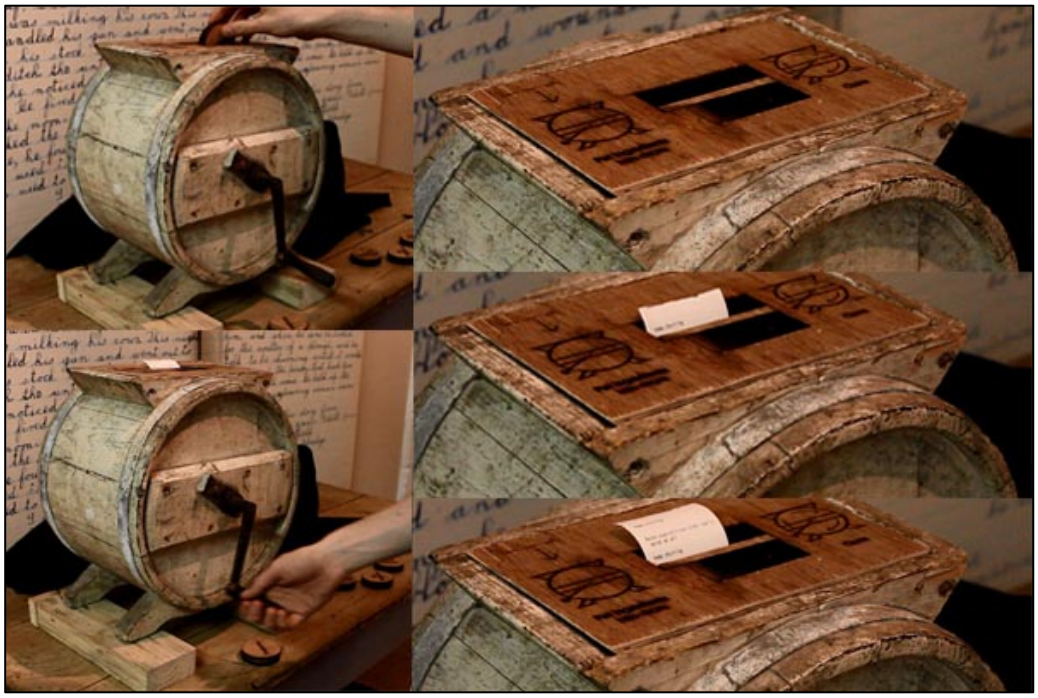

Figure 5.3 The churn after the changes took effect. The thermal printer was embedded into the cap and printed intermittently as the track was playing.

After these changes were introduced, the churn was redeployed in the museum. Table 5.2 shows the data that was gathered from the observations.

Amount of People	**Visitor Description**	**Did they Stop Slow down?**	**Did they churn?**	**Insert token?**	**Take receipt?**
2	Young Germans	Yes	Yes	Yes	Yes
2	Older German	Yes	Yes	No	Yes
2	Italian/Spanish	Yes	No	No	No
2	Young Europeans	Yes	Yes	Yes	Yes
3	Chinese/Irish	No	No	No	No
3	American family	Yes	Yes	Yes	Yes
1	Girl	Yes	Yes	Yes	Yes
3	Dutch family	Yes	Yes	Yes	Yes
1	Alone	Yes	Yes	No	No
2	Couple (small)	Yes	No	No	No
1	Part of family	Yes	Yes	Yes	Yes
2	Aging couple	Yes	Yes	Yes	Yes
4	Irish family	Yes	Yes	Yes	Yes
Groups: 13		**12**	**10**	**8**	**9**

Table 5.2 Data gathered from observations of the final iteration of the butter churn.

Vignette 5.2 illustrates the interaction of the young European couple who are highlighted in Table 5.2.

Vignette 5.2

A young European couple enter the museum halfway through the 18 minute audio/visual feature and sit in the back row of seats. Throughout they are restless and continuously shift their posture. As soon as the credits begin to roll they stand up and explore the museum, the young man leading the way. They go to the butter wrappers and the panels on mechanisation, and then they sit down to watch the six minute audio/visual feature. During this the man begins to laugh at a particular scene, looking towards the girl as he does so. She quickly glances to him but maintains her focus on the screen. When it finishes they take the headphones off and initiate a conversation. They then approach the butter churn and almost immediately the man puts his hand on the handle and begins to churn. When the story begins to play he leans in close to the speakers, stops churning and looks towards the woman. By this stage the printer has printed 'keep churning', but the man has stopped churning for too long so the story fades out and stops. He then picks a token up, talks to the woman, and inserts the token into the churn, noticing the slot closing as he does so. He then begins to churn, this time looking at the cap of the churn as he is listening to the story. When the printer prints a receipt he and the woman start to talk and lean in to read it, first reading it aloud in English and then start speaking in Spanish. They churn all the way to the end and then begin to hold the receipt. The man takes his phone out and keeps it pointed it at the receipt for a time, every-so-often bringing back closer to his chest and looking down towards it, talking to the woman as he does so. He eventually tears the receipt off and puts it into his pocket with the phone before the two carry on with their visit.

Vignette 5.2 Illustrating a young European couple interacting with the butter churn.

The positive effects of removing the need to insert a token into the churn to listen to a story are illustrated in the vignette above. The fact that the visitors inserted a token after the story faded out the first time shows that the artefact had elicited enough curiosity for them to maintain engagement, despite the story fading out the first time. The contrast between their behaviour when they were engaging with the artefact and watching the audio/visual features is evident. For example, when the man laughed during the six minute feature the woman only responded by glancing towards him but kept her focus on the screen. However, with the churn they were able to maintain a dialogue and

proactively converse about the experience they were engaging in, where they could collaboratively make sense of what was happening. So, rather than simply consuming the content, they were actively engaging with it and with each other.

This was particularly evident in the case of the receipt where they worked together to translate it from English to Spanish, and then when the man used his phone to scan the QR Code, which is what he was doing when he was holding his phone up to the receipt.

The couple were interviewed after their visit and their response to the churn was very positive, describing it as 'really original' (Appendix F). They said that they found it difficult to listen to the audio, but could use the QR Code on the receipt to find out more about it, showing that they understood that the QR Code allowed them to reengage with the churn after their visit. The presentation of the content (audio and receipt) also inspired conversation, which engendered a more participatory consumption of the content, where the visitors created the unfolding narrative between themselves based on their own interpretations, understandings, and social interactions. This meant that the footing between the visitors and the museum was more evenly balanced, where the museum was facilitating conversations about history through the content that it was presenting and activities it hosted, rather than prescribing a particular view on history through its presentation of content.

Though this vignette illustrated that the churn was performing well and creating the desired experiences for visitors who engaged with it, it was decided to redesign the tokens so that their function would be more immediately clear. An icon of a butter churn was engraved on the token with an arrow pointing from the title of the token to the top of the churn. The rear of the token was also redesigned to include an outer ring to complete the clock face. (This failed to engrave previously due to a technical issue.) Figure 5.4 shows these changes that the tokens went through. The purpose of the redesign was to illustrate that the tokens could be inserted into the churn.

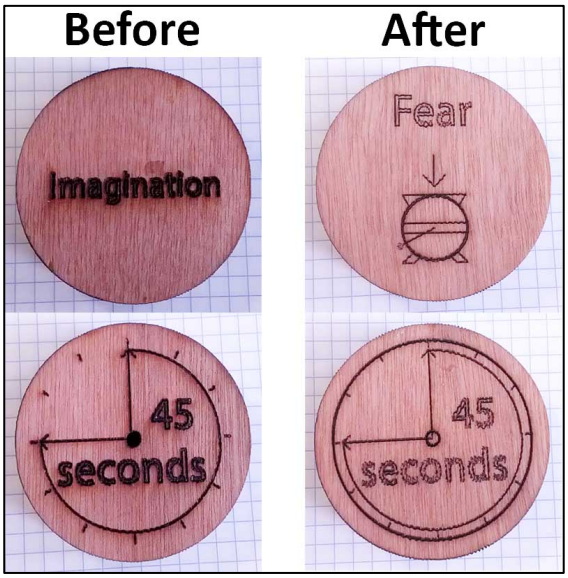

Figure 5.4 The two images on the left shows the first iteration of the design of the tokens, images on the right show them after they were redesigned to illustrate more clearly their function.

An interesting behaviour that emerged around the churn was the performative aspect to using it, as Vignette 5.3 demonstrates:

Vignette 5.3

After watching the first audio/visual feature, a middle aged European couple stay sitting in their seats to read the translation booklet. They take their time walking around the museum, and seem to show great interest in the butter churn. They churn once without inserting any token, leaning in to listen to the audio as it begins to play, however as they do so they stop churning and the audio fades away. The man holds a receipt that had been printed out from previous visitors interacting with the churn in his hands and then, tentatively, goes to insert a token. As he is churning, he and the woman begin to laugh when the audio starts to play. The woman then stands back and lifts up her camera and points it towards the man and the churn. Laughing, the man leans down next to the churn to pose for a photo and they both continue to laugh as she takes a photo of him churning. The inset image shows the man churning with the woman obscured behind him.

Vignette 5.3 Illustrates a middle aged European couple engage with the churn before it turns into a spontaneous photo opportunity where the man poses with the churn.

As can be seen here, the churn allowed the couple to take on a playful role in their interpretation of the content in the museum and encouraged sociable interaction that played out between them, thereby transforming the role of the museum form a protector or teacher into a facilitator. They responded to the activity and its effect very positively, such to the point that the interaction turned into a spontaneous photograph opportunity with the man laughing and posing with the churn as he was engaging with it.

This concludes the section detailing the deployment of the augmented butter churn in CBM. The problems with the first iteration (not providing adequate feedback, visitors not maintaining churning, not making the link between churning and the receipt clear, visitors difficulty in understanding the function of the tokens) were addressed over the course of the case study. The effects that the artefact had on visitors to the museum and whether or not the achieved the goals set out by the design framework will be considered in the next chapter, but before that, this chapter will continue with an analysis of the firkin crane after it was introduced into the museum. The first iteration of the firkin crane had some of the same issues that were encountered in the butter churn, and these will be brought to light next through a series of vignettes and analyses.

5.2.2 Firkin crane

The concept and interactions that the interactive firkin crane supported are explained below. Figure 5.5 shows a diagram describing how it worked and Figure 5.6 shows an image of it installed in the museum.

The firkin crane was designed to allow visitors to weigh the effects that superstitions had on the process. Tokens were designed to represent superstitions, and each token had an RFID card embedded on the inside. Putting a token into a holder (which had an embedded RFID sensor) affected the firkin crane. Each token was engraved with the title of the superstition it represented. A screen was placed next to the firkin crane which gave contextual information on the particular superstition that had been put onto the holder and how it affected butter making. The superstitions were of three different strengths (light, medium, strong), each of which imbalanced the firkin crane to a different degree. Figure 5.7 shows how the strengths of the superstitions affected the firkin crane.

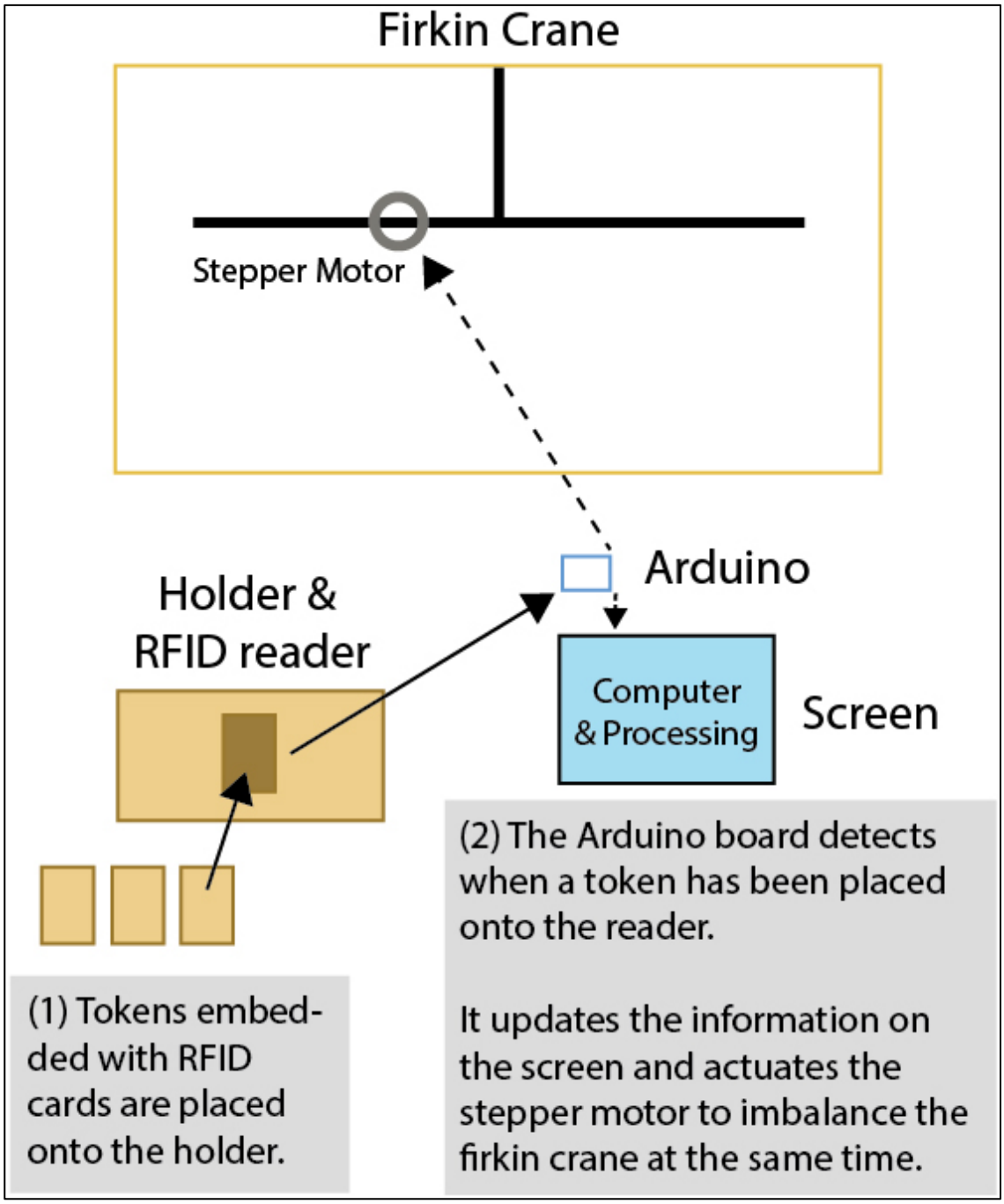

Figure 5.5 A diagram that shows how the first iteration of firkin crane worked.

Figure 5.6 shows an image of the firkin crane as it was first introduced into the museum.

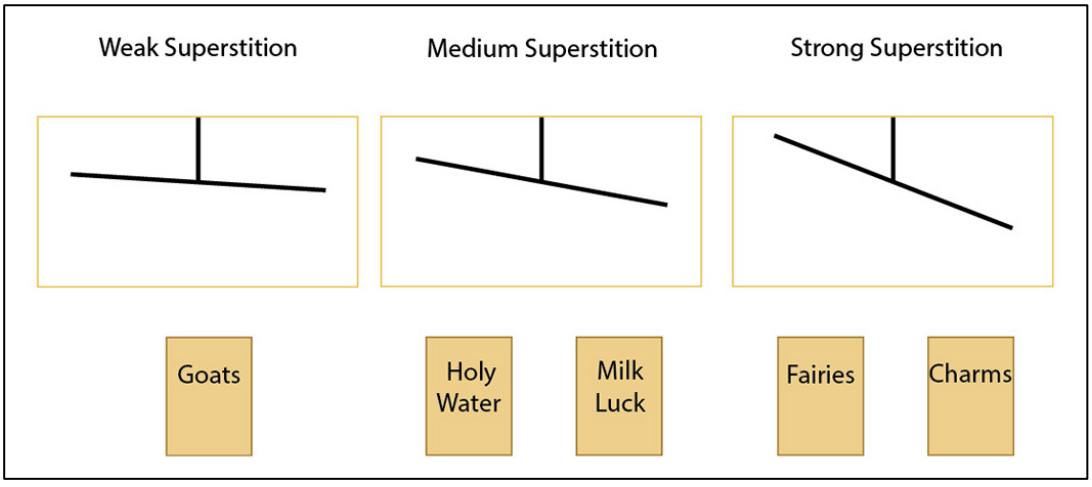

Figure 5.7 The effect that a superstition had on butter making determined the effect that it had on the firkin crane when the token was placed on the holder.

The firkin crane was placed in the Butter Exchange section of the museum. It's initial introduction was positive, despite some of issues. A number of visitors were observed picking up tokens and inspecting them in their hands but not placing them on the holder, possibly demonstrating that visitors were having problems making sense of the interface. However, the majority of visitors who engaged with the balance put at least one token into the holder. After realising that the firkin crane's movement was as a result of their action, visitors smiled and laughed, often pointing it out to their companion. Table 5.3 shows the data that was gathered from observations. A number of interesting behaviours and activities were observed as visitors were engaging with the churn, which are highlighted in Vignette 5.4.

	Date: Saturday 28th June			
No. of Visitors	**Description of visitors**	**Placed token on holder**	**More than one token**	**Noteworthy actions.**
1	Irish male, alone	No	No	Did nothing, was using phone through visit.
1	European lady	Yes	Yes	Smiled to herself
2	Man and young girl	Yes	Yes	Plenty of talk, the man interpreted the content for her
2	European couple	Yes	Yes	Some talk
2	Students, not native English speakers	Yes	Yes	Loads of talk and smiles, one uses Peter Pan to explain what fairies are to the other
1	English lady	Yes	Yes	Smiled, conducted interview with this lady. She was very interested in superstitions and dairying.
3	European students– two women and one man	Yes	Yes	Loads of talk and photos
5	Family group led by the mother	Yes	Yes	Lots of talk amongst the family
	Total: 8	**7**	**7**	**7**
	People: 17			

Table 5.3 Data gathered from observations of the first iteration of the firkin crane. The highlighted cell is described in Vignette 5.4.

Vignette 5.4

A group of three European students enter the Butter Exchange room. One is carrying a translation booklet and occasionally translating for the group. The man, who has a camera in his hands and is taking photographs of the panels, tentatively approaches the firkin crane by himself. With one hand he picks up and inspects the tokens. Slowly he places a token onto the holder. He then looks up towards the firkin crane after hearing it moving and smiles to himself. He looks towards the screen and keeps looking at it for roughly 30 seconds. He looks back to the holder, takes the token off and looking up at the firkin crane he smiles again when it begins to move back to a balanced position. He then crouches down and points his camera towards the firkin crane. Next he picks up the token he had and places it on to the holder and adjusts the camera as he's doing so; he's using the camera to take a film of his interactions with the firkin crane. After this he calls the two women over and shows the exhibit to them. They talk amongst each other, inspecting the tokens and looking at the firkin crane as they do so. They put a number of tokens onto the holder, smiling and talking as the firkin crane moves, collaboratively translating the text on the screen as it comes up. The images illustrate the group engaging with the artefact.

Vignette 5.4 Group of three European students engaging with the firkin crane.

This vignette in particular was included because it highlights the fact that a visitor was quickly able to build an accurate mental model of how the artefact worked and then share it with fellow visitors. After his initial interaction he repeated his steps and used a camera to record further interaction with it, which in itself was also interesting – the experience had an effect that inspired him to repeat and record another interaction. Following this, he shared his experience of it with his visiting partners in a highly collaborative and proactive exchange organised around the interface. After this the group put a number of tokens onto the holder, conversing with one another and inspecting the tokens and the interface as a group. The brevity of the interactions, together with the approach taken to the overall narrative (i.e. fragments of a narrative embedded in tokens) helped to keep the group engaged throughout the interaction. If the duration of the interactions and content had lasted longer, it is unlikely that the high level of interest and participation amongst the visitors would have been maintained. It is also interesting because English was not the first language of these visitors, so despite the language barrier the experience still elicited considerable interest in the visitors.

Despite the fact that the firkin crane facilitated a high level of collaboration in its first iteration, it did go against some of the sensitivities recommended by the design framework. As well as the presence of the screen not being entirely respectful to the museum's natural aesthetic, observations revealed that participants spent a lot of time looking at the screen. The screen took much of the participants' attention away from the artefact and each other; after visitors placed a token into the holder and looked at the firkin crane moving, they spent the majority of their time looking at the screen. Despite the fact that content on the screen was interpreted socially amongst visitor's (which was taken as a positive as it fulfilled the aims of the design principles because visitors reading it aloud and discussing it between themselves), it attracted most of their attention resulting in visitors paying scant attention to the firkin crane itself. Another issue with this iteration was the design of the interface; the holder and the tokens seemed to be causing confusion as a number of visitors were recorded picking the tokens up but not putting them onto the holder. Combined, these issues led to a redesign that substituted the screen for a thermal printer (see Figure 5.8), and the holder was redesigned to resemble a plate that would hang off the sides of a firkin crane (a plate being the thing that the weight was rested on). The tokens themselves were also redesigned to include an engraving of a firkin crane plate. Further to this, appropriate

amounts of lead were put into each token to give them physical weight that corresponded to the strength of superstition that the token represented, as was illustrated in Figure 5.7. (These changes were based on observations and interviews which are detailed in Appendix F.) The printer was programmed to print similar but less content than what the screen had been used to display and a QR Code that linked to a .pdf document that gave more information on the particular superstition. (See Appendix H for examples of the .pdf content and images of the receipts.)

Figure 5.8 A thermal printer, which printed receipts, was introduced to the design to replace the screen.

The redesigned system was also programmed to work somewhat differently to the previous design. When a token was placed on the holder, the firkin crane imbalanced to the appropriate angle based on the strength of the superstition. This took between 10-15 seconds depending on the angle, and when it stopped moving a receipt was printed. The firkin crane returned to a balanced position after the token was taken off the holder. The main difference between this design and the previous one was that that the 'content' (i.e. the receipt) was delivered *after* the firkin crane finished moved in the latest iteration. In the first version, the content and the firkin cranes movement were initiated at the same time. Finally, the tokens were put into a box with a simple diagram showing the tokens being put onto the holder. Figure 5.9 shows the updated system design and Figure 5.10 shows an image of the setup installed in the museum. (Appendix G shows the Arduino code that was written to programme this iteration of the firkin crane.)

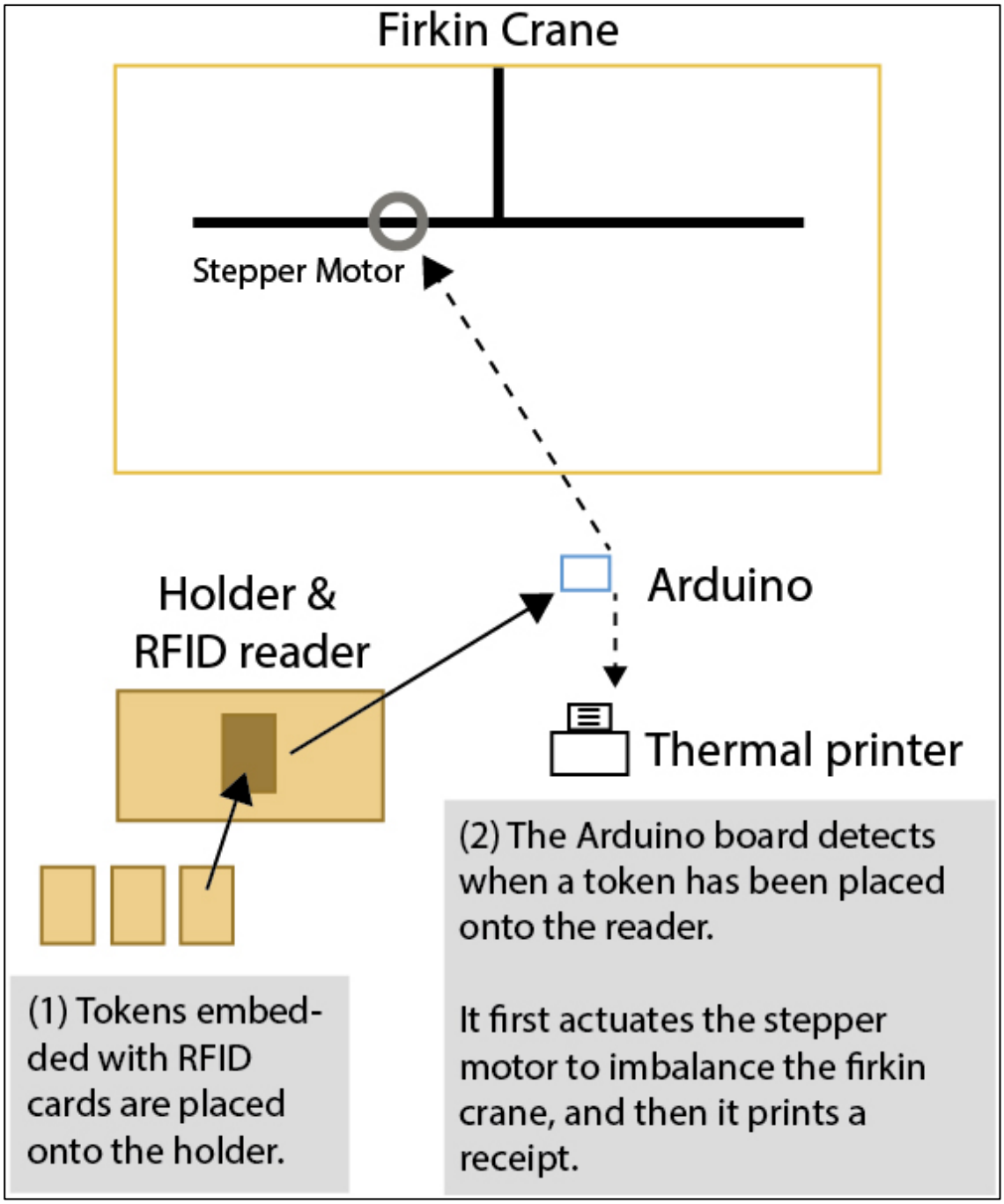

Figure 5.9 A diagram of the redesigned firkin crane.

Figure 5.10 An image of the firkin crane installed in the museum after the holder was redesigned and the thermal printer substituted for the screen.

Once reintroduced into the museum, the redesigns had a positive effect on the behaviour of visitors who engaged with it. Table 5.4 shows data that was gathered from observations, and one group in particular is expanded upon in Vignette 5.5.

No. of Visitors	Description of visitors	Placed token on holder	More than one token
3	European family	Yes	7
2	European couple	Yes	2
2	Mother and daughter	Yes	3
15	European teenagers	No	No
2	American couple	Yes	5
2	American women	Yes	2
1	European Woman	No	No
1	Student (girl)	No	No
2	Ageing Europeans	Yes	Yes
3	European family	No	No
5	Irish family	Yes	Yes
3	Aging Irish family	No	No
1	American man	Yes	Yes
1	American woman	Yes	No
2	Europeans	No	No
1	European	No	No
2	French	Yes	Two
	Total Groups: 17		

Table 5.4 Data gathered from observations of the final iteration of the firkin crane.

Vignette 5.5

Two women, a mother and daughter, approach the table on which the tokens and holder are resting. The mother looks up from the translation book and puts a token onto the holder. Both react with surprise when they see the firkin crane moving. When the mother notices the receipt printing out she points to it and they both begin to laugh. The daughter then puts her translation book down and picks a token up out of the box, then another. She notices the difference in weight between them, and says this to her mother. They speak to one another in German, and the daughter then looks to the sign on the table. She takes the mother's token off the holder, replaces it with another, and starts to laugh when the firkin moves again. She points it out to her mother, and then they both laugh again. When the firkin crane comes to a resting position she looks at the receipt printing out and they both continue to laugh. The daughter weighs three more tokens by putting them on the plate. The mother then begins to look through the translation booklet for a few seconds while the daughter tears the receipt off. She looks at the receipt then stands in close to her mother, and while she is looking at the receipt begins to talk aloud in German. (Presumably, she is translating the receipt for her mother.) They laugh as they are reading the receipt, and then weigh two more tokens. A man (the father/husband) then walks into the room and naturally beings to move towards the women. The girl turns around to him and beckons him over. The daughter begins to demonstrate the firkin crane to him – putting the token onto the holder and pointing at the printer box in anticipation of the receipt being printed. The man then picks up a token himself, puts it into the holder, and then tears the receipt off once it prints out. The daughter put her receipts into her purse, and the father takes his receipt and puts it into his pocket. They talk to each other some more, and then walk off. In total they spend almost 8 minutes with the firkin crane. The following images show the family engaging with the artefact from start to finish.

Vignette 5.5 A European family engaging with the firkin crane.

As can be seen from Vignette 5.5, the redesigns engendered a more positive experience that enabled people to collaborate and socialise with one another during their engagement with the firkin crane. In the first iteration, both the firkin crane and screen immediately reacted to a token being put onto the holder, possibly causing a sensory overload and conflict of interest for the visitors who were unsure of where to place their attention. The second iteration simplified the interaction; the firkin crane reacted immediately, but the printer's reaction was delayed until the firkin crane had finished moving to an imbalanced position. It was designed this way to allow the artefact to attract visitor's full attention without burdening them with informational content. This would also give people time to appreciate the artefact and socialise with one another *before* the delivery of the content. The thermal printer introduced an unexpected sense of fun to the interaction – in the first iteration, people simply looked at the screen and read the content that was displayed on it. However, as can be seen from the vignette, people reacted to the receipt being printed with delight, pointing and laughing as it printed out before them. It was also a much more sociable way of delivering content than the screen given that visitors were able to take it in their hand and read it amongst themselves. It created a more personalised experience for the visitors where they could interpret the content amongst themselves, so the narrative was not being imposed by the museum, but simply being offered up to the visitors for their consideration. It also meant that they were able to take something tangible from museum away with them, as could be seen when they put the receipts into their handbags or pockets. In this way, using the printer and receipt wasn't simply just a way of delivering content; it was also a record for the visitors to keep and take away with themselves. The receipts fulfil a functional need (delivering content) with an aesthetic quality that elicited positive emotions from visitors (smiles and laughs). This was not the case when the installation was using the screen to deliver the content.

As with the butter churn, the design of the interaction with the firkin crane engendered a performative element, which could be seen when the man entered the room. He was attracted by the women engaging with it, and when they noticed him they called him over to give a demonstration of how it worked, highlighting both the interaction (putting the tokens on) and the delivery of the content (the receipt).

The firkin crane also elicited a positive response from younger visitors to the museum, as can be seen from the following Vignette 5.6 where a group of kids first engage with the installation and then call their mother into the interaction:

Vignette 5.6

Three young children (a boy and two girls, ranging in ages five to eight) enter the room and go straight to the table then pause for a few moments. The boy picks a token up and looks at the poster that gives some pictorial instructions on what to do with them. He places it onto the plate but nothing happens. He pokes at the printer with his finger, trying to get at the paper. The mother and father enter the room and the father walks up to the table to join him and inspect it. After about 20 seconds his father walks off to inspect another part of the museum and the mother turns her back to go to the panel behind the table. The boy puts a different token onto the holder; this time the firkin crane begins to move and he reacts with surprise. He then notices the receipt printing out. He tears it off and walks up to his mother, presenting it to her. She asks what it is and then he takes her over to the table, showing her how it works. At this stage the whole family minus the father are around the table. The mother reads the sheet on the table and then weighs a token and watches the receipt as it is printing out. She smiles and takes the receipt. Then she reads it out, explaining the effect of superstitions on butter making to the children. They all leave except for the youngest girl who stays behind to weigh four more superstitions, watching the firkin crane move and tearing the receipt off each time. The following images show the group engage with the artefact.

Vignette 5.6 A family with young children engaging with the firkin crane.

The vignette shows that the receipt was an effective tool in encouraging interpersonal interaction and collaboration amongst the boy and his family. After the boy got the receipt he took it up to his mother, who then became a part of the interaction. Given his

young age, it's unlikely that he would have been able to understand the meaning of the firkin crane weighing the superstitions by himself, but the fact that he was able to take the receipt and present it to his mother meant that he could easily bring it to her attention. Following this the mother began to explain the significance of superstitions and their effect on the butter making process, expanding on the fragment of text that was printed on the receipt with her own knowledge on superstitions.

This concludes the section detailing the deployment of the firkin crane in CBM. After the firkin crane was introduced into the butter museum a number of issues presented themselves, which were addressed over the course of the case study. Redesigning the presentation of content by substituting the screen for a thermal printer and timing it to be delivered after the artefact responded to visitors' interactions created an experience that allowed visitors to focus on each other and the artefact itself, rather than the informational content. The holder and tokens were also redesigned over the course of the case study, which helped visitors make sense of the artefact. The effects that the artefact had on visitors to the museum and whether or not the achieved the goals set out by the design framework will be considered in the following chapter.

5.3 Closing Remarks

This chapter has described a case study of two augmented artefacts that were introduced into Cork Butter Museum. The chapter showed data that was gathered from observations and used vignettes to illustrate this data. It also described and analysed interesting behaviours and activities that happened as a result of the interventions. The following chapter will reflect on the effects that the augmented artefacts had on the museum and the impact they had on visitors who engaged with them.

Chapter 6
Discussion

This chapter will discuss the case study of augmented artefacts that were introduced into Cork Butter Museum. It will explore whether or not they fulfilled the objectives of the research, which was to create novel interactive experience for visitors that respected the museum environment. The rational for creating the features that the artefacts supported will be described. Discussions will then move onto the case study and how observations and analysis of visitor's behaviour with and around the artefacts influenced further iterations that made changes to the design in order to achieve the goals set out by the research objectives. The design principles which were identified in chapter three will be used to inform the heuristics that will be brought to bear on the evaluation of the artefacts. Because these principles were interrelated to one another, the discussions will take a discursive approach to examining the effects of the artefacts. As in the previous chapters, each of the artefacts will be discussed individually.

6.1 Butter Churn

This section will discuss the augmented butter churn. It will describe the rational for the intial features of the butter churn and the redesigns that it went through based on data gathered and analysed from observations.

6.1.1 Initial Design and Rational

An analysis of the interview with the curator (Appendix A) uncovered that the museum did not wish to adopt the role of an expert or teacher. Instead, the curator identified with a more balanced approach to the exchange that might take place between the museum and its visitors. It was their intention to adopt a stance that centred on affective and experiential engagement rather than a stance that was guided by an aim to teach the visitors. They wished for visitors to be able to construct their own meaning derived from their understanding and interaction with the materials inside the museum. In conjunction with a literature review that was conducted in parallel, this analysis led to the establishment of design principle one which related to the footing (or attitudinal stance) that was at play inside the museum and how this was expressed in its arrangement and approach to the artefacts and contextualising content.

However, while the curator did express that it was not their intention to adopt the role of a teacher but instead to create the conditions for visitors to engage with the museum based on their own interests and intentions, observations at the museum revealed that the arrangement and presentation of its resources didn't necessarily allow for visitors to adopt this role. To give a brief example, upon entering the museum all visitors were shown an 18 minute audio/visual feature on the mechanisation of the butter trade in Ireland. This was shown on a large screen located inside the entrance to the exhibition space and had a number of seats placed in front of it, and is sketched in Figure 6.1.

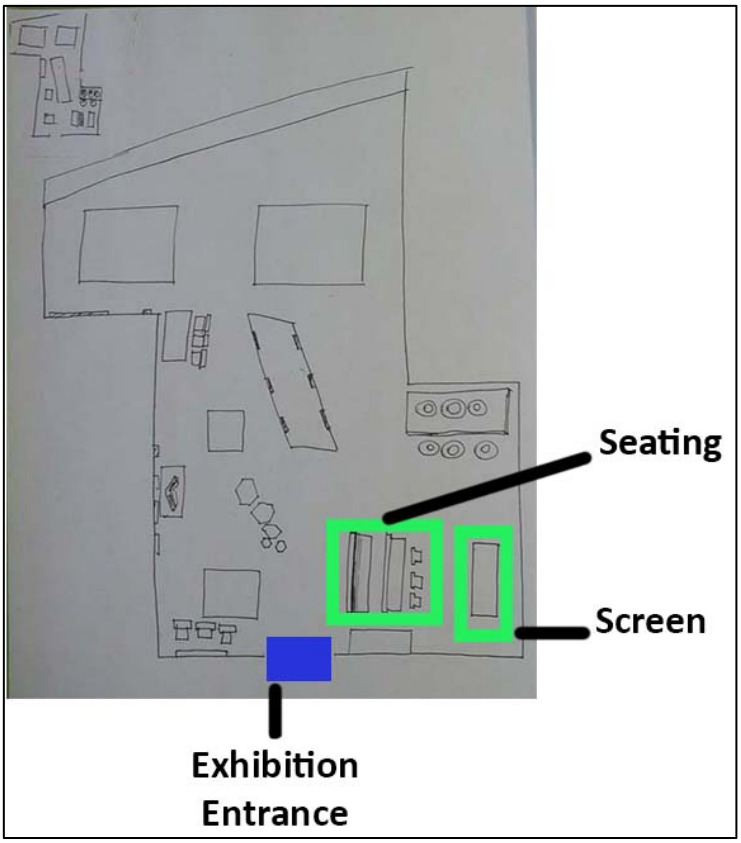

Figure 6.1 Location of audio/visual feature 1 and seating arrangement.

The audio from the feature could be heard throughout the museum when it was playing. It had to be manually started by the attendee at the door for each visitor (or group of visitors) who entered the museum. However, if additional visitors arrived and it was midways, these visitors were admitted entry and informed to request it to be restarted when it finished so they could see the parts at the start that they missed. Visitors themselves could decide whether or not to sit down in the middle of the feature and watch it to the end and then request for it to be restarted, or carry on to the rest of the museum and come back to watch it from the start again after it finished. This brief example shows how this method of presentation cast the visitors in a role that was quite strict and narrowly focused as a result of the limitations of the medium itself. While the use of audio/visual features in museums has advantages in certain scenarios, in this particular case it was not respecting the curators desire to allow visitors play a more active role in their museum experience.

The butter churn took a different approach to presentation of content by overcome such issues by avoiding the need to 'start' the media content; it gave visitors agency and control to select different content to either listen to or not to listen to. Visitors

themselves could decide whether or not they wanted to engage with it, when they would engage with it, and for how long they wanted to maintain their engagement with it. Further, the presentation of the content through the butter churn didn't attempt to cast visitors in a spectator or viewer role over an extended period of time, unlike the audio/visual features or various other contextualising materials in the museum.

The interview analysis also identified that the curator believed that a traditional, linear approach to narrative resulted in a disengaged experience for visitors, after which they expressed that they were adopting an alternative approach to narrative where they were 'not offering a narrative […] offering fragments' (Appendix A, p. xi). This led to the emergence of the second design principle, which related to an approach to narrative that could be supported by novel interactive experiences.

However, while the curator did express that they were attempting to adopt a non-traditional approach to narrative, observations revealed that many elements of a traditional approach to narrative could be found throughout the museum. Besides the fact that this went against the expressed wishes of the curator, it was clear that this traditional approach was creating an experience for visitors that was not ideal. For example, the museum has three audio/visual features; the 18 minute feature mentioned above, a 10 minute feature on how butter was marketed to the British markets, and a 6 minute feature on how butter was made in the home. While the 18 minute feature was shown on a large screen with speakers that played audio that could be heard throughout the space, the other features played audio through headphones that visitors had to wear to listen to. The vast majority of visitors who were observed watching the 18 minute feature were seen making attempts to converse with one another during parts of the film when the dialogue stopped. However, when the dialogue started again most visitors stopped conversing immediately. Those who continued to converse did so in whispers, looking between the person they were talking to and the screen, attempting to give both their attention. Visitors who were on their own spoke more freely to one another, sometimes even over the dialogue, but visitors who were in the presence of other visitors spoke only in whispers. In the case of the shorter features where visitors had to wear headphone to listen to the audio, many visitors were observed talking to one

another very loudly over the audio before becoming aware of the loudness of their voices, after which they quickly apologised for making so much noise, clearly embarrassed of their actions. This was particularly evident in cases where young children were engaged in the features, as they would sometimes shout excitedly for their parents after seeing something interesting to which the parents would hastily respond to by telling them to keep their voices down. Aside from how the unintended consequences of the approach to narrative that was supported by the audio/visual features was having on visitors, there was also the issue that by their very nature, the narrative they presented was linear and prescriptive. While a linear approach to content delivery that relies on a narrator can be suitable in some museum scenarios (if for instance a museum was presenting a complex or abstract topic), it did not seem to be appropriate for CBM. Further, as well as the fact that the audio/visual features were not in accordance to the approach to narrative that the curator identified with, this traditional approach to content presentation and delivery was creating a range of issues that were resulting in a strained visitor experience. Besides these audio/visual features, contextualising content throughout the museum took a didactic and linear approach to the presentation of content. Static panels of text and illustrations that gave information on artefacts and heritage did not afford the creation unique narratives, and minimal interaction between visitors around content was observed.

The features of the butter churn aimed to create a more rewarding visitor experience by adopting a less prescriptive and more participatory approach to narrative. Content was split up into 45 second fragments, embedded into tokens, and users had a choice of which individual fragments they could listen to. By keeping the stories short, they were designed to be fragments that could be assimilated into an overall narrative that the visitor happened to create. Further, given that they were fragments, users could pick and choose which one they wanted to listen to and play them in whatever order they wanted – in this way, the narrative structure they supported was designed to give more freedom for the creation of unique narratives by the visitors, which was in contrast to the approach taken by the existing material in the museum. The brevity of the fragments and the means to listen to them (inserting a token and churning) aimed to allow users to consume the content socially – if they wanted to listen to a fragment they could insert it and churn, and because they could control whether or

not the audio would play they could conduct conversations without having to account for the content starting or stopping. It was designed this way so that users would not feel like they were missing out on a part of the story if they continued to talk, which was identified as the reason for visitors stopping their conversations whenever dialogue returned during the audio/visual features. In summary, the design aimed to use the butter churn to support a narrative structure that was more suited to what the curator identified in the interview by arranging the content as fragments and creating more appropriate interaction with it. It also created the conditions for the possibility to include the features that were required by the third design principle, which related to facilitating collaboration.

The analysis of the interview identified that the curator was attempting to encourage a collaborative approach to the creation of history inside the museum, a concept that was well represented in the literature review. The curator was aware that visitors own cultures and histories are brought to bear on their museum experience and plays a large part in determining how they experience the museum. Their view on this was highlighted when they correlated European visitors' responses to the museum to the presence of butter in their countries; visitors from countries where butter was exported to and used widely such as Germany responded to the museum more positively than visitors from countries where butter was not as popular such as Spain (Appendix A, p. ii). The curator also said that 'the content works by interaction' (Appendix A, p. xi), illustrating that they are aware that it is the visitors who make sense of the museum content and create their experience in an active process, and that in essence the 'museum experience' is a collaborative endeavour between the museum and the visitors.

The curator expressed that the aim of the museum was to encourage visitors to collaboratively construct their experience through their own interpretations of content that was available to them inside the museum, and that the museum was not attempting to prescribe a version of history that would not allow visitors to proactively engage with the content. However, as has been highlighted above, opportunities for a collaboration of this nature were hampered. The issue identified with the audio/visual features was that as a method of presentation, the narrators and protagonists' dialogue was inhibiting conversation which was not allowing visitors

to collaboratively create a narrative of their own understanding amongst themselves. Given that visitors started conversations when dialogue in the audio/visual feature stopped but stopped conversations when it resumed, in practical terms the museum was didactic with regards to how the material could be interpreted by visitors seeing as the voice of the museum took precedent over the voice of the visitors.

This analysis of the interview, observations in the museum, and a review of the literature led to the third design principle which advocated that a more participatory and collaborative approach be taken to how visitors can experience the museum. It had some crossovers with the previous principles because in order to facilitate and encourage meaningful collaboration, the footing between the museum and its visitors and the approach it takes to narrative needed to complement one another. In essence, the principle called for a design solution that would enable visitors to actively participate in making sense of the material in the museum which would allow them to create their own personal narratives based on the history. This type of collaboration was not just limited to an exchange between the visitors and the museum, but also amongst the visitors themselves, who most often visited the museum in pairs or groups.

Interaction with the butter churn allowed for a more collaborative approach to the narrative in the museum, between both the museum and the visitors, and amongst the visitors themselves. Engaging with the churn required an active participation in order to access fragments from an overall narrative. The tokens showed the title of the fragments and the length of time it would last. The design gave visitors a sense of agency where they could coordinate activities such as conversations and interpersonal interaction. This was in contrast to existing contextualising material, especially the audio/visual features, which didn't allow visitors to do this and resulted in them attempting to make conversation but being cut off abruptly whenever the dialogue returned. The design allowed visitors to organise their conversation so that they could talk about and appreciate the heritage, not just consume it. The printed receipt was also designed to allow visitors to coordinate their conversation more effectively as it gave them control over it as a piece of content; they could tear it off, hold it in their hands, and read it, which was a more direct way of interacting with content than pre-existing museum content.

The final principle in the design framework, which advocated an approach to design that aimed to create an 'authentic' experience, emerged from the interview and analysis of the museum space. It was observed that the curator intended to keep the appearance and character of a museum environment that gave primacy to the artefacts themselves; it was not their intention to give prominence to mediating devices such as screens, panels or texts. By allowing visitors to focus on the artefacts in the museum and not placing an emphasis on learning about the historical relevance of the artefacts, the curator believed that they were creating an authentic experience where visitors could directly engage with the artefacts. The butter churn attempted to respect this principle by keeping the technology out of sight. The interactions that the churn supported also created an authentic experience of the artefact, as the method used to play stories resonated with how a butter churn would have be used to make butter. Further to this and with regards to the experience that the butter churn was created to support, the butter churn itself was designed to become a part of the discourse of the unfolding narrative that it was mediating to visitors. As stated earlier, the subject of the narrative was butter making and the superstitions that affected this practice. Given that this was the subject matter, butter churns and churning played an important part in this history. Because it was being mediated through a butter churn, the design envisaged that the artefact itself would become a part of the history due to the fact that butter churns played such a big part of this history. In this way, the churn was designed to become a tangible link between the past and the present, because it existed both in the stories from the past that it was mediating and in the present with the visitors inside the museum at the point and time at which they were engaging with it. Taking inspiration from how Benjamin critiques screen media where the spectator does not have time to contemplate the content that is being presented due to the scenes changing so quickly (Benjamin, 1968), the approach taken here to the experience of the narrative, which requires the visitor to adopt the role of a fully engaged participant, was designed to create the conditions where the visitor could fully engage in both the artefact and the narrative. It was envisaged that this would provide a more equitable experience of the significance of the heritage that was associated with the artefact itself.

6.1.2 Case Study Reflections and Further Iterations on Butter Churn

Whilst the initial design of the butter churn performed well during the case study, it did go through a number of reconfigurations, which were documented in the case study in chapter five. The reconfiguration that had a strongest impact on visitors' behaviour with it was integrating the thermal printer into the churn itself by embedding it underneath the cap. Printing a receipt intermittently as the story was playing also had a positive impact on visitor's interaction with it. Prior to this, (when the printer was located on the table, next to the churn) it was clear from observations that visitor's attention was unfocused when they were using the churn and they were having difficulty in making sense of the purpose of the receipt. The relocation of the printer helped focus visitor's attention and it created a much stronger semantic link between the act of churning and the printing of the receipt. Chapter four noted how the printer was originally introduced to resonate with the notion of how something 'new' was created when cream was churned, however, when the printer was located next to the churn this link wasn't immediately clear to the visitors, which was evident in Vignette 5.1. By embedding the printer into the churn itself, this link became much clearer to the visitor, to which they responded positively.

The approach to narrative that the design of the butter churn took attempted to ensure that the visitors could take a more participatory role in engaging with the historical content in the museum. As noted above, the pre-existing approach to narrative supported in the museum (especially by the audio/visual features) was a linear narrative that was prescribed to the visitors which created negative issues such as not allowing visitors to engage with another whilst engaged in any of the three features. The initial design of the butter churn proved to be successful in creating the conditions for a more participatory role in the interpretation and creation of a narrative for visitors to engage with, and the approach it took went through minimal changes after it was introduced into the museum. After analysing the data gathered from observations, the most significant change made to the approach to narrative was to print the receipt intermittently throughout the story, rather than at the end of the story which was how it was initially designed to operate. Delivering the content in multiple forms of media (audio and text) throughout the interaction created an experience that visitors responded too much more positively and ensured that they maintained their engagement with the artefact. With the first iteration, one group out

of fout took a receipt (Table 6.1), and in the final iteration three groups out of four took a receipt (Table 6.2).

Table 6.1

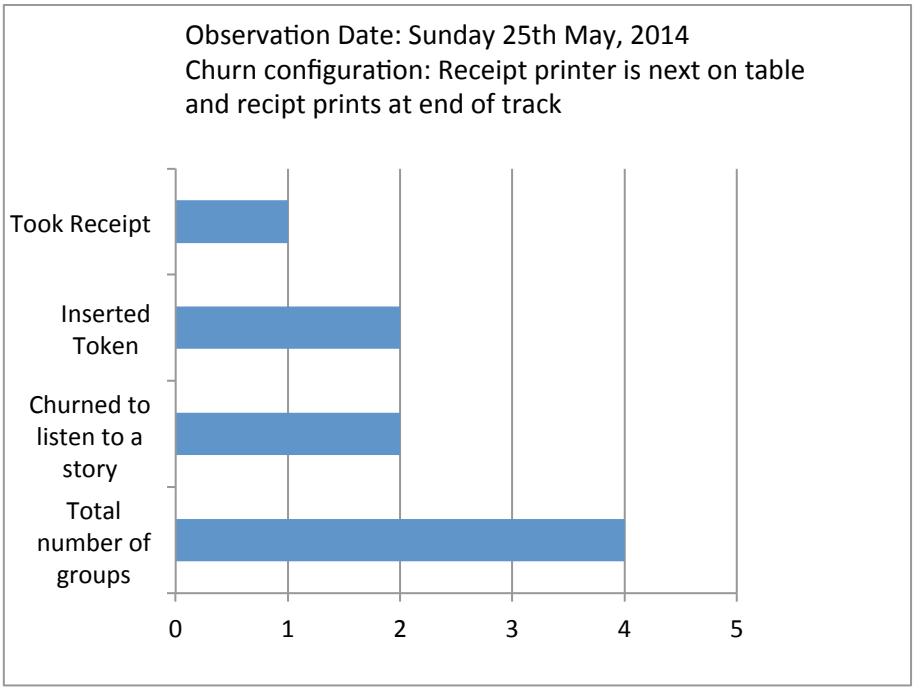

Table 6.1 Data recorded of visitors engaging with the first iteration of the butter churn

Table 6.2

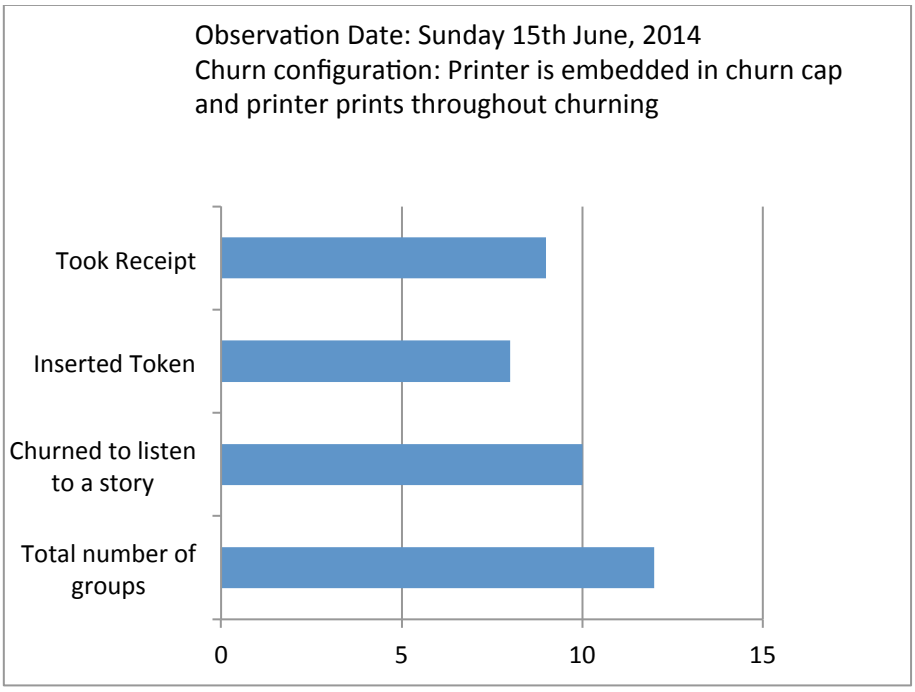

Table 6.2 Data recorded of visitors engaging with the final iteration of the churn.

As can be seen from tables 6.1 and 6.2, the final iteration also encouraged a larger number of groups to insert tokens and churn more. With the first iteration, two out of four groups inserted a token, which was the same amount of groups who churned. However, the final iteration recorded 10 out of 12 groups churning, and eight out of 12 groups inserting a token. This can be attributed to two factors, the first being the final iteration didn't require that visitors insert tokens in order to listen to a story. As a result, the artefact was immediately responsive to visitors who engaged with it by churning, grasping their attention and encouraging them to maintain engagement. The second factor was the receipt being printed at the start (and throughout) the story, rather than at the end. These changes ensured that the access and approach to the narrative supported by the butter churn encouraged a more prolonged engagement.

Vignettes from chapter five illustrated the high level of interpersonal interaction and collaboration that was inspired by the final iteration of the butter churn. The tokens and the receipts allowed visitors to arrange their conversation around the churn in an effective and organised manner, which was improved upon by the iterations that it went through over the course of the case study. After the printer was relocated to the cap of the churn, visitors responded to the printing of the receipts more positively which also encouraged collaborative exchanges amongst the visitors. Visitors were observed translating the receipt from English into their native language, and some attempted to scan the QR Code (illustrated in Vignette 5.2). When the receipt was printed at the end of the story (which was the case for the first iteration), these collaborative exchanges didn't occur because the churn did not maintain visitor's interest long enough for them to stay until the end. Also, when changes were made so that a story would play without the need to insert a token, visitors often called over their partner to investigate, or else their partner was attracted to the churn upon hearing the story play and seeing their partner interacting with the churn. Again, the first iteration didn't inspire these types of social interactions because the churn was not as responsive to visitor interaction. The final iteration created an experience that allowed visitors to negotiate the content and interaction with the churn in a collaborative exchange, rather than the solitary experience that the existing static content or the audio/visual features in the museum engendered.

Interviews also indicated that design of the butter churn was successful in respecting the authentic environment of the museum space. Some visitors who were interviewed after exiting the museum expressed surprise after hearing that the butter churn was 'interactive' (Appendix F). This illustrates that the design of the artefact did not negatively disrupt the environment but still provided opportunity for novel experiences for visitors who did explore the space and figured out for themselves that the butter churn was in fact interactive. After visitors went through the initial exploratory phase of engaging with the churn and built a mental model of how to operate it (tentatively churning, realising that tokens can be inserted, etc.), churning, as a means to play the stories, didn't appear to cause confusion for visitors. The interactions with the artefact itself (i.e. inserting something through the cap and churning) were also respectful to the museum environment, as they did not subvert the original use of the butter churn. However, on the few occasions when the churn malfunctioned as visitors were using it, visitors became intensely interested in the technology and tried exploring the augmentations (looking for wires, poking at the mechanical parts, etc.). In cases such as these, the authenticity of the churn as a genuine museum artefact was undermined and it became an object worthy of investigation due to the difference between it and what visitors might generally expect from an unmodified, 'normal' museum artefact.

This concludes the discussion on the introduction of the butter churn into Cork Butter Museum. A general reflection and evaluation on its introduction will be included at the end of the chapter, but before this the chapter will discuss the introduction of the firkin crane into the museum.

6.2 Firkin Crane

This section will discuss the augmented firkin crane and the redesigns that iterations went through based on data that was gathered and analysed from observations.

6.2.1 Initial Design and Rational

As mentioned above, the curator expressed that they did not want to adopt the role of a teacher. This led to the emergence of the first principle reflecting the desired attitudinal stance that the museum wished to support, which was labelled as footing. The features of the firkin crane were designed to achieve the goal of creating a more

balanced footing between the museum and its visitors by taking a more exploratory approach to interaction with it and the content it mediated. No task or goal was associated with engaging with the artefact – visitors could simply use it to explore the superstitions that affected butter making in the past. The firkin crane imbalanced depending on the strength of the superstition that was weighed and the screen next to it provided contextualising information on how and why the superstition had such an effect on butter making. In this sense it was exploratory. Similar to the butter churn, by giving visitors the opportunity to interact with and control an actual artefact, the role of the visitor was transformed from a viewer or spectator into an active and engaged participant, creating a more balanced footing between them and the museum. This allowed the role of the museum to be transformed from that of a protector into a facilitator.

The second design principle, which recommended a less prescriptive approach to narrative, inspired the interactions that were supported by the firkin crane. It was designed to act as a tool that would allow visitors to explore the effects that superstitions had on the butter making process. Tokens were designed to represent superstitions which could then be 'weighed' by the firkin crane using the holder. The individual tokens acted as fragments of the overall narrative, thereby allowing visitors to negotiate the narrative by accessing and assimilating the fragments by themselves. Unlike the existing static material and audio/visual features in the museum which took a linear and prescriptive approach to narrative, the firkin crane and the interactions it supported aimed to ensure that visitors could create their own stories. The firkin crane also served as a tangible metaphor for the story-world that it was designed to express; the degree to which it imbalanced was relative to the effect that the superstitions had on the butter making process. This way, the actions of the artefact were designed to reinforce the history that it was mediating. Further to this, by acting as a tangible expression of the history, the firkin crane aimed to create a tangible link between the past that it was expressing and the present. (So, while the artefact is from the past and is being used to express a story from the past, it also exists in the present with the visitor who is interacting with it in the museum.) This way, the artefact itself was designed to become part of the discourse of the narrative that visitors were constructing, similar to the butter churn aimed to do the same which was described above.

The interaction and structuring of the content were designed to encourage a more collaborative approach to exploring the heritage, both between the museum and the visitors, and between visitors who engaged with the artefact as a group. The tangible tokens ensured that the visitors had to actively participate in order to access the content, thereby facilitating an engagement between the museum and its visitors. They also afforded physical interaction amongst visitors, and a number of the vignettes illustrated how tokens were sometimes passed around amongst participants. The actions of the firkin crane were designed to give participants ample opportunity to make conversation with one another – unbalancing the firkin crane took approximately between 10 and 15 seconds, during which time visitors were observed conversing or laughing with one another. The interactions that it supported were also predictable which meant that visitors could shape their conversations around the interactions. Interactions were also designed to be visible so that participants could coordinate their interpersonal interactions – i.e. placing a token on the holder was a visible action that others could see and therefore respond to by either making themselves available for interaction or initiating interpersonal and social interaction.

Similar to the approach taken with the butter churn to the fourth principle (which recommended that interventions respect that natural environment), the firkin crane was designed to support interactions that were authentic and resonated with the original use of the artefact. Unbalancing the firkin crane expressed elements from the narrative that it mediated (i.e. the force or weight that a particular superstition had on butter making) whilst also demonstrating the purpose for which it was originally used – to measure the weight of things. In this way, the augmentations resonated with the original purpose of the artefact. The nature of the interactions (which had no goal or task associated with them) were designed to ensure that visitors could engage in an affective experience rather than having to learn historical facts related to the firkin crane, which adhered to what the curator expressed in the interview. This was designed to give primacy to the artefact, allowing visitors to create a stronger connection with the artefact itself where they would not have to be burdened by the ‘intellectual’ or historical content associated with it.

6.3.2 Case Study Reflections and Further Iterations on Firkin Crane

While the initial introduction of the firkin crane into the museum was successful and visitors were able to make sense of it, issues that needed to be addressed did arise in order for it to respect the design principles. The first iteration used a screen to deliver contextualising content on how the superstitions had an effect on butter making. However, it was clear from observations that this was not having the desired effects of creating a more balanced footing between the museum and its visitors due to the fact that visitors focusing the majority of their attention on the screen. This led to the introduction of a thermal printer to deliver the content, which printed a receipt after the firkin crane imbalanced, which was written about in chapter five. After the redesign was implemented and the second iteration was reintroduced to the museum, the modifications created the conditions for a much more balanced footing. Visitors who weighed a token were observed laughing and conversing with one another as the firkin crane moved to an imbalanced position, so their focus was on each other and the artefact, not the content. The interaction allowed them to appreciate the experience of engaging without placing an emphasis on content or historical information. Further, delivering the content through the medium of the printer elicited a more positive response than the screen; the vignettes in chapter five showed visitors laughing when they were being printed out.

Rethinking the approach to delivering content by substituting the screen for a thermal printer that printed a receipt after the firkin crane had imbalanced also created the conditions for a more collaborative exchange between visitors. By offsetting the delivery of the content, visitors were afforded the opportunity to appreciate the artefact without being burdened by textual content, which resulted in conversations and laughter amongst visitors who were engaging with it. The printing of the receipt also created a dynamic where visitors were observed appreciating this novel approach to content delivery, sharing smiles and laughs as the receipt came out. After it printed out, they took it in their hands and began to speak about it, sometimes translating it from English into their native language whilst standing in close proximity to one another, as was illustrated in Vignette 5.4 and Vignette 5.5. The receipt created the conditions for visitors to interpret the museum content in a collaborative exchange, something which was not being achieved when the same content was being delivered via the medium of the screen. While delivering

contextualising content through screens can have advantages in certain situations (more dynamic, instant response, easier to edit), given that the design of the artefact was being guided by a principle that recommended an approach to design that created a balanced exchange between the museum and the visitors that was not guided by the museums desire to teach, using a screen in the context of this project was not feasible.

Using a receipt as a medium to deliver content also had a positive impact on how the narrative supported by the museum could be interpreted by visitors. When content was being delivered through the screen, it was prescriptive in its nature and did not appear to give visitors time to appreciate the artefacts. This was evident through observations, as discussed above and in chapter five, which recorded that the majority of visitor's attention was focused was on the screen. This resulted in an scenario were visitors spent their time consuming the content rather than interpreting it, so in effect the narrative they were experiencing was created by the museum. The introduction of the thermal printer allowed a more participatory approach to the narrative that was accessible through the screen and visitors were also able to take the receipts (which were fragments of the overall narrative) in their hands and converse about them amongst themselves, rather than consuming the text on the screen in a solitary experience.

Another reason for substitution the screen with a thermal printer was because it was not adhering to the sensitivities recommended by the fourth principle of the design framework, which advocated an approach to design that created the possibility for an authentic experience by giving primacy to the artefacts. As well as placing the museum in the role of a teacher which casted visitors in the role of a learner (which was related to the first principle and discussed above), the screen was not creating an authentic experience where visitors would be able to engage with the artefact without being prescribed informational or contextualising content. When the screen was used and programmed to display content immediately after a superstition had been weighed, visitors' attention was attracted to the screen, which is where it stayed for the majority of the interaction, resulting in little of their attention being directed towards the artefact itself. As stated above, offsetting the printing also ensured that visitors were able to appreciate the artefact prior to the delivery of the content.

Besides the positive effects that delivering content through a receipt had on creating an authentic experience with the artefact, the interactions that were supported by the firkin crane (i.e. using it to weigh superstitions that affected butter making) also created an effective authentic experience as it allowed visitors to engage with the essence of the work that the artefact was originally designed to do.

Interviews uncovered that with the first iteration, visitors may have found it difficult to make sense of the semantic link between using the firkin crane to 'weigh' the effect of the superstitions and the original use of a firkin cranes, which was to weigh things of a tangible nature. During an interview, one visitor expressed that they only looked towards the firkin crane after they heard it moving, possibly indicating that they were unsure of the purpose of placing tokens onto the holder until *after* they observed the firkin crane responding to their actions. Another interviewee revealed that they expected the tokens to '*have weight*', but then '*realised that it was electronic'* (Appendix F). While it was taken as a positive that this particular visitor understood that the purpose of the interactions was to weight the superstitions, given that they said it was 'electronic' they were clearly aware of the technology that was being used to create the experience, which went in contrary to design principle four (authenticity). A number of redesigns were implemented to overcome these issues for the second iteration. While the design of the holder in the first iteration technically worked, it didn't take the form or appearance of a holder that would have been attached to an authentic firkin crane in the past, causing difficulties for visitors as a result. The second iteration aimed to overcome this issue by designing a holder which created a more appropriate interface for visitors to engage with. This redesign was necessary in order to create a more suitable interaction that resonated with how firkin cranes were used in the past. In order to create a more authentic experience for 'weighing' the tokens, physical weights were added to them so that their physical weight would correspond to their 'superstitious weight'; i.e. the fairy and charm tokens, which had more of an effect on the butter making process than the goat token, physically weighed more than the goat token which could be felt by visitors if they picked them up and compared them in their hands. The redesign of both the holder and adding weight to the tokens was necessary to create a more meaningful experience that visitors could make sense of more easily.

This concludes the discussion on the introduction of the firkin crane into Cork Butter Museum and the iterations that it went through based data gathered from observations. The chapter will now finish with a conclusion that considers some issues for critique.

6.3 Conclusion and Issues for Critique

The discussion thus far has shown that the designed artefacts achieved the majority of the research objectives, which were to create novel interactive experiences that respected the museum environment. There were however some issues that were encountered over the course of the study, which will now be discussed.

The objective of extending the reach of the museum (allowing visitors to connect with the museum outside its physical walls) proved to be a difficult objective to achieve within the timeframe. While the early explorations with the online interactive map connected to a tangible artefact inside the museum (which was detailed in Appendix C) provided insight and allowed the overall work to progress positively, this objective proved to be an area that required more time than the period of study provided. The interactive map and artefact was put aside after it was deemed to be too inert to satisfy the requirements of creating an engaging experience for visitors to the museum due to the fact that it did not afford much interaction.

After this approach was discarded and the research turned to designing novel experiences using the butter churn and firkin crane, the final design of the augmented artefacts took a different approach to satisfying the objective with the inclusion of the printer. It was envisaged that the receipt would encourage visitors to *re*-connect with the museum after their visit. So, while the interactive map and artefact attempted to create a 'new' connection, the receipt attempted to reignite a connection that was already forged over the course of a visit. The receipt was designed to be received by visitors as a type of 'reward' following their interaction with the artefacts. A QR Code and sniped of content was printed on the receipt, which it was hoped would inspire visitors to scan with their phones. This QR Code would direct the user to a .pdf which was located online on a wordpress.com blog site (Appendix H). However, while some visitors were seen to scan the QR Code (as was illustrated in Vignette 5.2), the website did not record any activity, indicating that there was an

issue with online analytical software that was being used to record incidences of visitors reengaging with the museum. Because of this, it is difficult to know how many visitors actually did scan the QR Code to reconnect with the museum after their visit. However, each .pdf document contained a link to an online survey that was designed to collect responses from visitors, and no responses were collected. While no survey responses does not necessarily mean that no one visited the .pdfs, it may indicate that the content on the .pdfs was not interesting enough to encourage those who did visit them to click on the link and commit to filling out the survey. Given the positive responses to the receipts that were expressed by visitors during interviews, the lack of responses to the surveys was unexpected and therefore identified as an area that demanded a level of investigation that went beyond the scope of this study.

With regards to visitor's interaction with the augmented artefacts, one of the main issues for critique to emerge was as a result of the concealed use of technology. As mentioned throughout this thesis, the main objective of the research was to introduce a range of physical prototypes supported by a design philosophy that respected the museum's natural aesthetic. This led the research to design solutions that kept the visibility of technology to a minimum. Though this worked very well in the majority of cases, creating authentic experiences and interactions for visitors that resonated with the heritage and essence of the artefacts, hiding the technology did have some negative consequences. Some visitors showed great inquisitiveness in the technology and the mechanical components to the point that they became more engaged in exploring how the interactive elements worked than in the experience that the augmented artefact was intended to create. Similar issues have been noted elsewhere by Ciolfi who noted that visitors became more engaged in the task of trying to figure out how components worked than in the exhibition's intended activities (2004). Visitor inquisitiveness in the technology increased dramatically in cases when the artefacts malfunctioned. On occasions when tokens got stuck in the butter churn causing it to become unresponsive, rather than give up and move on to the next section of the museum some visitors became intensely interested, even lifting the whole cap out of the churn, revealing all of the technology hardware beneath it. Similar patterns emerged around the firkin crane when it malfunctioned – visitors became more interested in the mechanical parts of the interaction, inspecting its

components. However, it is important to note that when the artefacts performed as they were designed to, visitors who engaged with them paid little attention to the technology and instead engaged with the artefact and their visiting companion.

Another issue for critique was the sensitivities that need to be considered with using authentic artefacts to create participatory experiences in a museum setting. It was observed in some cases that visitors were reluctant to engage with the artefacts due to their perceptions of the role and function that artefacts generally serve in a museum. An example of this was captured when two visitors were observed around the butter churn; after one put their hand on the handle the other rather disparagingly inquired as to what they were doing, finishing by saying '*would you touch the painting in an art gallery?'* (Appendix F). Here, the preconceived inhibitions that visitors had of what is and isn't acceptable behaviour to engage in at a museum (or art gallery) acted as a barrier to participation. This indicates that there is a fine line between allowing visitors to explore the museum space for themselves, and explicitly telling them what is and is not acceptable for them to do. Though the former might mean that some visitors would miss out on hidden interactive experiences, the latter (telling visitors what is and isn't acceptable) would result in the museum adopting quite an authoritative stance leading to an imbalanced footing.

This chapter has discussed a public case study involving augmented museum artefacts that aimed to create novel and authentic experiences for museum visitors to Cork Butter Museum. The performance of the artefacts was discussed along with the redesigns they went through based on observations of visitors engaging with them throughout the case study. The chapter finished with a critique of the artefacts.

Chapter 7
Conclusion

This chapter will summarise the thesis and discuss the work completed in the context of the aims and objectives of the research. It will then discuss the work in the wider context of museum design and interaction design in general, relating the work to relevant literature identified throughout the thesis. It will conclude by identifying areas for further study that were confronted over the course of the work.

7.1 Summary of Thesis

This study has investigated the possibilities of creating novel interactive experiences for visitors to a museum that respected its natural environment. In doing so, it took an alternative to the mainstream approach to designing museum experiences for visitors. It aimed to design interventions that were shaped by the unique features of Cork Butter Museum and the history it remembers. Though the aim was to introduce technology into the space, a guiding principle from the outset was to ensure that any interventions would be authentic and resonate with its features. This is in contrast to some comtemporary approaches to the design of novel experiences for museum visitors that are technologically determined. For instance, the Cooper Hewitt, Smithsonian Design Museums which opened December 2014 in New York give each visitor who enters an 'interactive pen' that can be used to save exhibits they like to a profile (Cooper Hewitt, Smithsonian Design Museum 2014). The profile can then be accessed using interactive touchscreen tables distributed throughout the museum space or on a website after their visit. Gallery One at Cleaveland Museum of Art features 'Collection Wall', a 40-foot interactive multi-touch screen that visitors can use to browse a vast digitised version of the museum's collection (The Cleaveland Museum of Art 2013). These examples, which place an emphasis on digital and screen based interactions, place access to information ahead of meaningful interactions with artefacts or history embodied in artefacts. Further still, they do not allow visitors to engage with the artefacts at all – visitors can only access digital representations of the artefacts and information relating to them.

The research documented in this thesis took an alternative, more exploratory approach to designing a museum experience that attempted to allow visitors to engage with real artefacts through appropriate interactions. After a number of early explorations, an appropriate area of butter making history and two artefacts were identified which were then transformed through an iterative design and development cycle. These artefacts were then introduced into the museum for a case study and a series of observations, the data from which was analysed and discussed.

In summary, the research objectives were:

- Determine how best to introduce digital media technologies into the museum;
- Support the visitor experience through the creative use of digital technologies in a way that compliments the existing goals and objectives of the museum;

- Establish design principles that guide the development of physical prototypes;
- Implement a range of physical prototypes supported by a design philosophy that respected the museum's natural environment and integrity;
- Extend the reach of Cork Butter Museum and allow visitors to engage with it beyond the physical walls of the museum.

The departure point to the research was given at the outset of the thesis, outlining how it was not opting for a 'technologically led approach' to the design of museum interventions, instead deciding to focus on designing for meaningful and authentic experiences which resonated with the essence of the museum and its heritage. This led to an alternative views on how technology could be used to enhance the visitors experience, which in turn led to approaches to narrative and footing that allowed for a more balanced exchange between the museum and its visitors. Novel concepts and approaches to human interaction with technology and thoughts on how contemporary museums can engage with visitors were then considered in a literature review. Design research that led to the emergence of a set of design principles was documented in depth. An area of butter making heritage and two historically significant artefacts also emerged from this research phase. An iterative prototype design cycle was then initiated in order to design and develop authentic interactive experiences around the artefacts and the histories they embodied. These prototypes went through a number of usability studies before being brought into the museum for a case study. The case study was conducted over an extended duration of time and a number of observational techniques were used to determine the effects that the artefacts had on visitors to the museum. Further iterations were also committed to the artefacts based on data that was gathered from the observations. Finally, the design principle informed the heuristics that were brought to bear on a discussion of the case study.

7.2 Results and Reflections

For the purpose of evaluating the research and proving its value in the wider context of museum design, the design principles (footing, narrative, collaboration, and authenticity) will be used to frame the concluding discussion.

Footing, the principle that related to how the museum wished engage with its visitors through a more balanced dialogue, was central to how the research developed. Chapter two explored

the notion of living heritage and how a museum could be transformed into a stage that supports a dialouge between the museum and its visitors. While Giaccardi used audio recording devices and multi-touch screens that allowed people to reflect on heritage to encourage such dialogue, this research explore the idea by augmenting authentic artefacts and allowing visitors to engage with them through authentic and appropriate interactions. In this way, the museum facilitated the visitors to directly interact with the heritage being remembered by the museum. Through their interaction with the artefacts they were able to engage with them in ways they were designed to be used (i.e., churn a butter churn, check the weight of something with a crane), and by using the artefacts they were able to explore the heritage they embodied. Unlike Cork Public Museum (investigated in chapter three), the artefacts were not kept at a distance from the visitors, inaccessible behind glass cabinets. Visitors could directly engage with them, and the content being mediated was not delivered in a didactic format that attempted to cast user in the role of a learner. This approach to the relationship between the museum and its visitors could be beneficial to the design of museums in the future. While the study was confined to Cork Butter Museum, the principle of footing it explore could be applied else where to allow for a more authentic way for visitor to engage with museums and the content they are custodians of. For instance, whereas the 'Collection Wall' in Gallery One at the Cleaveland Museum of Art allows visitors to explore huge amounts of digital content, its primary purpose is to deliver information and contextualising content on the museums digitised collection. As a result, the museum implicitly adopts the role of a teacher, casting visitors in the role of a learner. This is in contrast to the butter churn and firkin crane, which were not simply designed to deliver information but also had the dual purpose of creating a more balanced relationship between the museum and visitors by allowing the visitors to engage with the artefacts themselves.

The second principle related to narrative, and attempted to allow visitors to be active participants in making sense of heritage inside the museum. Rather than adopting a linear approach that prescribed a narrative created by the curator, the augmented artefacts allowed visitors to interpret and create a narrative that was dependent on their understanding and engagement with the space. Again, this is a principle that contemporary museums could benefit from when attempting to design for a more engaging visitor experience. The majority of museums take a linear approach to narrative, regardless of weather its through making visitors consume content or by prescribing a path for visitors to take through the museum, which was identified in chapter three. In such museums, content is usually arranged

chronologically by the curator. Also, how visitors confront it is also determined by curators, whether it is through audio guides or through physical maps that plot a path for visitors to follow. This can result in a disengaged or even isolating experience that fails to fully involve the visitor. This research proved how an alternative approach to narrative encouraged more interpersonal interaction amongst visitors who were able to interrogate the content, in turn creating their own narrative based on their understanging.

The third principle, collaboration, intended to transform the museum into a space where history could be constructed through a dialogue between the museum and visitors. Relevant literature on living heritage was explored in chapter three, which mostly documented how participants were facilitated in the construct of local history through self-documentation on social media or how participants could contribute their physical artefacts to pop-up a museum. The research documented in this thesis proved how collaboration could also be achieved through alternative methods that didn't rely on digital interactions through social media platforms. The research also showed how visitors 'contributions' could be facilitated in museums where physicla space was limited; while examples in chapter three documented participants contributing physical artefacts, this research showed how allowing visitors to contribute personal opinions in the form of conversation inspired by artefacts resulted in an engaging and participatory experience. Allowing space for conversation around content, which in turn allows for history to be created through interaction between the museum and the visitor, is something that would be useful in museum design. For instance, interactions with the firkin crane were not instantaneous and took a certain amount of time, and this time allowed visitors to converse about the artefact and the content. However, in the examples mentioned earlier (Collection Wall and Cooper Hewitt, Smithsonian Design Museum), interactions, which are almost instant, do not allow time for visitors to dwell or reflect on the content. Not having time to reflect can have the result of the history being purely of the curators making, therefore being a didactic, non-collaborative exchange between the museum and its visitors.

The final principle, authenticity, aimed to encourage visitors to experience and appreciate the artefacts without needing to have a comphrensive knowledge on their history. It also aimed to allow visitors to engage in authentic interactions with real artefacts. The intention was to give the aura of the artefact primacy over it's intellectual (or purely historical) relevance. This had a rewarding effect on the visitors experience, allowing them engage with artefacts and the

content being mediated through them without having to first consume and understand contextualising information. The approach also meant that interactions supported by the artefacts (or the 'interface') and the content beind mediated through them were directly relevant to history of those artefact In this sense, the interaction embodied a sense of meaning that was related to its intentionality. It is an approach to interaction and content delivery that contemporary museums could benefit from. For example, Collection Wall at Gallery One takes an abstract approach to interaction and content delivery – regardless of what type of content a visitor is accessing, the interface and method of interaction is the same. Further still, all content accessible through Collection Wall is digital – the museum does not allow visitors to engage with any actual artefacts. This is in contrast to the butter churn, which as an interface created meaningful interactions for visitors to engage in, and of course also allowed visitor to engage with an actual artefact. Given that visitors attend museums for more than just educative purposes and wish to be engaged and immersed, the design principle of authenticity could be beneficial for other contemporary museum who want to create interactive experiences that are about more than accessing endless amounts of content.

In summary the principles led to the creation of artefacts that were designed to create a more balanced exchange between the museum and its visitors by allowing the museum to adopt a role that encouraged visitors to become participants rather than learners or spectators. The approach to narrative that was taken facilitated visitors in the creation of their own narratives, rather than prescribing a narrative of the museum's creation to the visitors. The role that the museum adopted together with the approach taken to narrative created the conditions for collaboration to occur between the museum and the visitors (in the creation of the history) and amongst visitors themselves around the artefacts. Finally, due to the sensitive approach taken to the introduction of technology and the role adopted by the museum, the interventions allowed for visitors to engage in authentic interactions that focused on the experience of the artefacts themselves and not just the historical content that was mediated through them.

While the discussion argued that the majority of the objectives were satisfied, the objective of extending the virtual reach of the museum proved to be an area that would have required more time than this period of study allowed for. Over the course of the work a number of approaches were adopted in order to satisfy this objective, first with the online interactive map connected to a tangible artefact, and then with the receipts that were printed after visitors engaged with the augmented artefacts. Upon reflection, the initial approach was considered

too inert as it would not have afforded a great deal of interaction or active participation for visitors inside the museum. After a new approach was adopted with the butter churn and firkin crane, it was envisaged that more engaging interactions supported by these artefacts in conjunction with the printing of the receipt would accomplish the requirements set out by the objective, encouraging visitors to reconnect with the museum after their visit via the QR Code on the receipt. This approach was somewhat similar to how Cooper Hewitt, Smithsonian Design Museum approached the notion of getting visitors to re-engage with content they engaged with in the museum after they have left. 'The Pen', which is a digital tool that resembles a traditional pen, will allow visitors to collect objects during their visit and access them online after their visit. While the study documented in this thesis was no long enough to determine the success of printing fragments of a story and QR Codes in order to encourage visitors to re-connect with the museum after their visit, the fact that new museums are also exploring the notion through different methods is fortifying for the research. However this research is different in that it attempted to do it through tangible media that was delivered through interaction with the artefacts themselves, which visitors responded to positively given that many who too a receipt treated it as a mememto, placing them safely in their pockets.

Notwithstanding the difficulties in satisfying the objective of extending the reach of the museum, the augmented artefacts still managed to accomplish the remaining objectives over with relative success. The design principles ensured that the artefacts and the interactions they supported were sensitive to the environment at Cork Butter Museum. Their success makes a strong case for their application in other environments. Allowing visitors to adopt a more participatory role in their visit is something that many contemporary museums are attempting to achieve, and this thesis has put forward a set of principles can could be useful in meeting such an objective. The principles could guide others in designing rewarding museum experiences that places an emphasis on real artefacts, tangible interaction, and interpersonal interaction, creating a more balanced exchange between the museum and its visitors and facilitating a collaborative creation of heritage.

7.3 Future Work

Below is a summary of some concepts worthy of further explorations followed by suggestions and concluding remarks on how and why they should be further explored.

- Extending the reach of the museum through creating novel and authentic experiences – this research has documented a number of approaches that were taken to explore this concept, however it proved to require a longer time frame.

- Investigating the effects of using authentic artefacts augmented with novel technologies to create interactive experiences for visitors to engage with – given that the results documented in this thesis were largely positive, their application in a different environment would be a worthwhile investigation.

- Investigating the possibilities of creating authentic interactive experiences that do not cast the visitors in the role of a learner – it would be necessary to explore this concept in the context of a different museum, as the high levels of positive engagement may have been due to the unique history is remembered by Cork Butter Museum.

It was discovered over the course of the work that the objective of extending the reach of the museum was an area that demanded a longer timeframe than this period of study allowed. While the approach taken in the attempt to satisfy this objective led to collaborative behaviour amongst visitors in the museum with the receipts, further investigations would be necessary in order to satisfy and fully explore the objective. Observations and interviews showed that visitors responded positively to the receipt; it inspired a high level of interpersonal interaction (smiling, laughing, conversations, etc), visitors took the receipts away with them, and during interviews visitors produced the receipts without any prompts from the interviewer, however it did not result in visitors reconnecting with the museum. These explorations are however suitable foundations on which further explorations could be conducted over a longer period of time. As mentioned previously, many museums are now trying make themselves more accessible and relevant for visitors, attempting to forge stronger links with people outside the museum. This research documented in this thesis provide the foundations for an alternative to a digital approach to extending the reach of the museum.

Another area suitable for investigation is the main proposition that this research aimed to investigate, which was exploring the effects of using authentic artefacts to create interactive experiences in a museum. As the thesis has shown, the majority of visitors to Cork Butter Museum exhibited positive responses to the augmented artefacts but some did express preconceptions and inhibitions that acted as barriers for interaction. Also, at times when the artefacts malfunctioned visitors turned to investigating the embedded technologies, showing

more attention to the technology than to the experience that the artefacts were designed to support. These issues warrant additional inquiry in order to discover how such barriers for interaction could be overcome and how to ensure that augmentations direct visitor's focus on the 'designed experience' rather than the technology. Explorations in a wider variety of museums and scenarios would be necessary in order to examine if a similar approach taken throughout this research would have corresponding effects in different contexts. The research documented in this thesis is particularly useful in that it proved the value of designing heritage experiences that focused on tangible interaction, especially given that most explorations in this area usually give priority to digital and virtual technologies. For instance, during the course of the study, the researcher attended the Digital Heritage 2013 conference (Digital Heritage International Congress 2013), and noted its emphasis on virtual and 3D technology. Much of what featured in the preceedings focused on re-creating virtual versions of ancient civilisations, which 'visitors' could then nagivate. While such virtal technology can be useful in certain contexts, this research proved how explorations that focused on tangible interaction with real artefacts result in rewarding experiences for visitors.

Another interesting issue is that of attempting to create authentic interactions that resonate with the heritage of the artefacts but are careful not to cast visitors in the role of a learner. The designed interaction were conceived as being more than input and output; the goal was to bring visitors closer to the history that the artefacts embodied through meaningful and authentic interactions. In this sense, the theory of embodied interaction was applied to the creation interactive, historical meaningful experiences. While this approach worked well and the artefacts were successful in engaging visitors, the approach would require further investigations in the context of other museums. It may be the case that this approach worked well in the context of CBM due to the unique nature of the history it commemorates and the disposition from which visitors approach the museum – because it is dedicated to butter, visitors may be coming to the museum with a playful and explorative mind-set, and therefore open to this type of experience. However, this approach to engagement may not be appropriate for museums dealing with a more contentious subject (perhaps conflict or war), as this may imply requiring visitors to engage in interactions that may not be tasteful or morale. Therefore, this is concept worthy of further explorations in the context of different museum spaces.

While these concepts were all identified as being relevant over the course of the work as it unfolded, a thorough investigation of them went beyond the scope of the research. However, the thesis provides the foundations on which such explorations could be carried out.

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Appendix A

This interview aimed to discover curatorial intentions of the curator in Cork Butter Museum. The interview took the form of semi-structured interview where the researcher asked a number of open-ended questions to guide the conversation. The questions are included below, followed by a transcript of the interview itself.

Interview questions:

- Broadly, what would you like visitors to experience when they're here?
- What was the motivation behind organising the artefacts into their current arrangement?/What was your intention with the layout of the artefacts?
- Are there any particular areas that you have attempted to highlight?
- Do you know what areas do visitors find most interesting?
- When visitors leave, what story do you want them to take away from the place?

The interview transcript includes time stamps and some descriptive commentary on the conversation between the researcher and the curator. The questions that were asked by the researcher have been formatted differently so as to distinguish them from the rest of the conversation.

Date of interview: January 3rd 2013

Interview transcript:

Researcher: [**TIME**: *08:12*] [**Question 1**: '*Broadly, what would you like visitors to experience when they're here?*']

Peter: I'm not sure I want to say what I want them to experience, ah, … I don't feel like I'm delivering a special, a specific product, you know; 'this is what I want you to have'. I think more I'm of creating an environment from which they can take out what they want.

Researcher: ok

Peter: Yeah? And if then what they want they're happy with it, if they find something they're happy with then I'm happy. Am, but … I'm not happy with the concept of delivering something to the visitor; it's more like a showroom: they come in, they might like the video they might like this, they might like that but they might like this, if they like the whole thing that's good too, but the question, what you, [**TIME**: *09:00*] what's the question again?

Researcher: What would you like them to experience when they're here?

Peter: I want them to have a good experience, that's all, however that's defined I don't care. If they're happy with the video that's grand, as I said if they like any one part of all parts that's fine. Am, that's in terms of experience, I mean I would like obviously to acquire some knowledge, familiarity or regard for the subject matter which is the diary culture in Ireland but, I cant make them do that, you know, I can only put the stuff out there.

Researcher: Yeah

Peter: Its what they bring is what's as important as what's in here. It's quite interesting in our statistical data, when we did a break-down of positive response by language group [non English speakers], right, the worst response was the Spanish, because the Spanish don't have a butter culture, it's quite a complicated history about the Spanish and animal fat, but they don't, except for the very northern part, so they're not, it's not a culture they're familiar with right [**TIME**: 10:00], whereas the highest of the non-English speaking was the Germans, because Kerrygold has a huge profile in Germany and they're used of it. So, in a sense, their response is determined not so much from with what's in here, but what they brought in the first place.

Researcher: Yeah

Peter: because that impacts on what they see… so, yes, I'm straying off a bit, does that answer you? Do you know what I'm saying, I mean, that's what I say, I don't want people coming out, I don't feel I fail if they don't go out (not) knowing the history of the butter trade like, I just want them to have a good time. If they want to know about the butter trade they can buy a book.

Researcher: [**TIME**: 10:41] [**Question 2**, Am, and I'd suppose, what's your motivation behind the organisation of the artefacts?]

Peter: (smiles) this comes out of some type of journal 'motivation behind the organisation', repeat that again?

Researcher: So, I assume that the way the artefacts are organised here, there is…

Peter: (interrupts) there is

Researcher: is there a motivation like?

Peter: No. Well partly, no, there isn't, well [**TIME**: 11:00], I didn't set this place up, but the place was set up, you see, this place suffers from the fact that it was a building…it is not purpose built, right?

Researcher: Uh-hmm.

Peter: So therefore the arrangement of the artefacts and the arrangement of the exhibition had to fit in with the building, not the other way round, which is what you really want it to be. The building is built to suit the (rtc???), this includes the internal organisation of the building. So the structure of the building defines certain cat-things; one is that this is the biggest space: the ground floor is the biggest space, big in our terms like, and then there's two rooms upstairs, and they're rooms, and what do you do with a room, I mean you know, one room, each room almost demands a thematic unit.

Researcher: Yeah

Peter: So, that, that's one of the problems of the place had to deal with. So…what's the question again? …what's the motivation of the organisation? Oh yeah, you mean the layout.

Researcher: Yeah, but I'd suppose the layout and how the artefacts [**TIME**: *12:00*] are organised in the layout.

Peter: Yeah, ok. Well the determine of the layout [sic], of one, is the physical restraints of the building, which is a big problem. A, both the size of the place, and B

there are already internal partitions which cannot be moved, so you have to live with those. Now upstairs means there's two rooms, which a decision was made to cut half a room actually, I don't know why…and budget of course is another issue. When this place was set up you know, the budget was tight and it went over, substantially went over it, am you know, it is done to quite a high standard, am, so that's the determinant . So I inherited that in a sense, I inherited a four part system; one small section upstairs dealing with early Ireland, where we had artefacts from... yeah the other problem, the issue about this museum and I'd suppose any kind of folk museum, or museum that deals in folk artefacts, oh well no, that's not quite right, I take that back, but [**TIME:** *13:00*] certainly in the butter trade anyway, is that there aren't that many artefacts; its not that difficult to make butter. You got six objects, you got the butter trade basically

(both laugh)

so, there's an issue about the subject matter, in terms of what you do, anyway, that's the other determinant, is your subject determines it to an extent, but you are talking about dairy. So upstairs has one that deals with early Ireland, the second one deals with the Butter Market in Cork, now, and then down here there was freer, but the decision was made to ah, the, to have a video on the modern trade here, and then back there was traditional butter making. It was a fairly sparse exhibition to tell you the honest truth, even my best friend said that…am, so, what we, so the (expos) so… that's what happened in the beginning anyway, kind of four thematic sections. Since then I have…what's the motivation… well the motivation is almost external; if someone comes, you see something, I mean, part, [**TIME**: *14:00*] part offering a good or trying to offer a good visitor experience, you also have a certain responsibility to the subject area. If someone comes along and says 'I have this stuff, do you want it', you know it's going to be lost unless you take it. Well then, like the butter wrappers for example, now not that they would be lost, so they, I felt that they had to come into the museum. So then you have to find a space for them. So, once the die is cast, after that then, particularly given the constraints of this building, you are kind of dealing with what comes at you, rather than making a strategic (decision???) 'we want this', because you can't do that, because you can't say 'we want this, this and this' because A you can't afford it and B what you want mightn't exist.

Researcher: Yeah

Peter: It's much more to do with like, that's material that came in (pointing to the old churns); someone came along and saw some old churns. Once you got some old churns you buy more old churns because, look, [**TIME:** *15:00*] there's actually a typology of churns there, you know, am, so then you have to do something with them, you can't just put (inaudible),

Researcher: Yeah

Peter: that's almost, a matter, now there were some churns here before, but once you develop something, you know, it almost, at that stage, the artefacts, if you make a decision about one, they almost determine themselves, you say 'we're going to collect churns therefore we have to find a space for churns therefore we have an exhibition based on churns', you know, and that slightly overlaps with our view that we have to do something on the Creamery phase. So, to go back to your question, the motivation; once you've left the blank canvas of day one right, this case, our case, the motivation is very much 'well what stuff comes in' and what we feel we have to do with it, and weather we have the responsibility to take it. Now there's all other, we have a fair bit of paper material we can't take, we've taken, but I'm not sure what were going to do with, am, so that's it; it's almost reactive, rather than making decisions and acting upon them, it's the other way round, its events occur for which we have to react, primarily [**TIME**: *16:00*] artefacts coming in, now it's not always about, something's you say 'right, we're not collecting those, we can't afford them' – someone said you should have a butter dish collection – there's millions of butter dishes in the world, forget it, you can't do that yeah? Let me think, anything else around here that strikes me…yeah…does that answer your question?

Researcher: I guess it does…

Peter: how…the motivation of the development of the collection…oh the other motivation funnily enough, well, I think… I think there's a kind of a strong visual element I think, that's one of the things we want to have…am…there's always this tension between putting lots of text on the wall but trying to communicate a different way – or not even trying to communicate – the dangers of when you start

communicating things you just have a book… a sound, but trying to create an environment…where people can engage…without using words [**TIME**: *17:00*] is very difficult to do, you know…

Researcher: [**Question**: '*Would you say the physicality of the artefacts and their bulk adds to what they offer?*']

Peter: Yeah, I think that's quite important, I mean that's what…you know, yeah, good question. Am. I think that's what makes a museum a museum, it is the authenticity of the artefact – that's what makes a museum a museum. Otherwise it can be a video show.

Researcher: Uh-hmm…

Peter: right, a video show, that's what a lot of these places are frankly, am, but I… multimedia interactive – what a disgusting phrase

(both laugh)

Peter: I personally think it is…yeah, the artefact. In a sense its almost like a sculpture exhibition.

Researcher: Yeah, interesting.

Peter: Actually, that's a fair point actually. I do believe strongly in that, I wouldn't, I won't think, yeah, yeah…(trails off)

Researcher: [**Question**: '*Are there any particular areas that you've attempted to highlight?*']

Peter: Yeah, I think the butter wrappers. [**TIME**: *18:00*] I mean the butter wrappers is [sic] unique… we did, they arrived in about two years ago, am, they kind of, partly because the coinsided with my life, you know I remember them – well not quite, but I kind of remember the tail end of it, and I know, I know because I'm an archavist that doc- paper material can disappear very quickly so I think that was an important collection, that we had to get in and do something with, which we did you know. In terms of (sigh), try to highlight…what's a- I don't understand what you mean.

Researcher: I'd suppose, to my mind I'm thinking of the bog butter churn upstairs

Peter: Yeah

Researcher: Like is that, would you see that as a particular area that, I know you're saying like the space had determined much of the artefacts and there is one room in there.

Peter: Yeah

Researcher: Would you say that's because it's in a room by itself you're trying to highlight it maybe.

Peter: I say, well we didn't make that, well I didn't make that decision well yeah I suppose. I mean that is the jewel of the crown really, in terms of artefacts, am, but no we [**TIME**: *19:00*] haven't. I mean budget… while we can add to what has been done it is very difficult for us to modify the basic structure because the cost, plus the fact that when it was it was quite well done visually so the whole thing is tonally – works together, so you can't just take one bit out, and tweak it, because the whole rest of it has to be tweaked as well, you know?

Researcher: Yeah…

Peter: Am, and, well actually I'm quite happy with those two rooms up there, I mean the one I'm not happy with is the one that deals with Cork; Cork Butter Exchange and that – that's *way* too inert. Am, I (short incoherent mutterings and ramblings), yeah, to talk about ahh highlighting… no, no the answer to that 'do we want to highlight something' no, not especially, no. Am, I mean this is, in a sense, unfortunately this is a big part of the exhibition, the 15-18 minute video, because people like pictures you know? [**TIME**: *20:00*]

Researcher: Yeah.

Peter: We've become a screen culture, am…and its showing its age (referring to the video screen), I must make a new job of that actually, am, but do we highlight any part – no. No we don't highlight any part of it no, no. It isn't big enough to pick out one bit and say 'oh this is the best' because everybody would go there then, and then

they'll all go away. I mean we have to make the optimus- we try to make the optimum visual impact of what little we have, you know. I mean we have a lot – this is a specialist subject, a specialist subject, in a confined space, and that's a hard sell, you know?

Researcher: Yeah

Peter: If we had twice the space we could put in a whole creamery with machines and the whole fucking lot going like no problem yeah, that'd be great, because you'd keep half the population happy just looking at it, [but] we can't do that, we haven't enough space, you know.

Researcher: Yeah, yeah…

Peter: We could, I was offered a churn last year, a big creamery churn, *massive* thing – these things can be huge, this is the one now I was offered (reaches for phone to show me a picture of it) but we couldn't take it d'you know. So, the combination of a small premises and a specialist area does [**TIME**: *21:00*] make it difficult to create something, plus and budget, that has kind of wow factor, you know, that you highlight, and that would be a highlight of any museum, a working creamery, but you know, that's not going to happen. Sorry yeah, next question.

Researcher: [**Question**: '*Am alright, I'd suppose this is sort of related somewhat, are there any particular areas that you've noticed visitors find most interesting?*']

Peter: I, unfortunately it's the video.

Researcher: And regardless of language?

Peter: It seems, well we never ask them that question, um, I think people watch the video and walk through the rest of it fairly quickly, in the main I think you know, am, but that being said you get a fairly good positive response too you know I mean amm…yeah [**TIME**: *22:00*] I think the video is the one that's most easily accessed, so I think that's the one that has clearly the strongest impact. You have people coming down and saying, this that, up in the stairs there, in the early Ireland section there's an information panel on cattle raiding – some people mention that strangely enough, it's

never struck me, not as particularly interesting like, cattle raiding, but no I wouldn't say there's a stand out wow, this is the hit of the show like, no.

Researcher: [**Question:** '*Am, this is just a general question, but like, would you say its, people are most interested in the video because the sit here the longest…?'*]

Peter: You mean how do I make this judgment?

Researcher: Yeah.

Peter: In so far as I keep an eye on that sort of stuff yeah, people will sit and watch the video, and then they will go through quite quickly, so if they're here half an hour and the watch the video, half the time is watching the video, and the other half is just wandering through,

Researcher: Yeah,

Peter: you know. Which is fair, I mean, you know; it's a restaurant, you don't have to eat everything like [**TIME**: *23:00*] but I do feel a little bit that this is too dependant on this very simple solution, but there's only so much we can do between constraints of space and constraints of budget. I mean, if I… if I had the crafts centre next door and unrestraint budget yeah I could do something no problem no problem, much bigger, much bigger, much more impressive sort of…but I have neither so what's the point.

(both laugh)

Researcher: You can dream

Peter: Exactly

Researcher: [**Question**: *'Am, when visitors leave, what story do you want them to take with you, or with them, sorry'*]

Peter: The only story I want to take with them is that they had a good experience and they enjoyed it, right. If they've gone out thinking butters made of chicken's legs I couldn't care less, that's up to them

(both laughs)

Peter: I'm not an apostle for the dairy industry, and I'm not a history teacher, right. I'm providing a space, in which people come in, and experience, hopefully [**TIME**: *24:00*] and aesthetically pleasing experience about something to do with the dairy industry, I can't make them read the panels, you know.

Researcher: Yeah

Peter: So that's what I want them to go out as, positive, 'that's good, I enjoyed that', I'm not going to say 'well if you enjoyed that answer these six questions', d'you know, I'm not interested in that, yeah. So, I don't buy this story business

Researcher: mh- hmm,

Peter: And I never have, that I'm telling a story, I'm not; I'm delivering an experience right, that's the way I look at it. That experience may contain narrative elements about the history of the dairy industry…

Researcher: Yeah..

Peter: I can't control how people react, I can't … all these Failte Ireland people talk about what stories we've got to tell, I mean, telling stories is for books, right, these are objects – this is a space, its not a book, right, so that's not about stories, its about experiences.

Researcher: [**TIME**: 25:00] [**Question:** *'And when you say there's a, some type of…did you say there's a loose narrative of the diary industry?'*]

Peter: Yeah, exactly, a loose narrative, this is not, I mean some dairy, we do get occasional complaints, 'you forgot this, you forgot that', actually I didn't forget it, I ignored it…am, exactly, it's a loose narrative. But you've got to dethatch the content from…sort of the intellectual content from the place, d'you know or the experience you're offering… you know, the question 'affective Vs cognitive' I think museums are affective experience and not cognitive experiences. I mean I go to museums a lot, ask me, a simple question about, where was I, I don't know, the Jewish Museum in Paris, which I've been to two or three times; I couldn't tell you on fact, now, well maybe one or two, right, but I remember it, and I remember it extremely well, and I remember what I felt there, do you know what I mean?

Researcher: Yeah

Peter: So do you take my point? If people go out and say 'wow, the dairy, that's an impressive museum that's an impressive industry, I never knew this' that's fine, that's alright.

Researcher: [**Question:** '*And like, I don't want to be pushing this narrative thing, if you said that there, like, is the narrative made up of the individual artefacts themselves or is it made up of the relationships that the artefacts have between one another?'*]

Peter: But you see, ok, I'll answer your question in a second, but this business of narrative, you see it's the person who engages with the narrative is as much a part of the narrative as any narrative right, its what they pick, they create the narrative. Now you can't impose on them what their narrative is going to be. A Spaniard will see it different from a German because they've different engagement with butter, right, you cannot, you're not offering a narrative, you're offering fragments, and they've to put the pieces together as they wish, or as they can, doesn't matter right. [**TIME**: 27:00] So, the question, how does the narrative work, in here, the answer is there is no narrative in here, right, in that sense of the word. We're not offering a product that 'you must read this, and come out with this'

Researcher: [**Question**: *'So, you're not prescribing a narrative…?'*]

Peter: Exactly. Within the more specific question…how does the content, forget the word narrative, use the word content, that's a much, because is a very low 'ding ding ding' (maps out line on the table with three different points drawn by his finger), whereas content is a simpler word. The content works by interaction yeah, to a degree, to a degree, I mean, I think more, the place works visually in a set of zones right, amm, and those zones should be reasonably self-contained, that's my view. It isn't (1, 2, 3, mapped out with finger on the table), right, now. In other words, those churns there right, and the woman Magie, [**TIME**: 28:00] turning those churns (gesturing towards the wall panel with a photo of a woman with a churn), amm, unless you really knew a bit about the dairy industry, you would not necessarily make a connection with those churns and those wrappers, unless you knew something about

the dairy industry. Now we don't make that diary connection, partly because if you do that, well, I don't want a language driven museum in the first place, and I don't want a narrative museum in the second place, yeah, I want an experience, so if they come out saying 'wasn't she very pretty' that's fine, ok; they noticed something. I don't mean they noticed but d'you [sic] know, am, you see, what this corner does, it conveys churns, right. So if they go out saying, thinking churns were important, that's enough, perfect, that's all I want to know. And if there they go out saying, or thinking 'god weren't some of those wrappers very nice' – that's fine. I'm not being trivial about this, I don't buy, so to answer your question, I don't see the place, you can if you bring the right sort of background to it, create a narrative right through, I could do it, obviously, like when I go and do guided tours I can do it, but I have to do it, I have to talk it through. Am, but within the specific spaces, I would hope they would be self, not self-explanatory, but self-contained, yeah, and how they work together, no, I don't put up 'and then, and then' or 'please go here, or please go here' no, I don't do that, I don't do that, we don't have it. If I had a different space, yes, but when I started here first, when I inherited the job, we started people off up in Early Ireland, up in one of the top rooms upstairs. [**TIME**: 30:00] Until somebody whose a specialist in tourism said 'don't do that, don't start off at the beginning' because you've Germans and Spaniards looking at bog butter, and they don't know what a bog is, right, so they've no idea what they're looking at. Start off with what they know, and then work backwards, if you have to do a narrative. So start off with the video, and work backwards. Now two or three people actually complained about that, the said 'why don't you start at the beginning', but you don't, you start at what people know at, then when they go, if they know something about Kerrygold then when they see the bog butter upstairs they'll have context in which to interpret the unfamiliar.

Researcher: Yeah.

Peter: So it makes much more sense.

Researcher: They know what they're looking for…

Peter: Yeah, as opposed to looking at a big lump of something

Researcher: Yeah, and maybe not finding out (what it is that they're looking at)

Peter: Or maybe not finding out. So, anyway, does that, what was the question… narrative, oh yeah, the narrative is accidental. It is the viewer who creates the narrative. I cannot control the viewer, and I'm not imposing a narrative. It also puts the practical matter, if, 45% of our visitors do not have English as a first language, you can't be imposing in English a narrative on people, because they won't understand it.

End of interview

Appendix B

This appendix gives details on a prototype development that was explored during the design research phase. It deals in particular with an online interactive website that was created to map and document stories related to the Butter Road, and how a tangible artefact was then connected to this map.

Concept

Research on the origins of the Butter Exchange led investigations to the Butter Road and its significance in the success of how butter from Cork and surrounding areas was exported throughout the world. Though many 'butter roads' were built throughout the country, the most significant in terms of the Butter Exchange was the one that went from Kerry to the Butter Exchange.

The butter road was used to transport butter from areas as far as Kerry to the Butter Exchange where it was then graded and sold. Much has been written about these roads and history that was associated with them, which goes beyond butter to include social and economic history. For instance, living conditions of people who lived along the road were recorded by early 19th Century tourists and have been documented in local history publications such as 'Aubane: Where In The World Is It?' (Lane, 1999). Incidences of highwaymen who took up positions along the road and carried out muggings on passing traders and travellers have also been recorded.

An early prototype aimed to capture this heritage that was associated with the history of the museum and make it accessible to visitors beyond the walls of the museum. This prototype took the form of a website with an annotated interactive map that could be used to explore the Butter Road and its heritage. The interactive map used Google Maps and a historical map of the land as it appeared in a 19th century. The old map was placed on top of the contemporary Google Maps map layer. Visibility of the old map could be switched on and off, which allowed users to see the historical topography relative to contemporary topography. Markers were placed along the road in the map, and clicking on a marker played a particular story related to the highwaymen that operated along the road. Figure 1 illustrates the map and the different in a number of different states. Stories were stored in a database on a webserver, and clicking on the marker played the

story in the web browser. The technologies used were a mix of HTML5, CSS, JavaScript, PHP and MySQL.

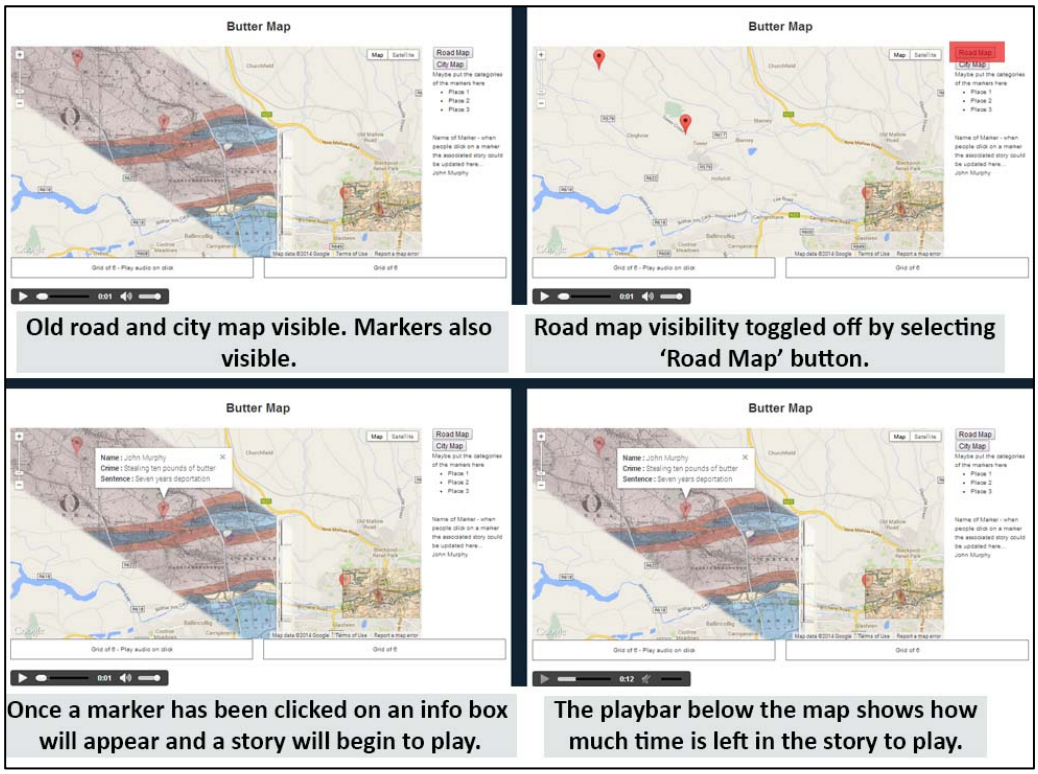

Figure 1 Illustrating the different states of the interactive map; toggling the old map on and off and listening to the stories by clicking on the markers.

This prototype was then used for further explorations and a tangible museum artefact was connected to the map using Arduino and Processing. Briefly, the general idea guiding the exploration was that in order for the stories on the website to remain accessible, the artefact in the museum had to have been engaged with by visitors in the past two hours. In was envisaged the website and the stories on it was the 'memory' of the artefact, and that the artefact forgot the stories if no one engaged with the artefact itself. This way, visitors inside the museum had to maintain a regular engagement with the artefact in order for the stories to remain accessible. Further, if someone visited the site and the stories were inaccessible, they were able to 'poke' the artefact through the website, which would actuate a motor in the artefact causing it to make a knocking noise in an attempt to attract the attention of museum visitors who may be close to it. When someone in the museum interacted with the churn by lifting the cap off it, the stories became accessible again. Lifting the cap off it also caused a story from the

website to play. People outside the museum were able to access the website via their smartphones through poster that had QR Codes printed on them.

The website and artefact created a communication channel between visitors in the museum and people outside the museum. Figure 2 illustrates this.

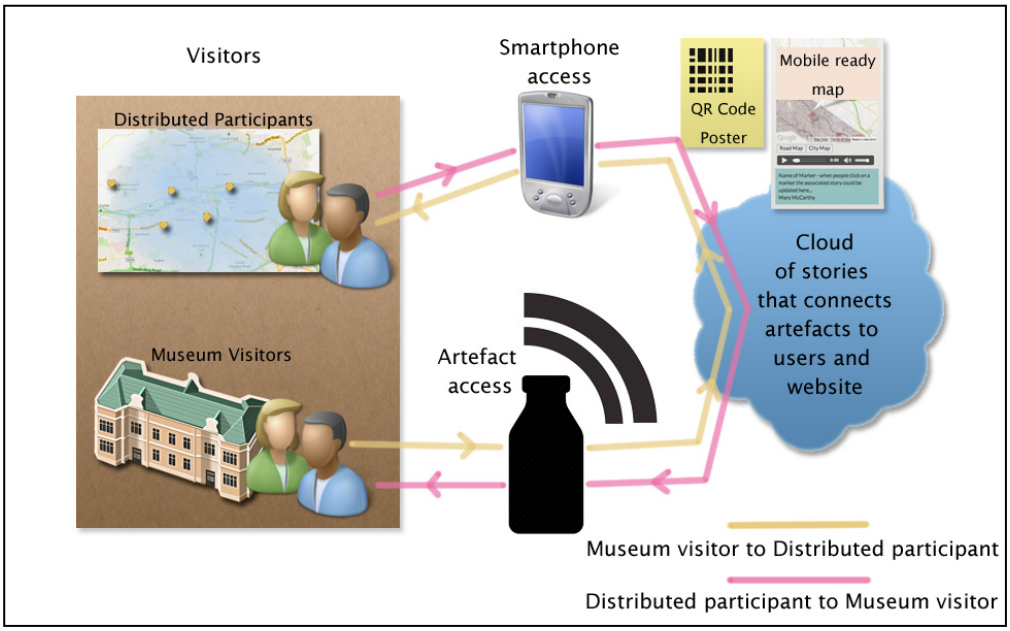

Figure 2. Illustrating the communication channel that the prototype supported between visitors in the museum and outside the museum.

Conclusion

While the explorations that were involved in the development of this prototype were useful, superstitions eventually emerged as a more suitable strand of history around which to create novel experiences for visitors to engage in. As a result, these developments stopped in favour of designing and developing concepts the butter churn and firkin crane.

Appendix C

This appendix documents developments of an early prototype during the design research phase that aimed to make a museum artefact (a milk churn) responsive to the presence of people.

Concept

The concept behind the exploration was inspired by observations in the museum. Visitors were observed inspecting the milk churns that were arranged on the first floor, often looking into to them. The interest that they were showing in the artefacts naturally gave rise to the possibility of attempting to augment the artefact so that it could provide some multimedia content to visitors who engaged with it.

The first iteration was designed to play a random story related to milk churns and dairying when the cap was taken off the churn. An Arduino board, a light sensor, and Processing were used to create this prototype. When the cap was lifted off, the light sensor registered this and then caused a Processing sketch to play a random story.

This was tested on a corridor in CIT, as can be seen in Figure C.1. However, no-one stopped to lift the cap off.

Figure C.1 The first iteration of the milk churn that played stories.

Following this, a motion sensor and stepper motor was introduced to the design. The stepper motor had piece of timber attached to it which knocked off the inside of the

churn when the motion sensor detected someone walking past the churn. Again, this when this was tested no-one lifted the cap off. Figure C.2 shows the churn setup.

Figure C.2 The second iteration of the milk churn that played stories when the cap was taken off. This version had a stepper motor inside the churn that made a knocking noise whenever someone walked past it.

Though the milk churn did cause people to slow down, no-one actually stopped or lifted the cap off. After these iterations proved unsuccessful in attracting the attention of people and encouraging them to take the cap off to listen to a story, a more direct approach to attracting attention was adopted.

The next iteration attempted to make the milk churn 'look' at people who were passing. The concept was inspired by how visitors spent a lot of time 'looking' at the milk churns in the museum, which led to the question: '*what if the roles were reversed, what if a milk churn could look at the visitors?*'

For this prototype, Arduino, Processing and Flash were the software applications that were used, along with a series of web cameras and a servo motor. The video stream from the camera was sent to Flash, and when movement was detected in a particular frame of the video, a signal was sent to Processing, which sent a signal to servo motor that was connected to the Arduino. The servo motor was connected to the cap, so this allowed the cap of the milk churn to rotate around to where activity was detected.

Again, this prototype went through a number of iterations and a series of observations were carried out while it was tested. Figure C.3 shows an image from the setup of the observations.

Figure C.3 The image on the left is the first iteration of the milk churn that looked at people, and the image on the right shows the final iteration of the prototype.

Conclusion

While exploring the possibilities of making an artefact responsive to people's presence uncovered valuable and interesting data, the concept was eventually put aside as the research focused on using superstitions as a strand of butter making heritage to create novel and authentic interactions. Other than attracting the interest of people who walked past the churn and noticed it responding to them, the milk churn didn't afford any type of participatory activities, which is what the research was attempting to facilitate in the museum. For this reasons, using a milk-churn as a possible artefact was discarded in favour of designing and developing novel experiences using the butter churn and the firkin crane.

Appendix D

Sourcing content that would be mediated through the novel artefacts led the research towards consultation with experts in the area of folklore and Irish dairy history.

The curator of Cork Butter Museum was first queried about any relevant material or experts who would be willing to share information. This led contact being made with researchers in the Bealoideas/Folklore and Ethnology department in University College Cork, Ireland. Following this a meeting was set up with Dr Cliona O'Carroll from the Department which led to a conversation on superstitions and how they affected butter making. Dr. O'Carroll recommended some reading material that was able to give context to the existence of superstitions (Narváez) and a number interview videos made by the artist Michael Fortune on folklore and superstitions (Fortune).

The curator also recommended the book (Quish), which gave a great detail on the development of the co-operative creamers throughout Ireland in the late 1800s and 1900s. The book gave interesting personal accounts of superstitions and the effects that they had on people, all of which was very useful in gathering interesting content.

This research found that butter making was a very unpredictable process for various reasons and often resulted in failure. The root of the cause could range from inadequate sterilisation to high humidity, or sometimes through the fault of the butter maker themselves such as attempting to churn butter straight from milk without separating out the cream. Considering how important the profit generated from butter was for the financial security of families, a considerable amount of stress and apprehension surrounded the practice of making butter.

Because butter makers didn't fully understand the scientific process that was of critical importance to successfully make butter, they often searched for reasons that explained their failure. The result was many superstitions surrounding the practice of butter making.

Cork Butter Museum itself features a panel of text entitled 'Folklore' that gives details on some of the superstitions that had an effect on butter making. The following portion of text is from the aforementioned panel:

Precautions and remedies were devised to ensure that nothing interfered with the butter making process.

To protect the cattle, crosses, particularly St. Bridgid's crosses, were hung in the cow houses. The dairy was built away from enclosures, such as ring forts, which were thought to be the territory of the fairies. A red rag was tied to the cow's tail after churning as the colour red was said to have protective qualities. Holy water was sprinkled on the cattle, and many incantations were recited to prevent illness.

Incantations or prayers were recited during churning to invoke the blessing of a deity. These incantations were a mixture of pagan and Christian prayer.

To ensure good luck every person in the household, including visitors, were expected to take a turn at churning. A burning cinder was placed under the churn for protection. Unsalted butter was sometimes spread on the wall to protect from supernatural interference. It was forbidden to take ashes, water or fire from the house during churning.

Further research of various sources uncovered a whole host of other superstitions:

- Cattle were driven across dying flames of a bonfire on May Even and Saint John's Eve, or driven between two fires.
- Cows were forced to swim in a lake or a river to avert illness or bad luck.
- Goats were kept with cows to bring them luck.
- A cow that never bourn calf was kept with cows to bring them luck.
- Holy water was sprinkled on livestock.
- Charms were recited to avert or cure disease.
- The first stream of milk that was milked from a cow was left 'for those who might need it', ie. the fairies.
- A charred sod of turf from the Midsummer bonfire was placed in the milk-house as protection.
- It was forbidden to drink milk on Good Friday.
- A lice cinder was placed under the churn, or else shoe from a horse or ass.
- An iron nail was driven into the timber or a withy of rowan-tree was bound around it.
- The tongs as kept in the fire during the period of churning.
- Water of fire-ashes were not allowed out of the house until the operation had ended

- During churning, fire couldn't be taken out of the house by a visitor (if for instance they wanted to light their pipe).
- Visitors were forced to take a 'brash' (hand) at churning before leaving to keep the butter from harm.

Further to this a number of interviews with people who had first-hand knowledge and memories of butter making in the home were conducted. One such interview took place on 07/05/2014 with the intention of using the material recorded during this interview as part of the stories that would play out of the butter churn. The interview was open ended and aimed to ask the interviewee general questions on butter making and the superstitions that characterised the practice. The interview lasted approximately 30 minutes and extracts were taken from the overall interview, the transcriptions of which are below:

1. *Anyone that'd call in then, in the run of the day, which people used that time would drop into houses, they'd always have to, turn that two or three times, for there was, there was the thing about Piseogs. There was people, evil enough, to be able to take that cream through a silk thread to their own farm.*
2. *If there was people evil enough living alongside you that could do this thing. You'd have nothing below at home, the neighbours out the road would have what you'd have taken. And this was the way of breaking that mould they'd have to churn that churn if they called then to break that circle.*
3. *As late as last, the first of June last Thursday night, I had a man here and he said I must go home, I must go out with the holy water yet at home for to shake it around the bounds. That was last Thursday night. T'was [sic] serious, but ah, the more fear you had of these things being done to you, the more problem t'was [sic] going to cause.*
4. *It was a desperate art, whatever way twas [sic] done I don't know, I don't want to know. I don't know and I don't want to know. But it was a strange setup. I mean it was a mean, begrudging sort of a setup. Like, everyone was entitled to make his own few bob [money] whatever way t'would [sic] be, but to take it from him in that kind of a caper was very bad.*
5. *Everyone was afraid of their life that t'was [sic] the work of the devil, t'was [sic] evil doing, maybe t'was [sic], I don't know, but I met a man, and he told me, d'you [sic] know Sean he said to me any of us could do that if we were bad enough. I have hear of places, and new places where that happened, like and t'was [sic] very frightening, very frightening now.*

In summary, the research on superstitions set the foundations for appropriate and authentic content that would be mediated through the augmented artefacts. Visitors

responded extremely positively to this lesser known but all the same very important side of butter making.

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Appendix E

Reports from Usability Testing

This appendix reproduces the reports that were generated from a number of usability studies conducted during the prototype development stage. These reports were written in a reflective and discursive style and the aim of the appendix is to:

- illustrate the goals of the testing,
- the methods that were used, and
- results that they led to.

It will also include some stills taken from video footage of the studies.

Usability Study 1

Date: 27/01/14

Location: Prefab22, Bishopstown, CIT

Participants: Joseph Cronin, Roy Collins, Kevin O'Mahony, Barry Gettings.

Purpose: prototype technical testing, usability testing, open-ended discussions.

The primary goal of the usability study was to test the technical performance of the prototypes. It aimed to do this through recruiting a group of people to use the prototypes in an informal setting. They were advised that the focus group would be short and informal, and that they were not going to be examined or asked any difficult questions.

The researcher introduced the participants to the artefacts and what they were built for in very general terms; they were part of a master's degree that aimed to investigate how the museum setting can support novel and authentic multimedia interactions.

In hindsight, this was a mistake. It meant that the participants didn't know what was expected of them – though they knew that they were supposed to 'interact', they didn't know how this interaction would manifest itself through the interfaces that were in front of them. Though the final artefacts would be situated in the museum and wouldn't provide much explicit instructional content on how to use them, the fact that the prototypes were of a primitive nature meant that instructional content would have been very useful for the participants.

The participants were also missing the context to the artefacts, something that museum visitors would be afforded and be aware of. (Context here means what the artefacts were and how they were used; the firkin crane was used for weighing butter to ensure it was of good quality, the churn was used to make butter out of cream and it had a lot of superstitions associated with it.)

This report will be broken down into a number of areas; focus group issues; technical issues; and conceptual mapping issues.

Focus group issues:

The usability study should have been controlled much more tightly. The conversation went astray and into issues that it had not intending on discussing. Further to this, participants didn't know what to do. Both of these issues would have been solved if they had been provided with descriptive information prior to the focus group, information such as:

- What the purpose of the focus group is
- Specifically what they will be doing (what artefact they'll be using)
- Context to the prototypes (that they will eventually be put in a museum, and so in a different context)
- A brief history on the artefacts (what they were originally used for)

Technical issues:

- The butter churn prototype broke down after less than 10 seconds use. The handle was also too noisy for them to hear the audio properly.
- They though that the noise of churning was too loud for them to hear the audio; Barry thought that leaning closely was an inconvenience. They all said that louder audio would solve this.
- The firkin should only register a token when it is placed on the scale plate.
- The position that the tokens should be put in should also be much clearer.
- The tangible and digital interfaces should be more tightly mapped.

Conceptual mapping issues:

Butter churn

System design: A slowed down audio track was playing out of the butter churn. When it was churned played at a normal speed.

The participants spoke about how they had different ideas of how it would have worked, but all expected that the action of churning would have an effect on the audio. Kevin thought it would either fast-forward or rewind the audio content, whereas Barry expected it to play the audio at normal speed. Roy noted the same.

Firkin Crane

System design: A replica firkin crane and three fiducial markers were placed on the table in front of a computer. On the screen of the computer there was a basic interface that had text located in positions that corresponded to the firkin crane. The firkin crane was imbalanced, and the reason for the imbalance was shown on the screen. Users had to use one of the three tokens to balance the firkin crane by putting them on the left side.

Technically the firkin crane worked well, but participants had great difficulty in making sense of it. They didn't know that there was a problem there to be solved by using the tokens. Barry was able to make out the relationship between the token and the screen content 'the top left corner…' but this was the exception rather than the rule.

Problems with firkin crane:

- Some didn't realise that there was a problem that had to be solved – couldn't see a starting point to their action
- Some didn't know that to solve the problem the scales would come level – couldn't see the end point of their action
- The feedback that the scales and the screen gave was not useful to the participants. The digital and tangible interfaces should be coupled more closely. The user should also be given adequate time to taken in all of the happenings.
- The relationship between the screen and the scales wasn't clear – it needs to be made much stronger
- Whereas people had some idea that the token were meant to be placed on the scales, the coupling of the tokens and onscreen content needs to be much stronger
- Where the tokens were supposed to be put wasn't clear – some people tried to weigh the tokens against each other by putting tokens on both sides of the scale (giving strength to the argument that people didn't understand the conceptual model that the scales was based on)

Summary of Usability Study 1

The purpose of the firkin crane was obscure and participants simply could not make sense of it. In order to alleviate this issue, participants will:

1. Need to know the function of a firkin crane in the context of the Butter Museum, which will be provided through the history of what firkin cranes were, (essentially a large type of balance used to weigh butter firkins as part of the quality control);
2. Need to understand that supernatural forces had an influence on butter making and that people had particular and peculiar ways of defeating these supernatural forces;
3. Need to understand that the idea of the interactive artefact is that it is used to balance out supernatural forces with superstitious remedies.

Besides this, the tangible and digital elements are two separate interfaces, and should be seen as such. So, the coupling between the two should be an event or 'phenomena' that is easy to make sense of. Space on the screen should be used carefully and wisely in order to create this illusion.

Next steps:

Fix technical issues in both the firkin crane and the churn:

- Firkin Crane:
    - accidentally registering something as being weighed – Flash AS3
    - mapping between digital and tangible interface – Flash AS3 & Arduino
    - make type of content more visual – Sketching, Photoshop, Flash
- Churn:
    - Rotary encoder gear broken – Fix.
    - Belt between handle and encoder keeps slipping off
    - Noise of handle is too loud – candle wax to reduce friction
    - Audio levels – better place for sound, maybe closer to top?

Figure E.1 Images taken from Usability Study 1 of participants engaging with the artefacts.

Usability Study 2

Date: 18/02/14

Location: Prefab22, Bishopstown, CIT

Participants: Four sessions; Two groups of two and two individuals.

Purpose: prototype technical testing, usability testing, open-ended discussions, discover how participants were making sense of the prototypes (ethnomethodological study)

The purpose of the usability study was to do an (ethnomethodological) study on how people made sense of two prototypes that are under development. The data that is uncovered will then be used to provide formative feedback on the prototypes, which will iterated upon depending on the results.

In total, four focus group sessions took place. Two of the sessions involved groups of two participants, and two involved individual participants, so in total six participants took part. Participants were recruited in advance and emailed documents which

provided them context to the focus group along with additional procedural ethical information.

The usability studies were video recorded, the permission for which was sought and approved in written format prior to its commencement. The researcher explained to the participants the purpose of the research and what they will be asked to do during the focus group, and that they will be observed from the side, but are available if the participant requires assistance throughout the session.

An important part of the design to the focus group was the fact that participants were asked to engage in think aloud protocol. Think aloud protocol asks the participants to continuously verbalise their thoughts as they're using a particular system. It is a very well documented usability method that provides a number of benefits; it's inexpensive, it's quick, doesn't require much preparation, and can uncover very valuable data. All participants were given a quick example of what think aloud protocol entails by the researcher, who used their own smart phone and verbalised their actions as they were navigating the interface.

Focus group sessions lasted between 15-25 minutes and each participant was asked to fill out a short survey sheet of 5 questions where answers were given in a range of 1-5 on a Richter scale. The focus groups were then concluded with an informal interview where the researcher asked the participants some general open-ended questions that were inspired by how they performed and used the prototypes.

Overall, there were a number of recurring issues that were experienced by a number of the participants:

Firkin Crane

Participants found it difficult to make sense of the artefact. It didn't provide them with a sufficient call to action which meant that they had to guess their way through. Some users when through the system purely in a trial and error fashion, and only realised what was happening half way through. Others needed assistance and still appeared confused after they got assistance.

The word 'weight' was mentioned by nearly all of the participants, and so they thought that they had to weigh things, rather than balance the firkin crane. For the second

session (which had two participants) the plate on the right was not covered up, and both participants thought that they had to weigh the tokens against each other (i.e. put a token on either side). One of them also put the token down on the left side very forcefully when there was nothing on the other side, and so was probably surprised when the firkin crane returned to the position it was in before they placed the token on the scales. People often said thinks like '*so I have to weigh…'* or '*so it needs a combination of these'* or something to that effect.

The places for the tokens should be redesigned – people looked like they were having trouble when they were putting the tokens on the firkin crane. Their fingers were getting caught in the string. It should be much easier for the users to put the tokens on the scales.

The software needs to be redesigned so that it only registers a token when it is put on the correct scales. After realising how it worked, some inquisitive users attempted to 'hack' the system by simply holding the token up in the air in their hands there they knew the camera would register.

However, for the participants who did understand the link between the firkin crane and the screen they said that the relationship between the two was quite strong.

Churn

The main issue that was observed with participants who were using the churn was that they simply didn't know what to do with it, what they could do with, or what it could do.

The most common thing that participants said when they were verbalising their actions was '*I can't hear it'* or something to that effect, which was followed by them looking towards the researcher for some sort of response, possibly even expecting the audio to be turned up. All participants were left in a state of confusion during and following their interaction with the churn.

The first thing all participants did was to try and make sense of the audio before interacting with the churn. This took various forms, but typically involved them coming in close or leaning down to listen to the audio.

Some participants begun to churn it by themselves, but others only did so after the researcher intervened upon seeing that the participants appeared to be under stress due to not knowing what action to take next.

When participants begun to churn they still couldn't fully hear the state change in the audio that was programmed to happen, as the noise of the handle was drowning it out. However, because they couldn't make sense of the audio before they begun to churn it's fair to say that they didn't know what they were listening out for, and so didn't know when to stop.

Participants often expressed confusing when it: '*I think something happened when its churned..'*. They also expected more from it: '*I kind of expected the audio to tell you something…but I can't really make out*.'

Conclusions

Overall, the usability study was a very positive experience as it uncovered a quite a number of important issues.

The most pertinent issue concerning the firkin crane was that users initially didn't know what it could do and what they were supposed to use it for; essentially, it didn't provide them with a sufficient call to action. The next iteration will have to address this. Another issue was that people thought that it was supposed to be used to *weigh* things, whereas it is in fact meant to be used to *balance* things. These two issues could perhaps be solved with a screen of image and text that shows users what the challenge is. This could be communicated by showing how a farmer had to balance the (imbalanced) firkin crane with their butter firkin, and that as well as balancing this physical scales, they had to take many superstitious precautionary measures to balance the supernatural forces that were acting against them.

The visual link between the firkin crane and the screen needs to also be made stronger, perhaps by mapping them in physical space much more closely (so when the scales is up, the corresponding item on screen is also up, etc).

The place for the tokens to go also needs to be redesigned for accessibility; in its current status it requires dexterity. It should just be a surface to put the tokens onto without anything on either side, people are getting their fingers caught in the strings. The

position that the hand would need to be in to put them on the scales is also quite an awkward position, especially if someone is using their right hand to put the tokens on the left firkin crane.

The physical design of the tokens might also have to be reconsidered. In their current form they're all the same shape and size, which may have led to some confusion. If they were different sizes people would have been able to differentiate between them more easily, which could have allow them to see them as being distinct from one another.

Regarding the churn, additional feedback (other than audio) for churning may have to be sought and the reward for churning must be greater. People didn't know what it could do or what do with it, and so didn't know how or even why to interact with it. The audio that was playing before they churned it was unclear and hard to make sense of, and the difference churning made on it was marginal, which meant that they didn't know what effect their action was having on the output. Some participants even imagined the effect that their input was having on the output. However, they did listen very intently to the audio that was coming out of it, but this may just have been a situational factor considering they were under observations.

Alternative methods through which feedback that reinforces user interaction with the churn will have to be investigated, possibly looking towards visual feedback, haptic feedback, alternative sources for the audio feedback, etc.

<u>To Do List</u>

- Firkin crane:
    - Firkin crane needs to issue a 'call to action' to the users before they begin to use it.
    - It needs to tell them that the challenge is to balance the scales rather than weigh things out.
- Balance:
    - Audio needs to be clearer, and more interpretable feedback must be designed.

Figure E.2 Images of participants taken from Usability Study 2

Usability Study 3

Date: 24/03/14

Location: Prefab22, Bishopstown, CIT

Participants: Two participants, Luke Twomen, Ciaran Brohan.

Purpose: prototype technical testing, usability testing, open-ended discussions, discover how participants were making sense of the prototypes (ethnomethodological study)

Butter Churn

System setup and design: A butter churn up on a table with a number of small (fiducial sized) blocks placed in front of it. The top of the churn has an opening that the blocks fit into. If somebody churns when a block is placed on the opening, a track will begin to play. The track stops either when the churning stops or when the token is taken away.

Observations on users interacting with the churn:

One of the main issues with the butter churn was the design of how it delivered content. Whereas the users were able to make sense of the input/output relationship (or the conceptual model of how it worked), the design of the mechanics of the interaction was

not very effective. The cognitive load that the artefact expected users to maintain appeared to be too great, or else the issue was that the audio wasn't loud enough or the speaker was poorly positioned.

The tokens were laid out on the table directly in front of the churn by the researcher. Users placed the tokens on top of the churn without much hesitation. After this, they appeared to be expecting some sort of response, as they looked around the churn inquisitively/expectantly. After nothing happened, they began to churn. One asked the researcher if it was alright to churn before they actually started to churn.

After the track started to play, participants leaned forward over the churn. In many cases, after they leaned in to listen they stopped churning. This in turn caused the track to stop playing. Following this, they leaned back out and looked around the churn, possibly looking for an explanation as to why the sound stopped. They then started to churn again. The track started to play again, from the start, so the users were listening to the start of the track for a second time. This happened for a third time in some cases, at which point the users replaced the token on top of the churn with another one from the table. No users expressed surprised that a different token played a different track.

At this stage, users knew and understood how the artefact was supposed to operate; they place a token in the holder, and the churn to listen to an audio track.

However, they also understood that it was malfunctioning in some way, but could not seem to find a concrete reason as to why. They intuitively knew that tracks shouldn't be playing replaying from the start again and again. They even mentioned the word 'looping' in a manner that expressed dissatisfaction.

As a result, participants came up with their own theories on how to get the sound to play more effectively. Participants recognized the fiducials on the bottom of the tokens, and this informed the strategies they employed in order to ensure that the track kept playing without looping back to the start again and again.

All participants reached this stage, and came to the conclusion that the rate of churning could have a positive effect on the audio output. When they started again they clearly put more effort into churning. The way they were positioning themselves in front of the churn changed and as a result their whole posture. They took a more serious posture and

held their faces in a state of concentration, holding their gaze on a particular point on the churn or around the room.

One participant (in a matter of fact manner) mentioned that fiducials need to be kept stable, and so firmly rested his hand on top of the token when he was churning. This resulted in very awkward posture, and the participant looked like they were in a considerable state of concentration.

Information gathered from informal/reflective interview

It was clear that the participants knew and understood how the churn should work. They put the issues that they were having with it down to technical issues that were beyond their control. They also went as far as providing design advice on how to solve these issues, which provided very valuable insight on how the mental model they drew of the artefact.

Users said that they weren't listening to the audio content, as they were too busy listening to ensure that the sound was coming out when they were churning. In this way, the interface demanded too much from them – having to both churn and listen to the audio content was too much. The cognition that the interface required of them was too great.

> **P 1:**'I think it was because it was trying to listen to…amm… the information. But like, I think you kinna almost, just stop, you know it's almost like you don't really realise that you should be multitasking or something like, kinna, as you listen harder or something you almost slow down or stop with the churning. It's not really…it's not something you consciously…its almost in the back of your head or something like that.

> **P 2:** I kind of was going in this order as well; I probably could have taken them from anywhere, but for some reason I started taking them in order, I wasn't sure, because I wasn't really, you know I wasn't really listening, because I wanted to see how it worked and stuff, plus his accent was really really strong. Yeah, I wasn't really sure if he was telling a story and if I had

> to go one by one [taps tokens as he says this] or not, I wasn't really sure if I could go this way, but maybe that was just my own mindset.

The cognitive demands of the interface took over the visceral responses participants initially had to it. So whereas users were pleasantly surprised that audio begun to play when they were churning, the effort required to keep the audio playing required too much cognition in order for them to continue to enjoy the experience.

Other interesting things to note were the conflicting remarks the users passed. One user appeared to question why he should be taking the tokens on and off, not in the functional sense, but in the contextual sense of how they imagined churns would have been used to make butter:

> **P 2:** *Like if they used to take out the milk or the butter even then that's, I get it, [*motioning with his hands of something going into the churn*], but I just need something that I can [*he motions with both of his hands as if there's a panel in front of him*] like "oh, the reason why you taken on and off this is because this is because of this", or if you're doing it with fiducials then that makes sense too, just not sure where its exactly coming from right now that's my only reason.*

Then, following this remark he goes on to say:

> **P 2:** I like the sound though, the look of it and stuff, you can tell it's pretty much authentic, well completely authentic. I like the idea as well that it can tell the story as you turn it – <u>you're cranking butter obviously</u>, so I like that as well.

It appeared that the participant was attempting to fully immerse themselves in the butter making exercise, even though there was no mention of this from the researcher.

Participant 1 had similar issues with the function of the blocks in the context of the authentic artefact. They understood the 'mechanical function' of the blocks, but it seemed as they were searching for some sort of metaphorical significance to the tokens that was missing.

> **P 1:** I just think that…I get the idea that its turning the thing to make the… the voices play but aaah…I think it's just, trying to understand like, as to what block, you know what they do and what they represent, if that makes sense? It's just very kinna…its almost random what block to put up…I don't really – if there is a relationship between what blocks…are they going to be a – representing something you're putting into it, is that how? …yeah so maybe if they had an icon on the top…
>
> I was just thinking examples now if that was milk and butter or something and you put the two up and you started churning it then it'd play something relative to what's on the front or…it's just at the moment … I get the relationship that they're supposed to be…ammm…these have some sort of relationship to something that's playing, but at the moment I think that it's almost ammm…like I dunno it, like maybe it's the fact that I know how the fiducials work and stuff and I have an understanding that that's [the fiducial marker in his hand, holding it up] where as people who mightn't understand what fiducials do might just see blocks…get the relationship.

The issue that both users had was that the metaphorical significance of placing the tokens on top of the churn was missing was twofold; the interface itself (the token) and the interaction (placing it on the churn). Though they were able to understand that they had to put them on the churn to listen to different track and churn, they didn't seem to understand why this was the case. It was something that they grappled with.

<u>Firkin Crane</u>

System design and setup:

The firkin crane replica (50cm in height) is placed on a table, and about 70cm in a line behind it is a computer screen (an iMac). There are a number of cubes with labels on them placed close to the scales. Access to one the right side of the scales is blocked off so tokens cannot be put there.

Initially, the firkin crane is balanced. It is connected to the screen, and when someone approaches it a comic that explains how a firkin crane was used begins to play on screen for roughly 30 seconds. After this the firkin crane moves to an imbalanced position, and

the challenge for the user is to use to tokens to balance the scales against supernatural threats that put the features and practices of farming in danger.

For the purpose of clarity: the firkin crane is the physical artefact by itself, the screen is the screen by itself, and the whole thing will be described as the installation from hereon in.

Issues:

Participants were confused as to how the firkin crane worked. Some didn't know that the screen and the physical firkin crane were actually related to one another when they first approached it. The animation lasted too long, and users attempted to interact with the firkin crane before it finished. However, the installation was not designed to be responsive to participants' interactions until after the animation was finished, and when it finished it moved to an imbalanced position by itself. This led to issues for participants who interacted with the firkin crane before the animation finished; they put tokens on the scales and then it moved to the imbalanced position, but it did not move as a result of their interaction. This would more than likely cause confusion and cloud their mental model of how it worked.

Participants first put the tokens on the firkin crane with the fiducial marker placed faced down, and then ask if there is a particular way if they should be placed, indicating that they expect something to come up on the screen after they put something on the scales. The tokens should be redesigned to eliminate the possibility this happening – RFID technology plus physical shapes that lend themselves to only being placed in one position might solve this issue.

Participants weren't entirely too sure what or why they were putting tokens on the firkin crane, and some even wondered why they could only put them on one side. This indicated that the comic didn't effectively communicate the purpose of the firkin crane, as is demonstrated in the following expert from a transcript taken from the focus group.

> **P 1**: But d'ya know the way you're saying it needs to balance…[the researcher didn't actually say this], what are you balancing it with is one of the things I'm a bit..? [looks towards researcher here]…it's just your balancing one thing, but what's the…

Researcher: so you know you're balancing something but you don't know what you're balancing it against?

P 1: Yeah, exactly…so you're balancing…that's the house leek plant [he has the this particular token in his hand and puts it on the scales] so if you were balancing that…it says you don't seem to be doing great [takes it off again] …but then you don't really know what [picks up a different token]…you know its…[points between the other tokens]…its probably a random thing to be saying really…but it's just like you're trying to balance it, but you don't know what. Like I just thought you'd have to… [picks up a token in each hand and placed them above each side of the scales and 'balances' them in the air] move them up, if that makes sense?

The other participant didn't seem to have much trouble grasping that the challenge was to balance the scales:

P 2:'balance the scales was the first test…supernatural forces…ok. So its, balancing things. Ok so its salt, holy water and house leek plant'

….I'm assuming we're going to be placing them on this side because this is over here so ('this' is the role of tape that's blocking up the other side) no…

[as he is about to place the token on the scales it begins to move]

you're milk is in danger from fairies

(laughs)

but there's nothing really telling me what to do with this I'd suppose…this might sound confusing ok so the supernatural … fairies

'so I guess some holy water maybe because we're Irish, we have holy water (laughs)…not sure, I is there a place to place it, is it just up here, is it, do you need the, ok so there's holy water here ok, this doesn't seem to be doing much let's try another one ok….sorry, I was placing the thing [fiducial] the wrong way.

[Replaces the token with the salt token]

> Salt – so salt gets rid of the fairies…so it's telling me I got it right – I think there's too much of a delay between this and the next one maybe, unless the idea is for me to keep it balanced the whole time…your cows are under threat from supernatural forces…so I'm assuming I'm going to try the house leek plant this time? Ok, that one doesn't seem to work….try holy water – ok, holy water is working against the cows for some reason
>
> 'So basically, back in the day, they used these, so I'm learning anyway, that holy water was used for cows, and salt for the fairies, and that this leek plant cured eyes, which is ridiculous.

Participants eventually grasped how the installation was supposed to be used:

- all of the tokens were different,
- the tokens *had to* go on the left side,
- when the 'correct' token was selected the firkin crane balance,
- after a while it went back to the imbalanced position and they went through the same process again.

However, as well as not fully understanding why they were balancing the firkin crane, users didn't understand why the firkin crane was going between being balancing and imbalanced –

> **P 2:**'your cows are under threat from supernatural forces…so I'm assuming I'm going to try the house leek plant this time? Ok, that one doesn't seem to work….try holy water – ok, holy water is working against the cows for some reason

From this excerpt, it's clear that the participant doesn't understand why holy water 'worked against the cows'. However, prior to this the participant had said:

> **P 2:** 'I think there's too much of a delay between this and the next one maybe, unless the idea is for me to keep it balanced the whole time

What happens after a remedy has been selected needs to be decided upon. Whereas there may be a case to provide the users with content on why the remedies that they used worked, it needs to be balanced carefully with the flow of interaction that they're currently engaged in. Using a printer could be useful in this regard – the printer could print them a token of their success, in the same way that farmers butter was graded after

it was tested (though it was only graded after it was taste tested, as opposed to weight testing). The printer could print a receipt that would let them know basically why their remedy worked and give a link to a webpage that has more information on this.

One participant thought that there wasn't enough time:

> **P 1:** if you put the wrong thing up it was okay because you get that it wasn't balancing, but when you put up the right one, it almost jumped onto the next one a bit quickly and you didn't really have time to take in that was the right one and why it was the right one.

But another participant thought it took too long:

> **P 2:** I think there's too much of a delay between this and the next one maybe…

Overall, there seemed to be a number of issues associated with the firkin crane:

- initially participants weren't sure if the screen and the firkin crane were related to one another,
- the comic didn't effectively explain the function and/or purpose of the firkin crane,
- the animation was too long and interacting with the firkin crane before it finished would have caused problems for the user to build an accurate conceptual model,
- the tokens were poorly designed – they had to be placed a particular way (they were cubes – 8 in 9 chance of getting it wrong),
- participants need more instructions to place the tokens on the firkin crane,
- how it responds to someone placing a token on the firkin crane needs to be redesigned – what shows up on screen, maybe the physical firkin crane should respond somehow as well,
- transitions between succeeding in balancing the firkin crane needs to be redesigned – balance between providing information on why the remedy worked and maintaining the users flow.

An issue with the interface could have been that it was too cognitively demanding; there was a lot to read and make sense of. This probably had an impact on how users were aware of their interactions with the interactive; they may have found it difficult to be more aware of the feedback loop they were engaged in when interacting.

Appendix F

This appendix aims to give an overview of the approach to observations during the course of the case study and how data was collected.

Observations took a grounded approach, and notes on the behaviours and activities of visitors were taken. Figure F.1 shows the initial notes that were taken during early observations of the butter churn.

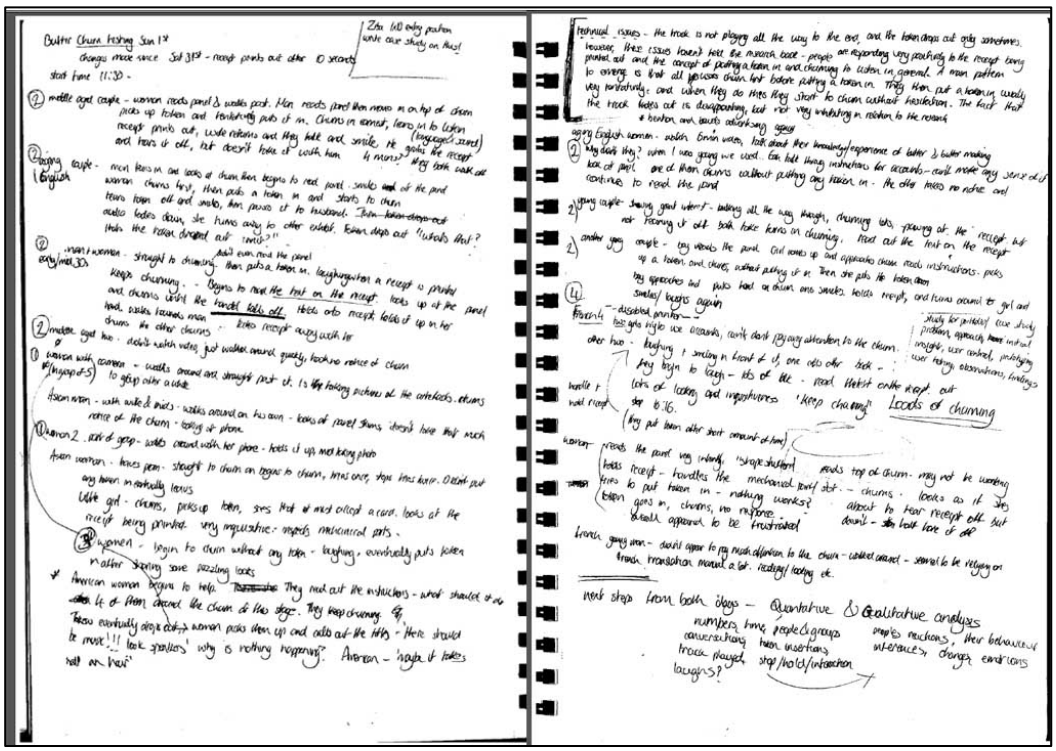

Figure F.1 Notes taken during early observations of visitors engaging with the butter churn.

After the observation technique changed and the researcher adopted the role of a 'full participant', shorter brief notes were taken during observations when opportunities for discrete note taking presented themselves, which were later expanded upon. Figure F.2 shows a number of pages of brief notes that were taken, and Table F.1 shows reflections following the observations.

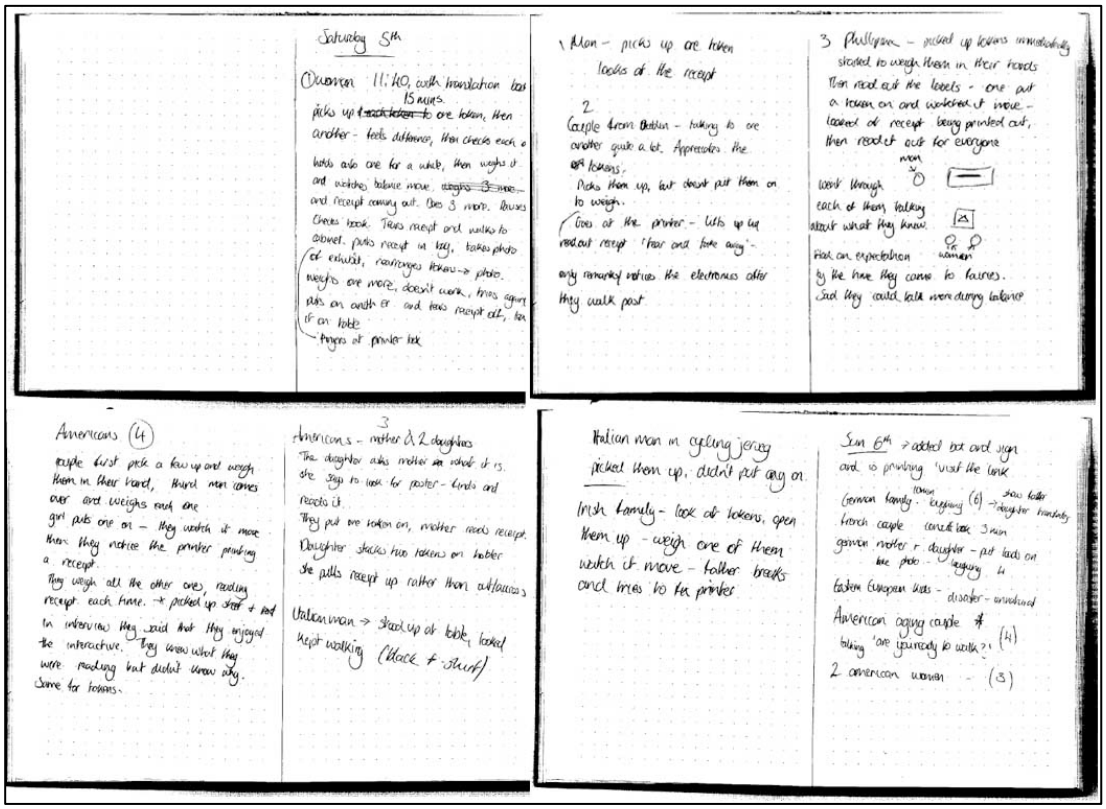

Figure F.2 Brief notes that were taken discreetly during observations.

11:40 Woman with translation book
Initially passes the table, then comes back around 10 minutes later. Picks up one token, then checks the other one – 'weighs them' in her hand, feeling the difference, then checks each one. Holds one of them for a while, then puts it onto the holder, and watches the balance move, then looks at the receipt come out. Does 3 more and pauses. Tears receipt off, then goes over to cabinet and puts book on top of it. Takes out her camera and takes a photo of the exhibit, then arranges the token and takes a photo of them. Investigates the printer box for a while. Weighs one more token and it doesn't work, attempts to weigh this token for 10 second, then tries another. Tears the receipt off and leaves it on the table.

Man – picks up one token, looks at the receipt, carries on.

Couple from Dublin
Very talkative. They pick up the tokens and appreciate how well they were made. The weigh them in their hands, calling out the names of them 'Fairy' 'Holy Water'. The man goes to the printer, lifts up the lid and reads out the text. They only notice the electronics after they pass.

Philippines and British
Man walks past, but other two come up. The younger one goes straight to the tokens and picks them up, and then notices that they are all of different weights. The other joins her and does likewise, calling out the names of each the tokens. They weigh a token and watch the balance move, then look at the receipt printing out, then read the text aloud, adding their own insight –
Woman 'it was just the weather'
Man 'was it?'
Woman 'yes, it was just the weather'
When the woman comes to the Fairy she has an expectation – 'oh they had fairies here too'
In the interview the said that they spoke more when engaging with the balance

4 Americans
Couple first pick up a token and then another and notice the difference, then go through each of them, passing them to one another. Then they weigh one and watch the balance move, then look at the receipt printing out. One of their group comes up and then picks up each of the tokens in his hands, comparing their weight. They weigh all the tokens, reading the receipt each time. The also pick up the sheet and read it together.
In the interview they said that they enjoyed that it was interactive – they like that they could do something, and something happened. However, they did say that while they understood what they were reading, they didn't know why they were reading it – they just didn't understand that they were weighing superstitions.

Americans (Mother and 2 daughters)
The daughter looks at the tokens then walks up to behind the balance, then asks the mother what it is. The mother says she doesn't know and walks up to her, then says to look for the instruction poster. They lift the tokens up and feel the different weights. They put a token on, the the mother reads the receipt. Daughter stacks two token up on top of each other. She pulls the receipt up rather than out. They put a second token on it and no receipt comes out. The daughter tries to fix the printer, but the mother gives out to her.

Italian man – stood at table, looked, kept walking (black t-shirt)

Italian – cycling t-shirt. Picks up one token, but puts it back down and keeps walking.

Irish family
Talkative, they pick the tokens up and talk about them, opening them. The put one on, and watch the balance move and the receipt printing out. They try a seconds one, but the printer doesn't work this time – the father tries to fix it but the son tells him to leave it alone.

Table F.1 Reflections following the notes that were taken, which are shown in Figure 2.

These notes then were then used to create an initial observation sheet, which is shown in Table F.2.

Butter Churn *Observation Sheet (Version 1)* Time: _____ Date: _____
Part of group: Yes/No
Group size: ____
Watch main film? Yes/No Watch short film? Yes/No
Return? *(Did they already pass the butter churn by previously?)*
English speaker? Yes/No
Specific
Underline which activity the visitor engaged in first
Churn? Yes/No *(Did they churn without putting a token in?)*
Investigate? Yes/No *(Did they peer into the slot on the cap?*)
Consult companion? Yes/No *(Did they consult the person who they were visiting with?*)
Token? Yes/No *(Did they insert token?)*
Read? Yes/No *(Did they read instructions out before inserting?)*
Churn? Yes/No *(Did they churn after inserting a token?*)
Smile/Laugh? *(Did they smile/laugh when audio begun to play?*)
Maintain churning? Yes/No *(Did they maintain churning?)*
If no to this, the token drops out.
Response? *(Confusion/smiles/laugh?)*

Repeat? Yes/No *(Did they put another token in?)*
Churn after audio reduced? Yes/No *(Did they start churning again after the audio went down?)*
Receipt – touch? *(Did they hold the receipt as it was printing?)*
Receipt – smile/laugh? *(Did they smile/laugh when the receipt was printed?)*
Read receipt out? *(Did they read out the receipt?)*
Listen? *(Did they listen to the audio?)*
Take receipt? *(Did they take the receipt away with them?)*
Repeat? Yes/No? *(Did they repeat the interaction?)*

Table F.2 The first observation sheet that was used during observations of visitors engaging with the butter churn.

This observation sheet was refined and led to the creation of a questionnaire that was used to interview visitors as they were exiting the museum, the questions of which are listed in below. A short interview followed the questionnaire, reflections from which are included in Table F.3.

Questions asked:

- Which one of these did you enjoy the most?
- Did you understand what to do with the churn?
- Did you like churning the butter churn?
- Did you use the churn by yourself or as a group?
- Did you like churning the butter churn?

Amount of People	Description	Comments
2	Young Germans	They read the receipt but didn't keep it with it, they thought it was interesting but averagely interesting, they liked it because they understood about butter churning from their country, Germany. They liked the film the best because of the information value
2	Aging German	They really liked it, interactive is always better, had very positive experience in museums in Ireland, mentioned the irish linen museum. Understood the tokens, the receipt and the code, when mentioned the receipt, he pulled it out of his pocket. Group of two.
2	Young Europeans	Short film on TV screen. Understood how to use the churn and the tokens, Took receipt, tried to use the Qr code, but it was too dark and possibly too small, said the Qr code was brilliant idea as he couldn't hear very well but can go back and hear it again using the receipt. He pulled the receipt out of his pocket when talking about it. Group if two, she gave a rating of 3 out if 5 but he gave a higher mark. Called it really original.
3	Chinese & Irish	More staff, quiet samey, more history, more pictures, less interactive, do something with the world, port of cork, butter tasting. Group of 3 only one used it, understood you,

3	American family	Group of 3., son did the talking/using. Felt it fitted in with everything, didn't stand out from other exhibits, Understood he could put different tokens in and it changed stories.
3	Dutch family	They didn't see it, so didn't use the churn.
1	Lady alone	Interactive, cool, she felt that it fit quite nicely with the museum, she churned and realised that each token would change, didn't realise you could take the receipt, but read it, she really enjoyed engaging with it. Had a "nice" experience. By herself
2	Inquisitive Aging couple	Didn't spend much time on it didn't give it much thought, just checked to see if he could do something, but didn't stay to see. Thought the short video was most interactive
4	Irish family	There was someone else on the churn, they did use the glass ones. They thought it would be cool to use it, so went back in to use it. Group of 4 people.

Table F.3 Questions from the questionnaire with comments and reflections from the interview.

Discrete notes were taken during observations of the firkin crane, which were later expanded upon. A number of visitors were also interviewed as they were exiting the museum. These interviews were semi-structured and the intention was to discover how visitors made sense of their engagements with the artefact. These interviews led to a number of changes being made to the interface. One such change was to add weights to the tokens after one visitor remarked that she expected the tokens to '*have [physical] weight*' a physical weight, but then '*realised that it was electronic'*.

Analysis of interviews with other visitors revealed that they only looked up towards the firkin crane after they heard it moving, possibly indicating that they were unsure of the purpose of the tokens and the holder until *after* they saw the firkin crane move. This led to the physical redesign of the holder to resemble an actual holder that one would expect to use to weigh things with. Figure F.3 shows the notes taken from the first iteration.

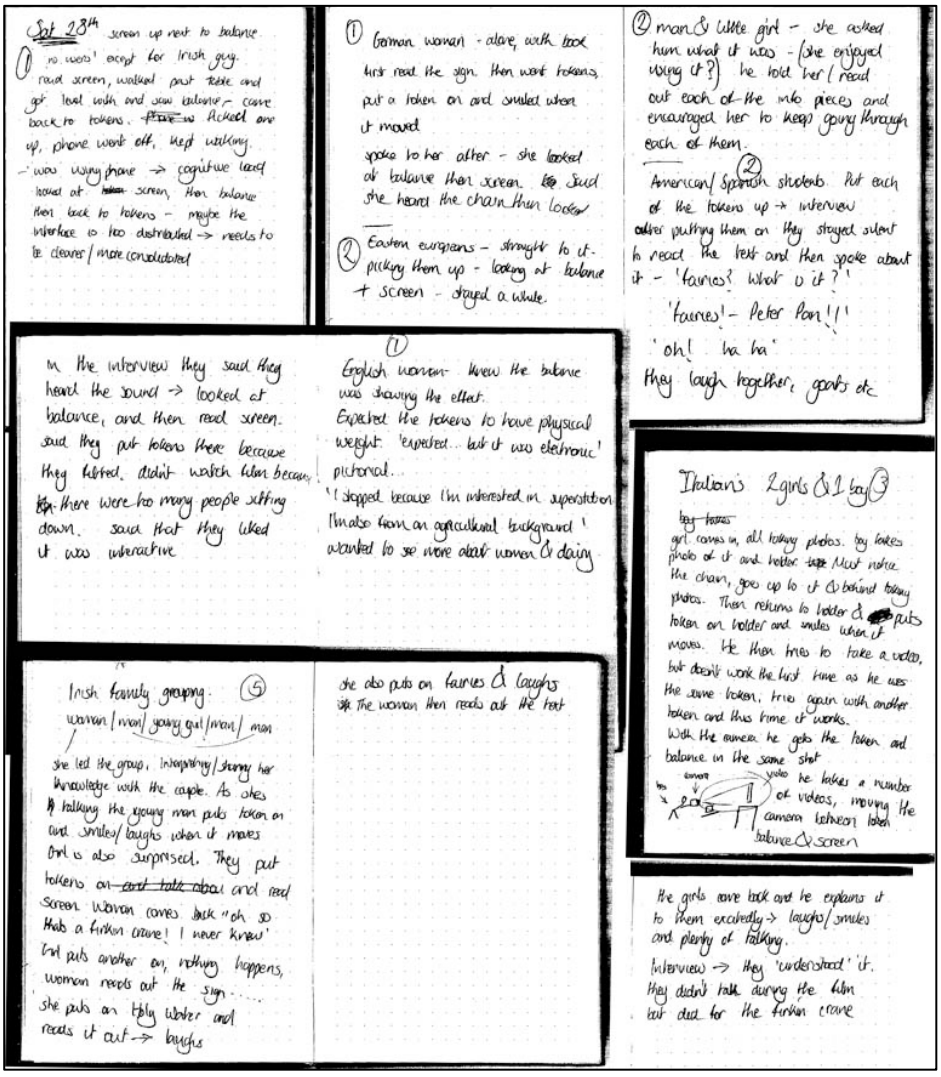

Figure F.3 Notes taken during observations of the first iteration of the firkin crane.

Appendix G

This appendix shows the Arduino and Processing code that was written for the final iterations of the augmented artefacts. The butter churn used Arduino and Processing, and the firkin crane just used Arduino. All code was written using Arduino 1.0.5 and Processing 2.1.1. The code was written modularly, and the code for some of the individual modules were sourced from various open source websites online.

Butter Churn Code

Arduino code:

```
/*
ROTARY ENCODER:
On the side of the rotary encoder with 3 legs, theres
a green and a black mark;
!!! 2 AND 3 are special Pins !!!
Green Mark <---> Arduino Digital Pin 2
Black Mark <---> Arduino Digital Pin 3
middle     <---> Arduino Ground
RFID CARD:
Needs to be powered off the Arduino
RFID ENABLE <---> Arduino Digital Pin 10
RFID SOUT <---> Arduino Digital Pin 11
SERVO
Need to be powered externally
Run a ground between the Arduino and the ground for the servo
PRINTER
GREEN WIRE <----> Arduino Digital Pin 5
YELLOW WIRE <----> Arduino Digital Pin 6
*/
//#include <SoftwareSerial.h>
#include <Servo.h>
//PRINTER
#include "SoftwareSerial.h"
#include "Adafruit_Thermal.h"
//add the irish times QR Code
#include "story1.h"
#include "story2.h"
#include "story4.h"
#include "story5.h"
#include "story6.h"
#include <avr/pgmspace.h>
int printer_RX_Pin = 5;  // This is the green wire
int printer_TX_Pin = 6;  // This is the yellow wire
Adafruit_Thermal printer(printer_RX_Pin, printer_TX_Pin);
//Parallax RFID Reader
//can be set to either 2 or 4
#define RFIDEnablePin 10 //Pin that enables reading. Set as OUTPUT and LOW to read an
RFID tag
#define RFIDSerialRate 2400 //Parallax RFID Reader Serial Port Speed
//Using SoftwareSerial Library to locate the serial pins off the default set
//This allows the Arduino to be updated via USB with no conflict
#define RxPin 11 //Pin to read data from Reader
#define TxPin 10 //Pin to write data to the Reader NOTE: The reader doesn't get written
to, don't connect this line.
SoftwareSerial RFIDReader(RxPin,TxPin);
String RFIDTAG=""; //Holds the RFID Code read from a tag
String DisplayTAG = ""; //Holds the last displayed RFID Tag
int firstSensor = 0;
int secondSensor = 0;
//int thirdSensor = 0;
int trackNum = 0;
int inByte = 0;
char val;
int encoderPin1 = 2;
int encoderPin2 = 3;
```

```
volatile int lastEncoded = 0;
volatile long encoderValue = 0;

long lastencoderValue = 0;
int lastMSB = 0;
int lastLSB = 0;
//servo motors
//attached to 8 & 9
//slotServo is for the slot, gateServo is to hold the card
Servo gateServo, slotServo, handleServo;
int slotServoPos = 0;
//SLOT LIGHT
int slotLight = 18;
//Printer text
//strings should be short
String story1 = "Feel free to visit neighbours, but don't be surprised if they don't
trust you";
String story2 = "Watch out for evil neighbours hoping to steal your butter.";
String story3;
String story4 = "Maybe superstitions didnt really exist at all";
String story5 = "Stealing butter was evil but who would do such a thing";
String story6 = "But why did people believe in superstitions";
String currentStory;
String lucky = "Lucky you the butter is made";
String keepChurning = "Keep churning";
//Printer QR Code
String currentQR;
int LED_13 = 13;
void setup()
{
  //
  // RFID CARD READER CODE
  //
  // RFID reader SOUT pin connected to Serial RX pin at 2400bps
  RFIDReader.begin(RFIDSerialRate);
  // Set Enable pin as OUTPUT to connect it to the RFID /ENABLE pin
  pinMode(RFIDEnablePin,OUTPUT);
  // Activate the RFID reader
  // Setting the RFIDEnablePin HIGH will deactivate the reader
  // which could be usefull if you wanted to save battery life for
  // example.
  digitalWrite(RFIDEnablePin, LOW);
  Serial.begin(9600);           // set up Serial library at 9600 bps
  Serial.println("Hello world --!");  // prints hello with ending line break
  //
  //  ROTARY ENCODER CODE
  //
  pinMode(encoderPin1, INPUT);
  pinMode(encoderPin2, INPUT);
  digitalWrite(encoderPin1, HIGH); //turn pullup resistor on
  digitalWrite(encoderPin2, HIGH); //turn pullup resistor on
  //call updateEncoder() when any high/low changed seen
  //on interrupt 0 (pin 2), or interrupt 1 (pin 3)
  attachInterrupt(0, updateEncoder, CHANGE);
  attachInterrupt(1, updateEncoder, CHANGE);
  //SERVO CODE
  handleServo.attach(7);
  gateServo.attach(8);
  slotServo.attach(9);
  gateServo.write(0);//bottom servo, 0 == closed, 90 == open
  slotServo.write(60);//top servo, 0 == closed, 60 == open
  handleServo.write(90);
  pinMode(12, OUTPUT);
  pinMode(LED_13, OUTPUT);
  //SLOT LIGHT
  pinMode(slotLight, OUTPUT);
  //establish contact with Processing
  establishContact();
}
void loop()
{
  if(RFIDReader.available() > 0) // If data available from reader
  {
    gateServo.detach();
    slotServo.detach();
    handleServo.detach();
    ReadSerial(RFIDTAG);   //Read the tag number from the reader. Should return a 10
digit serial number
```

```
    digitalWrite(RFIDEnablePin, HIGH);
    //attatch servo and ease it close slot
    slotServo.attach(9);
    slotServo.write(0);
    /*
    //go FROM 60 TOO 0
    for(slotServoPos = 60; slotServoPos >= 0; slotServoPos -= 1){
      //slotServo.write(0);
      slotServo.write(slotServoPos);
      delay(20);
    }
    */
    //thirdSensor = 1;
    delay(500);
    slotServo.detach();
    //digitalWrite(RFIDEnablePin, LOW);
  }
  //This only displays a tag once, unless another tag is scanned
  if(DisplayTAG!=RFIDTAG)
  {
    gateServo.detach();
    slotServo.detach();
    DisplayTAG=RFIDTAG;

    //Serial.println(RFIDTAG);
  }

  if(RFIDTAG == "0415ED50A4"){
    trackNum = 1;
    currentStory = story1;
  }
  if(RFIDTAG == "0415ED29AC"){
    trackNum = 2;
    currentStory = story2;
  }
  if(RFIDTAG == "0415ED41D2"){
    trackNum = 3;
    currentStory = story3;
  }
  if(RFIDTAG == "0415ED4C69"){
    trackNum = 4;
    currentStory = story4;
  }
  if(RFIDTAG == "0415ED33DF"){
    trackNum = 5;
    currentStory = story5;
  }
  if(RFIDTAG == "0415EA9F36"){
    trackNum = 6;
    currentStory = story6;
  }
  firstSensor = trackNum;
  Serial.write(firstSensor);
  Serial.write(encoderValue);
  //Serial.write(thirdSensor);
  //secondSensor ++;

  if(Serial.available()){
    val = Serial.read();
    if(val == '0'){  //--if someone churned their way to the end of the track, eject and
print--\\
      //someone has listened to the full track
      //so eject the token and print a receipt
      digitalWrite(12, HIGH);
      //TURN THE RFID READER OFF
      digitalWrite(RFIDEnablePin, HIGH);
      gateServo.attach(8);
      slotServo.attach(9);
      gateServo.write(90);  //open servo
      //handleServo.attach(7);
      //handleServo.write(90);
      //slot is open, so don't play any track
      //thirdSensor = 0;
      delay(2000);       // wait 3 seconds
      gateServo.write(0);   //close servo
      slotServo.write(60);
      //slotServo.write(0);
      delay(500);
```

```
      gateServo.detach();
      slotServo.detach();
      //set track to 0
      trackNum = 0;
      digitalWrite(12, LOW);
      //TURN THE RFID READER ON AGAIN
      digitalWrite(RFIDEnablePin, LOW);
    }
    if(val == '1'){  //--if someone stopped churning mid way, eject the card--\\

      digitalWrite(12, LOW);
      //someone has listened to the full track
      //so eject the token and print a receipt
      digitalWrite(12, HIGH);

      //TURN THE RFID READER OFF
      digitalWrite(RFIDEnablePin, HIGH);
      gateServo.attach(8);
      slotServo.attach(9);
      gateServo.write(90);  //open servo

      //handleServo.attach(7);
      //handleServo.write(90);
      //slot is open, so don't play any track
      //thirdSensor = 0;
      delay(2000);       // wait 3 seconds
      gateServo.write(0);   //close servo
      slotServo.write(60);
      delay(500);
      gateServo.detach();
      slotServo.detach();
      //set track to 0
      trackNum = 0;

      digitalWrite(12, LOW);
      //TURN THE RFID READER ON AGAIN
      digitalWrite(RFIDEnablePin, LOW);
    }
    if(val == '2'){
      digitalWrite(LED_13, LOW);
      handleServo.attach(7);
      handleServo.write(90);
    }
    //IF SOMEONE IS CHURNING - ACTUATE HANDLEMOTOR
    if(val == '3'){
      digitalWrite(slotLight, LOW);

      handleServo.attach(7);
      handleServo.write(70);
    }
    //if someone isn't churning
    //code taken from http://labs.ideo.com/2014/03/20/vodafonepursecharger/
    if(val == '4'){
      static bool isLightOn = false;                     //-- initialize as static (i.e.
persistent in this function)
      static unsigned long lastTimeRecorded = millis(); //-- history of time where we
switched the lights
      unsigned long currentTime = millis();             //-- read the current time once

      if ( currentTime - lastTimeRecorded > 1000 ) { //-- if it's been more than 1000ms
        if( isLightOn ) {                               //-- and if the light is on
          digitalWrite(slotLight, LOW);                   //-- turn it off
          isLightOn = false;                            //-- set our flag to false
        } else {                                             //-- otherwise, we know the
light is off
          digitalWrite(slotLight, HIGH);                  //-- so turn it on
          isLightOn = true;                             //-- set our flag to true
        }
        lastTimeRecorded = currentTime;                    //-- update the last time we
switched
      }
    }
    if(val == '5'){
      digitalWrite(LED_13, HIGH);
      printer.begin();
      //PRINT STORY
      printer.setSize('S');
      //printer.setLineHeight(50);
```

```
      printer.println(keepChurning);
      delay(2000);
      Serial.write(firstSensor);
      Serial.write(encoderValue);
      //Serial.write(thirdSensor);
      printer.feed(2);
      digitalWrite(LED_13, LOW);
      RFIDReader.begin(RFIDSerialRate);
    }
    if(val == '6'){
      digitalWrite(LED_13, HIGH);
      printer.begin();
      printer.println(currentStory);
      printer.feed(1);
      delay(2000);
      Serial.write(firstSensor);
      Serial.write(encoderValue);
      //Serial.write(thirdSensor);
      digitalWrite(LED_13, LOW);
      RFIDReader.begin(RFIDSerialRate);
    }
    if(val == '7'){
      digitalWrite(LED_13, HIGH);
      printer.begin();
      printer.println("link to story");
      if(trackNum == 1){
          printer.printBitmap(story1_width, story1_height, story1_data);
        }
        if(trackNum == 2){
          printer.printBitmap(story2_width, story2_height, story2_data);
        }
        if(trackNum == 4){
          printer.printBitmap(story4_width, story4_height, story4_data);
        }
        if(trackNum == 5){
          printer.printBitmap(story5_width, story5_height, story5_data);
        }
        if(trackNum == 6){
          printer.printBitmap(story6_width, story6_height, story6_data);
        }
      delay(2000);
      Serial.write(firstSensor);
      Serial.write(encoderValue);
      //Serial.write(thirdSensor);
      digitalWrite(LED_13, LOW);
      //printer.feed(1);
      RFIDReader.begin(RFIDSerialRate);
    }
    if(val == '8'){
      digitalWrite(LED_13, HIGH);
      printer.begin();
      printer.println(lucky);
      delay(2000);
      Serial.write(firstSensor);
      Serial.write(encoderValue);
      //Serial.write(thirdSensor);
      digitalWrite(LED_13, LOW);
      printer.feed(3);
      RFIDReader.begin(RFIDSerialRate);
    }
  }

  else{
    Serial.write(firstSensor);
    Serial.write(encoderValue);
    //Serial.write(thirdSensor);
  }
}
void establishContact() {
  while (Serial.available() <= 0) {
    Serial.print('A');   // send a capital A
    delay(300);
  }
}
void ReadSerial(String &ReadTagString)
{
  int bytesread = 0;
  int  val = 0;
```

```
  char code[10];
  String TagCode="";
  if(RFIDReader.available() > 0) {          // If data available from reader
    if((val = RFIDReader.read()) == 10) {   // Check for header
      bytesread = 0;
      while(bytesread<10) {                 // Read 10 digit code
        if( RFIDReader.available() > 0) {
          val = RFIDReader.read();
          if((val == 10)||(val == 13)) {    // If header or stop bytes before the 10
digit reading
            break;                          // Stop reading
          }
          code[bytesread] = val;            // Add the digit
          bytesread++;                      // Ready to read next digit
        }
      }
      if(bytesread == 10) {                 // If 10 digit read is complete

        for(int x=0;x<10;x++)               //Copy the Chars to a String
        {
          TagCode += code[x];
        }
        ReadTagString = TagCode;           //Update the caller
        while(RFIDReader.available() > 0) //Burn off any characters still in the buffer
        {
          RFIDReader.read();
        }
      }
      bytesread = 0;
      TagCode="";
    }
  }
}
void updateEncoder(){
  int MSB = digitalRead(encoderPin1); //MSB = most significant bit
  int LSB = digitalRead(encoderPin2); //LSB = least significant bit
  int encoded = (MSB << 1) |LSB; //converting the 2 pin value to single number
  int sum  = (lastEncoded << 2) | encoded; //adding it to the previous encoded value
  if(sum == 0b1101 || sum == 0b0100 || sum == 0b0010 || sum == 0b1011) encoderValue ++;
  if(sum == 0b1110 || sum == 0b0111 || sum == 0b0001 || sum == 0b1000) encoderValue --;
  lastEncoded = encoded; //store this value for next time
}
```

Processing Code:

```
import java.util.*;
import ddf.minim.*;
import processing.serial.*;
Minim minim;
AudioPlayer player;
Serial myPort;
int[] serialInArray = new int[2];
int serialCount = 0;
int rfid, rotary;
boolean firstContact = false;
int[] churnArray = {0,0,0,0};
float value;
int churnInt;
int begintime = 8;
int window = 0;
int start;
PFont font;
boolean playerPlaying = false;
boolean playStory = false;
boolean ejected = false;
void setup()
{
  size(640,480);
  noStroke();
  fill(0);
  loop();
  frameRate(1);
  background(0);
  hint(ENABLE_NATIVE_FONTS);
  font = createFont("Arial", 18);
  minim = new Minim(this);
  println(Serial.list());
```

```
  String portName = Serial.list()[0];
  myPort = new Serial(this, portName, 9600);
  player = minim.loadFile("sean_1.mp3");
  println("player gain is " + player.getGain());
}
void draw()
{
  if(window == 0){
  background(#FF0000);
  }
  churnArray = splice(churnArray, rotary, 0);
  churnArray = shorten(churnArray);
  if(churnArray[0] == churnArray[3]){
  }
  if(churnArray[0] != churnArray[1]){
    churningStarted();
    player.play();
    player.setGain(10.0);
    playerPlaying = true;
    window = 1;
    start = millis();
  }
  if (window == 1) {
    background(#FFFFFF);
    int ms = millis()-start;
    println("ms = " + ms);
    int sec = ms/1000;
    int timer = begintime - sec;
    float currentPos = player.position();
    float num = currentPos / 1000;
    float posRound = round(num);
    println("seconds since start " + posRound);
    if(posRound == 5){
      println("its 5 - print keep churning");
      myPort.write('5');
    }
    if(posRound == 10){
      println("10 seconds - print story");
      myPort.write('6');
    }
    if(posRound == 20){
      println("20 seconds - print link");
      myPort.write('7');
    }
    if(posRound == 35){
      println("35 seconds - lucky");
      myPort.write('8');
    }
    if(posRound == 44){
      player.mute();
      posRound = 0;
      println("eject and print");
      myPort.write('0');
      ejected = true;
    }
    if(ms > 3000){
      println("start to turn down");
      println("turn down. player.getGain() is now : " +player.getGain());
      if(player.getGain() > 6.0){
        player.shiftGain(6.0, -10.0, 1000);
      }
    }
    if ( (timer <= 0) || (posRound == 45) ) {
      println("Stop the track and eject the token.");
        stopPlaying();
        myPort.write('1');
        window = 2;
    }
  }
  if((playerPlaying == true) && (churnArray[0] == churnArray[2])){
      println("someone has stopped churning as the track is playing");
      myPort.write('4');
    }
  if (window == 2) {
    //println("change bg");
    background(0);
  }
}
```

```
void keyPressed(){
  if (key == 'p') {
    churningStarted();
    player.play();
    if(player.getGain() < 6.0){
      player.shiftGain(-10.0, 6.0, 5000);
    }
    playerPlaying = true;
    println("playing from keypress");
    window = 1;
    start = millis();
  }
  if (key == 's') player.pause();
  if (key == 'e'){
    player.shiftGain(6.0, -10.0, 5000);
    println("e");
  }
  if (key == 'g'){
    println("g");
    window = 1;
    start = millis();
  }
}
void churningStarted(){
  if(rfid == 1){
     //println("rfid card 1");
     if(playerPlaying == false){
        player = minim.loadFile("sean_nar_1.mp3");
        playerPlaying = true;
     }
   }
  if(rfid == 2){
    //println("rfid == 2");
    if(playerPlaying == false){
      player = minim.loadFile("sean_nar_2.mp3");
      playerPlaying = true;
    }
  }
  if(rfid == 3){
    //println("rfid == 3");
    if(playerPlaying == false){
      //player = minim.loadFile("sean_nar_3.mp3");
      playerPlaying = true;
    }
  }
  if(rfid == 4){
    //println("rfid == 4");
    if(playerPlaying == false){
      player = minim.loadFile("sean_nar_4.mp3");
      playerPlaying = true;
    }
  }
  if(rfid == 5){
    //println("rfid == 5");
    if(playerPlaying == false){
      player = minim.loadFile("sean_nar_5.mp3");
      playerPlaying = true;
    }
  }
  if(rfid == 6){
    //println("rfid == 6");
    if(playerPlaying == false){
      player = minim.loadFile("sean_nar_6.mp3");
      playerPlaying = true;
    }
  }
  if(rfid == 7){
    //println("rfid == 7");
    if(playerPlaying == false){
      player = minim.loadFile("story_7.mp3");
      playerPlaying = true;
    }
  }
}
void churningStopped(){
  println("turn sound down and get ready to stop");
  player.shiftGain(6.0, -10.0, 5000);
  //stopPlaying();
```

```
}
void stopPlaying(){
  println("stop minim object");
  minim.stop();
  playerPlaying = false;
}
void serialEvent(Serial myPort) {
  int inByte = myPort.read();
  if (firstContact == false) {
    if (inByte == 'A') {
      myPort.clear();          // clear the serial port buffer
      firstContact = true;     // you've had first contact from the microcontroller
      myPort.write('A');       // ask for more
    }
  }
  else {
    serialInArray[serialCount] = inByte;
    serialCount++;

    if (serialCount > 1 ) {
      println("rfid is = " + rfid);
      rfid = serialInArray[0];
      rotary = serialInArray[1];
      println(serialInArray);

      myPort.write('A');
      serialCount = 0;
    }
  }
}
```

Firkin Crane Arduino Code

```
#include <SoftwareSerial.h>
#include "Adafruit_Thermal.h"
#include <avr/pgmspace.h>
int printer_RX_Pin = 8;  // This is the green wire
int printer_TX_Pin = 9;  // This is the yellow wire
Adafruit_Thermal printer(printer_RX_Pin, printer_TX_Pin);
#include "charms.h"
#include "fairy.h"
#include "goat.h"
#include "holywater.h"
#include "milk.h"
#define DIR_PIN 10
#define STEP_PIN 11
#define RFIDEnablePin 4 //Pin that enables reading. Set as OUTPUT and LOW to read an
RFID tag
#define RFIDSerialRate 2400 //Parallax RFID Reader Serial Port Speed
#define TxPin 4 //Pin to write data to the Reader NOTE: The reader doesn't get written
to, don't connect this line.
#define RxPin 5 //Pin to read data from Reader
SoftwareSerial RFIDReader(RxPin,TxPin);
String RFIDTAG=""; //Holds the RFID Code read from a tag
String DisplayTAG = ""; //Holds the last displayed RFID Tag
int card_1 = 0; // gen counter
int card_2 = 0;
int card_3 = 0;
int move_too = 0;
int balance = 0;
int balance_too = 0;
const int hallPin = 12;
int hallLED = 13;
```

```
int hallState = 0;
int photocellPin = 0;     // the cell and 10K pulldown are connected to a0
int photocellReading;     // the analog reading from the analog resistor divider
char val;
int timeSent = 0;
void setup()
{
  RFIDReader.begin(RFIDSerialRate);
  pinMode(RFIDEnablePin,OUTPUT);
  digitalWrite(RFIDEnablePin, LOW);
  Serial.begin(9600);           // set up Serial library at 9600 bps
  pinMode(DIR_PIN, OUTPUT);
  pinMode(STEP_PIN, OUTPUT);
  pinMode(hallPin, INPUT);
  pinMode(hallLED, OUTPUT);
}
void loop()
{
  photocellReading = analogRead(photocellPin);
  if(RFIDReader.available() > 0) // If data available from reader
  {
    ReadSerial(RFIDTAG);   //Read the tag number from the reader. Should return a 10
digit serial number
  }
  if(DisplayTAG!=RFIDTAG)
  {
    DisplayTAG=RFIDTAG;
  }
  if(RFIDTAG == "0415ED2EB7"){ //MILK LUCK
    while (card_1 <= 200){
      if(timeSent < 1){
        Serial.println("1");
        timeSent ++;
      }
      balance = 0;
      card_2 = 0;
      card_3 = 0;
      digitalWrite(DIR_PIN, LOW);
      card_1++;
      digitalWrite(STEP_PIN, HIGH);
      delay(10);
      digitalWrite(STEP_PIN, LOW);
      delay(10);
      if(card_1 == 201){
        printer.begin();
        printer.println("Milk Luck");
        delay(500);
        printer.println("Milk luck had to be protected from supernatural forces because
it was hard to make butter without it.");
        delay(1000);
        printer.println("visit the link");
        printer.printBitmap(milk_width, milk_height, milk_data);
```

```
      printer.println("tear and take away");
      printer.feed(6);
      delay(2000);
      RFIDReader.begin(RFIDSerialRate);
    }
  }
  balance_too = 200;
}
if(RFIDTAG == "17007EFC59"){ //GOAT
  while (card_1 <= 100){
    if(timeSent < 1){
      Serial.println("4");
      timeSent ++;
    }
    balance = 0;
    card_2 = 0;
    card_3 = 0;
    digitalWrite(DIR_PIN, LOW);
    card_1++;
    digitalWrite(STEP_PIN, HIGH);
    delay(10);
    digitalWrite(STEP_PIN, LOW);
    delay(10);
    if(card_1 == 101){
      printer.begin();
      printer.println("Goats");
      delay(500);
      printer.println("Goats were kept with cows to bring them luck.");
      delay(1000);
      printer.println("visit the link");
      printer.printBitmap(goat_width, goat_height, goat_data);
      printer.println("tear and take away");
      printer.feed(6);
      delay(2000);
      RFIDReader.begin(RFIDSerialRate);
    }
  }
  balance_too = 100;
}
if(RFIDTAG == "0415ED414E"){ //HOLY WATER
  while (card_2 <= 200){
    if(timeSent < 1){
      Serial.println("2");
      timeSent ++;
    }
    balance = 0;
    card_1 = 0;
    card_3 = 0;
    digitalWrite(DIR_PIN, LOW);
    card_2++;
    digitalWrite(STEP_PIN, HIGH);
    delay(10);
```

```
      digitalWrite(STEP_PIN, LOW);
      delay(10);
      if(card_2 == 201){
        printer.begin();
        printer.println("Holy Water");
        delay(500);
        printer.println("Holy water was sprinkled on livestock to keep them safe from
harm.");
        delay(1000);
        printer.println("visit the link");
        printer.printBitmap(holywater_width, holywater_height, holywater_data);
        printer.println("tear and take away");
        printer.feed(6);
        delay(2000);
        RFIDReader.begin(RFIDSerialRate);
      }
    }
    balance_too = 200;
  }
  if(RFIDTAG == "190035D511"){ // FAIRIES
    while (card_3 <= 300){
      if(timeSent < 1){
        Serial.println("3");
        timeSent ++;
      }
      balance = 0;
      card_1 = 0;
      card_2 = 0;
      digitalWrite(DIR_PIN, LOW);
      card_3++;
      digitalWrite(STEP_PIN, HIGH);
      delay(10);
      digitalWrite(STEP_PIN, LOW);
      delay(10);
      if(card_3 == 301){
        printer.begin();
        printer.println("Fairies");
        delay(500);
        printer.println("Fairies were very aggressive and often stole butter from
people.");
        delay(1000);
        printer.println("visit the link");
        printer.printBitmap(fairy_width, fairy_height, fairy_data);
        printer.println("print and take away");
        printer.feed(6);
        delay(2000);
        RFIDReader.begin(RFIDSerialRate);
      }
    }
    balance_too = 300;
  }
  if(RFIDTAG == "190035E1EF"){ // CHARMS
```

```
    while (card_3 <= 300){
      if(timeSent < 1){
        Serial.println("5");
        timeSent ++;
      }
      balance = 0;
      card_1 = 0;
      card_2 = 0;
      digitalWrite(DIR_PIN, LOW);
      card_3++;
      digitalWrite(STEP_PIN, HIGH);
      delay(10);
      digitalWrite(STEP_PIN, LOW);
      delay(10);
      if(card_3 == 301){
        printer.begin();
        printer.println("Charms");
        delay(500);
        printer.println("Charms and incantations were recited to ensure the butter was
made.");
        delay(1000);
        printer.println("visit the link");
        printer.printBitmap(charms_width, charms_height, charms_data);
        printer.println("tear and take away");
        printer.feed(6);
        delay(2000);
        RFIDReader.begin(RFIDSerialRate);
      }
    }
    balance_too = 300;
  }
  if (photocellReading < 800){
    digitalWrite(RFIDEnablePin, LOW);
    digitalWrite(hallLED, HIGH);
  }
  if (photocellReading > 800){
    digitalWrite(RFIDEnablePin, HIGH);
    digitalWrite(hallLED, LOW);
    while(balance <= balance_too){
      timeSent = 0;
      Serial.println("0");
      digitalWrite(DIR_PIN, HIGH);
      balance++;
      digitalWrite(STEP_PIN, HIGH);
      delay(10);
      digitalWrite(STEP_PIN, LOW);
      delay(10);
      if(balance == balance_too){
        digitalWrite(RFIDEnablePin, LOW);
        balance_too = 0;
      }
    }
```

```
  }
}
void ReadSerial(String &ReadTagString)
{
  int bytesread = 0;
  int  val = 0;
  char code[10];
  String TagCode="";
  if(RFIDReader.available() > 0) {          // If data available from reader
    if((val = RFIDReader.read()) == 10) {   // Check for header
      bytesread = 0;
      while(bytesread<10) {                 // Read 10 digit code
        if( RFIDReader.available() > 0) {
          val = RFIDReader.read();
          if((val == 10)||(val == 13)) {    // If header or stop bytes before the 10
digit reading
            break;                          // Stop reading
          }
          code[bytesread] = val;            // Add the digit
          bytesread++;                      // Ready to read next digit
        }
      }
      if(bytesread == 10) {                 // If 10 digit read is complete
        for(int x=0;x<10;x++)               //Copy the Chars to a String
        {
          TagCode += code[x];
        }
        ReadTagString = TagCode;          //Update the caller
        while(RFIDReader.available() > 0) //Burn off any characters still in the buffer
        {
          RFIDReader.read();
        }
      }
      bytesread = 0;
      TagCode="";
    }
  }
}
void establishContact(){
  while (Serial.available() <= 0){
    Serial.println("A");
    delay(300);
  }
}
```

Appendix H

This appendix documents some of the content that was delivered through the augmented artefacts.

The final iterations of each of the artefacts printed a receipts that contained lines of text and a QR Code. The lines of text gave contextualising information on the content that the interactive experience was built around, which were superstitions. The printed text was designed to brief and open ended in order to inspire conversation amongst the visitors. The QR Code linked to a .pdf document on the web that gave more detailed information on the superstitions.

Figure H.1 shows the receipts that were printed by both the butter churn and the firkin crane.

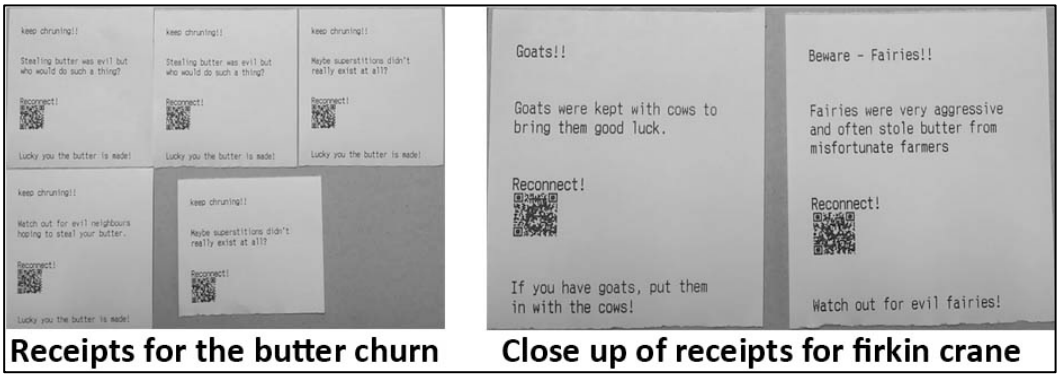

Figure H.1 Pictures of the receipts that were printed after visitors engaged with the artefacts.

Scanning the QR Code with a QR Code scanning application would take the visitor to a .pdf document that was hosted on a blog. Table H.1 shows an example of the .pdf that was linked to from the QR Code that was printed out when a visitor weighed the Charms superstition using the firkin crane.

Cork Butter Museum – Firkin Crane

To the right is a picture of a road side butter market. In the background we can see a balance hanging off a horse cart which is being used to weigh butter.

Charms Superstition

Charms were recited to avert disease in cows.
They were often a mix of pagan and Christian prayer.
Charms would protect against the many diseases could become victim to, whether through natural causes or as the folk often suspected, through the evil eye of an unfriendly neighbour.
Charms were also used to bless new born infants.

This firkin crane was developed as part of a Research Degree by Martin McCarthy, who is interested in how people experience museums. No personal information was recorded when people were using either the firkin crane or this web page.

If you could fill out a short survey it would be greatly appreciated. All information gathered is anonymous and will be treated with utmost respect.
https://www.surveymonkey.com/s/P9N58VW

If you have any enquiries, please don't hesitate to contact <name> at <email>

Table H.1 An example of the .pdf that was linked to from the QR Code.